جامعة الملك فهد للبترول والمعادن

King Fahd University of Petroleum & Minerals

Graduate BULLETIN

2015-17

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King Fahd University of Petroleum & Minerals

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About this Bulletin

The Graduate Bulletin of King Fahd University of Petroleum & Minerals (KFUPM) is an official publication of the University issued by the Office of the Dean of Graduate Studies. The final version of the current document was prepared during March 2015. The contents were compiled from input received from academic departments and administrative offices throughout the University. All changes from the previous Bulletin were verified against the decisions of the University Board.

The Bulletin gives, at the time of printing, up-to-date information about all graduate programs, some of which have been recently modified or introduced. It provides detailed information about each graduate academic program offered at KFUPM, a summary of the University policies and procedures pertinent to graduate studies, selected activities and services, and a listing of the administrative officers and faculty. It is hoped that the Bulletin will serve as a useful guide to faculty members, graduate students, and staff whenever questions arise regarding the relevant University rules and regulations, the graduate courses and their prerequisites, the degree requirements, and other academic matters.

The Bulletin is distributed by the Office of the Dean of Graduate Studies, KFUPM, Dhahran 31261, Saudi Arabia.

Dr. Ashfaque H. Bokhari

Prof. Department of Mathematics & Statistics
Editor Graduate Bulletin, May 01, 2015

Acknowledgments

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Foreword

The principle objective of the Deanship of Graduate Studies at KFUPM is to offer education beyond the baccalaureate level to those who aspire to become intellectual leaders in their professions and in various fields of teaching and scientific research. It undertakes to assist graduate students in developing and pursuing individual educational programs requiring superior accomplishment through carefully directed intellectual activities. Also, the primary purpose of the graduate programs is to train the creative type of scientists or engineers so urgently needed in educational, governmental and industrial development.

The purpose of this Bulletin is to provide information about the graduate programs of KFUPM to current and prospective students, as well as to the faculty and staff of the University. Information concerning requirements for admission to the graduate programs of KFUPM, the University research supporting units, services available to students, graduate course offerings and listings of the current graduate faculty and administrators of the University are all included in the Bulletin.

In the graduate programs, KFUPM offers courses leading to the degree of Master, Master of Science, Master of Engineering, Master of Business Administration, and Doctor of Philosophy in various disciplines.

Since its establishment in 1972, the Deanship of Graduate Studies (previously known as the College of Graduate Studies) at KFUPM has witnessed a phenomenal expansion. Currently, 39 programs are being offered at the Master and 13 at the Ph.D. levels. These programs span the fields of Engineering, Sciences, Business, and Environmental Design.

At the start of the third millennium, the Graduate Studies at KFUPM is facing several challenges. First, the graduate programs have to be current and dynamic to keep up with, and be able to accommodate, the fast developments in knowledge and technology. Second, they have to accommodate more students, many of whom may be part-timers who do not fit the traditional model of a full-time residential student. Third, the quality of the graduate education provided by KFUPM has to equal or surpass standards set by the international academic community. Fourth, the Deanship has to implement graduate studies of high quality within the unified regulations issued by the Ministry of Higher Education. Finally, it has to develop effective ways and means to disseminate knowledge into the University and its surrounding community and to contribute to, and enhance, undergraduate education. In order to meet these challenges, the Deanship is continuously enhancing the flexibility and variety of course offerings, forging stronger links with the international academic community through innovative programs such as scholarship and research assistantship programs, and establishing a permanent system of independent periodic evaluation of graduate programs. It has also moved steadily to strengthen ties with industry through programs to establish endowment scholarships and industry-related projects.

The University has also been trying to upgrade its standards by having its

programs evaluated by international bodies such as the Accreditation Board of Engineering Technology (ABET), and the Association to Advance Collegiate Schools of Business (AACSB).

Currently, over 1500 students are pursuing studies in graduate programs spanning various disciplines. The University has a full-time faculty of more than 800. The faculty members are also extremely active in research-related work in their areas of specialization, thus contributing to the general atmosphere of intellectual curiosity and creative activity generated on the KFUPM campus.

Prof. Salam Adel Zummo

Dean of Graduate Studies, May 01, 2015

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GENERAL INFORMATION

HISTORY AND PHILOSOPHY OF THE UNIVERSITY

King Fahd University of Petroleum and Minerals (KFUPM) was officially established by Royal Decree on 5 Jumada 1, 1383 (23 September, 1963). The first students were admitted a year later, on 23 September, 1964, when 67 young men enrolled in what was then named the College of Petroleum and Minerals (CPM). The University enrollment had exceeded 8000 students by the academic year 2014-2015.

Several significant events have marked the University's growth. In 1971, at the first graduation ceremony, four men received their baccalaureate degrees in Engineering. In 1975, the College of Petroleum and Minerals became the University of Petroleum and Minerals, a change both in name and academic status. In 1986, the University was renamed: The King Fahd University of Petroleum and Minerals. As a result of the vast growth of KFUPM, 30,831 degrees had been awarded, including 3,346 Master's and 217 Ph.D. degrees, by the end of the academic year 2013/2014. The rapid growth of KFUPM is related to the rapid economic and technical development of the Kingdom. It also reflects the rising expectations of the people of Saudi Arabia, the expanding opportunities for the country's young men, and the increasing importance of the Kingdom as a major source of the world's energy.

The vast petroleum, mineral and energy resources of the Kingdom pose a complex and exciting challenge in scientific, technical, and business education. To meet these challenges, the University has adopted advanced training in the fields of science, engineering, and business as one of its goals in order to promote leadership and service in the Kingdom's petroleum and mineral industries. The University also furthers knowledge through research in these fields. In addition, because it derives a distinctive character from its being a technological university in the land of Islam, the University is unreservedly committed to deepening and broadening the faith of its Muslim students and to instilling in them an appreciation of the major contributions of their people to the world of mathematics and science. All areas of KFUPM—facilities, faculty, students, and programs—are directed to the attainment of these goals.

KFUPM MISSION, VISION AND VALUE STATEMENTS

The mission, vision, and value statements of KFUPM are in accordance with similar international institutions.

Vision

"To be a preeminent institution known for its globally competitive graduates, cutting edge research, and leadership in energy discoveries".

Mission

The mission of KFUPM is to make a difference within the Kingdom of Saudi Arabia and beyond in the fields of sciences, engineering and business. KFUPM is committed to:

1. Graduating leaders who are knowledgeable, skillful, and productive members of society,
2. Creating new knowledge that makes a scholarly impact, provides innovative solutions, and contributes to the national economy, and
3. Engaging society, alumni, and partners in valuable endeavors for the prosperity and intellectual development of the community, and enriching the experiences of the KFUPM community.

Values

Guided by Islamic principles, KFUPM builds its reputation and success on the following core values:

Integrity
Adhere to an ethical and professional code of conduct that encapsulates honesty, sincerity and trustworthiness.

Fairness
Deal fairly and humanely with all people, respecting justice and individual rights and freedom.

Transparency

Deal in a transparent manner in matters of education, performance and progress of faculty, staff and students.

Passion
Conduct our work with enthusiasm and engage actively and positively with our partners and collaborators.

Inclusiveness

Attract and develop employees and students of different nationalities seeking to promote cultural diversity through the inclusion of a broad range of people and perspectives.

Care
Provide support to our community and look after their growth and needs in a motivational work environment.

Discipline
Focus on a disciplined behavior, interaction and approach to our professional work.

Creativity

Encourage and welcome creative ideas and solutions in teaching, learning, and research, placing them at the forefront of our focus and initiatives.

KFUPM Commitment to Values

- Teach and emphasize our values to the students through course work, extracurricular activities, advising and counseling, academic processes, outreach programs, and through the practice-what-you-preach behavior of mentors.
- Make all employees aware of the institutional values through employment contracts or conditions, a specified code of conduct, administrative processes and policies, and annual performance evaluation.
- Abide by our commitment to preserve and nurture these values by requiring the measurement of their improvement in all proposed new initiatives and programs.

ORGANIZATION

King Fahd University of Petroleum & Minerals is one of the 27 Saudi Universities that, alongside the Council of Higher Education, the Ministry of Higher Education, and several specialized colleges and institutions, comprise the main components of the higher education system in Saudi Arabia. KFUPM and the other Saudi Universities are supervised by the Ministry of Higher Education and regulated by the Council of Higher Education.

KFUPM, like other Saudi Universities, has a board chaired by the Minister of Higher Education while the Rector serves as the deputy chairman. Membership of the Board includes the Secretary General of the Council of Higher Education, the vice rectors, the deans, and three external members appointed by the Minister of Higher Education. This Board is responsible for all

university operations, it grants degrees to students, approves programs and curricula of existing departments, and makes recommendations to the Council of Higher Education in other matters.

The Rector of the University is the chief academic and executive officer of the University. He is responsible for administering its affairs in accordance with the Law, the Charter of the Council of Higher Education and the Universities, government edicts, and decisions of the Council of Higher Education and the University Board. He also represents the University in contacts with outside organizations.

The Rector is assisted by three Vice Rectors (Vice Rector for Academic Affairs, Vice Rector for Graduate Studies & Scientific Research, and Vice Rector for Applied Research) and two supervisors (the General Supervisor and Supervisor for Technology Transfer, Innovation and Entrepreneurship).

The Vice Rectors (appointed for renewable three-year terms) are assisted by Deans, Directors of the Centers in the Research Institute, Academic Department Chairs, the Director of the Information Technology Center (ITC), Director Generals and Directors of the administrative units. The Deans and Academic Department Chairs are appointed for renewable two-year terms. Director Generals and Directors of the administrative units are appointed for indefinite terms.

The University is financed principally by Saudi Arabian government grants, but also receives donations from companies, grants and awards from foundations, and other support. Eventually, the University will obtain a portion of its income from student tuition, but at the present time no charges are levied for full-time instruction, or accommodation.

The University's regular and adjunct faculty is multi-national. Instruction is in English and the resources of the technical library are predominantly, though not exclusively, printed in English. Teaching methods, curricula, administration, and organization of the University are largely designed in accordance with reputable international standards, which have been adapted to Saudi Arabian needs.

The academic organization of the University includes the Preparatory Year Program, seven academic colleges, and the Deanship of Graduate Studies. The Preparatory Year Program is designed as a bridge between the level a student attains upon graduating from the secondary schools of the Kingdom and the academic and language requirements of each of the six undergraduate degree-offering academic colleges. Although the great majority of students admitted to the University begin their studies in the Preparatory Year Program, a small number of high achievers may, upon passing a qualifying examination, enter the college of their choice directly. The six[1] undergraduate colleges are the College of Applied Engineering, offering degrees in Applied Chemical, Applied Civil, Applied Electrical, and Applied Mechanical Engineering; the College of Engineering Sciences, offering degrees in Aerospace, Chemical, Civil, Electrical, Mechanical, and Petroleum Engineering; the College of Sciences, offering degrees in Chemistry, Geology, Geophysics, Mathematics, Physics, Statistics & Actuarial Science; the College of Environmental Design, offering degrees in Architecture, Architectural Engineering, and City Planning; the College of Industrial Management, offering degrees in Accounting, Finance, Information Systems, Marketing, and Operations Management; the College of Computer Sciences & Engineering, offering degrees in Computer Science, Software Engineering, Computer Engineering, Industrial & Systems Engineering, and Systems & Control

[1] The college of Engineering Sciences & Applied Engineering being counted as two colleges for the nature of their degrees.

Engineering, and the College of Applied and Supportive studies that offers service courses in Islamic and Arabic Studies, English, Physical Education, and General Studies.

The Deanship of Graduate Studies awards Master of Science (M.S.) degrees in 23 major fields, namely: Aerospace, Architectural, Chemical, Civil, Computer, Electrical, Industrial and Systems, Systems & Control, Mechanical, Petroleum, Software, , Telecommunication Engineering, as well as in Applied Statistics, Chemistry, Computer Networks, Computer Science, Construction Engineering Management, Environmental Sciences, Geology, Geophysics, Mathematics, Physics, and Security & Information Assurance. The Deanship of Graduate Studies also awards Master of Engineering (M.Eng.) in Architectural, Civil, Industrial, Oil & Gas Surface Facilities & Systems, Systems & Control, and Master's degrees in Accountancy, Business Administration (M.B.A.), Executive Business Administration (E.M.B.A.), City & Regional Planning, Engineering Management, Geology, Geophysics, Medical Physics, and Supply Chain Management. Doctoral programs are offered in thirteen specializations, namely: Chemical, Civil, Electrical, Industrial & Systems, Mechanical, Petroleum, Systems and Control Engineering, as well as in Chemistry, Computer Science, Computer Engineering, Geology, Mathematics and Physics.

LOCATION

The University is located in Dhahran, near the headquarters of the Saudi Arabian Oil Company (SAUDI ARAMCO) in the Eastern Province of Saudi Arabia. The campus is situated near the Arabian Gulf at a distance of about six kilometers from the town of Al-Khobar, and 15 kilometers from the city of Dammam. The academic buildings are located on a 100-foot "Jebel" (Arabic for hill). The University overlooks the Arabian Gulf, and is about 60 kilometers away from Bahrain and linked to it by the King Fahd Causeway.

The University is easily accessible by road or airline from any point in the Kingdom, or by international air, sea and road routes from Europe, Asia, Africa, or other Middle Eastern countries. The highway distance to Riyadh is about 400 kilometers and that to Jeddah is about 1,450 kilometers. A network of paved roads leads to various distant points, such as Najran, Abha, and Jaizan in the far south, to Burayadah and Hail northwest of Riyadh, to the lovely mountain resort of Taif near Makkah and Jeddah, and to Qaiysumah, Turaif, and Tabuk along the Northern frontier. King Fahd International Airport is about 50 kilometers from the University campus, and a regular airline service exists to all domestic and many international terminals.

FACILITIES

The campus of the University features a physical plan of exceptional beauty and size. The buildings are both architecturally imaginative and educationally sound and viable. Their exterior design combines the stark color and ruggedness of the landscape with the graceful lines of the Islamic arch, dome, and minaret. Interiors feature laboratories, lecture halls, classrooms, seminar rooms, offices and a variety of special facilities including computer terminals, closed circuit television outlets, a wireless connectivity (Wi-Fi) service in all academic and administrative buildings, and other amenities.

The Academic Complex consists of a number of buildings, with a few under construction. The facilities available include: faculty/staff offices; workshops and laboratory buildings, which include the Heavy Equipment Laboratory building and the Energy Research Laboratory building; the Information Technology Center; classrooms; the Administration Building; the Library; the Faculty/Student Center, which includes the Faculty Dining Hall, the Post Office, and the Stationery Shop; the Auditorium, which seats 850 people and is equipped for simultaneous translation in three languages; the Gymnasium; a Mosque; the Research Institute; the Stadium,

which seats 10,000 people; the Medical Center; the Conference Center; and multi-story parking garages. The facilities also include a natural exterior amphitheater, playing fields and indoor courts for intercollegiate and intramural sports.

To the north of the Jebel there are: Newly constructed multi-story student Housing, including the Student Reception Center; the Student Cafeteria; Mosques; Student Clubs and Services; the Projects & Maintenance Complex; the University Storehouse; the Security & Safety Department; the Transportation Center; the Garage for maintenance of University vehicles; and newly built Preparatory Year Campus, consisting of a classroom building, faculty office building, an auditorium for 1,200 people, and a mosque.

To the south of the *Jebel*, there is faculty & staff housing, including the family Community Center and the Coop Store; the Telephone Exchange; the University Press Building; the Bookstore; and the University Nursery and Kindergarten Schools are located on the southeast of the University campus.

The University also has a private beach, about half an hour's drive from the main campus, at Half-Moon Bay. At this facility, which is for the use of the whole university community, one can swim, surf, sail or merely relax and enjoy a change of pace by the sea, with undulating sand dunes and palm trees in the background.

The Conference Center. It is adjacent to the main University concourse and car park, has extensive modern facilities for hosting conferences of international level. In addition to the main auditorium, it has briefing and committee rooms and its own kitchen. Conference meetings are supported by the latest audio-visual equipment, the Community Antenna Television (CATV), connecting with all parts of KFUPM campus, and it has its own typing facility.

The Medical Center. The Medical Center of KFUPM provides the community (students, faculty, staff, laborers and their dependents) with primary health care services. The Medical Center comprises multidisciplinary clinics with several doctors assisted by qualified technicians both male and female. A few beds are available for observation of patients in emergency cases before transferring them to the nearest governmental hospitals. The X-ray department, the dental clinic and the laboratory are equipped with modern diagnostic and testing equipment including ultrasound, mammography, panoramic x-rays, and others. A pharmacy with the majority of routinely prescribed medicines is also available. In general, the Medical Center provides the KFUPM community with the following services:

a) Primary health care.
b) Laboratory & X-ray facilites in conjunction with the available medical facilities.
c) Referrals to the local governmental hospitals for hospitalization, further investigations and consultations.
d) Multi-specialty clinics in Internal Medicine, Pediatrics, Gynecology & Obstetrics, Ophthalmology, Skin & Venereal Diseases, and Dentistry.
e) Vaccinations, which include primary (essential) vaccinations for children, as well as participation in the national preventive campaigns.
f) 24-hour first-aid service for the management of emergency cases.
g) 24-hour ambulance service to attend emergency cases.
h) 24-hour nursing service which includes administering injections, dressing, and all possible nursing assistance, such as checking blood pressure and vision tests.

i) Short-term observation inside the Medical Center, leading to either patient dischargeor referral to hospital.

j) Issuing medical reports for residence permits (iqama), sick leave, etc.

k) Providing the majority of medicines according to University policy.

l) General dental clinics for dental care and oral hygiene.

m) Check-up service for new students, students taking up coop programs, pre-employment of students after graduation, new employees including staff & faculty, workers of the KFUPM food services on a regular three-month basis, housemaids and drivers working for staff & faculty, and for the KFUPM Schools before registration and before frequent short activities.

Student Housing. The University provides student housing for the total student enrollment in keeping with its policy of being an entirely residential institution. The multi-story student housing consists of furnished rooms, having two beds per room, showers and hygienic facilities. These units are equipped with new facilities of modern design, consistent with the architecture of the University. All the student housing is provided with multi-story parking to house student vehicles. Housing for graduate assistants is also provided on campus.

The University Cafeteria. A large spacious building – *Student Cafeteria* – is situated adjacent to the Student Dormitories. It can accommodate more than 1500 students at a time. Students are provided with subsidized meals, comprising breakfast, lunch and dinner.

The preparation of food is handled by a well-qualified and professional team in the Central Kitchen, equipped with modern machinery and equipment. The Food Services Department makes sure that the food offered to students consists of a balanced diet, conforming to the Saudi Standards (SASO).

Apart from the Student Cafeteria, there are a number of coffee shops, located in different academic buildings and student dormitories, offering varied refreshments. These facilities are complemented by a newly constructed student mall which houses fast food, modern coffee shops, stationery, general items, computer accessory stores, etc.

The University Bookstore. The Bookstore is located in Building #55, near the KFUPM Press. Text books are issued to students and faculty free of charge. As a large number of specialized textbooks are needed for different University programs, a comprehensive textbook acquisition system is followed to ensure that the latest editions of books are used, as far as possible.

Sports and Recreation Facilities. The University's major sports facility is the Stadium, located near the main entrance to the University. It is designed to seat 10,000 spectators. The Stadium is open and has facilities for VIP seating, press box, and TV booths. It is consistent with the style and construction of all other permanent buildings within the Academic Complex.

Other facilities available are: swimming pools, changing rooms, soccer fields, tennis courts, athletics track, basketball and volleyball courts, handball courts, squash courts, and athletic support facilities.

THE UNIVERSITY LIBRARY

The University Main Library is centrally located in Building 8 within walking distance of most classrooms and laboratories. The Library supports teaching and research in line with KFUPM's mission by providing access to recorded knowledge through collections, services, cooperative programs, and connections to worldwide resources. It is an "open stack" library, allowing users free access to its resources. Reading areas are provided on the first, third, and fourth floors. There are many reading and study rooms on the third floor for serious reading, student-teacher

meetings and discussions. To encourage and maximize utilization of its resources and services, the University Library operates with minimum regulations and restrictions.

The current collection of monographs and bound periodicals totals 391,806 volumes, of which 75% is in Science and Engineering, and the remaining 25% in Humanities and Social Sciences. In addition to its print collection, the Library provides access to more than 190,000 electronic books through various aggregating databases. Also, there are 2,035 educational films and other media, subscriptions to about 226 periodicals with many titles available in both print and e-journal formats.

The Library has a fine collection of electronic resources, including 67 online databases and membership of many professional societies, providing article-level access to more than 40,000 journal titles. The Library is also a member of the prestigious Saudi Digital Library consortia, one of the pioneering projects of the National Center for E-Learning, Ministry of Higher Education. Most of the electronic resources including online databases can be accessed remotely from on/off-campus through the Internet.

In addition to providing a complete range of library services to the KFUPM community, it also provides borrowing privileges and other select services to local government agencies and private institutions.

Some of the major library services on offer are:

a) Circulation of library materials,
b) Reference and Information Services,
c) Research assistance, including literature searches and on-line searching of bibliographic and full-text databases,
d) Interlibrary loan and photocopy services,
e) Audio Visual and Multimedia Services,
f) Library instruction (the orientation of new faculty, graduate and preparatory year students in the effective use of the Library).

There are two separate Internet search labs for faculty and students with over 45 high-end personal computers providing access to electronic resources through Intranet and the Internet.

Audio-Visual materials and services are provided through a well-equipped AV department, as well as a Library Auditorium mainly used by faculty and students for the projection of AV materials, and also for seminars, lectures, short courses, thesis defenses, and other presentations.

The Library has also deployed Summon, a web-discovery service providing users with a familiar web-searching experience. The full range of library contents (from books, e-books, and journals to full-text articles and much more) can be searched from one easy to use search interface, . The Library also uses Symphony, an Integrated Library System, which has all the features of a modern system, including client/server architecture, GUI, Web interface, etc.

For the convenience of Library patrons, a Self-Check-Out station is also available for checking-out library materials without the mediation of the staff.

During a normal semester, the Library opens from 07:30 to 22:00 on weekdays, it also operates during weekends, and has special timings for families. The Library also opens for an extended period of time during final examinations and on selected days during *eid* vacations.

In addition to providing the usual services and resources, the Library also acts as a node for access to Turnitin & iThenticate, software for checking originality (plagiarism), and other user-centric services.

INFORMATION TECHNOLOGY CENTER

The Information Technology Center (ITC) is the primary computing facility at KFUPM. It provides computing support for education, research, and administration at the University. The ITC also provides services to some government and industrial agencies.

Vision and Mission

Vision: World-class Information Technology Center

Mission: To provide excellent IT services that foster productive education, research, community service, and administrative activities at KFUPM through competent staff, effective processes, and state-of-the-art systems.

ITC Services

The following is an listing of ITC services that are provided to the community:

Web Services

ITC provides website design and development services for all departments, the publishing of websites, blogs for all faculty and staff, social networking sites (the University's Facebook and Twitter pages), Web analytics (including Search engine optimization of sites), Faculty Information System, Student Information System, Faculty and Student personal homepages, Mobile web apps, etc.

Web Hosting

ITC provides web-hosting services to University departments, officially recognized groups, projects, and all members of the KFUPM community (students, staff & faculty). Access to scripting technology is provided as standard with options for more advanced features such as web databases.

E-mail and Messaging services

Providing the KFUPM community with an E-mail and messaging platform,maintaining departmental aliases, and circulatingKFUPM announcements electronically.

ERP services

Providing the KFUPM community with ERP services such as managing responsibilities, user access, and technical back-end support.

Student Information Systems (Banner) Services

Providing the KFUPM academic community and administrative offices with Banner self-service support (access, technical issue resolutions and backend support).

Learning management system

Blackboard (formerly WebCT) is an online e-learning systemused in many academic institutions as a course management system for higher education. To their Blackboard courses, instructors can add such tools as discussion boards, quizzes and assignments, mail systems, and live chat, along with documents and other content.

KFUPM Portal

The University Portal is the electronic gateway to all information relevant to a user's your pursuits and interests at KFUPM. It primarily serves students and faculty with its built-in

integration with email, calendar and Banner Student ERP, along with a single sign-in for various services such as the Library portal, Blackboard, RMS, the Oracle E-Business suite, student loans, and so on.

Critical IT Security Services

Critical IT security services are provided by the ITC 24 hours a day and seven days a-week as a matter of course to the KFUPM community. The ITC is committed to maintaining these services, committed to ensuring their operation during a disaster, and to recovering from a disaster with the utmost expediency. Critical services are funded through the KFUPM budgeting cycle for the ITC department and there is no charge for use of these services.

High Performance Computing services

The ITC provides the KFUPM research community with high-end high-performance computing resources which include parallel hardware and software, compilers and other associated tools.

Connecting to file and database structures

The ITC provides connectivity to critical business processes that require file and database access, such as Banner, Portal, ERP, and others.

Data Center Management Services

The ITC maintains and enhances data center resources (Databases, Storage, Servers, Network, etc.,) and ensures that they have 24 x 7 uptime with assured performance levels.

Document Management System

Document management controls the life cycle of documents at KFUPM, and the ITC is involved in they are created, reviewed, published, and ultimately retained.

Research Repository

KFUPM ePrints serves as the centralized research repository of KFUPM. It offers students, staff and faculty members the facility to upload and search research literature, student theses, project reports, and teaching materials.

External access to online journals and databases

Ezproxy provides users with remote access to the library-subscribed online journals and databases. The service provides a simple Portal login for KFUPM faculty and graduate students.

Financial Aid Services – FinAID

The ITC provides financial aid services for processing students' monthly stipend including access, technical issue resolutions and backend support.

Hardware repair service.

The ITC provides a repair service for KFUPM-owned hardware which is not covered under the warranty agreement or if the warranty has expired. It operates a help desk and offers a computing support capability to provide personalized assistance with technical problems and questions. The Help Desk is the University's central support service for IT, especially in the areas of system problems, network connectivity, and the use of supported desktop applications.

Helpdesk consultants are trained and ready to assist users with their technology needs, whether they are in a campus lab or office. They help computer users of all levels, from beginner to advance.

Library Information Services

The ITC provides students, faculty and the KFUPM community with Library Information Services (access, technical issue resolution, and backend support) for four libraries including the KFUPM main library, the Community Center Library (CCL), the English Language Center (ELC) Library and the College of Environmental Design Library (CED).

Online storage services

The ITC provisions storage space, and maintains and rationalizes quotas for the KFUPM Filer (File server).

Operating data center facilities

The Networking Services Unit (NETS) operates KFUPM's data centers, ensuring the proper operation and performance of all facility infrastructure such as uninterruptible power systems, cooling systems, space, racks, and generators. Additionally, NETS provides constant monitoring of most of KFUPM's mission-critical systems and services described in this document.

Providing Hardware support for hardware under warranty

The ITC provides support for hardware which is still under warranty and makes the arrangements with the vendor for the repair or replacement of faulty hardware.

PCs Lab Support

The PC lab support for students is provided by the Computing Services & Support (CSS).

Provision of Licensed software

The ITC provides and maintains the license applications that are used by the instructional and educational community at the University.

Providing a Core Networking Infrastructure with Internet Access

The ITC maintains the on-campus, core networking infrastructure and ensures reliable network connectivity to appropriate internet service providers.

a) The ITC provides Internet connectivity to the KFUPM community through the service provider KACST (King Abdul Aziz City of Science and Technology).
b) It maintains connections to research and education networks such as SAARINET (Saudi Arabia Academic Research and Innovation Network).

Providing domain name services and resolution

The ITC provides a basic set of base-level Internet name lookup and address provisioning services (e.g. DHCP, DNS, monitoring, etc.). It provides a DNS hosting service for KFUPM and other approved government organizations.

Providing wired network connections

KFUPM's wired network supports a minimum of 100Mb/s data transfer rate. Each student is provided with one wired network drop in the student housing on campus.

Providing wireless network connections

Wireless connectivity is available inside all the academic/administrative buildings on campus and a few selected outside locations. Self-help via detailed configuration steps (with screenshots for each platform) is available at http://wlan.kfupm.edu.sa.

Provision of Internet bandwidth for specific requirements

The ITC provides internet bandwidth for users if they have special requirements to support KFUPM's critical mission.

NETS will provide the bandwidth based on the IP address, and all the details will be coordinated with the request.

Users may request bandwidth through Helpdesk. Requests for changes should be communicated to a member of the Information Technology Change Advisory Committee.

Printing Resources

The ITC connects KFUPM-owned computers to appropriate printing resources.

Faculty and staff computers will be properly installed and configured to use the print resources of the respective department, i.e. either a local printer or a shared departmental printer.

Students can print in various academic labs including those in the colleges. Printing charges are 20 Halala per page for black and white laser printing.

Student Housing Services through Residential Management System-RMS

The ITC provides KFUPM housing-eligible students and the student housing department with Residential Management Services support (access, technical issue resolution, and backend support).

Student Mailbox Services

The ITC manages and maintaines student mailbox services, including access, technical issue resolution, and backend support.

Virtual Private Network (VPN)

This service offers an encrypted connection tunnel for the KFUPM community to enable a secure connection while travelling or connecting from off campus locations via the Internet.

Organization of the ITC

The ITC consists of the following departments as shown in the figure below:

a) Academic Information Systems (ACIS);
b) Administrative Information Systems (ADIS);
c) Computing Services Department (CSS);
d) Networking (NETS);
e) Systems Operations and Support (SOS).

In addition, Business Support Department (BSD) handles all ITC administrative & financial support services.

Computing Services (CSS) is a major department within the Information Technology Centre (ITC) responsible for supporting the computing infrastructure of the University. The University computing facilities are designed to support electronic services, information and the computational needs of the University. These services have become an integral part of the teaching, learning and research activities at the University.

The NETS department is responsible for all networking activities including network cabling, providing the network infrastructure, and monitoring/management of the network services in the University. It provides Internet and Intranet services to the KFUPM community. Services include LAN services for all academic/administrative buildings and student dorm buildings, Wired/Wireless networking, ADSL network for faculty housing and the Remote Access Dial-Up

services. It is also responsible for monitoring and managing all network devices, which includes routers, switches, access-points, packet-shapers, load balancers, servers and the critical services running on those servers in addition to securing KFUPM's IT infrastructure from inside and outside threats by placing proper access controls on the network devices. Intranet and Internet services to remote sites i.e. Dammam Community College, Hafr Al Batin College and SCITECH are also provided and maintained by the NETS department using Wi-Fi technology.

The SOS department provides systems and operational support to different operating system platforms (Linux and Windows on Intel in addition to the HPC platform). Comprehensive technical support, design and implementation of ERP systems running on Oracle databases, for the E-Business Suite, Real Application Cluster (RAC)-based Banner database, data warehouse, Medicare System, etc., is provided by the SOS department. The SOS department is also responsible for the administration of database management for all back-end servers, email services and Internet access authorization. SOS provides online storage through SAN & NAS disk storage management, data backup & recovery procedures, and operations & management of the Business Continuity/Disaster Recovery Center (BC/DR).

The ACIS department provides IT services with an academic focus to the KFUPM community (students, faculty and staff) as well as the deanships of Admissions & Registration, Graduate Studies, Student Affairs, Library Affairs, Academic Development and the Student Housing Department. The services are provided in terms of software developed in-house by the ACIS staff or through the packaged software systems acquired and customized.

The ADIS department is responsible for the administrative applications of the University. It provides services and support for a number of administrative applications ranging from an enterprise e-Business ERP system, Enterprise BI (business intelligence) system, and satellite applications developed in-house for the KFUPM community.

The Business Support Department (BSD) plays an important strategic support role by facilitating all business-related and administrative tasks of the ITC departments through the best-practice models in IT. BSD consists of the following units: Accounting, Administrative & Reporting: Human Resources, and Customer Relationships.

The Web Services Unit (WSU) is responsible for the strategic and operational development and delivery of the University's web presence. The main activities of the unit include development, design and implementation of the KFUPM main website, the hosting and maintenance of departmental websites, faculty and staff web pages, along with the administration of University web servers.

For additional information, please visit the following URL: **www.kfupm.edu.sa/itc.**

DEANSHIP OF ACADEMIC DEVELOPMENT

The faculty, curricula, and facilities are the key components of the academic system of any university. The effectiveness of each of these components directly influences the effectiveness of student learning. King Fahd University of Petroleum & Minerals realized from the very beginning the vital importance of continuous improvement and development of its faculty, academic programs and instructional technology, which forms the corner stone in the quality of its graduates. Although the University has a rigorous academic system based on the regulations of the Ministry of Higher Education, on international standards and through various academic committees at all University levels, it has always been dynamic in exploring ways and means that lead to excellence in all academic activities. The Deanship of Academic Development (DAD) has therefore been established to help the University community, particularly the faculty members, to increase their effectiveness in teaching and learning, to insure the highest quality in academic programs, and to utilize the latest technologies in teaching.

DAD was originally established as the Academic Development Center (ADC) in the year 2000, and was later promoted to a Deanship in the year 2003. DAD creates a focal point for the emphasis on academic matters such as teaching excellence, program development, quality assurance, and e-Learning at KFUPM. It deals directly with issues related to the development of academic excellence for all faculty members through a variety of means such as workshops, discussion forums, seminars, publications, and faculty peer consultation.

Objectives

DAD mission will be accomplished by assisting the academic departments in their pursuit of the following objectives:

1. Excellence in teaching: Enhance the teaching effectiveness of faculty and teaching assistants that provide instruction consistent with the best systems on quality teaching and learning.
2. Excellence in research: Continuous improvement of faculty development to enable faculty members to reach their highest potential in research and to progress in academic rank in a timely fashion.
3. Effective processes and methods: Enhance the effectiveness of processes and methods that are critical to teaching and research.
4. Quality assurance: Assist the departments toward the quality assurance of their academic programs and academic advising.

Activities and Services

In order to achieve its objectives, DAD identified specific fields of interest, which are reviewed periodically according to the University's evolving plans and policies. The main areas currently under DAD focus include:

1. Faculty development to enhance teaching, learning and research productivity;
2. Quality assurance of academic programs;
3. Assessment of student learning;
4. Self-Assessment of academic programs;
5. Development of administrative skills;
6. Instructional technologies;
7. Development and delivery of quality online courses;

DAD offers most of its services to the University community through its four Centers. It provides a range of academic development workshops, discussion forums and seminars in which international, national and local experts participate. The Deanship, through its Centers, sponsors

activities related to teaching, research, faculty evaluation, student learning and curriculum often with a specific audience in mind, such as new faculty members, department chairmen, and college deans. The Deanship also conducts training programs on web-based education and develops its own expertise in this direction. In addition, personal consultation is available to any faculty member to enhance his teaching.

DAD also provides financial support/incentives through various grants to enable faculty to meet their objectives. The faculty members involved are expected to conduct studies in various academic development areas such as faculty development; enhancement of the learning environment; technology-enhanced learning, etc. The Deanship is keen to collaborate with members of the University community on issues that lead to academic development at KFUPM. DAD also manages a resource center, offering a range of books, newsletters, journals and multimedia references such as videotapes, CD's, slides and other materials relating to its main areas of interest, especially teaching and learning and quality-assurance-related issues. In addition, the Deanship publishes the proceedings of its workshops and discussion forums, as well as pamphlets on research and practices related to teaching, learning, assessment and evaluation. These resources can be accessed by contacting the Deanship's office.

Organization of the Deanship of Academic Development

The Deanship of Academic Development (DAD) has four centers under its patronage, namely:

1. Teaching & Learning Center
2. Program Assessment Center
3. e-Learning Center
4. Testing & Evaluation Center

Each center carries out various activities in its specific domain and is headed by a Director who reports to the Dean. The Dean reports directly to the Rector of the University. A standing Committee on Academic Development comprises members from various academic departments of the University, and supports the Deaship in carrying out the activities.

Teaching & Learning Center

KFUPM believes that every individual on campus has a right to experience personal growth and development through enriched academic opportunities. The purpose of establishing the Teaching & Learning Center (TLC) as one of the centers of the Deanship of Academic Development is to provide such experience by promoting excellence in teaching at all ranks and excellence in student learning inside and outside the classroom. The TLC activities include workshops, mini-courses, seminars, consulting services and resources for the faculty and graduate teaching assistants to enhance teaching and learning. The TLC also administers several special programs including academic development grants.

Program Assessment Center

Continuous assessment is the key to quality assurance at the University. The aim of assessment is to understand how educational programs are working and to determine whether they are contributing to student growth and development. Program assessment focuses on programs rather than on individual students. It provides information on whether the curriculum as a whole provides students with the knowledge, skills and values that graduates should possess in accordance with its mission,stated educational objectives, and learning outcomes.

The new trends in accreditation criteria have brought outcome assessment into focus. Accrediting agencies such as the Accreditation Board for Engineering and Technology (ABET), the Association to Advance Collegiate Schools of Business (AACSB), and the National Architectural Accrediting Board (NAAB) require programs or colleges seeking accreditation to have self-

assessment. Industry push and competitive job markets have also contributed to the need for continuous program quality improvement that focuses on student learning and preparation for professional practice after graduation.

The Program Assessment Center (PAC) at KFUPM strives to achieve its mission towards developing quality education that meets local industry needs following reputable international standards. It provides the necessary services and support for the various academic programs and research units at the University. It also facilitates and coordinates their efforts to meet their objectives and institutional goals.

e-Learning Center

With the new emerging information and instructional technologies and their influence on teaching and learning, it is essential to equip faculty members with the necessary skills to cope with these developments and utilize their benefits in teaching and learning. The e-Learning Center assists the University community in exploiting the potential of technology to enhance teaching and learning. One of the primary goals of the e-Learning Center is to promote quality self-paced, learner-centered education through the development and delivery of quality web-based courses that can be delivered completely online. Moreover, the e-Learning Center provides assistance to KFUPM faculty members to enhance their teaching and learning effectiveness through the development of interactive web-based supplementary materials to traditional courses as well as organizing training workshops related to the development and delivery of online material.

Testing & Evaluation Center

The Testing & Evaluation Center is a specialized resource for support and training in methods of test construction and validation, which is meant to provide further stimulus for active learning and objectives-based instruction. A significant component of the work of the Center is to study student selection procedures in order to provide reliable information to the administration for decision-making purposes on a continuous basis. The Center is determined to achieve high standards of excellence, while abiding by the rules of fairness and equity. Placement exams as well as outcome exams (exit exams) are other important components of the work of the Center. Yet another major concern for the Center is to study and evaluate faculty performance indicators.

OFFICE OF PLANNING AND QUALITY

As the University moves forward to the next chapter of its growth and evolution, it unerringly recognizes that it must improve its functional efficiencies with proactive policies and processes, and strategically align the University to seize the emerging opportunities and counteract the competitive threats. With this realism, **the Office of Planning & Quality (OPQ)** is committed to providing services to the University in three key areas: *Strategic Planning, Quality and Process Improvement, and Information and Data Management*.

Mission

The mission of the OPQ is to review, update, and, if necessary, redevelop the University's strategic plan with the aim of addressing the strategic directions of the University in Teaching and Learning, Research, and Community Service, to improve the quality of services and the processes, and to provide University decision-makers with data and information designed to improve the quality of planning and making informed decisions.

Objectives

The objectives of the Office of Planning & Quality are:

1. to be proactively involved in all stages of strategic planning, including the identification of strategic issues, review and updating of the strategic plan in place, and redevelopment of the

plan as and when necessary;

2. to provide advice and support services for quality management planning through improvement in processes and controls;
3. to provide the decision-makers with data and information that are required for all aspects of planning, bench marking and quality assurance program.

SULTAN BIN ABDUL-AZIZ SCIENCE AND TECHNOLOGY CENTER (SCITECH)

Scitech is affiliated with King Fahd University of Petroleum and Minerals. The basic aim of the Center is to educate the community, especially teenagers, in the principles of science and its applications. Through experiments and observation, Scitech simplifies and explains science via engaging and interactive 'edutainment' methods depending on the education level of the participants. It is located on the Corniche of the city of Al-Khobar and covers 21,700 sq. meters. The building itself consists of 14,100 sq. meters. Its design is consistent with the most modern scientific centers. It is composed of seven main exhibit halls, which deal with a variety of sciences and technologies. These halls include more than 350 scientific exhibits. There is also a scientific dome showcasing a state-of-the-art IMAX theater as well as an astronomical observatory. Additionally, the building contains a Conference Hall, the Educational Unit, a spacious Temporary Exhibitions Hall, and the Administrative and Services Facilities.

Mission of the Center

The mission of Scitech is to enhance the understanding of the fundamentals of science and technology by presenting them in a modern and enjoyable format to the community, especially teenagers. Our aim is to widen their scientific horizons and encourage everyone to embrace science and technology so that they are empowered to raise themselves and the nation to distinguished levels of excellence in these fields.

Goals of the Center

- Widen the horizon of visitors to the center in terms of science and technology.
- Simplify the subject of science and its ideas by making them interesting and enjoyable to everyone.
- Nurture curiosity, familiarity and discovery in numerous aspects of science.
- Help visitors to develop and retain scientific thinking and analysis skills, and enable them to apply these skills in their daily life.
- Develop each visitor's awareness and appreciation for the role of science and technology.
- Connect the programs and exhibitions of the Center to the educational curricula of the Kingdom.
- Solicit and acquire temporary exhibitions pertaining to science and technology. These exhibitions include scientific texts, software applications, communications equipment, and much more.
- Deliver the Center's message to everyone in the immediate area.

For more information visit www.scitech.sa.

ENGLISH LANGUAGE DEPARTMENT

The English Language Department (ELD) offers service courses designed to enhance students' spoken and written communication skills in English in order to prepare them for future academic and professional life. The ELD offers three undergraduate English courses:

English 101: An Introduction to Academic Discourse,

English 102: An Introduction to Report Writing, and

English 214: Academic & Professional Communication.

DEANSHIP OF STUDENT AFFAIRS

The Deanship of Student Affairs deals with all issues concerning students and helps them from the joining date until graduation. According to its administrative structure, the Deanship consists of three main Assistant Deanships: Student Affairs, Employment & Training, and Counseling & Advising. The main units and departments of the Deanship include: the General Directorate of Student Affairs, the Student Housing Department, the Student Activities Department, the Student Fund, the Counseling and Advising Center (CAAC), the Training Department, the Alumni Department, the Career Guidance Department, the Part-Time Unit, the Scholarship Program Unit, the Alumni Club, the Religious Affairs Committee in Student Housing, and the Special Needs Office.

General Directorate of Student Affairs

The Deanship of Student Affairs is always concerned for the student and gives him full support and care from the day he joins the University until the day he graduates. The General Directorate of Student Affairs plays a vital and steady role in providing this care through facilitating the tasks required of students in the University. The Directorate provides the following services for students: issuing identification certificates, clearance certificates, and low-price ticket certificates; issuing university ID's, contacting parents (when appropriate), issuing official medical excuses, and replying to all student inquires and directing students to the appropriate parties.

The Student Records division plays a vital role in keeping the Deanship's documents and transactions in good order and in regularly updating the many regulations and instructions pertaining to the Deanship. The work in this division is divided into two main areas:

- Student records: to keep a student's original certificates when accepted into the University and any other formal papers during his stay at the University.
- Various other records: to keep all correspondence requests that are related to Student Affairs services

Student Housing Department

To support KFUPM students' academic achievements, the University pays special attention to student accommodation. The Student Housing Department provides the requisite services and facilities for students on the University campus. The University aims to provide an accommodation environment that supports students in their studies and promotes their social interactions. The student housing comprises modern buildings with about 4000 furnished rooms that can accommodate up to 8000 students. Students living on campus enjoy many services including internet and phone services in each room, transportation to and from academic buildings, maintenance, hygiene, recreation facilities, car parking, and general services such as food supplies, student services, restaurants, and cafes. Moreover, students can enjoy and participate in several cultural, social, and sports activities organized by the student clubs.

The student-housing department uses an effective electronic system to manage student accommodation whereby students can submit their applications and execute a number of housing services electronically. In addition, they are kept well informed about available lists of housing, and they can register in the lists announced by the Housing Department.

Student Activities Department

The primary objective of the Student Activities Department is to provide a healthy and active atmosphere that enables each student to practice his hobbies, activities and suitable recreational preferences after the daily efforts exerted in studying. Students play the main role in planning all

extracurricular activities that are coordinated and executed through student clubs, supervised by the Deanship of Student Affairs. The Department of Student Activities aims to help students to form well-balanced personalities and to invest their time in meaningful and fruitful programs to enhance their talents and abilities. Students also receive training in leadership, loyalty and in how to bear responsibility; brotherly ties among students are strengthened, and a spirit of cooperation and harmony is fostered among students and between students and their instructors. The department also provides opportunities for students to get to know some of the administrative and social aspects.

There are 40 clubs supervised by the Student Activities Department, covering all scientific disciplines in the University, as well as sports, social, cultural and art activities. The University through the student fund provides full financial support for all approved programs and activities proposed by the student clubs. The activities of the student clubs focus on arranging training courses, scientific visits, scientific competitions, lectures, exhibitions, excursions, cultural competitions, art, literary programs, scouting, sports activities, visits from school delegations, and on representing the University in many forums in the Kingdom and internationally. There are allocated offices and halls for club members.

Training Department

The task of the Training Department is to follow up on all programs of Cooperative Training and Summer Training for all university students. It approaches various companies to provide training opportunities, nominates students for training in these companies, each according to his field, and then monitors their training until the end of the training period. Forming a triangular link between students, training companies and academic departments is the prime aim of the department.

The Cooperative Program (Coop) is a structured educational strategy for undergraduate students, to integrate the theoretical knowledge learned in the classrooms and laboratories with real-world experiences.

The Summer Training Program is similar to the cooperative program for undergraduate students in its objectives except that it lasts for eight weeks. It is one of the graduation requirements for some academic departments. The Summer Training Department is responsible for coordinating with the employers to provide suitable training opportunities for the students.

Career Guidance Department

It is a specialized department to help undergraduate students choose the most suitable major based on accurate information about their inclinations, attitudes and abilities.

Alumni Department

There are a number of tasks and services provided by this department. These include reviewing the graduation documents, having them signed by the relevant University officials, and then delivering them to graduates, issuing certificates of good behavior, ratifying the document copies, preparing the final graduation certificates to be signed by the relevant officials and delivering them to graduates, participating in the annual graduation and honor award ceremonies, providing employers with requested information regarding the alumni for the purpose of recruitment, and informing alumni about the employment opportunities available in organizations and companies in the private and public sectors.

Scholarship Program Unit

Major national and international companies and government agencies provide scholarship opportunities for high achievers among the University students. This unit coordinates with different divisions of the University to provide the necessary support to such companies and agencies to announce their scholarship opportunities to all students and also to help them in

identifying eligible and qualified students. The Scholarship Program Unit honors the signed agreement between the sponsoring agency and the student, delivers official documents and graduation certificates, and provides the necessary information to the concerned officials of the sponsoring agencies, which include the academic status and progress of the student and the delivery of official documents and graduation certificates.

Part-Time Unit

This unit coordinates part-time work inside the University, nominating and assigning students to part-time jobs based on the actual needs of the academic and administrative departments in the University.

Counseling and Advising Center (CAAC)

The main objective of the CAAC is to help equip KFUPM graduates with the right technical information and the proper personal skills. It aims to provide all students with academic and social counseling and advising. The CAAC has many objectives, among which are the following:

1. Assisting the students to achieve psychological, social and academic adjustment.
2. Psychological prevention of emotional and psychological disorder through primary and secondary prevention.
3. Assisting to modify unwanted behavior.
4. Psychological support to face psychological, social and academic stresses.
5. Holding lectures, workshops and discussions for educational and preventive goals.
6. Provide psychological, social and academic help, guidance and advice to all students.
7. Prepare new students for university life.
8. Activate/improve academic advising.
9. Looking after students with poor academic performance and providing the necessary guidance and follow ups.
10. Studying the behavior and common practices of student and the expected effects. The services provided by the CAAC include counseling in the following forms:

- **Individual Counseling:** A student meets with a counselor on a one-to-one basis to work through personal concerns.
- **Group Counseling:** Counseling in groups offers a broad range of insight and support from peers and professional counselors.
- **Student/Guardian Counseling:** Couples counseling works toward alleviating the strains in close relationships. In such cases, one of the relatives, usually the father or a brother, are contacted and asked to visit the Center.

Counseling is a collaborative process, which involves the development of a unique, confidential helping relationship. The CAAC treats all of its contacts with students in a highly confidential manner.

In addition, the CAAC arranges and conducts skill-building workshops and interactive seminars, which provide a structured presentation of information and skills practice appropriate to the students' personal development and career in the University. The CAAC participates in the issuance of bulletins and brochures on different topics that relate to student life and skill development. The Center also participates with relevant departments in supervising the social activities in the student dorms and it participates in planning and conducting the introductory (preparatory) program for new students. Furthermore, the Center studies student requests related

to loans and financial aid, the part-time employment program, and housing, and makes the appropriate recommendation. It also interviews students who are planning to withdraw from the University and provides them with appropriate alternatives.

Faculty members are encouraged to utilize the services of the CAAC by referring the student to the Center or by seeking advice on what might be done for a particular student or group of students.

Student Fund

The Student Fund, established in 1406 H / 1986 by a decision of the University Council, is considered to be one of the most important elements of the Deanship of Student Affairs as it is directly connected with the student and his financial needs. The Student Fund performs various tasks including the financial assistance for students through subsidy and loans, as well as providing incentives for honor students. One of the vital tasks of the Student Fund is to support the students' activities through Student Activities Clubs. The Student Fund also contributes to cooperative projects that would benefit the students.

The Student Fund council management includes the Dean of Student Affairs (President), the Assistant Dean for Student Affairs (Vice President), the Executive Manager for the Student Fund (member), the Financial Controller (member), three faculty members (members), and three distinguished students (members).

Alumni Club

The Club was established by the University Board in 1420 H /1999 and its headquarters are located at KFUPM. It aims to enhance the role of alumni in serving the Kingdom and society. The Club provides continuous communication with alumni, aiming to strengthen the relations between the University and the establishments where alumni are working and encouraging them to contribute financial and moral support to University programs and activities. The membership of the Club is divided into active, associate, and honorary membership. The Club has a council consisting of nine members who meet the selection requirements established by the University Council, and are chosen for three years (renewable) by the University Council as per the nomination of the Rector of the University The head of the council is a member of the KFUPM Board of Executives.

Religious Affairs Committee in Student Housing

Religion is an important part of student life, and both individual and group activities are available. Students are encouraged individually to seek the mosques on the campus for prayers and to utilize the large collection of books on Muslim thought available in the University Library. Also, the University schedules breaks to coincide with the periods of the *Id' Al-Fitr* and *Id Al-Adha* vacations. In addition, the University arranges special programs of group activities in the spirit of Islam. These programs are managed by a committee for Religious Affairs in Student Housing. This committee supervises a number of activities including:

- Religious seminars held throughout the week.
- Meeting and study sessions after *Al-Isha* or *Al-Fajr* prayers in which religious issues are discussed.
- Religious symposia and open discussions held periodically and often attended by faculty and staff members as well as students.
- Lectures delivered by reputable religious scholars. These are organized by the Islamic Studies committee.

GRADUATION

Upon satisfactory completion of all requirements for a degree from the University, students are invited to participate in the graduation ceremony. This colorful, time-honored university tradition, was instituted at KFUPM in 1972, and was the first such ceremony to be held at a university in Saudi Arabia.

A unique feature of the graduation ceremony is the dress worn by graduates. Designed especially for KFUPM, the gown is the Arabian *meshlah*, featuring the color of the specific college from which a particular student graduates. Instead of the usual "mortarboard" cap, the KFUPM graduate wears his traditional *ghutra* and *egal*. The ceremony and the dresses are an impressive blending of academic and Arabian traditions.

DEANSHIP OF GRADUATE STUDIES

DEANSHIP OF GRADUATE STUDIES

The Deanship of Graduate Studies (DGS) is the organizational unit of the University responsible for the administration of programs, and instruction leading to graduate credit and graduate degrees. It utilizes the specialized faculty and physical facilities of the five academic colleges, and draws upon other University facilities such as the Library, Information Technology Center (ITC), Deanship of Scientific Research (DSR), the Research Institute (RI), Centers of Research Excellence, and Dhahran Techno-Valley (DTV) for services essential to its instruction and research programs.

Vision

To enable KFUPM to be a preeminent institution through its provision of globally competitive graduates in Science, Engineering and Management

Mission

To provide quality graduate programs according to the best international practices that will enhance the research environment at KFUPM and make a difference within the Kingdom of Saudi Arabia and beyond.

Goals

The goals of the Deanship of Graduate Studies are to:

I. Enhance the research environment at KFUPM.
II. Disseminate knowledge in the society.
III. Improve the quality and efficiency of the graduate programs.
IV. Increase diversity in the graduate student body.
V. Increase the efficiency of the processes of the Deanship of Graduate Studies.

To achieve the aforementioned goals, the University offers both research-oriented and professional graduate-level degrees. The research-oriented degrees include the Master of Science (MS) and Doctor of Philosophy (Ph.D.), which are offered in various Engineering and Sciences disciplines. To help develop professionals in the regional industry, the University offers many professional degrees such as Master of Construction Engineering and Management, Engineering Management, Geology, Geophysics, Environmental Sciences, Business Management, Medical Physics, Maintenance, Industrial Engineering, System & Control engineering, etc.

STRUCTURE OF THE DEANSHIP

The Dean of Graduate Studies has primary responsibility for the academic direction and administration of the Deanship. The Dean of Graduate Studies is assisted by the Deputy Dean, Graduate Council, Director of Admissions and Director of Auditing.

The Deputy Dean of Graduate Studies assists the Dean in his responsibilities.

The Director of Admissions manages the admissions office and all matters related to applicants.

The Director of Auditing manages the Academic Auditing Office and deals with the processing of academic matters related to graduate students.

The Graduate Council is composed of the following: The Dean of Graduate Studies (Chairman), the Dean of Scientific Research, the Deputy Dean of Graduate Studies and one faculty member from each college offering graduate programs. This Council is charged with advising the Rector of the University on all policies relating to graduate studies and programs, exercising supervision over the academic requirements for all advanced degrees, and performing various other administrative duties related to the graduate programs.

ACCREDITATION

The quality of University programs is periodically appraised and monitored by independent qualified agencies from outside the Kingdom.

Assessment of Programs: King Fahd University of Petroleum & Minerals, from its inception, has taken careful steps to meet the standards required for accreditation, even where formal accreditation and evaluation were not possible. Its programs and courses of instruction have been certified as the equivalent of those which can be formally accredited. Thus numerous top North American universities usually accept KFUPM students for transfer and grant transfer credits for courses similar to those which they have taken. KFUPM has been evaluated and listed by the American Association of Collegiate Registrars and Admissions Officers since 1967.

Standards: The University uses the standards of the Accreditation Board for Engineering and Technology (ABET) for professional development as the basis for all engineering programs; the American Assembly of Collegiate Schools of Business for programs in accounting, business administration and industrial management; the American Chemical, Mathematical, and Physical Societies for courses and programs leading to degrees in Mathematics and the sciences, and the Association of Computing Machinery (ACM) for programs in Computer Science. Evaluation is conducted periodically to determine adherence to such standards.

ACADEMIC SYSTEM

The Credit Hour System: The University and the Deanship of Graduate Studies are organized on a modification of the American university model, adjusted to Saudi needs. The academic year is divided into two semesters of 16 weeks each, including examination periods. A summer session of eight weeks is scheduled, with attendance voluntary or for required make-up of deficiencies. Classes are scheduled for five days a week, Sunday through Thursday; though certain specialized work may be scheduled during the evening or on weekends. The basic unit for measure for the quantity of instruction is the credit hour. This unit is defined as the equivalent of one class-hour per week of formal instruction, with necessary preparation and assignments outside of class, for a standard semester. The amount of out-of-class work for graduate instruction is greater than for undergraduate, so that all course work must also be identified as “undergraduate” or “graduate.” In general, 2 to 3 hours preparation outside of class is expected in undergraduate courses, and 3-4 hours outside of class per class hour, is expected in graduate courses. The maximum full-time load for a graduate student in the Sciences and Engineering is 12 graduate credit hours per semester, not counting credit for the Master’s thesis. To schedule a course load greater than this, a graduate student must secure approval from his advisor, his academic department head, and the Dean of Graduate Studies. When suitable courses are available, a graduate student may register for a maximum of 6 credit hours during a summer session. Part-time graduate students are required to take a reduced course load.

The Grading System

The basic unit of measure of academic quality or achievement in instruction is the Grade Point System. The term “quality point” is sometimes used interchangeably with “gradepoint”. The University grading system for graduate courses is shown in the table below:

Letter Grade Points

A+	4.00	Exceptional
A	3.75	Excellent
B+	3.50	Very Good
B	3.00	Average
C+	2.50	Below Average

C	2.00	Low Pass
D+	1.50	Not Pass - High
D	1.00	Not Pass - Low
F	0.00	Fail
IP	-	In Progress
IC	-	Incomplete
DN	0.00	Denial
NP	-	No Grade-Pass
NF	-	No Grade-Fail
W	-	Withdrawn
WP	-	Withdrawn With Pass
WF	0.00	Withdrawn With Fail
AU	-	Audit

IC grade: Upon the instructor's recommendation, the council of the department which teaches the course may allow the student to complete the requirements of any course during the next term. In such an event the grade IC will be recorded for the student in his academic record. A grade of IC must be removed during the regular semester immediately following that in which the grade was given, or it will automatically become a grade of F. Under very exceptional circumstances, the Dean of Graduate Studies may permit an extension of time, not to exceed one semester, for the removal of a grade of **IC**.

The temporary grade of **IP** is recorded for work on the thesis/dissertation only during those semesters when the graduate student is formally registered for thesis/dissertation work. When the thesis/dissertation is completed and given final approval by the Deanship, the grade is changed to NP. The AU grade will be assigned to students who attend a course as auditors without being given any grades, regardless of their performance in the course. The effect of this assignment on the student's cumulative or semester grade is the same as the grade "no-grade pass" or NP.

The scholastic index, which represents the overall performance in any selected group of courses, is a weighted average known as the Grade-Point-Average **(GPA)**. This index is found by multiplying the number of semester credit-hours in each course by the numerical point equivalent of the grade received in that course, then adding the results for all courses being considered in the index. This sum is known as the "Total Grade-Points". When this sum has been divided by the total number of semester-credit-hours included in the courses being considered, the quotient is the weighted average known as Grade-Point-Average or GPA. This index is normally calculated to three decimal places (Example: GPA 3.475), and all University scholastic regulations assume this degree of accuracy. The GPA index may be applied to various groups of courses. Thus, it may be applied to all the courses taken at a certain level, or in a particular subject by a single student. It may also be applied to all the courses taken by a specific group of students, etc. The GPA index is frequently employed at the University as a quantitative measure in academic evaluations.

The following are in regular use:

1. The "Semester or Term GPA" is based on all work during a particular semester;
2. The "Cumulative GPA" which is based on all academic work taken at the University, whether submitted for degree requirements or not; and
3. The "Degree GPA" which is based on all courses taken in fulfillment of degree requirements, whether passed or not. The GPA is calculated only on work taken at KFUPM. Thus credit for work transferred from another university may be accepted to meet the total credit hours requirement for a degree but will not affect the GPA.

Methods of Instruction: The graduate programs at King Fahd University of Petroleum & Minerals are based on a concept of instruction which involves three elements.

1. Acquiring skills and mastering existing knowledge in the subject area;
2. Demonstrating proficiency in the use of these skills and knowledge in practical applications; and
3. Discovering new techniques and new knowledge through problem solving and research.

Graduate programs are, therefore, more than merely an array of graduate courses and an extension of undergraduate work. They require an element of creativity on the part of the successful student. It is not enough to memorize, repeat, and verify the knowledge assembled by others. The graduate student must be able to use and apply existing knowledge and also discover new knowledge. In addition to classroom lectures and standardized experiments in laboratories, familiar from his undergraduate days, the graduate student will participate in seminars and in laboratory investigations where the ultimate results are not known. The culmination of these methods of instruction is the preparation of a thesis or a dissertation based upon original research applied to a carefully defined problem. The Graduate Seminar is a method of sharing knowledge among students and faculty. The students, in turn, present their projects, discuss the problems they have encountered, and defend their conclusions. In the interplay of trained minds concerned with different but similarly directed projects, each learns from the other and from the exposition and discussion of each other's research.

The Master's Thesis/Ph.D. Dissertation: The preparation of a graduate thesis or dissertation involves several formal steps in the process of discovering original knowledge:

1. Studying the related published literature;
2. Identification of the problem;
3. Finding a successful procedure for tackling the problem;
4. Design of the experiment, where relevant;
5. Data collection, storage, and manipulation, where relevant;
6. Postulating and obtaining a solution;
7. Verification;
8. Writing a detailed report in the form of thesis or dissertation;
9. Defense of the thesis or dissertation.

While working on his research, the student reports his progress regularly at seminars and through progress reports to his thesis/dissertation advisor. Upon completion of the research, he is examined by a faculty committee. Six credit hours are assigned to the M.S. thesis. Three credit hours are assigned to the Ph.D. Pre-Dissertation which enables a Ph.D. student to submit his Ph.D. Dissertation proposal and defend it in public. The student passes the course if the Ph.D. Dissertation committee accepts the submitted dissertation report and upon successfully passing the Dissertation proposal public defense. It is followed by a Ph.D. Dissertation course which is of nine credit hours and is expected to involve original scholarly research conducted on a full-time basis (for full-time Ph.D. students) on the KFUPM campus, and under KFUPM faculty supervision. Part-time Ph.D. students are required to go through the same sequence, but they are required to spend at least a one-year, full-time residency period on the KFUPM campus in order to register for Ph.D. Pre-Dissertation and Ph.D. Dissertation courses, after completing all the coursework and passing the Ph.D. comprehensive exam.

A Department Graduate Committee is appointed by the chairman of each department to advise the graduate students on matters relating to graduate studies in their departments. It is composed of the department graduate coordinator and selected members of the senior faculty.

A Department Graduate Coordinator is appointed by the department's chairman, with the approval of the Dean of Graduate Studies, as the principal source of guidance for graduate students preparing the degree plans of studies and choosing a thesis advisor. He becomes the academic advisor of all newly admitted graduate students. He also makes sure at the beginning of the semester that the registered courses conform to the degree plan already devised for the student. If any courses to be taken in a semester are different from those in the degree plan, the coordinator may recommend that the student, with the approval of the department chairman, petitions to change the degree plan.

The Degree Plan is a list of courses that the student selects to be counted towards his degree in agreement with the approved degree plan of the corresponding program of study. All graduate students are expected to submit their approved degree plans by the middle of their second semester from their enrollment in the program. The degree plan has to be approved by the student advisor, Department Chairman and the Dean of Graduate Studies. Graduate students have to submit their degree plans by the middle of the second semester of enrolment at the latest. The semesters spent at Pre-Graduate level are not counted in this duration.

Note: The information presented in this chapter represents the implementation rules for KFUPM and it is based on the Unified Regulations for Graduate Studies document prepared by the Ministry of Higher Education. For full details of the unified regulations document, please visit the website of the Deanship of Graduate Studies at http://www.kfupm.edu.sa/gs.

ADMISSIONS

ADMISSION PROCESS

The online admission application is open twice a year to local and international applicants on the website of the Deanship of Graduate Studies. It is important to note that the admission procedure is time-dependent and strictly bounded by deadlines. For a complete schedule of the submission of admission applications and all other related information, please refer to the Graduate Studies Academic Calendar, which can be found at the Deanship of Graduate Studies website http://www.kfupm.edu.sa/gs.

General University Requirements

Graduate students are subject to the general regulations of the University, which apply to all students. In addition, there are various rules which have been adopted specifically for graduate students on the approval of the Graduate Council.

For admission to the Ph.D. Program the applicant must hold a M.S. degree equivalent in quality to, and involving the same length of study duration as, those granted at KFUPM. The specific documents required are cited in "Admission Procedures" and on the Deanship of Graduate Studies website. Inquiries should be directed to the Admissions Office at the Deanship of Graduate Studies.

Students are admitted to the academic program and the area of specialization identified in their online application. If this program differs from their previous program of study, they will be required to make up deficiencies after admission. A request for a change of academic program is required for any continuation beyond the original program requested or for a change to a new program before an existing program is completed. A request for a change in program will be considered as if it were an entirely new application, subject to procedures and standards currently applicable at that time. A graduate student is eligible for one change of major during his study in an academic program.

All applicants whose credentials meet the stated minimum quantitative standards are considered for admission to Graduate Studies. The close relationship between a graduate student seeking an advanced degree and the faculty makes it necessary for a careful screening of applicants. Consideration, however, is given to the availability of facilities and to the array of professional specializations within the current graduate faculty. Priority is given to those students having the highest qualifications, with preference given to those whose previous academic record is from universities offering courses equivalent to those at KFUPM.

GRE and GMAT

Applicants to Graduate Studies in Sciences and Engineering are normally required to take the general graduate record examination, whereas applicants to the MBA are required to take the GMAT examination. Some applicants may be required to submit the GRE subject in lieu of GRE General. KFUPM graduates with a GPA above 3.00 are exempted from the GRE and GMAT requirements.

Language Requirements

The language of instruction at the University is English, and all courses are in English. It is essential, therefore, that all candidates for admission demonstrate a high proficiency in English language before being admitted for graduate study. Standards and procedures for demonstrating this proficiency have been established by the Graduate Council and are administered by the Dean of Graduate Studies. The minimum scores required for admission as a Graduate Student are 520 (PBT), 190 (CBT) or 68 (iBT) for Masters and 550 (PBT), 213 (CBT) or 79 (iBT) for Doctoral

programs in the TOEFL examination. Alternatively, IELTS bands of 6.0 for Masters and 6.5 for Doctoral admissions are considered as minimum scores accepted by the Deanship of Graduate Studies. KFUPM graduates who score an average GPA of 3.00 or above in the University English Courses (ENGL 101, ENGL 102, and ENGL 214) are exempted from the TOEFL requirements.

Provisional Admission

Provisional admission is the status granted to a student who does not qualify for immediate admission as a regular student but who has demonstrated professional promise. An applicant whose academic credentials do not meet the minimum regular admission requirements may be admitted on a trial basis as a "provisional student", pending some provisions such as TOEFL and/or GRE scores or deficiency courses.

Provisional students should clear their admission provisions within the first semester of their enrolment in the graduate program. Failure to satisfy the provisions mentioned in the admission letter within the first semester will result in holding the student registration in a subsequent semester until the required provisions are met.

General University Requirements for Admission to Master Programs

- Graduate students are subject to the general regulations of the University, which apply to all students; apart from this, all the rules and regulations which have been adopted specifically by the University Administration will also apply.
- In addition to the online application forms for admission and other documents, the candidate must also supply other formal documents attesting to his good health and character and also a certificate that he has graduated from a four-year university system with a bachelor degree in a subject area which is pertinent to the graduate course offering at KFUPM.
- The candidate must also submit TOEFL (or IELTS) and GRE/GMAT score reports, as required by the University.

General University Requirements for Admission to Ph.D. Programs

In addition to the items mentioned above, an applicant must hold a M.S. degree equivalent in quality and involving the same length of study duration as those granted at KFUPM.

General Rules

- Students are admitted to the academic program and the area of specialization identified in their applications.
- If this program differs from their previous programs, they may be asked to take make-up deficiency courses after admission.
- Any request for a change of academic program to a new program will be entertained as if it were an entirely new application, before the existing program is completed, subject to procedures and standards currently applicable at that time. Change of major is only allowed once during the pursuit of an advanced degree.

Admission Requirements for Programs Leading to Master's Degrees

The minimum requirements for possible admission as a regular graduate student to pursue an approved program leading to an advanced degree in engineering and science are:

1. A Bachelor's Degree in engineering or science from an institution whose undergraduate programs are substantially equivalent in length, content, and quality to those of KFUPM, with a major in the proposed field or evidence of suitable background for entering the proposed

field.

2. A Grade-Point Average (GPA) of 2.50 or higher on a scale of 4.00 or equivalent, and a GPA of 3.00 in the subject of the major field. Official transcripts and degree certificates are required for final admission.
3. Completion of TOEFL with a minimum score for M.S. admission of 520 (PBT), 190 (CBT) or 68 (iBT). The TOEFL score must be sent directly to the Deanship of Graduate Studies (University Code is 0868). IELTS is also accepted with a minimum score of 6.0.
4. General Graduate Record Examination (GRE) score with minimum scores in quantitative and analytical sections of 156 and 4.0, respectively. The GRE score must be sent directly to the Deanship of Graduate Studies (University Code is 0868).
5. Three letters of recommendation from the faculty who taught the applicant university-level courses.
6. Satisfactorily meeting any additional departmental or university admission requirements.
7. Applications for competitive scholarships are expected to demonstrate a high academic performance with a minimum GPA of 3.00 or higher on the scale of 4.00.

Admission Requirements for the Master of Business Administration Program

An applicant for admission to the MBA program should have the following minimum requirements:

1. A four-year Bachelor's (B.A., B.S. or B.E.) Degree from a recognized institution (for MBA), or a Bachelor's Degree with a major in Accounting/Business Administration/Economics/ Management Information Systems from a recognized institution.
2. A Grade-Point Average (GPA) of at least 2.5 on a scale of 4.0 or equivalent. Original transcripts and official degree certificates are required for final admission.
3. Completion of TOEFL with a minimum score for M.S. admission of 520 (PBT), 190 (CBT) or 68 (iBT). IELTS is also accepted with a minimum score of 6.0.
4. Completion of the Graduate Management Admission Test (GMAT) with a minimum score of 450.
5. Three letters of recommendation from the faculty who taught the applicant university-level courses.
6. At least one course in college-level calculus which covers both differentiation and integration.
7. A working knowledge of computers as evidenced by at least one course in that area (e.g. data processing, programming, information systems, etc.).
8. At least one-year of full-time work experience. This requirement may be waived for graduate assistants, research assistants, full-time students and applicants with exceptional academic records.
9. Satisfactorily meeting any additional departmental or University admission requirements.
10. Applications for competitive scholarships are expected to demonstrate a high academic performance with a minimum GPA of 3.00 or higher on the scale of 4.00 and a high GMAT score.

Admission Requirements for Executive MBA Program

Applicants should possess the following minimum requirements:

1. A Bachelor degree from a recognized institution of higher education with a minimum GPA of 2.5 out of 4.0.
2. Satisfactorily meeting the University's language requirements i.e. a score of 520 (PBT), 190 (CBT) or 68 (IBT) in the TOEFL examination, or alternatively, IELTS with a band of 6.0 or other proof of English Language proficiency.
3. A minimum of 8 years work experience including 3 years in mid- or upper-level managerial positions.
4. Three Letters of Recommendation.
5. A current resume.
6. A letter of endorsement from the applicant's employer (if applicable) which should clearly demonstrate the employer's understanding of the demands of the program and his willingness to support the applicant's admission to the EMBA.

All applications will be evaluated and potential candidates will be invited for a personal interview. The interview is aimed at evaluating the candidate's personal attributes deemed necessary for success in the EMBA. These attributes include, among others, ambition, motivation, commitment, communication and interpersonal skills.

Admission Requirements for Ph.D. Programs

Applicants will be considered for admission to the Doctorate Programs, provided they satisfy the following minimum requirements:

1. An M.S. degree in engineering or science from an institution whose graduate programs are equivalent to those of KFUPM in quality and length, with a major in the proposed field or evidence of suitable background for entering the proposed field.
2. A minimum GPA of 3.00 on a scale of 4.00 or equivalent. Official transcripts and degree certificates are required for final admission.
3. Completion of TOEFL with a minimum score for Ph.D. admission of 550 (PBT), 213 (CBT) or 79 (IBT). The TOEFL score must be sent directly to the Deanship of Graduate Studies (University Code is 0868). IELTS is also accepted with a minimum score of 6.5.
4. A General Graduate Record Examination (GRE) score with minimum scores in quantitative and analytical sections of 156 and 4.0, respectively. The GRE score must be sent directly to the Deanship of Graduate Studies (University Code is 0868).
5. Three letters of recommendation from the faculty who taught the applicant university-level courses.
6. Satisfactorily meeting any additional departmental or university admission requirements.
7. Applications for competitive scholarships are expected to demonstrate a high academic performance with a minimum M.S. GPA of 3.5 or higher and B.S. GPA of 3.0 or higher on the scale of 4.0.

Admission With Deficiencies

a) **Course Deficiency**

An applicant may be admitted with course deficiencies in any of the degree options following departmental recommendations. However, he must complete a specific number of credits in the field of his proposed graduate study or in related fields as indicated by the department. Such credits will not be counted as part of the student's graduate program, and students are

required to make up their deficiencies by the end of the first semester of enrollment. Applicants for competitive scholarships are expected not to have any course deficiency. Only in highly exceptional cases, admission may be allowed within a maximum of 3 courses as deficiency.

b) **Preliminary Examination, if Needed**

Upon the recommendation of the Department's Graduate Program Committee, a Ph.D. student may be required to take a preliminary examination which is mainly used to determine his areas of deficiency. This examination will be organized and administered by the Department Graduate Program Committee at a time no later than two semesters after enrollment. A clearly unsatisfactory performance in the preliminary examination may also form the basis for dismissal of the student from the program.

c) **Special Departmental Requirements**

Besides the minimum requirements for admission to the Graduate Studies Program, individual academic departments may set additional or higher standards for certain areas of specialization. Inquiries should be directed to the Dean of Graduate Studies or to the chairman of the department concerned.

Classification of Admission Status

Admission to Graduate Studies is in one of the following three categories: Regular, Provisional, and Pre-Graduate.

Regular Admission is the status granted to a student who meets the minimum established admission requirements. This admission status is granted, in general, to those students who have a record of high scholarship in their major fields and show promise of excellence in graduate study, research, and professional development. As previously indicated, meeting the minimum standards does not automatically guarantee admission.

Provisional Admission is the status granted to an applicant whose academic credentials do not meet the minimum regular admission requirements. Such a student may be admitted on a trial basis as a "provisional student", pending some provisions such as TOEFL and/or GRE/GMAT scores or deficiency courses. Such students are required to clear their admission provisions within the first semester of their enrolment in the graduate program to avoid holding their registration for future semesters.

Pre-Graduate Admission is a special admission type in which students not eligible for Regular Admission can officially be admitted to the Pre-Graduate Program. It is mainly designed to serve students with one of the following conditions:

1. A GPA ranging from 2.0 to less than 2.5.
2. A major background deficiency.
3. A requirement of taking English courses at KFUPM.

The details of the Pre-Graduate Program is described under the Academic Regulations section.

Admission of Undergraduates to Graduate Courses

A student having a GPA of 3.00 or higher may, with the approval of the Dean of Graduate Studies, pursue one or more graduate courses during his final undergraduate year. The total undergraduate and graduate semester-credit-hours taken in any one semester shall not exceed fifteen (15).

No duplication of credit is permitted, and no course whose credit is applied to meet the requirements for the undergraduate degree may subsequently be used to meet the course

requirements of a graduate degree. Graduate courses taken in excess of the course requirements for the undergraduate degree, if suitable to the approved graduate program of the student, may be credited towards the graduate degree. Courses taken to remove a deficiency in the graduate admission prerequisites may not be credited towards an advanced degree.

Transfer with Advanced Standing

Graduate students with previous graduate academic credit from another university may request admission with advanced standing and transfer of credit towards an advanced degree in the University. A maximum of 30% registered semester credit-hours of graduate credits may be accepted for transfer provided that after completion of these credit hours no more than four (4) years will have elapsed before the remaining credits required to fulfill the total requirements towards the advanced degree will have been completed. In addition, any such course must be relevant to the student's approved graduate program at the University, and the credits must have been earned at an institution of higher learning with academic standards equivalent to those of King Fahd University of Petroleum & Minerals. A request for such a transfer of credit will be considered by the Dean of Graduate Studies only in exceptional cases and only after such a request has first been evaluated by the departmental graduate committee concerned and approved by that department's chairman.

The student should initiate the request for transfer of credit through the Deanship of Graduate Studies and must furnish official transcripts of the academic grades from all universities where the credits have been earned.

ADMISSION PROCEDURES

Online Application

The complete application for admission to Graduate Programs must be submitted online through the Deanship of Graduate Studies website. The opening and closing of the application is mentioned under 'Prospective Students' → 'Application Deadlines'.

Prospective candidates should direct their relevant queries to the Admissions Office at the Deanship of Graduate Studies. All applicants will be notified via email of the results of their application and, where relevant, their admission status, further procedures, and reporting date at the University.

Documentation Checklist

During the phase of online application, the following documents are mandatory for submission through the online application system:

1. **Identification**

   National ID is needed for Saudi Nationals, Iqama for Non-Saudi KSA Residents, and Passport for International applicants

2. **Transcripts**

   Complete official transcripts are required for admission processing. Doctoral applicants should upload B.S. & M.S. transcripts whereas Master applicants should upload the BS transcript. Transcripts should only be in the English language. Other language transcripts should be translated into English by a certified translator. Only university-level transcripts are required and not the high school ones. Once an applicant is approved, he shall be required to send the original hardcopy of transcripts to the Admissions Office at the Deanship of Graduate Studies.

3. **Statement of Purpose**

   This is usually a one-page essay outlining the applicant's academic background, research

interests, practical experience and his intended research if he joins KFUPM.

4. GMAT

For international applicants, a high GMAT score is mandatory along with the online application.

5. Recommendation Letters

The applicant should provide names and email addresses of three academic referees. These academic referees will be requested by KFUPM to complete an online recommendation form.

The following documents are not mandatory for application processing, but must be provided before final admission:

1. Degree Certificate(s)

Applicants who have completed their respective programs at the time of application should upload their official degree certificate(s). Ph.D. applicants should upload official certificates of both Master and Bachelor degrees, whereas Master applicants should upload certificate of their Bachelor degree. Applicants who are in the last semester of their current degree program can also apply to graduate programs at KFUPM.

2. TOEFL

Applicants are encouraged to upload their TOEFL score along with the application. The KFUPM Educational Testing Services (ETS) code for reporting TOEFL is 0868. Applicants can apply without providing their TOEFL results. However, TOEFL is mandatory and final regular admission is officially granted only upon receipt of the TOEFL results.

3. GRE

GRE is required for all applicants to Engineering & Science programs. The KFUPM Educational Testing Services (ETS) code for reporting GRE is 0868. Applicants can apply without providing their GRE results. However, GRE is mandatory and final regular admission is officially granted only upon receipt of the TOEFL results.

4. GMAT

GMAT is required for all applicants to Business programs. The minimum required score is 450. Applicants are encouraged to submit GMAT along with their application. If they cannot submit GMAT while applying, they must provide it later as GMAT is mandatory for final regular admission. The KFUPM Educational Testing Services (ETS) code for reporting GMAT is 0868.

International Applicants

International applicants are required to obtain a Saudi Arabian entry visa. The University assists admitted candidates with visa formalities upon approval of the relevant authorities.

Tuition Fees and Financial Aid

Full-time graduate students receive stipend fellowships, including a tuition-waiver, textbooks, an air-ticket, accommodation and a subsidy on meals and basic medical care, in accordance with the terms of their grants.

Full-Time graduate students have the chance to participate in projects funded by the University through the Deanship of Scientific Research (DSR), Centers of Research Excellence, King Abdul Aziz City of Science & Technology (KACST) and/or in contractual research projects through the Research Institute (RI) after securing the approval of the concerned Department Chairman and the Deanship of Graduate Studies. More details on such funds are available at the websites of the

DSR and RI.

In addition to the cost of books, all part-time graduate and pre-graduate students pay a tuition fee. The tuition fee for part-time graduate students is SAR 300 per credit hour for Saudis and is SAR 550 per credit hour for local non-Saudi students. The tuition fee for part-time pre-graduate students is SAR 550 per credit hour. This tuition fee covers only tuition and the use of essential University facilities required for that instruction or research. It does not cover costs of transportation, room and board, uniforms, or specialized equipment. Students in need of supplementary financial aid should direct their requests to the Dean of Student Affairs.

Student Assistantships & Scholarships

Various types of assistantships and scholarships are available to graduate students of exceptional professional promise**.**

1. **Graduate Assistant**

   Saudi graduate students are eligible to apply for a graduate assistantship. This position is intended to develop future faculty members for the University and thus the appointment is normally made for an indefinite period. A student qualifying for this position is expected to pursue his Master program at KFUPM.

2. **Research Assistant**

   Saudi and Non-Saudi graduate students are eligible to apply for a research assistantship. Research Assistants are expected to spend 50% of their time supporting the teaching and research activities of the University with the other 50% devoted to their respective graduate program. Such employment offers the student a professionally rewarding experience as well as a modest stipend during their graduate study. A student qualifying for this position is expected to pursue his Master program at KFUPM.

3. **Full-Time Master Student**

   Saudi and Non-Saudi graduate students are eligible for this scholarship. Full-Time Master students are expected to devote 100% of their time to their graduate programs. This scholarship offers the student a modest stipend during their graduate study.

4. **Lecturer**

   Saudi graduate students are eligible to apply for a lectureship. This position is intended to develop future faculty members for the University and thus the appointment is normally made for an indefinite period. A student qualifying for this position is expected to pursue his Ph.D. program at KFUPM.

5. **Lecturer-B**

   Saudi and Non-Saudi graduate students are eligible to apply for this type of lectureship. Lecturer Bs are expected to spend 50% of their time supporting the teaching and research activities of the University with the other 50% devoted to their respective graduate program. Such employment offers the student a professionally rewarding experience as well as a modest stipend during their graduate study. A student qualifying for this position is expected to pursue his Ph.D. program at KFUPM.

6. **Full-Time Ph.D. Student**

   Saudi and Non-Saudi graduate students are eligible for this scholarship. Full-Time Ph.D. students are expected to devote 100% of their time to their graduate programs. This scholarship offers the student a modest stipend during graduate study.

Note: The information presented in this chapter represents the implementation rules for KFUPM and it is based on the Unified Regulations for Graduate Studies document prepared by the Ministry of Higher Education. For full details of the unified regulations document, please visit the website of the Deanship of Graduate Studies at http://www.kfupm.edu.sa/gs.

REGISTRATION

REGISTRATION PROCESS

The formal registration of students intending to follow an approved academic program takes place on registration day at the beginning of each semester. The registration process consists of four steps:

1. Securing career guidance in selecting an area of specialization compatible with the professional goals of the student,
2. Selection of appropriate courses for the semester or academic term which are consistent with the approved degree plan, in consultation with the student's academic advisor,
3. Adding an approved selection of academic courses through the office of the University Registrar website,
4. Submitting the Registration confirmation through the office of the University Registrar website, which completes the registration process.

For continuing graduate students, an early registration (step 2) is usually carried out in a period preceding the semester of study.

General instructions on registration procedures are posted on the Office of the University Registrar website shortly before the date indicated in the academic calendar for registration. Students must submit their registration confirmation through the Office of the University Registrar website in order to formally register for the term.

Late registration, adding new course(s), dropping courses without being noted in the permanent record, partial dropping with a grade of "W", and dropping the entire semester with a grade of W, WP or WF are permitted according to the deadlines included in the academic calendar published on the website of the Office of the University Registrar. If a student registers but fails to appear for classes, he is held responsible for all courses he has formally registered for, and appropriate grades for such courses will be made a part of his permanent academic record.

Courses for Graduate Credit

A student must be admitted to a graduate program and must register during the regular registration period in accordance with procedures prescribed by the Deanship during the regular registration period in order to receive graduate credit. Any transfer of credits earned while the student had non-degree status will not be considered for credit in any graduate program.

Deficiency Courses

If a student's previous undergraduate or graduate preparation is considered inadequate in one or more subjects of importance to his approved graduate program, certain deficiency courses are normally prescribed by the academic department concerned. Such courses must be taken as early as possible in the program, preferably during the first semester after admission to the program. No graduate credit is earned by taking these courses and removing the deficiency, and the undergraduate credit-hours for such courses cannot be credited towards an advanced degree.

Transferred Credit

A maximum of 30% registered credit hours of graduate credit may be transferred from another university towards a graduate student's program at KFUPM (see "Transfer with Advanced Standing" under the Admissions section).

Registration without Course Credit

A student working on his thesis/dissertation or preparing for graduate examination, but not taking formal course work, must register during the regular registration period and, when appropriate, pay registration fees. This applies to a graduate student working on his thesis, whether in absentia

or on campus, as well as to a student who desires to use the facilities of the University to consult with his thesis advisor or other faculty members regarding any aspect of his program. Graduate students with a GPA less than 3.00 are not allowed to register for M.S. Thesis or Ph.D. Dissertation.

Auditing Courses

Registration in a course for the privilege of auditing is permitted in exceptional cases (see "Classification of Admission Status" under the Admissions section). No academic credit can be earned by auditing courses. A graduate student wishing to audit a course must secure approval from the instructor of the course, department chairman and the Dean of Graduate Studies. A student cannot register for any previously audited course. A student can only audit a course during his last term of study in a graduate program, i.e. he should be expected to graduate in the same term, he intends to audit courses.

Academic Records

A permanent computer record of all academic work for each course completed is maintained at the Office of the University Registrar and this data may be drawn on in order to print an official record or transcript at any time in the future. No part of the student's academic record may be omitted for any reason as it is an official document from the Office of the University Registrar.

Registration of XXX – 610, 711 and 712

1. All departments offering Ph.D. programs include XXX 699 as a prerequisite for XXX 711. Similarly XXX 711 is a prerequisite for XXX 712 to be taken by Ph.D. students; for the M.S. program, XXX 599 is a prerequisite for XXX 610.
2. The students who were assigned an IP grade in the Thesis/Dissertation course, are required to register it again in the subsequent semester and confirm the registration. Not doing so will result in the student becoming inactive and will require him to apply for readmission.

Masters and Ph.D. Programs

The Deanship of Graduate Studies offers graduate programs leading to the Doctor of Philosophy, Master of Science and Masters in the disciplines listed in the table below:

Degree Programs at KFUPM (As of Sep. 1, 2014)

Colleges & Majors	**Degrees**		**Abbrev.**			**لدرجات والتخصصات**
College of Eng. Sc.			(ES)			كلية العلوم الهندسية
Aerospace Eng.	MS	--	AE	--	ماجستير	هندسة الطيران والفضاء
Civil Eng.	MS/MEG	PHD	CE	دكتوراه	ماجستير	الهندسة المدنية
Chemical Eng.	MS	PHD	CHE	دكتوراه	ماجستير	الهندسة الكيميائية
Oil & Gas Surface	MT	--	OGSF	--	ماجستير	المنشآت السطحية للنفط
Electrical Eng.	MS	PHD	EE	دكتوراه	ماجستير	الهندسة الكهربائية
Telecom Eng.	MS	--	TELE	--	ماجستير	هندسة إتصالات
Mechanical Eng.	MS	PHD	ME	دكتوراه	ماجستير	الهندسة الميكانيكية
Material Science & Eng.	MS	--	MSE	--	ماجستير	علوم و هندسة المواد
Petroleum Eng.	MS	PHD	PETE	دكتوراه	ماجستير	هندسة البترول
College of Sciences			(SC)			كلية العلوم
Chemistry	MS	PHD	CHEM	دكتوراه	ماجستير	الكيمياء
Physics	MS	PHD	PHYS	دكتوراه	ماجستير	الفيزياء
Medical Physics	MT	--	MEPH	--	ماجستير	الفيزياء الطبي
Mathematics	MS	PHD	MATH	دكتوراه	ماجستير	الرياضيات
Applied Statistics	MS/MT	--	ASTA	--	ماجستير	علم الإحصاء التطبيقي
Geology	MS/MGOL	PHD	GEOL	دكتوراه	ماجستير	الجيولوجيا
Geophysics	MS/MGOP	--	GEOP	--	ماجستير	الجيوفيزياء
Environmental Sciences	MS	--	ENVS	--	ماجستير	العلوم البيئة
College of Industrial Management			**(IM)**			**كلية الإدارة الصناعية**
Accounting	MACC	--	ACCT	--	ماجستير	المحاسبة
Business Administration	MBA	--	MBA	--	ماجستير	ماجستير إدارة الأعمال
Business Administration	EMBA	--	EMBA	--	ماجستير	ماجستير إدارة الأعمال
College of Environmental Design			**(ED)**			**كلية تصاميم البيئة**
Architectural Eng.	MS/MEG	--	ARE	--	ماجستير	الهندسة المعمارية
Construction Eng. & Mgt.	MS/MEG	--	CEM	--	ماجستير	هندسة وإدارة التشييد
Engineering Mgt.	MEM	--	EM	--	ماجستير	الإدارة الهندسية
City & Regional Planning	MS/MCRP	--	CRP	--	ماجستير	تخطيط المدن والأقاليم
College of Computer Sciences & Eng.			**(CS)**			**كلية علوم وهندسة الحاسب الآلي**
Computer Science	MS	PHD	CS	دكتوره	ماجستير	علوم الحاسب الآلي
Computer Eng.	MS	PHD	COE	دكتوره	ماجستير	هندسة الحاسب الآلي
Computer Networks	MS	--	CNW	--	ماجستير	شبكات الحاسب الآلي
Industrial & Sys Eng.	MS	PHD	ISE	دكتوراه	ماجستير	الهندسة الصناعية والنظم
Maintenance Eng. & Mgt.	MT	--	MEM	--	ماجستير	هندسة وإدارة الصيانة
Software Engineering	MS	--	SWE	--	ماجستير	هندسة البرمجيات
Systems & Control Eng.	MS/MT	PHD	SCE	دكتوراه	ماجستير	هندسة النظم و التحكم
Security & Info Assurance	MS	--	SIA	--	ماجستير	الأمن وضمان معلومات
Supply Chain Management	MT	--	SCM	--	ماجستير	إدارة سلاسل الإمداد

Minimum Registration Load for Full-time Students

All full-time graduate students are required to register for at least nine (09) credit hours each semester. Violation of this rule results in dropping of all the courses registered in that semester. The following provides details of the mandatory minimum registration load for full-time graduate students:

1. All full-time graduate students are required to register at least 9 credit hours of courses.
2. M.S. students with 3/6 credit hours remaining must register the M.S. thesis to complete a load of 9/12 credit hours.
3. M.S. students whose transcripts show 24 or more earned credit hours are automatically waived from this condition. All such students must register the Thesis course at least.
4. Students enrolled in non-thesis degrees, whose transcripts show 36 or more earned credit hours are automatically waived from this condition.
5. M.S. students with 3 or more courses left are not allowed to register for the M.S. Thesis (XXX 610).
6. M.S. students who have completed 24 credit hours but their transcripts show less than 24 earned hours, must petition to include any uncounted courses (e.g. 400-level courses) towards the degree in order to avoid having their registration dropped.
7. Courses with IC grades are not counted automatically. Students with pending IC grades and no more courses left to register need to petition for their IC grades to be changed.
8. Ph.D. students who never registered XXX 710 are required to register and pass XXX 711 first and then take XXX 712 in subsequent semesters. For such Ph.D. students:
   a. If only 3 credit hours are remaining to complete the coursework, the student is required to petition to be allowed to register for 6 credit hours (the remaining course and XXX 711) only.

Registration Confirmation

All students who registered for courses during the Early Registration period are required to confirm their registration. Failing to do so results in the dropping of all courses and the student becoming inactive. In such cases, a student is required to apply for readmission in order to continue studies at KFUPM. Further details are found on the Registrar Office website http://regweb.kfupm.edu.sa.

Early Registration

Towards the middle of every semester, continuing students are expected to seek their advisors' approval and early-register for courses for the next semester through the University portal. Students who fail to seek their advisors' approval for early registration or fail to early-register courses for the next semester are put on hold. Removal of hold for either of the aforementioned cases is through the department chairman and Office of the Registrar. Check the academic calendar in the registrar website http://regweb.kfupm.edu.sa/default_fox.asp.

Registration Hold

Graduate Students whose names appear in the Hold List are put on registration hold, which prevents them from registration confirmation for the next semester. The Hold List comprises the graduate students who are still on Provisional Status due to some pending admission provisions in addition to those who have any unfulfilled requirements as stated in the list, and those who have exceeded the maximum allowed duration for degree completion.

Students who did not get their advisors' approval for early registration, are also put on registration hold. In addition, students whose names appear in the list of students expected to graduate are also treated as inactive students and are prevented from registration.

Students on hold due to provisional status, should clear any outstanding requirements stated on their Admission Letters and get their status changed to Regular in order to be eligible to register. Students on hold due to exceeding the degree time limit must submit a detailed report on their progress with a clear statement of the reason for delay, milestones achieved so far, and the plan for the completion of the degree, with the approval of their advisors and the department chairmen. The hold is then lifted subject to the approval of Dean of Graduate Studies.

If a student is placed on hold due to not seeking his advisor's approval for registration, he should contact his academic department and the Registrar's Office for the removal of hold. If a student is prevented from registration due to "Expected to Graduate" status, he may be able to register with the approval of his department chairman.

Inactive Status and Readmission

A graduate student can become inactive due to not registering any course or not confirming the registration in a semester, dropping all courses in a semester or getting dismissed due to a weak/unsatisfactory academic performance. In all such cases, a student is required to request readmission. The readmission form is available online and must be submitted, with the approval of the department, to the Deanship of Graduate Studies at least one month before the start of the intended term of readmission.

Note: The information presented in this chapter represents the implementation rules for KFUPM and it is based on the Unified Regulations for Graduate Studies document prepared by the Ministry of Higher Education. For full details of the unified regulations document, please visit the website of the Deanship of Graduate Studies at http://www.kfupm.edu.sa/gs.

ACADEMIC REGULATIONS

GENERAL REGULATIONS

Graduate students are subject to the general rules of the University governing appropriate conduct, discipline, professional ethics, and personal integrity. They are also governed by the specific academic rules and regulations adopted by the Graduate Council. It is the personal responsibility of the individual student to know and follow these guidelines. Faculty advisors assist and advise students in planning their programs, in the preparation of their thesis/dissertation, and in their professional development, but they are not expected to relieve students of this primary responsibility.

Integrity of Scholarship and Grades

The principles of truth and honesty are recognized as fundamental to any community of scholars. King Fahd University of Petroleum & Minerals expects that both faculty and students will honor these principles and, in so doing, protect the validity of the University's academic grades and degrees, current and past. This means that all academic work will be done by the student to whom it is assigned, without unauthorized aid of any kind. Instructors, on their part, will exercise care in the planning and supervision of academic work so that honest effort will be positively encouraged.

Failure to observe these principles will be viewed with extreme seriousness. Such action will result in immediate disciplinary procedures being taken against the individual or individuals concerned.

Class Attendance

Graduate students are subject to the same rules governing class attendance, the performance of assigned tasks, and course examinations as undergraduate students at the University. Regular and punctual attendance is both a University regulation and a mark of courtesy to the instructor.

Academic Standing and Probation

A graduate student working toward an advanced degree on a "Regular" or "Provisional" status must maintain a cumulative and major GPA of 3.00 or above. Failure to attain a cumulative or major GPA of 3.00 will result in his being placed on academic probation. A graduate student will not be permitted to apply for admission to candidacy for an advanced degree while on academic probation. The status of being on academic probation must be removed by raising the cumulative and major average for all work taken to a GPA of 3.00 or higher, by the end of the semester following that in which probation was incurred. The failure of a student to do so will result in his being suspended and/or dismissed from the University. Graduate students may be dismissed from the program upon extremely low performance without previous warning.

Removal of Provisional Status

To qualify for reclassification as a regular student the graduate student must make up all admission requirements, deficiency courses and attain a GPA of 3.00 or above in his first six (6) credit hours of graduate work attempted at the University. This requirement must be met within the first semester following admission. Failure to do so will result in his being suspended/dismissed from the University.

Credit for 400-Level Courses

Under certain conditions, courses carrying identification codes in the 400-level may be taken for graduate credit (towards a Master's program only). No more than two 400-level courses may be counted for credit towards the requirements of an advanced degree provided that they are permitted in the approved graduate program. Also, these two courses must be approved by the student's graduate advisor, the department chairman, and the Dean of Graduate Studies.

Grades below ‘C’

Individual course grades below C are included in computing the cumulative GPA, but they do not carry credit towards a degree, nor do they satisfy the student’s graduate course requirements. If a student scores a grade below C in a core course of his degree, then he has to repeat it with a grade of C or better, before being able to apply for candidacy.

Withdrawal from Course(s)

With the approval of the department chairman and Dean of Graduate Studies, withdrawal from some or all courses is permitted. Such withdrawal, if it is within the first two weeks of classes, will not appear on the student’s permanent academic record; if it is within the first six weeks, a withdrawal grade (W) will be given (see “Registration”). Full-time graduate students who do not maintain the minimum course load of nine (9) credit hours, withdraw from all courses, or who do not maintain satisfactory progress towards a degree, may be subject to special action by the University, including possible suspension of their degree program, or dismissal.

A student can drop a course or two provided that the registration load does not drop below the minimum load. For this purpose, request for withdrawal from the intended courses must be submitted online through the Registrar’s Office website http://regweb.kfupm.edu.sa. In addition, a duly signed paper form (available at the Registrar’s Office) should be submitted along with the clearance to the Registrar’s Office by the student in person. All the deadlines related to registration are available in the Academic Calendar available on the Registrar’s Office website http://regweb.kfupm.edu.sa.

Regulations for Pre-Graduate Program

The Pre-Graduate program is designed to serve the following classes of students:

Type I: Students with a GPA ranging from 2.0 to less than 2.5.

Type II: Admissible graduate students with a major background deficiency.

Type III: Admissible graduate students who are required to take English courses.

The following guidelines will govern the Pre-Graduate Program:

Type I:

Eligibility: In very special cases and upon the approval of the department and the Dean of Graduate Studies, part-time M.S. students with a GPA ranging from 2.00 to 2.49 on a scale of 4 may be admitted to the pre-graduate program. A work experience of at least two years is required for admission in the Pre-Graduate Program.

Regulations:

1. The student file goes through the normal admission process.
2. Upon approval, the department recommends a list of 3 graduate courses, at least one of which is a core course.
3. The student is required to register the 3 courses recommended by the department within 2 semesters.
4. The tuition fee for the Pre-Graduate courses is similar to the Continuing Education (SR. 550 per credit hour + SR 200 registration fee).
5. The student will be admitted to the Graduate Program after he fulfills the following:
   a. Passes each of the 3 assigned courses with a minimum grade of B.
   b. Submits acceptable TOEFL/IELTS and GRE/GMAT scores as required.

6. During the Pre-Graduate Program, the student has only one chance of re-admission provided he:

   a. Gets the approval of his department and the Deanship of Graduate Studies for discontinuation of one semester.

      Finishes the Pre-Graduate Program within a period of 3 semesters including the dropped semester, if any.

7. The performance of all pre-graduate students is monitored at the end of each semester and Warning or even Dismissal decisions may be taken against students securing grades below B in any of the registered courses.

Type II:

Eligibility: Graduate students with a major background deficiency in the intended program as recommended by the department.

Regulations:

1. The student file goes through the normal admission process.
2. Upon the recommendation of the department of the major background deficiency, the student will be admitted in the Pre-Graduate Program.
3. The student is allowed to register only for the deficiency courses recommended by the department except in the semester in which he is finishing the deficiency courses.
4. The student will be admitted to the Graduate Program after he fulfills the following:

   a. Passes each of the deficiency courses with a minimum grade of B.

   b. Submits acceptable TOEFL/IELTS and GRE/GMAT scores as required.

Type III:

Eligibility: Graduate students who are required to take English courses (The previous study was not in English).

Regulations:

1. The student file goes through the normal admission process.
2. The Deanship of Graduate Studies will recommend a list of English courses based on the performance of the student on the English Test.
3. The student is allowed to register only for the English courses.
4. The student will be admitted to the Graduate Program after he fulfills the following:

   a. Passes each of the English courses with a minimum grade of B and/or submits an acceptable TOEFL score.

   b. Submits an acceptable GRE/GMAT score as required.

DEGREE REQUIREMENTS

General Requirements

An advanced degree is awarded primarily in recognition of the professional development of a graduate student, rather than for completing a prescribed list of courses, which is common with undergraduate degrees. Thus, the requirements for graduate degree are “learning oriented”, rather than “teaching oriented”. The graduate student is required to demonstrate competence in a series of professional requirements expected of members of his profession, and responsibility for acquiring that level of competence is primarily his own.

The Deanship of Graduate Studies has established certain check points in the process of a graduate student’s professional development, and the departmental graduate coordinator and various committees advise and assist him to meet the standards required at these checkpoints. A major responsibility is that of scheduling the entire program so that it is completed in a period of time considered normal for that degree.

Degree Sequencing

The following checklists indicate the normal sequence in meeting degree requirements:

Master’s Degree

1. Admission process completed, including: evaluation of transcripts; tests, if required, completed (eg TOEFL/IELTS, GRE/GMAT, etc.); transfer credit, if any, evaluated and approved; and major selected,
2. Degree plan prepared and approved by the middle of the second semester (8^{th} week) of enrollment at the latest,
3. Thesis advisor and topic selected by the middle of the second semester of enrollment at the latest[2],
4. Student’s thesis committee appointed and thesis proposal submitted by the fourth semester of enrollment at the latest[2],
5. Completion of formal course work, and the grades reported to Registrar, with a CGPA of 3.0 or above,
6. Thesis oral defense (two weeks before the degree is conferred) with a minimum of 4 months and one semester difference required between proposal approval and oral defense,
7. Submission of the final bound thesis to the thesis committee, department and Deanship of Graduate Studies,
8. Proof of completion of degree requirements,
9. Graduation and award of advanced degree.

Ph.D. Degree

1. Admission process completed, including: evaluation of transcripts; tests, if required completed (eg TOEFL or IELTS, GRE, etc.); transfer credit, if any, evaluated and approved; major selected,
2. Degree plan prepared and approved by the middle of the second semester (8 weeks) of enrollment at the latest,
3. Dissertation advisor and topic and advisor selected by the third semester of enrollment at the

[2] Not applicable for students pursuing Master of Engineering or Master Programs that do not require a thesis.

latest,

4. Fulfillment of course requirement, and remedial courses, if any, with a CGPA of 3.0 or above,
5. Comprehensive examination passed by the fourth semester of enrollment at the latest,
6. Student's dissertation committee appointed; Dissertation proposal defended in public by the sixth semester of enrollment at the latest,
7. Dissertation oral defense (two weeks before the degree is conferred) with a minimum of 9 months and two semesters difference between proposal submission and oral dissertation defense,
8. Submission of the final bound dissertation to the dissertation committee, department and Deanship of Graduate Studies,
9. Proof of completion of degree requirements,
10. Graduation and award of Ph.D. degree.

All candidates for advanced degrees must meet certain basic minimum requirements established by the University. In addition, the academic colleges and departments may have additional requirements for advanced degrees in certain areas of specialization. Graduate students are referred to the departmental graduate committee of their major department for details of these special requirements.

Basic Requirements for the Master's and Ph.D. Degrees

All candidates for Master and Ph.D. degrees must meet the following minimum requirements:

1. Satisfactorily complete the minimum semester-credit-hours of course work prescribed for the degree (9 for full-time and 3 for part-time students),
2. Maintain a cumulative and major GPA of 3.00 or better in all graduate work;
3. Satisfactorily fulfill any special conditions and meet any special requirements connected with admission or with departmental requirements,
4. Satisfactorily pass all examinations approved for the program of study,
5. If applicable, satisfactorily complete a thesis or dissertation, on an approved topic and based on candidates original research, which has been supervised by the student's thesis or dissertation committee;
6. Maintain high standards of professional ethics and personal conduct;
7. Satisfactorily complete all special requirements of the candidate's academic college and department which are approved for that advanced degree.

Basic requirements for the Master's and Doctoral degrees are further elaborated in sections pertaining to individual departments (Refer to "A guide to the preparation and administration of an M.S. thesis and Ph.D. dissertation").

Performance Monitoring

The Graduate Council closely monitors the performance of all graduate students. The progress of Ph.D. students is monitored in order to ensure the timely completion of their degrees. All Ph.D. students are required to pass Ph.D. Comprehensive Exams by the 4th semester of their enrolment and are also required to submit their Ph.D. Dissertation Proposals by the end of the 6th semester of their enrolment. Before the end of each semester, the Graduate Council reviews the progress of all Ph.D. students and takes decisions including Warning, Severe Warning and, in severe cases,

Dismissal, as needed.

At the end of each semester, the Graduate Council also reviews and decides on the cases of students with a CGPA less than 3.00. Dismissals, Severe Warnings, Warnings and Academic Probations are issued to such students.

Degree Plan

Within the limitations established by the overall requirements for an advanced degree, the graduate program is intended to be individually planned for the professional development of each graduate student. This permits a considerable degree of choice among courses. The degree plan is the list of courses that will be counted towards the completion of an advanced degree. The degree plan must be submitted by the middle of the second semester (8^{th} week) of the graduate degree program (semesters spent on pre-graduate level are not counted in this duration). It must be confined to the generally approved degree plan of the intended program as described in the Graduate Bulletin. The degree plan must be reviewed and approved by the student's advisor or graduate advisor, the Department Chairman, and the Dean of Graduate Studies. Modifications may be made later, but only when authorized and approved by the same authorities.

Admission to Candidacy

Admission to Graduate Studies does not automatically admit a graduate student to candidacy for an advanced degree. It only admits the student to the process of preparing for such a degree. Initially, this implies the right to enroll in graduate courses.

Formal admission to candidacy is a step in the total process and implies that the graduate student has the intention of qualifying for the degree and has demonstrated sufficient preparation to pursue the graduate study and research required for that degree. Admission to candidacy is contingent upon the recommendation of the student's departmental graduate coordinator and the chairman of the department, and upon the approval of the Dean of Graduate Studies. This may be granted only after completion of certain formal requirements. In particular, an application for admission to candidacy for all master programs may be filed after securing a regular admission status, approval of the degree plan, and satisfactorily completing at least 75% of the semester credit hours of graduate credit in courses included in the student's approved degree plan of study with a GPA of 3.0 or above. These credits must have been earned at King Fahd University of Petroleum and Minerals. Deficiency courses required for admission in a degree program will not be included and have no bearing upon the decision to grant admission to candidacy.

In addition to candidacy conditions of Master programs, candidacy for the Ph.D. degree will only be granted after successful completion of course work and passing the Ph.D. comprehensive examination. Candidacy for the M.S. degree will only be granted after the preparation of a satisfactory thesis proposal. Candidacy for a part-time Ph.D. student is only granted upon starting the one year full-time residency as approved by the department chairman and the Dean of Graduate Studies.

Approval of admission to candidacy will generally depend upon three factors:

1. The quality of the applicant's graduate course work to date (see "General Regulations"),
2. The removal of any special conditions of the academic department related to admission including any admission provisions and deficiency courses,
3. Formal certification by the student's major academic department that the student is well qualified to continue work toward the advanced degree and has fulfilled all requirements. Application forms and instructions may be secured from the auditing Office at the Deanship of Graduate Studies or from its website.

Major and Minor Areas

The Ph.D. program as a whole must be rationally unified and all courses must contribute to an organized program of study and research. Courses must be selected from groups embracing one principal subject of concentration, called the major; and from one or two related fields, called the minor. The major field is normally co-extensive with the work of a single department or with one of the subjects under which certain programs have been formally arranged, but may involve course work in more than one department. The minor is intended to represent a coherent body of work in one or two related disciplines which are selected for their relevance to the major according to the regulations of the department concerned.

Ph.D. Comprehensive Examination

1. The student has to pass a comprehensive examination not later than the end of the second year from the student's enrolment in the Ph.D. Program.
2. The purpose of the comprehensive examination is to ensure that a student advancing to candidacy for a Ph.D. degree has sufficient knowledge in his subject area that enables him to undertake Ph.D. research in his field of specialization.
3. The comprehensive examination will have a written component, while having an oral component is left as an option to the individual departments.
4. The comprehensive examination should be on the student's field of specialization (graduate level). The exam is expected to cover topics from 4-6 graduate-level courses.
5. The comprehensive examination will be administered by the Department Graduate Committee. This includes examination scheduling, nominating faculty members for examination preparation, etc.
6. The comprehensive examination is graded as a unit – pass or fail. (Details of policies regarding Pass/Fail are available with the departmental graduate committees). If a student fails the comprehensive examination, he may be allowed to take it again in the next semester. In the case of failure in the second attempt, the student will be dismissed from the program.
7. A student will be admitted to Ph.D. candidacy after successful completion of the course work and passing the comprehensive examination, in addition to other candidacy requirements.
8. A Ph.D. student has to register the Seminar course XXX 699 in the semester in which he attempts the Ph.D. comprehensive exam for the first time. An NP grade in the Seminar course XXX 699 will only be awarded once the student passes the Ph.D. comprehensive exam. If a student did not pass the Ph.D. Comprehensive Exam at the first attempt, an IC grade will be awarded in the Seminar course XXX 699. The IC grade will be changed to NP upon passing the Ph.D. Comprehensive Exam in the preceding semester; otherwise, it will be changed to NF.
9. The comprehensive examination is the only University-required examination for Ph.D. students before the Ph.D. proposal defense. The preliminary examination is kept as an option for the individual departments to be administered for some students, as the departments consider appropriate.

Full-Time Residency Requirement for Part-Time Ph.D. Students

The PhD programs require that the Part-Time Ph.D. student should reside in one of the Eastern Province cities which are close to the university for at least six academic semesters, according to the following:

1. Four academic semesters while taking the required course load of the program in the Eastern Province cities within 200 km of Dhahran.
2. A full-time residency period of at least two consecutive semesters while working on the PhD dissertation. An agreement of this period by the student and his sponsor is required. This period should be taken after: completing all the required coursework, passing the comprehensive exam, and admission to candidacy. This is to enable the student to be free to accomplish the required research for his PhD dissertation.

Thesis/Dissertation Advisor

After consultation with the department graduate coordinator, and the approval of the department chairman, College Dean & the Dean of Graduate Studies, a dissertation advisor is chosen to be the student's principal source of guidance for his thesis or dissertation preparation. It is the advisor who guides the research activities until the thesis or dissertation is completed and presented for final evaluation, defense, and approval. The advisor is a member of the academic department in which the student is seeking a degree and preferably holds a rank higher than, or equal to, that of an Associate Professor. The professional relationship between the thesis or dissertation advisor and a graduate student is one of the most important and rewarding of all academic relationships. This relationship continues throughout the student's subsequent professional career. The thesis advisor must be selected by the middle of the second semester for M.S. students and by the middle of the third semester for Ph.D. students.

Thesis/Dissertation Proposal

An M.S./Ph.D. student prepares a thesis/dissertation proposal under the guidance of his thesis/dissertation advisor. The work on the thesis/dissertation starts by writing a comprehensive proposal that includes the following: Abstract, Introduction, Literature Survey, Motivation, Proposed Work, Methodology, Preliminary Results (if any), Completion Timeline and Expected Outcomes. The conditions required for approval of a thesis/dissertation proposal are:

1. Admission to candidacy.
2. Completion of course work in the semester the thesis/dissertation is submitted, including the seminar course XXX 599/699.
3. Registration of thesis/pre-dissertation courses in the semester the thesis/dissertation is submitted.
4. Approval of the thesis/dissertation proposal by the department,college councils and Dean of Graduate Studies.

Details are provided in the Thesis/Dissertation guidelines available at http://www.kfupm.edu.sa/deanships/gs/.

M.S. Thesis/Ph.D. Dissertation Committees: Following the selection of a thesis/dissertation topic, with the help of his thesis advisor (chairman of the thesis/dissertation committee), the student selects a thesis/dissertation committee whose membership reflects the specialized professional requirements of the thesis/dissertation topic.

General Requirements: The proposed thesis/dissertation committee should then be approved by the Department Graduate Committee, Department Council, the College Council and the Dean of Graduate Studies. This is an ad-hoc committee which is dissolved following official approval of the student's thesis and degree. In general, a Thesis/Dissertation Committee must comprise an odd number of members, chaired by the thesis advisor. The advisor and co-advisor (if any) should not constitute a majority in the committee and the majority of the committee must be from the academic department of the student. Decisions of the Committee should be based on a majority vote of at least two thirds of the total number of members. The advisor must be from the student's

department while the co-advisor (if any) may be from another department. Researchers in official posts at RI research centers should not constitute the majority of a thesis/ dissertation committee (collaborating faculty are not considered to be in 'official' posts).

Specific Requirements for M.S. Thesis Committee: An M.S. Thesis Committee must comprise at least three (3) members including the advisor. If there is also a co-advisor, the committee must comprise at least five (5) members (including the advisor and co-advisor). The Committee members should meet the conditions of the thesis supervision. At least one member of the Committee must be a Professor or an Associate Professor. All Assistant Professors in the committee should have a strong research background (with at least two (2) refereed ISI journal publications). One member of the committee may be from outside the department. M.S. thesis committees involving an external member and residing out of the Kingdom must be composed of at least five (5) members (including the advisor and coordinator, if any).

Specific Requirements for Ph.D. Dissertation Committees: A Ph.D. Dissertation Committee must comprise at least five (5) members (including the advisor and if any, co-advisor). In some special cases the committee may also comprise seven members. The Committee members must be of Professor or Associate Professor rank and at least one member of the Committee must be of a Professorial rank. One member of the Committee must be from outside the department or the University.

The submission of a dissertation proposal and the intended public defense date must be separated by two semesters, and nine (9) months for Ph.D. degrees. Further instructions about the Ph.D. Dissertation are found in the "Thesis/Dissertation Manual" available online at http://www.kfupm.edu.sa/gs.

Thesis/Dissertation Requirement

A thesis or dissertation is required of all candidates for the Master of Science (M.S.) or Doctor of Philosophy (Ph.D.) degrees regardless of the area of specialization. It is not normally required of candidates for the Master or Master of Engineering Degrees, which involve heavier course loads. The student's thesis/dissertation committee must be formally approved by the chairman of the department or program and the Dean of Graduate Studies.

The thesis or dissertation is considered as primary evidence of the student's capacity for research and independent thought and of his ability to write professionally in the language of instruction. The topic chosen for a graduate thesis or dissertation must be in the major field of the student, and must be formally approved by the student's graduate coordinator, his graduate thesis or dissertation committee, the academic department chairman, and the Dean of Graduate Studies. These approvals should be obtained as early as possible in the student's graduate program and concurrently with the establishment of his graduate thesis or dissertation committee.

Completion of the thesis or dissertation depends upon securing results from a program of independent research, not upon a predetermined amount of time involved in the research. Because research results are not predictable, it is desirable that work on the thesis or dissertation begin early in the student's graduate program. Guidance by the graduate coordinator and graduate thesis or dissertation committee on the choice of topic and the design of the research is essential to ensure that the problem selected is of manageable proportions.

Upon completion of the research, the written report of the findings must be prepared and approved. This document is often referred to as the thesis or dissertation, although the term also refers to the contents or findings of the research. This thesis or dissertation document must be prepared in conformity with the general publication regulations of the University, including correct use of the English language, and must conform to any special publication regulations established by the Deanship of Graduate Studies for thesis and dissertations. This office should be

consulted regarding the manual which specifies the style that must be adopted in thesis writing.

Only in very exceptional cases may an M.S. thesis be completed in absentia, under the careful supervision of the Deanship of Graduate Studies. The professional demands upon the in absentia student are inevitably much greater than when the full resources of the University are immediately available to him. Formal written permission for in absentia thesis completion must be secure in advance from the student's graduate coordinator, his graduate thesis committee, his academic department chairman, and the Dean of Graduate Studies. Before leaving the University for research in absentia, the student must also submit and secure formal approval of his plan of research and of his proposed thesis outline from the same authorities. Periodic progress reports to the graduate co-advisor are required.

Completed copies of the thesis/dissertation document must be submitted to the thesis/dissertation advisor, thesis/dissertation committee, and academic department not less than four (4) weeks prior to the date when the candidate expects to receive his degree. The student will be examined on his thesis/dissertation and on the research which produced it in a public examination scheduled not less than two (2) weeks before the graduation convocation.

Oral Thesis/Dissertation Defense

An oral defense of the M.S. thesis or Ph.D. dissertation is required of all candidates for a Master of Science or Doctor of Philosophy Degree. The oral defense is allowed in regular semesters from week two (2) till week fifteen (15) only. It is not allowed beyond this time or in summer. The oral defense is not normally required for the Master degrees that do not require a thesis.

The student is required, following consultation with his thesis or dissertation committee and upon securing the approval of the Dean of Graduate Studies, to arrange a time and a place for the public defense of his thesis or dissertation. The submission of a thesis/dissertation proposal and the intended public defense date must be in two different regular semesters. The M.S. thesis public oral defense can be scheduled at the earliest one semester after the thesis proposal approval with a minimum of a 4-month period separation. For PhD dissertations, there should be two semesters and a minimum 9-month period from the approval of the dissertation proposal to the dissertation public oral defense. The conditions needed for approval of thesis/dissertation oral defense are:

1. Admission to candidacy,
2. Approval of thesis/dissertation proposal at least one/two semesters with a minimum separation of 4/9 months for M.S. thesis/Ph.D. dissertation, respectively.
3. Thesis/dissertation course is registered in the semester in which the defense is planned.
4. Completion of all course work before or in the semester in which defense is planned, including the seminar course (599/699).
5. Completion of 4 semesters and 6 semesters in M.S. and Ph.D. degrees, respectively.

The oral thesis/dissertation defense covers the student's thesis or dissertation and the research involved in that study. It is conducted by the student's graduate thesis or dissertation committee. The student must secure approval from the Deanship of Graduate Studies and coordinate the time of his oral defense. A public notice is sent to all members of the Graduate Faculty, and University community inviting them to attend the thesis/dissertation defense. Faculty and graduate students enrolled in the University are invited to attend but not to participate in the examination. In addition, a faculty representative from Graduate Studies may attend the defense as an observer.

The graduate thesis or dissertation committee records its vote in closed session and formally reports its verdict to the Dean of Graduate Studies within three working days. Degrees will be conferred upon recommendation of the majority vote of the committee (excluding supervisor(s)).

The successful completion of the examination requirement must be registered not later than ten (10) days before graduation if the student is to be awarded his degree at the Graduation Convocation. It is important to note that thesis/dissertation defense can only be scheduled during the days of regular classes of regular graduate semesters i.e. it cannot be scheduled during the period of final examinations, registration week and summer semesters.

A student may attempt the oral thesis defense only twice and upon two unsuccessful attempts, he shall be dismissed from the University.

The University policy requires all members of the thesis/dissertation committee, including the external members, to attend the defenses by being physically present in the premises of the University. Exemptions are only given to external committee members residing out of the Kingdom, who can attend the public oral defense through video conferencing facilities.

The grading policy for **XXX 711 Ph.D. Pre-Dissertation** is as follows:

NP: Student has submitted the Ph.D. Dissertation Proposal and defended it successfully.

IC: Student has not submitted the Ph.D. Dissertation Proposal and/or has not defended it successfully. He can clear it to NP within the next semester at the latest.

NF: Student has FAILED to make any progress towards the Ph.D. Dissertation Proposal and has not defended it successfully.

The grading policy for **M.S./Ph.D. Thesis/Dissertation (XXX 610, XXX 712)** is as follows:

NP: Student has defended AND submitted his bound copy.

IC: Student has defended successfully and is working on the corrections.

IP: Student is progressing well. Students must continue registering the course in the subsequent semesters until he publically defends his thesis/dissertation.

NF: Student is progressing below satisfactory level or is not progressing at all. Securing an NF grade twice in the thesis/dissertation course results in final dismissal from the degree program.

Submission of Thesis/Dissertation

After the student has successfully defended his thesis/dissertation, he is given at most one (1) semester of final preparation for the submission of his thesis/dissertation. The scholarship provided for full-time graduate students will not be available in that semester.

Three (3) bound copies and one (1) unbound copy of the thesis/dissertation, formally approved by the thesis/dissertation committee, chairman of the academic department and Dean of Graduate Studies in addition to two (2) CDs comprising the PDF version of the unbound copy, must be submitted to the Deanship of Graduate Studies not less than ten (10) days before the graduation convocation. The students are also required to upload the thesis files through the ePrint system available at the University Library website. The students are advised to refer to the Thesis Manual for details, which is available online at http://www.kfupm.edu.sa/gs.

Proof of Requirement Completion

Advanced degrees are officially conferred at the end of the fall, spring, and summer terms and bear that date. Formal graduation exercises are held once every year, in the Graduation Convocation towards the end of the Spring Semester. Students who have fully met all requirements for graduation by the official dates of any of the three terms are considered to have been awarded the degree as of that date. All are invited to participate in the graduation exercises at the Spring Convocation, at which time the diploma for the degree is presented.

Students who complete their degrees in the summer and fall terms may request evidence of this

prior to receipt of their diplomas. Upon request, such students will be furnished with an official document certifying that the student has completed the requirements for a specific degree and stating the date on which the degree will be conferred.

Time Limit for Degree Completion

Work pursued towards an advanced degree must be reasonably current. This is especially necessary for studies in technical fields where changes take place rapidly. To ensure this, two time limitations applied to courses and degrees will be as follows:

- All requirements for any master's degree must be completed within a period of five (5) semesters for all full-time students including Research and Graduate Assistants, and five (5) years for part-time graduate students. However, under exceptional circumstances and upon the recommendation of the student's advisor and the concurrence of the chairman of the department concerned, a request for an extension may be considered by the Dean of Graduate Studies for not more than one additional year. For part-time Masters students this limit is five (5) years and for MBA students it is six (6) years.
- All requirements for any full-time Ph.D. degree (also for Lecturer B's) must be completed within a period of five (5) years. However, for part-time Ph.D. students the limit is seven (7) years. Under exceptional circumstances and upon the recommendation of the student's advisor and the concurrence of the chairman of the department concerned, a request for an extension will be considered by the Deanship of Graduate Studies for not more than one additional year.
- Part-time Ph.D. candidates must spend at least one (1) year of residency on full-time status by submitting a Letter of Release from the employer (template available at http://www.kfupm.edu.sa/gs) after passing the Ph.D. Comprehensive Exam and completion of coursework.

Credit Loads & Degree Completion Time Limits

Details about minimum and maximum allowed Graduate Studies workloads are summarized in the following table:

Admission Types	Credit Hours per Semester Min-Max	Time Limit for Completion
Graduate/Research Assistant	9-12	5 Semesters
Lecturer B	9-15*	10 Semesters
Full-Time Graduate Students	9-12	5 Semesters
Full-Time Graduate Students (Ph.D.).	9-15*	10 Semesters
Part-Time Graduate Students (M.S./MT/MEG)	3-6	10 Semesters
Part-Time Graduate Students (MBA)	3-9	12 Semesters
Part-Time Graduate Students (Ph.D.)	3-9	14 Semesters

***** The approval of the Vice Rector for Academic Affairs is needed to allow a 15 credit-hour load.

Regulations for Research Assistants and Lecturer-Bs

1. All RAs/LBs are expected to spend 15 hours/week in teaching, research or administrative duties in the assigned unit (department or center). Departments/centers should monitor the work load and quality of all RAs/LBs to ensure the high-quality delivery of services to the University.
2. All RAs/LBs in the University are treated as any full-time (FT) student in all academic matters in terms of course load, thesis formation, registration, etc.

3. All RAs/LBs and FT students may select their thesis/dissertation advisors and research topic from faculty in the departments offering the graduate program pending the approvals of the department chairman and Dean of Graduate Studies.
4. Researchers in official posts at research centers should not constitute the majority of a thesis/dissertation committee (collaborating faculty are not considered to be in ‘official’ posts).

A typical degree timetable for full time M.S. students

Admission

1st Semester

- Register 3 courses
- Submit Degree Plan (optional)

2nd Semester

- Register 3 courses and seminar course
- Submit Degree Plan (if not submitted already)
- Select thesis advisor
- Select preliminary thesis topic

3rd Semester

- Register remaining courses and Thesis
- Select thesis committee
- Submit thesis proposal

4th Semester

- Register Thesis
- Thesis defense and degree completion

A typical degree time table for part time M.S. students

Admission

1st Semester

- Register 2 courses
- Submit Degree Plan (optional)

2nd Semester

- Register 2 courses
- Submit Degree Plan (if not submitted already)
- Select thesis advisor

3rd Semester

- Register 2 courses and seminar course
- Select preliminary thesis topic

4th Semester

- Register remaining courses and Thesis
- Select thesis committee
- Submit thesis proposal

5th Semester

- Register Thesis
- Work on Thesis

6th Semester

- Register Thesis
- Thesis defense and degree completion

A typical degree time table for full time Ph.D. students

Admission

1st Semester
- Register 3 courses
- Submit Degree Plan (optional)

2nd Semester
- Register 3 courses
- Submit Degree Plan (if not submitted already)

3rd Semester
- Register 3 courses and Seminar course
- Select dissertation advisor
- Attempt Ph.D. Comprehensive Exam

4th Semester
- Register remaining courses and pre-dissertation
- Final chance to pass Ph.D. Comprehensive Exam
- Select preliminary dissertation topic

5th Semester
- Register Ph.D. Dissertation
- Select dissertation committee
- Submit Dissertation proposal

6th Semester
- Deadline to submit dissertation proposal

7th Semester
- Register Ph.D. Dissertation
- Work on Dissertation

8th Semester
- Register Ph.D. Dissertation
- Dissertation defense and degree completion

Note: The information presented in this chapter represents the implementation rules for KFUPM and it is based on the Unified Regulations for Graduate Studies document prepared by the Ministry of Higher Education. For full details of the unified regulations document, please visit the website of the Deanship of Graduate Studies at http://www.kfupm.edu.sa/gs.

RESEARCH SUPPORTING UNITS

All graduate students join the Deanship of Graduate Studies and enroll in the graduate programs operated originally in the KFUPM academic departments. Academic departments host a large number of research facilities in all areas. However, faculty members involved in the graduate programs and their graduate students can benefit from all research facilities and research avenues available in various research units at KFUPM. These research units are administered by three Vice Rectors, namely, Vice Rector for Scientific Research, Vice Rector for Applied Research, and Vice Rector for Technology Development and Industrial Relations. A brief description of the functionality of the units under these Vice Rectorships is given below.

VICE RECTOR FOR GRADUATE STUDIES & SCIENTIFIC RESEARCH

The units administered by the VR for Graduate Studies and Scientific Research include the Deanship of Scientific Research and the academic departments.

The Deanship of Scientific Research

The Deanship of Scientific Research (DSR) at King Fahd University of Petroleum & Minerals (KFUPM) was originally established as part of the Deanship of Graduate Studies in the year 2000, and then became an independent Deanship in September 2005. The DSR is responsible for the planning, management, promotion and support of research activities that are carried out by the academic departments through internal and external funding. The Deanship is managed by the Dean of Scientific Research. The functional responsibilities of the DSR include research activities such as funded research projects, professional conference attendance, sabbatical leaves, release time, research scholarship programs and research awards. In addition, the Deanship manages a central workshop that serves the research needs of KFUPM faculty. The Deanship plans and manages research and other scholarly activities through the Scientific Research Council, the Research Committee, the Arabic Research Committee and the Conference Committee.

The Scientific Research Council is a regulatory body chaired by the Dean of Scientific Research and the members are selected from various academic departments. The Research Committee is an executive body composed of 11 members that represent the different University colleges and the Research Institute. The Arabic research committee concentrates on the review and support of Arabic book authoring and translation in addition to Arabic research projects and studies. The Conference Committee is dedicated to the evaluation of applications submitted by faculty to attend regional and international scientific and professional conferences and meetings. All committees are chaired by the Dean of Scientific Research with members selected/elected from the different academic departments of the University.

Research Grants

The Deanship of Scientific Research provides support grants for research in all areas of science, engineering, environmental design and management with the aim of promoting productive research and creative scholarship. This support includes:

i. Monthly compensation for faculty, graduate students and technicians contributing to the project,

ii. Per diem support to attend internationally recognized conferences to present papers,

iii. Purchase of equipment, stationery and all expendable items,

iv. Support for sabbatical and summer scholarly programs.

v. Support to undertake local and international visits for the purpose of gathering information, discussing results, performing experiments and testing, and thereby availing of services that are not available at KFUPM.

vi. Payment of mandatory page charges up to a maximum of US$ 750 per paper for faculty and researchers, who do not have research projects funded by the University. If a faculty member has an approved University-funded project, containing a specific allocation for publication charges, the maximum limit can be raised to US$ 1,000.

In addition to the above, the Deanship launched a new initiative for undergraduate students in January 2012. The KFUPM Undergraduate Students' Research Grants (USRG) provides flexible and responsible research support to undergraduate students with outstanding credentials and who are interested in pursuing quality research work. The Grant intends to stimulate the interest in research and innovation among KFUPM undergraduate students, and inspire many of them to become future research leaders.

As part of its continuous support, the Deanship of Scientific Research has recently developed a portfolio of research grants suitable for different categories of KFUPM faculty and researchers. The Research Startup Grant is a new internal grant intended to meet the needs of a new category of faculty and researchers at KFUPM. It is suitable for those who are new to the University but do not fall into the junior faculty track or those who have been with the University for some time but have been relatively less involved/active in their research. This grant is intended to facilitate a smooth transition for new faculty from their previous research activities to the new research environment at KFUPM and for those who have been relatively less involved in their research, the grant is intended to act as a start-up facility to restart or reinvigorate their research.

The Major Research Equipment Grant (MREG) has been introduced at KFUPM to support major research equipment submissions from faculty and established researchers involved in active research programs. The MREG is an exclusive grant for purchasing equipment or establishing a facility for conducting research by the University faculty and researchers. The aim of the scheme is to encourage, support and facilitate collaboration among researchers in acquiring equipment that could be used by numerous parties. The MREG funds will be used to purchase equipment exceeding SR 100,000.

All proposals are evaluated by two or three international reviewers selected by the University Research Committee from well-known experts in the fields of the proponents. The final decision either to accept or reject the proposal is based upon the reviewer's evaluation of the proposal and a formal presentation. Research grants include Internal Project Grants, SABIC and Fast Track Grants, Junior Faculty Grants, Societal Grants, Book-Writing Grants, and a Sabbatical Leave Grant. The grant details and submission guidelines and forms are available at the Deanship website: http://www1.kfupm.edu.sa/dsr.

Conference Attendance Support

The University encourages and supports its faculty members to participate in high-quality conferences and professional meetings sponsored by leading professional societies and held both regionally and abroad. Attending such conferences or meetings permits a free exchange of new ideas, concepts and developments, and enables the faculty member to develop and execute his own research, and the University to be recognized as a center of academic excellence. A faculty member may apply for a travel grant to attend a conference provided he meets any of these criteria:

a. Attending a conference to present a paper,

b. Attending a conference on the basis of a published paper,

c. Attending a conference based on invitation/Keynote speaker, or

d. Attending a conference based on an approved research or book writing project.

Faculty can be supported to attend as many as three conferences a year. Graduate students can be

supported to attend one international conference per academic year based on the preceding criteria. Conference attendance support details and submission guidelines and forms are available at the Deanship website: http://www1.kfupm.edu.sa/dsr.

International Scholar Programs

Two major scholar programs are open to exclusively Saudi faculty from all the universities within the Kingdom. The British Council Summer Research Program is a Post-Doctoral research program designed to encourage Saudi faculty members to execute their research projects in British universities. The program carries a fixed financial grant by the British Council in addition to financial support from KFUPM. The Fulbright Scholarship Program, which is jointly funded by the University and the United States Information Service, is also a Post-Doctoral research grant designed to encourage Saudi faculty members to execute their research projects in reputable US universities. The grant includes financial support for a limited number of Saudi faculty members to spend between three months and one year in host institutions in the U.S.A. The scope of research includes a wide range of subjects in the fields of science and engineering.

As part of promoting technical cooperation with the researchers of university and national institutes of petroleum refining in oil-producing countries, the Deanship nominates through the Vice Rector for Graduate Studies & Scientific Research two researchers every year during summer to attend the Japan Petroleum Institute (JPI). The JPI invites researchers to attend suitable Japanese organizations in the researchers' fields of study based on the understandings between both parties

The Deanship of Scientific Research launched a new initiative for establishing collaboration in January 2012. The International Summer Scholarly Program (ISSP) is applicable to all professorial rank faculty members at KFUPM. The grant aims to expose faculty members to new experiences, new ideas and new opportunities for international research collaboration. The program is competitive and only selected individuals (3 slots) will be chosen based on merit, with preference given to those applicants who have not availed themselves of this opportunity in the past.

Research Awards

In recognition of active and quality researchers, the Deanship of Scientific Research offers a number of awards University-wide, which includes the Distinguished University Professorship Award, Distinguished Researcher Award, and Best Research Project Award.

The Central Research Workshop

The DSR manages a central research workshop that is capable of fabricating and fixing research equipment and instruments for research projects. The workshop has machining, assembly and instrumentation capabilities that can be utilized by all KFUPM faculty and students to support their research needs.

Research Day

The Deanship of Scientific Research has been organizing Research Day since 2010 to promote the culture of collaboration/cooperation in the emerging fields of knowledge in specific areas of national and international importance. This event provides an opportunity for the faculty, researchers, and graduate students to come together and enlighten themselves about the research activities at the University, explore new collaborations, and lay a foundation for new partnerships.

Science and Technology Unit (STU)

The Science and Technology Unit (STU) at King Fahd University of Petroleum & Minerals (KFUPM) established within the DSR in the year 2008 deals with projects for which King Abdul Aziz City for Science & Technology (KACST), Riyadh, serves as the funding body. This unit is a

link between KACST and KFUPM for overseeing these projects in order to manage, monitor and ensure proper implementation of all projects awarded under:

i. National Science, Technology and Innovation Plan (NSTIP)
ii. KACST Annual Program (KAP)

The following are the main strategic areas of research under NSTIP:

i. Water Technology (WAT)
ii. Enhanced Oil Recovery (OIL)
iii. Refining & Petrochemicals (PET)
iv. Nanotechnology (NAN)
v. Advanced Materials (ADV)
vi. Electronics & Telecommunications (ELE)
vii. Biotechnology & Genetic Engineering (BIO)
viii. Information Technology (INF)
ix. Aerospace Technologies (SPA)
x. Energy Technologies (ENE)
xi. Environment Protection (ENV)
xii. Medical and Health (MED)
xiii. Agriculture Technology
xiv. Building and Construction

The proposed topic should fall under any of the above specified strategic areas of the plan; the maximum duration of the project should not exceed 2 years; and the maximum budget of the project should not exceed SAR 2 million.

Information about NSTIP Proposals are available at: http://www1.kfupm.edu.sa/dsr/nstp.htm

Unlike NSTIP projects, KAP projects are open and not restricted to strategic directions. Also,the maximum duration and budget of these projects are not limited and depend upon the project type.

Information about KAP Proposals are available at: http://gdrg.kacst.edu.sa/.

VICE RECTOR FOR APPLIED RESEARCH

The research units administered by the VRAR include the Research Institute and the Centers of Research Excellence.

THE RESEARCH INSTITUTE

Research at the University can be classified into personal, sponsored, and client-funded. The first two categories involve faculty members in academic departments who may follow their personal interests or participate in research sponsored by the University or other funding agencies. Client-funded research is administered by the Vice Rector for Applied Research and involves the Research Institute (RI) and academic departments. The RI is the focus of client-funded research at the University and its full-time researchers together with faculty members undertake research projects. Graduate students participate in applied research projects and RI research faculty serve on their thesis committees.

The mission of the RI is “to serve the nation by conducting client-driven research and development utilizing University resources.” Among its objectives are: to serve the nation as a

professional problem-solver; adapt imported technologies to the Saudi environment; serve the needs of government organizations, local industry, and businesses in research and development; develop local expertise and extend the Kingdom's knowledge base; support graduate and undergraduate programs at KFUPM; and contribute to the high-quality education and training of students.

Client-funded research projects are undertaken either as a result of requests received from clients or technical memoranda submitted to prospective clients by RI researchers or faculty on potential applied research topics. However, in many cases, organizations approach the RI to seek help in dealing with problems they are facing. Alternatively, the RI may receive a 'request for proposal' (RFP) to submit a proposal and undertake applied research work. The response in all cases will be a proposal describing the approach, scope, duration, and cost, with milestones and deliverables.

Clients normally award contracts for very specific studies. A project team is formed consisting of fulltime RI researchers and faculty members with the required expertise and experience. This arrangement allows the utilization of the vast manpower pool available for applied research consisting of RI professionals and faculty members.

The main units of the RI and the available technical expertise for applied research are as follows:

- Center for Communications & Information Technology Research: Communications and Information Technology.
- Center for Economics & Management: Business Incubators, Economic Studies, and Management and Quality Control.
- Center for Engineering Research: Materials, Urban Areas Engineering, Engineering Analysis, Energy Systems, Materials Characterization and Metrology.
- Center for Environment & Water: Water, Environment and Marine Studies.
- Center for Petroleum & Minerals: Petroleum & Gas Engineering, Petroleum Geology & Geophysics, Mineral Resources, and Remote Sensing.
- Center for Refining & Petrochemicals: Refining, Petrochemicals and Petrochemical Product Development.
- Applied research support for the entire University is provided by the Center for Research Support.

Research conducted by the RI is in the following areas:

- Studies in the areas of communication and signal processing, computer networking and information security, database and web applications, e-business and enterprise resource planning, computer applications and smart systems,
- Strategic planning, e-government implementation, e-business, and e-health, cost, economics, financial analysis and business modeling,
- Studies in the areas of mechanical, civil, and electrical engineering such as building materials and corrosion, engineering of structures, power generation and transmission, simulation of engineering systems, metrology and materials characterization,
- Marine pollution; atmospheric pollution monitoring; landfill waste disposal; and groundwater quality monitoring,water resources and irrigation system analysis and modeling,
- Optimization of production of oil and gas via appropriate drilling and extraction techniques, maximization of knowledge of oil- and gas-bearing stratigraphy, enhancement of oil exploration through remote sensing, and mineral resource studies; and

- Development and improvement of catalysts, processes, and products, improvement of polymer production processes and enhancement of the use of polymers and plastics.

Typically, approximately 50 client-funded projects are active at any given time, and over 100 project reports are produced annually. Many hundreds of laboratory services are completed each year, and the number of clients served in a year is about 150. In addition, RI researchers produce over 100 publications in the open literature annually. Many patents have been issued for inventions resulting from applied research projects and others are under process.

The manpower of the RI consists of 252 full-time employees, comprising 63 Ph.D. degree holders, 73 M.S. degree holders, 43 BS degree holders, and 73 with other credentials. Project teams are typically formed of 35% full-time RI researchers, 25% faculty members, 10% students, and 30% support staff.

CENTERS OF RESEARCH EXCELLENCE

Center of Research Excellence in Petroleum Refining and Petrochemicals

The Center of Research Excellence in Petroleum Refining and Petrochemicals (CoRE-PRP) was established by the Ministry of Higher Education in February, 2007.

Mission

Conduct patentable, technology-developmental, basic and applied research in petroleum refining, petrochemicals, catalysis, and polymer science and technology, which together make the essential constituents of the strategic and major areas of research concentration for Saudi Arabia.

Vision

Achieve, preferably in five years, a research level that will increasingly attract relevant national and international industries, and especially attract talent worldwide for quality graduate and post-graduate education and training.

Objectives

- Establish and grow highly focused research programs that will generate novel concepts and intellectual properties, leading to produce higher value-added and improved products, and reduce production costs.
- Broaden undergraduate and graduate education in the areas of the Center’s research concentration, providing a strong workforce base and more highly skilled manpower for the local refining, petrochemical, and polymer industries.
- Enhance the international competitiveness of Saudi Arabian refining, petrochemicals, and polymer industries.
- Promote cooperation and efficiencies in research by strengthening domestic and international research linkages, and particularly by significantly increasing the current industrial affiliations.

Specific Focused Research Topics

Petroleum Refining

- Clean transportation fuels: Removal of sulfur, aromatics, and olefins.
- Fluid catalytic cracking (FCC): Development of additives and formulations for FCC catalysts.
- Heavy residual upgrading.

Petrochemicals

- Benzene, toluene, and xylene (BTX) aromatics.
- Selective oxidation of lower alkanes.
- Reaction kinetic and process simulation.
- Process synthesis and control.

Polymers

- Polyolefin research: Polyolefin synthesis and production.
- Novel supports (nano-support and polymeric support) and catalysts.
- Additives/formulations.
- Nanocomposites/blends.
- Plastics recycling.
- Polyolefin processing.
- Development of models capable of predicting the end-product properties.
- Identification and solution of problems facing the local plastics industries.
- Polyolefin end-products performance evaluation.

Center of Research Excellence in Nanotechnology

Center of Research Excellence in Nanotechnology (CENT) was established in 2007 with generous support from the Custodian of the Two Holy Mosques, King Abdullah Ibn Abdulaziz Al-Saud. CENT aims to be the platform through which KFUPM will develop a nanotechnology program that will enable its scientists and faculty members to conduct Nanoscience- and Nanotechnology-based research in areas of strategic importance for the Kingdom. CENT will also support the same through teaching at KFUPM.

CENT aims to build a world-class research capacity including highly qualified scientists and staff in the field of nanomaterials synthesis and their applications. CENT accesses state-of-the-art facilities including TEM, FE-SEM, AFM/STM, RF Sputtering system, CVD and PVD reactors, lasers, and more. CENT is committed to developing innovative nanotechnology-based solutions in strategic areas for the Kingdom such as water purification, petrochemicals, renewable energy and corrosion.

Objectives of CENT include:

- To build a world-class research capacity including highly qualified scientists and staff in the field of nanomaterials synthesis and their applications.
- To develop research infrastructure including state-of-the-art facilities that enable the Center to achieve its goals.
- To develop innovative nanotechnology-based solutions in strategic areas for the Kingdom such as water purification, petrochemicals, renewable energy and corrosion.
- To contribute to the development of teaching graduate programs and training students in the field of nanotechnology.
- To promote public awareness regarding the benefits and the risks of nanotechnology.
- To co-develop a graduate program in nanotechnology.

Center of Research Excellence in Corrosion

The impact of corrosion on industry in terms of safety, cost and reliable provision of services is undeniable. Likewise, the potential costs of corrosion to the environment and society as a whole can be enormous. As a result, corrosion mitigation has been increasingly perceived as one of the priority areas in the Kingdom of Saudi Arabia. The Center of Research Excellence in Corrosion (CoRE-C) was established by the Ministry of Higher Education at King Fahd University of Petroleum and Minerals to advance research in this field for the benefit of academic institutions and industry alike and form a nucleus for deriving a working strategy to combat corrosion to serve both the short- and long-term needs of the Kingdom. The Center of Research Excellence in Corrosion has substantive ties with academic institutions and industries within the Kingdom and other countries. The Center, in collaboration with the government and industrial sector, formulates research programs that cater to the local needs. It will also develop strategies to define, improve, measure and monitor the quality of corrosion research programs in the Kingdom. It acts as a platform to invite world leaders in the field of corrosion to transfer the latest knowledge and develop collaboration with professionals in the Kingdom. It will provide support for the development and use of new technologies.

Vision

The vision of the Center is to advance research in the field of corrosion with the ultimate aim of developing solutions and facilities for mitigating related problems in the Kingdom of Saudi Arabia.

Mission

The mission of the Center is as follows:

- To utilize the available pool of human resources and facilities in conducting basic and applied research in corrosion consistent with the requirements of the Kingdom of Saudi Arabia.
- Develop a strategy to combat corrosion and reduce its effect on the environment, industry and civil society.
- Provide nationwide support to the industry in solving the corrosion problems from its state-of-the-art corrosion laboratories.
- Share knowledge on corrosion prevention with other organizations in the Kingdom.
- Build critical technological and information resources.
- Support the development of creative and innovative activities in the area of corrosion prevention and monitoring.
- Define strategies to improve, implement and monitor the quality of corrosion research in the Kingdom.

Center of Research Excellence for Scientific Research Cooperation with the Massachusetts Institute of Technology

The Mechanical Engineering Department at Massachusetts Institute of Technology and the Mechanical Engineering Department at King Fahd University of Petroleum and Minerals agreed to form a seven-year joint collaboration in research and educational programs. The collaboration agreement is composed of two main components: research programs and education. Faculty and students involved in this collaboration, from both institutions, will conduct research and develop academic programs through projects in areas of strategic importance to Saudi Arabia and to disseminate knowledge, and transfer technologies for tackling problems associated with the progress of a knowledge-based economy. In addition, an applied aspect of this effort will focus

on solving current problems facing today's industry. The education component allows for an exchange of students and faculty to improve teaching and enhance academic programs.

Collaboration Programs

The Center will focus on three areas for research and education:

- Clean Water.
- Clean Energy.
- Design, Manufacturing and Nanotechnology.

The research projects in each program will lead to a better understanding of the fundamentals/basic knowledge which will address questions concerning the related technologies including the development of tools for innovative new technology development.

The education component of the Center also aims to develop new multidisciplinary courses at KFUPM and will involve faculty and students from both KFUPM and MIT conducting joint educational projects. It will include the opportunity for graduate students to be advised by faculty from both institutions and allow for the exchange of students and faculty.

Technology Innovation Center on Carbon Capture and Sequestration

This proposal was invited by the King Abdulaziz City for Science & Technology, Riyadh under the KACST Technology Innovation Centers program. The King Fahd University of Petroleum & Minerals proposed to establish the Carbon Capture and Sequestration Technology Innovation Center at KFUPM. Professor M. A. Habib is serving as the Center's Principal Investigator.

The goal is to establish a Carbon Capture and Sequestration Technology Innovation Center (KACST-TIC on CCS) at King Fahad University of Petroleum & Minerals that will address the technologies of Carbon Capture and Sequestration that can be utilized in the Kingdom of Saudi Arabia. The main goal of the Center is to:

- Develop strategic technology initiatives in the area of Carbon Capture and Sequestration,
- Create, develop and enhance capacities that are capable of transforming fundamental research into new technologies in the area of CCS,
- Enhance infrastructure for research and education in the area of CCS including facilities, instrumentation and partnerships,
- Promote university-industry research collaboration and technology transfer in the Kingdom of Saudi Arabia related to Carbon Capture and Sequestration, and
- Promote the role of large and small firms in developing new technologies of Carbon Capture and Sequestration.

Center of Research Excellence in Islamic Banking & Finance (CoRE-IB&F)

The Center was established in June 2009 to provide high-quality research and education in the field of Islamic Banking & Finance.

Vision

The vision of the Center is "To be a global leader of research and education in the field of Islamic Banking & Finance and promote the industry through the brightest research findings."

Mission

The mission of the Center is "To perform the highest quality research in our selected areas of Islamic Banking and Finance and provide a common research platform to the rest of the world in order to expand the horizons of an Islamic economic system."

Objectives

The Center aims to improve upon the limited research in the field of Islamic Banking & Finance carried out globally. Also, through relevant workshops, it endeavors to provide a center stage for well-known researchers and practitioners of the industry to present and share ideas based on the existing circumstances.

The specific objectives are to:

- Conduct research in the Center while also receiving input from well-known experts in the the industry.
- Host events such as workshops, conferences, and seminars to provide a forum to internationally renowned experts to share their findings and present new ideas.
- Execute training programs and popular lectures on Islamic banking and finance to raise awareness amongst the community.
- Establish a comprehensive academic program in the University with specialized faculty and textbooks.
- Contribute to the University Scholarship Program by selecting the most suitable students for higher education who will ultimately serve the industry.
- The Center also strives to assist the Department of Finance & Economics in developing effective undergraduate and graduate courses in Islamic Finance.

Center for Strategic Studies & Planning

The Center was established in 2009 to conduct studies and provide consulting services in strategic and operational planning.

The Center provides strategy consulting services to Government and private organizations with focused solutions in strategic, operational, and technical planning and initiative implementation. The Center is devoted to providing in-depth expertise and objective analysis of strategic issues of national importance.

The Center has recently completed a strategic planning project for research studies on post-secondary education. A project aimed at developing an e-learning strategic plan for the Royal Saudi Naval Forces is ongoing.

SUPERVISOR FOR TECHNOLOGY TRANSFER, INNOVATION AND ENTREPRENEURSHIP

The Technology Transfer Organization and Science Park of KFUPM were set up to support the Kingdom's transition to a knowledge economy. The Technology Transfer Organization constitutes three entities: Innovation Center, Entrepreneurship Institute and Science Park Liaison Office. The Science Park is managed by the Dhahran Techno Valley Company (DTVC), which is also mandated to invest in Intellectual Property (IP) commercialization and provide a platform for business development support.

A. Innovation Center

The Innovation Center (IC) acts as KFUPM's 'Intellectual Property and Technology Licensing' (IPTL) Office, and executes its activities under two sub-entities: 'Intellectual Assets Office' and 'Technology Business Support Unit'. The activities of the IC mainly include the following:

- **Continuously assessing all KFUPM assets for licensing**

  Assessment of a new invention disclosure or discovery to make a decision about licensing potential, including ownership and patentability. Additionally, ensuring that the newly disclosed intellectual property is in compliance with University policies.

- **Licensing potential assets and marketing for licensing**

  Performing an initial market assessment to identify market needs and trends, and demographic factors which influence the market.

- **Enhancing potential of KFUPM IP assets for licensing**

  KFUPM assets that have a potential for licensing but lack the proof of concept relevance support are advanced through the "Proof-of-Concept" (PoC) program. The PoC is designed to provide funding assistance to faculty/students in the early stages of developing and validating nascent technologies originating in their labs. The strategic objective of the fund is to assist KFUPM to license such technologies more effectively and to expedite the transfer and public availability of promising new technologies. The program is managed jointly by the IC and Deanship of Scientific Research.

- Informing the inventors about licensability of the inventions and the opportunities for licensing.

Managing other KFUPM IP issues:

a. The graduate students at KFUPM benefit from the Innovation Center's patentability analysis performed on all completed theses/dissertations. Each completed thesis/dissertation is subjected to a patentability check based on a review of the abstract by certified patent attorneys based in United States. If a thesis/dissertation is found to be potentially patentable, the graduate students complete the necessary formalities. Once the application is filed in the United States Patent and Trademark Office (USPTO), the student is entitled to a cash reward of SR 3000.

b. IC reviews all KFUPM Research Agreements for compliance with KFUPM IP policies.

c. The KFUPM's handbook for Intellectual Property lists the University's general policies for intellectual property and the codes of practice for intellectual property protection as well as research commercialization. It provides a framework for intellectual property identification, protection and management.

The Innovation Center always ensures that the missions of the University, i.e., Education, Research and Service, are not compromised by the business interest emerging from the technology licensing function.

B. Entrepreneurship Institute

The Entrepreneurship Institute is a KFUPM entity with a mission to prepare University graduates to be entrepreneurs. It provides many opportunities for advancing KFUPM students, particularly graduate students, where they can take their research outcomes a further step forward by enrolling in entrepreneurship training courses and other provided activities and programs. The courses, for example, cover various topics from Innovation and Intellectual Property to Business Plan Development. The graduate students will also have the option of joining Input for Graduate

KFUPM′s Annual Venture Concept Competition, by which they go through the exercise of creating startups and competing with their peers on writing a solid Business Plan based on their technical ideas. In addition, the currently developed Startup Center will allow graduate students to prove their research concepts that lead to technology development. Such opportunities ultimately provide an additional edge to KFUPM graduate students who want to be entrepreneurs.

C. Technology Advancement and Prototyping Center

Vision

The vision of the Technology Advancement and Prototyping Center (TAPC) is to be the most progressive university-based rapid prototyping and manufacturing facility in the MENA region, that:

- Bridges the gap between basic research and product development by introducing semi-industrial functional prototypes, and
- Caters to researchers' needs to advance basic research to applied research.

Mission

To establish and operate a sustainable state-of-the-art advanced rapid prototyping center that provides engineering solutions for researchers and product developers, enabling them to translate their innovations to produce industrial opportunities toward a comprehensive R&D ecosystem.

Role

To play an essential role in advancing technologies' readiness level (TRL) to potential entrepreneurial opportunities that will enhance the convergence of KFUPM's technology entrepreneurship ecosystem to a comprehensive R&D-based industrial ecosystem.

D. Science Park Liaison Office

The Liaison Office is well-positioned to help industry collaborators build mutually beneficial relationships with KFUPM researchers. The Office sets targets for the interaction between KFUPM and its industrial partners, tracks the implementation and follows up on the progress of joint activities. The activities of the Liaison Office mainly include the following:

1. Providing the industry/business community with an access to the KFUPM community (faculty, researchers and students), and vice-versa.
2. Marketing KFUPM's research and expertise.
3. Enhanced facilitation of sponsored research, collaborative research and consulting services.
4. Improving methods for the facilitation of internships and student employment in industry.

Science Park and 'Dhahran Techno Valley Company

The Science Park is integrated closely with the University ecosystem and is favorably positioned among a unique set of stakeholders i.e., Saudi Aramco, SABIC, SEC, Ma'aden, Saline Water Conversion Corporation (SWCC), and other Small and Medium Enterprises (SMEs). It houses a range of firms, mainly those involved in the regional petroleum and chemical industry and the growing IT sector, which are major strengths of the University. The primary goals of the Science Park include:

i. Providing a strong local presence for major companies to further their business and technology development agenda;

ii. Providing opportunities for faculty, students and staff to collaborate with industry;

iii. Promoting networking and partnering with local and international high-tech industries and other universities;

Dhahran Techno Valley Company (DTVC) is a wholly owned subsidiary of King Fahd University of Petroleum and Minerals and its commercial arm. DTVC was established by KFUPM to support the Kingdom’s initiative to transform into a knowledge economy. In addition to managing the Science Park, DTVC is mandated to invest in IP commercialization and provide the platform for business development support. DTVC will also support the KFUPM community (staff/faculty/students) including graduate students in transforming viable research ideas to commercial products/services.

The Office of Cooperation with King Abdullah University of Science and Technology

KFUPM and King Abdullah University of Science and Technology (KAUST) share an appreciation for the value of research, graduate education, and technology development in fundamental and applied science and engineering. With this in mind, the Office of Cooperation along with King Abdullah University of Science and Technology was established in November 2008. The mission of this office is to establish collaboration avenues between KFUPM and KAUST that help improve the standing, research, and academic functions of both universities. The areas of cooperation include:

- Joint research, including collaborations that involve other partners in research of common interest,
- Faculty visits, exchange, and sabbatical leaves,
- Joint supervision of graduate students’ theses and dissertations,
- Sharing of research facilities.

The office is actively working on bringing cooperation in these areas into its full potential and is exploring other areas of cooperation.

International Collaborations

KFUPM has very strong collaborative partnerships in conducting innovative research with the following international institutions. The collaboration with each of the following institutes is very focused on a specific research area of strategic importance to KFUPM and the economy of Saudi Arabia at large.

Institution	**Collaborative Research Area**
MIT	Clean Water and Clean Energy
Stanford	Oil, Gas and Geosciences
Caltech	Refining and Petrochemicals
Technical University of Munich	Refining and Petrochemicals
Cambridge University	Oil, Gas and Geosciences
Georgia Tech	Geo-Signal Processing
KAUST	Variety of Research Disciplines
Saudi Aramco	Variety of Research Disciplines
SABIC	Refining, Petrochemical and Polymer Research

COLLEGE OF COMPUTER SCIENCES AND ENGINEERING

DEPARTMENT OF COMPUTER ENGINEERING

Chairman

Dr. Ahmad Almulhem

Faculty

Abdulaziz	AbdulHafid	Ahmad
Aiman	Alaaeldin	Ashraf
Atef	Basem	Hakim
Hazem	Hosam	Kamel
Marwan	Masudul	Mayez
Mohammad, R	Mohammed, S	Muhammad, El
Muhamed, M	Radwan	Sadiq
Talal	Tarek	Uthman
Yahya	Ya'U Isa	

The increased integration of computing and communication devices in recent years is changing the landscape of the Computer Engineering discipline. There is now an obvious shift in the role of computers from that of only computation and information processing to that of diverse media processing, computer networking and data communications. Computers nowadays play a dual role as both computing devices and communication nodes. This has revolutionized the way many industries conduct their business over cyberspace and has given rise to a range of new applications.

This shift brings with it new opportunities and, of course, new challenges. One of the main challenges is that Computer Engineering now covers a wide range of multidisciplinary topics, such as Wireless and Sensor Networks, High-Performance Computing, Distributed and Real-time Systems, Embedded Systems, Systems on-Chip, Environment-Aware Devices, and Real-time Security and Multimedia Communication.

The new role of Computer Engineering is to study, analyze and exploit the interaction between its fast-changing and diverse disciplines covering computer hardware, software, networking and applications. The Department of Computer Engineering offers graduate programs leading to the degrees of Master of Science and Doctor of Philosophy that address the cutting-edge teaching and research needed in this field.

M.S. PROGRAM IN COMPUTER ENGINEERING

Admission Requirements

The students admitted to the Computer Engineering M.S. program must satisfy the following requirements:

- A 4-year BS Computer Engineering (COE) or closely related discipline with a GPA of at least 3 out of 4.
- Three letters of recommendation (at least two from professorial-ranked instructors) addressing the applicant’s academic achievements and professional accomplishments.
- Acceptable TOEFL and GRE scores.
- A statement of purpose written by the applicant.

Degree Requirements

The Computer Engineering M.S. program has three main elements. The first is the core courses, which establish the necessary common competence level for all students. The core courses are designed to equip students with sufficient knowledge to embark on a more in-depth study of any specific aspect of Computer Engineering. The second is the elective courses, which build upon the core. Students choose three COE electives in addition to two technical electives to further broaden their horizon in graduate-level courses (in COE, or related disciplines). The third component of the curriculum is the thesis.

A typical program plan will take two years to be completed by a full-time student. The plan calls for at least one full semester to be dedicated to the thesis research work.
Graduate COE courses have been grouped into the following four Computer Engineering areas:

- Computer Architecture, and High Performance Computing
- Computer Networks and Security
- Digital System Design and Automation
- Computer Systems and Applications

To ensure breadth of coverage, students are required to take three core courses one from each of the first three major areas: COE 501 Computer Architecture, COE 540 Computer Networks, and COE 561 Digital Systems Design and Synthesis. These courses cover, at an advanced level, the underlying key aspects of the above-identified major COE areas. Students enrolled in the program must also satisfactorily pass three COE elective courses. Students may select these courses from course lists of the above four COE areas.

Students are also required to pass two other elective courses that may be chosen from outside the COE department.

Academic Program

All candidates for the M.S. degree in Computer Engineering must satisfy the overall requirements of KFUPM in addition to the following:

- All students enrolled in the M.S. program in Computer Engineering are required to complete 24 semester-credit hours of graduate courses and a thesis of 6 credit hours. These courses should be selected from a degree plan which has been approved by the Graduate Committee, the Department Chairman, and the Deanship of Graduate Studies.
- Three core courses of 9 credit hours are required of all students:

  COE 501: Computer Architecture

  COE 540: Computer Networks

  COE 561: Digital System Design and Synthesis
- Three COE graduate-level electives to be chosen from the following four subject areas of Computer Engineering. Students are allowed to take up to four courses, including the corresponding core course, from any of the first three subject areas. For the network area, it should be noted that network courses with ICS or CSE prefixes would count towards this upper bound. An ICS or CSE course is considered as a network course if it is listed in the Network courses in the COE-ICS joint Network M.S. Program.

I. Area 1: Computer Architecture and High-Performance Computing

COE 502 Parallel Computing

COE 504 Heterogeneous Computing

COE 509 Special Topics in Computer Architecture and HPC

COE 586 Computer Arithmetic

II. Area 2: Computer Networks and Security

COE 520 Queuing Theory and Network Applications

COE 541 Local and Metropolitan Area Networks

COE 543 Mobile Computing and Wireless Networks

COE 544 Wireless Ad hoc Networks

COE 545 Wireless Sensor Networks

COE 546 Computer Network Design

COE 547 Network Management

COE 551 Computer and Network Security

COE 553 Fault Tolerance and Reliability in Computer Networks

COE 554 Modelling and Analysis of Computer Networks

COE555 Protocol Engineering

COE 559 Special Topics in Computer Networks and Security

III. Area 3: Digital System Design and Automation

COE 562 VLSI System Design

COE 563 Digital System Synthesis and Optimization

COE 567 Digital System Modeling and Verification

COE 568 Design of Re-Configurable ASICs

COE 571 Digital System Testing

COE 572 Computer-Aided Design of Digital Systems

COE 579 Special Topics in Digital Systems Design and Automation

IV. Computer Systems and Applications

COE 581 Digital Forensics

COE 586 Computer Arithmetic

COE 587 Performance Evaluation and Analysis

COE 588 Modeling and Simulation

COE 589 Special Topics in Computer Systems and Applications

COE 593 Multimedia Architectures

COE 596 Intelligent Computing

COE 597 Real Time Systems

- The two elective courses may be selected from within or outside the COE Department. The total credit hours of elective courses taken from outside the COE Department should not exceed six credit hours.
- The student must complete a thesis on an approved topic in Computer Engineering under the supervision of his graduate thesis committee.
- The student should present a seminar that describes recent research findings in Computer Engineering as well as attend the technical seminar series organized by the COE department. This requirement is satisfied by the zero-credit hours seminar course COE 599 (1-0-0).
- Students admitted on a provisional basis, should satisfy any conditions, e.g. remedial courses, required to attain regular status.

Degree Plan for M.S. in Computer Engineering

Course No.	Title	LT	LB	CR
First Semester				
COE 5xx	COE Core I	3	0	3
COE 5xx	COE Core II	3	0	3
COE 5xx	COE Elective I	3	0	3
		9	**0**	**9**
Second Semester				
COE 5xx	COE Core III	3	0	3
COE 5xx	COE Elective II	3	0	3
XXX xxx	Elective Course I	3	0	3
COE 599	Seminar	1	0	0
		10	**0**	**9**
Third Semester				
COE 5xx	COE Elective III	3	0	3
XXX xxx	Elective Course II	3	0	3
COE 610	Thesis			IP
		6	**0**	**6**
Fourth Semester				
COE 610	Thesis	0	0	6
		0	**0**	**6**
Total Number of credits required				**30**

Notes:

- Each student is expected to submit his detailed degree plan according to the above generic degree plan for approval by the department and the Deanship of Graduate Studies within the 8th week of the second semester of enrollment.
- Students are required to adhere to the regulations of the degree plan. No relaxations will be given to any student and the courses taken in conflict of the above will not be counted towards the degree.
- Up to two senior undergraduate 400-level COE courses may be taken in place of the two elective courses when approved in the degree plan.
- The order of taking the courses can be different from above but the students must take the core courses before the electives.

M.S. PROGRAM IN COMPUTER NETWORKS

This program is offered jointly by the Department of Computer Engineering and Department of Information & Computer Science.

The joint program in Computer Networks has been designed to give a balanced curriculum that covers three complementary areas in Computer Networks:

- Technology group courses that will be offered mainly by the COE department
- Distributed and Software courses that will be offered mainly by the ICS department program
- Design and management courses that can be offered by either department, and will be double listed.

The curriculum includes a core course from each of these areas. These courses cover, at an advanced level, the underlying key aspects of computer networks, their design and the software issues.

Program Management

The joint program on Computer Networks will be managed by the CCSE Committee for Joint M.S. Program in Computer Networks, headed by the Computer Engineering Chairman. Each student will register in one of the two departments. The student will be awarded the M.S. Degree in Computer Networks by his home department.

Admission Requirements

Applicants for the joint M.S. program in Computer Networks must hold a BS degree in Computer Science, Computer Engineering, or its equivalent from a reputable university. In addition, all applicants must satisfy the general admission requirements of the Graduate School.

Students admitted to the Computer Networks M.S. program must also satisfy the following requirements:

- A 4-year B.S in COE or ICS or closely related discipline with a GPA of at least 3 out of 4.
- Three letters of recommendations (at least two from professorial-ranked instructors) addressing the applicant's academic achievements and professional accomplishments.
- Acceptable TOEFL and GRE scores.
- A statement of purpose written by the applicant.

Academic Program

In addition to the KFUPM requirements, all candidates for the M.S. degree in Computer Networks must satisfy the following requirements:

- All students enrolled in the proposed M.S. program in Computer networks are required to complete 24-semester-credit hours of courses, (not including thesis) for graduate credits. These courses should be selected from his program of study which has been approved by his Graduate Committee, the Department Chairman, and the Dean of Deanship of Graduate Studies.
- There are three required core courses in this program:
  - COE 540: Computer Communication Networks (3-0-3)
  - CSE 550: Computer Network Design (3-0-3)
  - ICS 571: Client Server Programming (3-0-3)

- Five elective courses (15 credit hours) are to be chosen from graduate level courses as follows:

A. Three electives must be chosen from the following three areas of Computer Networks:

Network Technology

COE 541: Local and Metropolitan Area Networks

COE 542: High-Speed Networks

COE 543: Mobile Computing and Wireless Networks

CSE 554: Modeling and Analysis of Computer Networks

COE 549: Special Topics in Computer Networking Technologies

Network Design and Management

CSE 551: Computer and Network Security

CSE 552: Network Management

CSE 553: Fault Tolerance and Reliability in Computer Networks

CSE 559: Special Topics in Computer Network Design and Management

Network Software and Protocols

ICS 572: Distributed Computing

ICS 573: High Performance Computing

CSE 555: Protocol Engineering

ICS 575: Application Development for Internet-Based Services

ICS 579: Special Topics in Computer Network Software and Protocols

B. Two electives to be selected from a list of approved graduate courses from within or outside the Computer Engineering Department, and Information and Computer Science Department, provided the student's advisor also approves these two courses. Moreover, the total credit hours of electives courses taken by a student from departments other than the two departments mentioned above should not exceed six credit hours.

- In addition to the course requirements described above, a student must satisfy the thesis requirement. He should complete a thesis on an approved topic in Computer Networks under the supervision of his graduate thesis committee.
- The student should present a seminar that describes new research findings in Computer Networks.
- The student should satisfy any special conditions (such as passing some remedial courses satisfactorily), connected with his admission.

Degree Plan for M.S. in Computer Networks

Course	#	Title	LT	LB	CR
First Semester					
CSE/COE/ICS	5xx	Network Core I	3	0	3
CSE/COE/ICS	5xx	Network Core II	3	0	3
CSE/COE/ICS	5xx	Network Elective I	3	0	3
			9	**0**	**9**
Second Semester					
CSE/COE/ICS	5xx	Network Core III	3	0	3
CSE/COE/ICS	5xx	Network Elective II	3	0	3
XXX	xxx	Elective Course I	3	0	3
COE/ICS	599	Seminar	1	0	0
			10	**0**	**9**
Third Semester					
CSE/COE/ICS	5xx	Network Elective III	3	0	3
XXX	xxx	Elective Course II	3	0	3
COE/ICS	610	M.S. Thesis	0	0	IP
			6	**0**	**6**
Fourth Semester					
COE/ICS	610	M.S. Thesis	0	0	6
			0	**0**	**6**
Total number of credit hours					**30**

Notes:

- Each student is expected to submit his detailed degree plan according to the above generic degree plan for approval by the department and the Deanship of Graduate Studies within the 8th week of the second semester of enrollment.
- Students are required to adhere to the regulations of the degree plan. No relaxations will be given to any student, and the courses taken in conflict of the above will not be counted towards the degree.
- Two Electives are to be taken from the graduate courses from within or outside the Computer Engineering Department and Information and Computer Science Department.
- The order of taking the courses can be different from above but the students must take the core courses before the electives.

PH.D PROGRAM IN COMPUTER ENGINEERING

The Ph.D. program offers students opportunities to develop levels of expertise and knowledge consistent with a career of technical leadership. The doctoral program emphasizes the acquisition of advanced knowledge and the fostering of individual experience of significant intellectual exploration. The educational objectives of the Ph.D. program are to develop:

- Expertise in core areas of computer engineering;
- The ability of independent learning and advancing knowledge,
- The ability to identify pertinent research problems, formulate and execute a research plan, and generate and analyze original research results,
- The ability to lead research and to communicate the results in scientific publications and forums.

Admission Requirements

In addition to the admission requirements specified by the Deanship of Graduate Studies, the minimum admission qualifications for admission to the KFUPM Ph.D. program in Computer Engineering is:

- A Master's degree in a COE-related engineering or science discipline with a minimum GPA of 3.0 out of 4.0 from an institute with an M.S. program equivalent to KFUPM's.
- A minimum TOEFL score of 560 (PBT), 215 (CBT) or 80 (IBT) or other equivalent English tests. Scores should not be more than two years old.
- Three letters of recommendation (at least two from instructors or current supervisors) addressing the applicant's academic achievements and professional accomplishments.
- Acceptable GRE scores.
- A statement of purpose, where the student should elaborate on his general area of research and Ph.D. research plans at KFUPM (approximately 1000 words).

Degree Requirements

The Computer Engineering Ph.D. Program requirements are summarized in Table 1. Students enrolled in this program are required to complete 30 graduate credit hours of courses (excluding the dissertation). These courses should be selected from a program of study approved by the student's Graduate Committee, the Department Chairman, and the Dean of Graduate Studies. The program of study for each student should be documented in an approved degree plan, a sample of which is given before the course descriptions.

The Ph.D. degree in Computer Engineering will be awarded to candidates who successfully complete all requirements of the degree, listed below:

- Satisfaction of provisional status requirements, if any,
- Completion of course requirements (30 credit hours) with a minimum GPA of 3.0 (on a scale of 4.0),
- Passing the written and oral comprehensive examinations by the end of the 4th semester for full-time students, or the 5th semester for part-time students, after joining the program,
- Successful completion and defense of original research work documented as a dissertation,
- Other requirements as specified by the Deanship of Graduate Studies.

The Ph.D. program in Computer Engineering provides specialization in four areas of competency. These areas are chosen to provide coverage of established areas of COE and at the same time allow for coverage of anticipated future progress in the discipline. Each student must select one of the following as his major area, and another as a minor area:

Area 1: Computer Architecture and High-Performance Computing,

Area 2: Computer Networks and Security,

Area 3: Digital System Design & Automation, and

Area 4: Computer Systems and Applications.

To ensure depth of knowledge, a minimum of three courses (9 credit hours) must be taken from the student's selected major area (Table 2). In the minor area, a student must take a minimum of two courses (6 credit hours). To provide breadth of knowledge, the student is required to take two graduate technical elective courses which must be taken from outside the COE department. In addition, two COE elective courses (6 credit hours) should be taken from any of the four COE specialization areas. Furthermore, a graduate free elective course may be either a COE or a non-COE course. The graduate technical elective courses may be taken from other related disciplines, e.g. ICS, SWE, EE, SE, or Math. The maximum number of courses that may be taken from outside the COE department is four courses (12 credit hours).

TABLE 1: Course Requirements of the Ph.D. Program in Computer Engineering

	Minimum Requirements	**Notes***
Major Area	3 Courses (9 Cr Hrs)	Major area may be any of the 4 COE areas of competency.
Minor Area	2 Courses (6 Cr Hrs)	Any COE specialization area other than the major area.
COE Electives	2 Courses (6 Cr Hrs)	Any COE specialization area.
Technical Electives	2 Courses from COE related disciplines (6 Cr Hrs)	Should be taken from outside the COE department.
Free Electives	1 Course (3 Cr Hrs.)	May be either a COE or a non-COE course.
Comprehensive Exam		To be passed by the fourth semester (full time students) or the fifth semester (part time students).
Seminar	COE 699	Zero Cr Hr. (pass or fail basis)
Dissertation	COE 711 and COE 712	• 12 Cr Hrs. (3+9) • Dissertation topic is to be selected from the students' major area of specialization.

* No more than 4 non-COE courses are allowed

Table 2: Area-Wise Distribution of Ph.D. Courses

Courses for Area 1: Computer Architecture and High-Performance Computing

COE 501 Computer Architecture

COE 502 Parallel Computing

COE 504 Heterogeneous Computing
COE 509 Special Topics in Computer Architecture and HPC
COE 586 Computer Arithmetic
COE 601 Massively Parallel Computing
COE 602 Design and Modeling of Massively Parallel Architectures
COE 603 Parallel Computer Architecture
COE 604 Interconnection Networks
COE 605 Reliability and Fault Tolerance of Computer Systems
ICS 556 Parallel Algorithms

Courses for Area 2: Computer Networks and Security

COE 520 Queuing Theory and Network Applications
COE 540 Computer Networks
COE 541 Local and Metropolitan Area Networks
COE 543 Mobile Computing and Wireless Networks
COE 544 Wireless Ad hoc Networks
COE 545 Wireless Sensor Networks
COE 546 Computer Network Design
COE 547 Network Management
COE 551 Computer and Network Security
COE 553 Fault Tolerance and Reliability in Computer Networks
COE 554 Modeling and Analysis of Computer Networks
COE 555 Protocol Engineering
COE 559 Special Topics in Computer Networks and Security
COE 642 Computer Systems Performance
COE 644 Radio Resource Management
COE 645 Wireless Network Security
COE 647 Multimedia Networks
EE 571 Digital Communications I
EE 573 Digital Communications II
EE 577 Wireless and Personal Communication
ICS 553 Advanced Computer Algorithms
ICS 554: Applied Combinatorics and Graph Theory
ICS 555 Data Security and Encryption
ICS 571 Client Server Programming
ICS 572 Distributed Computing
ICS 575 Application Development for Internet Based Services
SEC 528 Security in Wireless Networks
SE 518 Deterministic Modeling and Simulation
SE 522 Stochastic Simulation and Queuing Models

EE 672 Satellite Communications

EE 674 Telecommunication Networks

Courses for Area 3: Digital System Design & Automation

COE 561 Digital System Design & Synthesis

COE 562 VLSI System Design

COE 563 Synthesis and Optimization of Digital Systems

COE 567 Digital System Modeling & Verification

COE 568 Design of Re-Configurable ASICs

COE 571 Digital System Testing

COE 572 Computer-Aided Design of Digital Systems

COE 579 Special Topics in Digital Sys. Design and Automation

COE 661 System-on-Chip Modeling and Design

COE 663 Applied Functional Verification of Digital Systems

COE 665 Hardware/Software Co-design of Embedded Systems

COE 686 Applied Cryptography: Techniques and Architectures

Courses for Area 4: Computer Systems and Applications

COE 581 Digital Forensics

COE 586 Computer Arithmetic

COE 587 Performance Evaluation and Analysis

COE 588 Modeling and Simulation

COE 589 Special Topics in Computer Systems and Applications

COE 593 Multimedia Architectures

COE 596 Intelligent Computing

COE 597 Real Time Systems

COE 683 Information Systems Planning

COE 684 Robotics

COE 686 Applied Cryptography: Techniques and Architectures

COE 696 Advanced Intelligent Computing

EE 555 Neural Networks Theory and Applications

EE 556 Intelligent Control

ICS 555 Data Security and Encryption

SE 515 Distributed Computer Control

SE 532 Industrial Robots

EE 663 Image Processing

EE 665 Signal and Image Compression

ICS 625 Advanced Neural Networks

ICS 627 Advanced Computer Vision

SE 660 Artificial Intelligence and Expert Systems in Control

SE 662 Image Processing and Pattern Recognition in Automation

The Table below shows COE courses that are equivalent to CSE Courses

COE Courses	Equivalent CSE Courses
COE 546 Computer Network Design	CSE 550
COE 547 Network Management	CSE 552
COE 551 Computer and Network Security	CSE 551
COE 553 Fault Tolerance and Reliability in Computer Networks	CSE 553
COE 554 Modeling and Analysis of Computer Networks	CSE 554
COE 555 Protocol Engineering	CSE 555
COE 605 Reliability and Fault Tolerance of Computer Systems	CSE 641
COE 642 Computer Systems Performance	CSE 642
COE 683 Information Systems Planning	CSE 621

Degree Plan for Ph.D. in Computer Engineering

Course No.	Title	LT	LB	CR
First Semester				
COE xxx	COE (major area)	3	0	3
COE xxx	COE (minor area)	3	0	3
COE xxx	COE Elective I	3	0	3
		9	**0**	**9**
Second Semester				
COE xxx	COE (major area)	3	0	3
COE xxx	COE (minor area)	3	0	3
XXX* xxx	Technical Elective I	3	0	3
		9	**0**	**9**
Third Semester				
COE xxx	COE (major Area)	3	0	3
XXX* xxx	Technical Elective Course II	3	0	3
COE xxx	COE Elective II	3	0	3
COE 699	Seminar	1	0	0
		10	**0**	**9**
Fourth Semester				
YYY yyy**	Free Elective	3	0	3
COE 711	Ph.D Pre-Dissertation	0	0	IC
		3	**0**	**3**
Fifth Semester				
COE 711	Ph.D. Pre-Dissertation	3	0	3
		3	**0**	**3**
Sixth Semester				
COE 712	Ph.D. Dissertation	0	0	IP
		0	**0**	**0**
Seventh Semester				
COE 712	Ph.D. Dissertation	0	0	IP
Eight Semester				
COE 712	Ph.D. Dissertation	0	0	**9**
Total Number of credits required				**42**

Notes:

- Each student is expected to submit his detailed degree plan according to the above generic degree plan for approval by the department and the Deanship of Graduate Studies within the 8th week of the second semester of enrollment.
- Students are required to adhere to the regulations of the degree plan. No relaxations will be given to any student, and the courses taken in conflict of the above will not be counted towards the degree.
- The order of taking the courses can be different from the above but the students must take the core courses before the electives.

*. The two XXX xxx courses are the graduate technical elective courses.
**. The YYY yyy free elective may be either a COE or a non-COE course.

COURSE DESCRIPTIONS

COMPUTER ENGINEERING

COE 501: Computer Architecture (3-0-3)

Computer architecture fundamentals, trends, and performance. Hardware and software approaches to ILP, dynamic, speculative, VLIW, and superscalar execution models. Examples and case studies. Dynamic branch prediction techniques. Memory hierarchy, cache and virtual memory, cache coherence, memory system performance. Parallel architecture models, coherence protocols, and interconnection networks. The students are expected to carry out research projects in related fields of study.

Prerequisite: Graduate Standing.

COE 502: Parallel Computing (3-0-3)

Introduction to parallel processing architecture, sequential, parallel, pipelined, and dataflow architectures. Parallel program models. Basic parallel programming techniques, problem decomposition, assignment, orchestration, and mapping. Examples and case studies of static, semi-static, and dynamic application parallelism. Performance: evaluation, scalability, and workload selection. The students are expected to carry out research projects in related fields of study.

Prerequisite: Graduate Standing.

COE 504: Heterogeneous Computing (3-0-3)

Taxonomy of heterogeneous computing. Introduction to Hard-RT, Soft-RT and Firm-RT heterogeneous systems. Network heterogeneous computing: design issues, architecture, programming paradigm and environment and Middleware Technologies. Applications and case studies. The students are expected to carry out research projects in related fields of study.

Prerequisite: Graduate Standing.

COE 509: Special Topics in Computer Architecture and HPC (3-0-3)

Advanced topics selected from current issues in Computer Architecture and High-Performance Computing.

Prerequisite: Graduate Standing and Consent of Instructor

COE 520 Queuing Theory and Network Applications (3-0-3)

Introduction to network applications, discrete random variables, continuous random variables, characteristic functions. Introduction to stochastic processes. Discrete-time Markov chains, continuous time Markov chains. Introduction to queuing theory, M/M/1 and derivative queues, and M/G/1 queues. Burke’s theorem. Jackson’s theorem: open and closed network of queues. Applications to computer networks and case studies.

Prerequisite: Consent of Instructor.

COE 540 Computer Networks (3-0-3)

Review of Computer network layering concepts and quality of service requirements. Physical Layer, Data Link Layer; ARQ Strategies; Analysis of ARQ Strategies. Multi-access communication. Network layer. Routing in Data Networks. Flow and Congestion Control. Transport layer. Application Layers: peer-to-peer networking, Content Distribution Networks. Studying a number of classic and current papers on these subjects.

Prerequisite: Graduate Standing.

COE 541 Local and Metropolitan Area Networks (3-0-3)

Local and Metropolitan Area Networks classes, standards, and network architectures. Physical layer for LANs and MANs. Multiple access techniques and protocols for advanced Local and

Metropolitan Area Networks. Design issues, and performance modeling and analysis. Interworking and network management for LAN and MAN. Case studies including Gigabit/Terabit Ethernet, Gigabit WiFi, G/EPONs, etc. Emerging LAN and MAN technologies.

Prerequisite: COE 520.

COE 543 Mobile Computing and Wireless Networks (3-0-3)

Introduction to radio frequency propagation models. Physical layer for advanced mobile systems. Cellular configurations and interference mitigation and coordination methods. Multiple access techniques for wireless networks. Wireless network architecture. Cooperative communications. Mesh networks. Ad-hoc networks. Mobility solutions for mobile networks (Mobile-IP, Session Initiation Protocol, mobile-Stream Control Transport Protocol, etc.). Quality of service, reliability, and security in mobile computing environment. 5th generation wireless networks. Case studies including Wireless Personal Area Networks (e.g. Bluetooth, Zigbee, etc.), Wireless Local Area Networks (e.g. 802.11n, 802.11ac, etc.) Wireless Metropolitan and Wide Area Networks (e.g. WiMAX-2, Long-Term Evolution and Long-Term Evolution Advanced).

Prerequisite: COE 520.

COE 544 Wireless Ad hoc Networks (3-0-3)

The basic hardware and software platforms for sensor networks and will address in detail several algorithmic techniques for deployment, localization, synchronization, MAC, sleep scheduling, data routing, querying processing, topology management and energy aware protocols. Hands-on experience through programming projects involving different platforms. In addition, different microcontrollers, such as Arduino will be used to interface different wireless communication transceivers with sensors.

Prerequisite: Graduate Standing.

COE 545 Wireless Sensor Networks (3-0-3)

Introduction to the most recent advanced Mobile Ad hoc Networks (MANETs) routing protocols. Issues that are related to design protocols such as scheduling, capacity, medium access, QoS, topology control, and mobility tracking will be covered. In addition, modeling techniques as well as delay models will be covered using Linear Programming.

Prerequisite: COE 540.

COE 546 Computer Network Design (3-0-3)

Network Development Life Cycle. Network Analysis and Design Methodology. Traffic Flow Analysis and Performance Evaluation. Network Simulation and Traffic Measurement Tools. Topology Design. Terminal Assignment. Concentrator Location and Servers Placement. Traffic Engineering. Structured Enterprise Network Design. Hierarchical Network Design Model. LAN and WAN Network Design. Backbone Design: Centralized vs. Distributed. Addressing and Routing. Network Management and Security. Network Reliability. Technology Choices. Structured Cabling Systems. Case Studies.

Prerequisite: Graduate Standing.

COE 547 Network Management (3-0-3)

Network Management Standards and Models. Network Management Protocols. Network Management Applications. Network Management Tools and Systems. Abstract Syntax Notation One (ASN.1). Structure of Management Information (SMI). Management Information Base (MIB). Simple Network Management Protocol (SNMP). SNMPv2 and SNMPv3. Remote Monitoring (RMON). RMON 1 and 2. Web-Based Management. Recent Network Management Advances.

Prerequisite: COE 540 or consent of the instructor.

COE 551 Computer and Network Security (3-0-3)

Overview of Online attacks, Malware, Social engineering, Physical and Communication security, Access control techniques, Cryptography: Classical cipher, Mathematical cipher, Stream cipher, Block cipher, public key. Other information security: Steganography, Hashing, Secret sharing, Software reverse engineering & Program security, Firewalls & IP sec, Security policy & risk management, Advanced security topics.

Prerequisite: Graduate Standing.

COE 553 Fault Tolerance and Reliability in Computer Networks (3-0-3)

Introduction to concepts of faults, errors, and failures. Basic concepts of dependable computing including dependability attributes, means, and validation. Stochastic modeling techniques in the context of network reliability analysis. Error detection and correction techniques. Fault tolerant topology design. The practices of reliable and fault-tolerant computer networks design. Case studies.

Prerequisite: Graduate Standing

COE 554 Modeling and Analysis of Computer Networks (3-0-3)

Numerical and analytical modeling. Performance evaluation and prediction. Exponential queuing systems; single and multiple servers, finite and infinite system size. Queuing networks. Cost effective design and operation. Characterization of relations between system parameters. Conventional and non-conventional measures of system performance. Using modern computational packages like Mathematica and Matlab for building models and performing analysis. Case studies in areas like resource sharing, multiplexing and stochastic control.

Prerequisite: COE 520 or Consent of the Instructor.

COE 555 Protocol Engineering (3-0-3)

Protocols and languages. Protocol structure. Structured protocol design. Fundamentals of Protocol Engineering. Specification and modeling. State Machines and Reachability Analysis. Formulation of desirable properties of protocols. Formal Logic and Deduction. Verification techniques. Formal description languages. Protocol synthesis. Protocol Design. Validation and conformance testing. Computer-aided design tools for protocol engineering (simulation and validation tools). A major project involving comprehensive design and verification of a non-trivial protocol.

Prerequisite: COE 540

COE 559 Special Topics in Computer Networks and Security (3-0-3)

Any state-of-the-art topic or topics of recent interest in any areas in computer systems and applications that may not fit well with the description of the previously mentioned courses.

Prerequisite: Consent of the instructor.

COE 561 Digital System Design & Synthesis (3-0-3)

Overview of modern digital systems; Systems-on-chip, virtual cores, design reuse and IP's (soft, firm and hard), ASIC design methodologies. Digital system hierarchy & abstraction levels, Hardware Modeling using HDL, Design optimization and performance criteria, HDL coding for synthesis, Testability of digital systems and High-Level synthesis.

Prerequisite: Graduate Standing.

COE 562 VLSI System Design (3-0-3)

Review of MOS transistors, modeling, scaling, sizing, physical design (layout). Combinational and sequential logic, static CMOS, Dynamic circuits, pass-transistor logic. Clocking strategies, clock skew, setup, hold & propagation delays, self-timed logic, I/O design. Design considerations of regular structures: ROM's, PLA's, arithmetic circuits. CAD tools used in VLSI design (schematic, layout, DFT, etc.). CMOS memory architecture, design constraints. ROM, SRAM

and DRAM cells. Single and double-ended bit line sensing. Multiport register files. The course is project-oriented stressing the use of CAD tools through class projects.

Prerequisite: COE 561

COE 563 Synthesis and Optimization of Digital Systems (3-0-3)

Digital design styles, design representations, abstraction levels & domains, Binary Decision Diagrams, Satisfiability and Covering problems, Two-level logic synthesis and optimization: Exact and heuristic techniques, Testability properties of two-level circuits, Multi-level logic synthesis and optimization, Observability and controllability don't care conditions, Testability properties of multilevel circuits, Synthesis of minimal delay circuits, Sequential logic synthesis: state minimization, state encoding, retiming, Technology mapping, High-level synthesis: data flow and control sequencing graphs, scheduling, allocation.

Prerequisite: COE 561.

COE 566 VLSI ASIC Design (3-0-3)

Review of MOS transistors, modeling, scaling, sizing, physical design (layout), and static versus dynamic logic. MOS logic optimization of delay and area. ASIC design flows. ASIC design with HDL. ASIC library design, cell characterization, design area and delay. Standard-cell design methodology, propagation delay, design area, critical path, placement and routing of cells, design optimization and back annotation. HDL modeling, technology mapping and synthesis. ASICs test techniques, fault models, boundary scan and DFT. The course emphasizes hands on experience through the use of available design tools for the design of ASIC VLSI.

Prerequisite: COE 561.

COE 567 Digital System Modeling & Verification (3-0-3)

Introduction and approaches to digital system verification. Simulation versus formal verification. Levels of hardware modeling (circuit, switch, gate, RTL, and Behavioral levels). Principle of formal hardware modeling and verification. Model checking; binary and word-level decision diagrams, symbolic methods, Mathematical logic (First order logic, Higher Order Logic, Temporal Logic). Abstraction mechanisms for hardware verification. Automated theorem provers. Verification using Specific Calculus. Formal verification versus formal synthesis. Future trends in hardware verification.

Prerequisite: COE 561.

COE 568 Design of Re-Configurable ASICs (3-0-3)

Review of modern digital systems and their designs. ASIC design flows. Field programmable gate arrays: Architectures, Configuration Techniques, Design Parameters and Models. FPGA design Flow. Application Domains, Custom computing machines and FPGA-based hardware accelerators. Case studies and contemporary issues in reconfigurable computing.

Prerequisite: COE 561.

COE 571 Digital System Testing (3-0-3)

Basic principles and practice of digital system testing, Test Economics, Fault models, Fault simulation, Test generation for Combinational and Sequential circuits, Test compaction, Test Compression, Fault Diagnosis, Delay-fault testing, Design for testability, Boundary Scan, Built-in self-test: logic BIST and memory BIST, Testing of system-on-chip.

Prerequisite: COE 561.

COE 572 Computer-Aided Design of Digital Systems (3-0-3)

The VLSI Design Process. Layout Styles. Graph and Circuit Partitioning. Floorplanning Approaches. Placement Heuristics. Routing: Maze Routing, Line Search Algorithms, Channel Routing and Global Routing. Layout Generation. Layout Editors and Compaction. Solutions to NP-Hard Problems in CAD. 3D VLSI Physical Design Automation. CAD for current issues and

emerging technologies.

Prerequisite: Graduate Standing

COE 579 Special Topics in Digital Sys. Design and Automation (3-0-3)

Advanced topics selected from current issues in the area of digital system design and automation.

Prerequisite: Consent of instructor.

COE 581 Digital Forensics (3-0-3)

A research-oriented graduate course in digital forensics. It aims to provide an extensive background suitable for those interested in conducting research in this area, as well as for those interested in learning about digital forensics in general. The course focuses on the technical issues and open problems in the area. Topics include fundamentals of digital forensics; digital forensics models, multimedia forensics; OS artifacts forensics; file carving; live and memory forensics; network forensics; mobile devices forensics; current tools and their limitations; legal and ethical issues. **Prerequisites:** Graduate standing.

COE 586 Computer Arithmetic (3-0-3)

Fixed point arithmetic: addition/subtraction, multiplication, and division. Modular multiplication, division and exponentiation. Floating point arithmetic: normalization, rounding, addition, subtraction, multiplication, division. Elementary functions; trigonometric, logarithmic, hyperbolic. Interval arithmetic, arbitrary-precision algorithms, modular arithmetic (multiplication, exponentiation, inversion), arithmetic in Galois Fields.

Prerequisite: COE 561.

COE 587 Performance Evaluation and Analysis (3-0-3)

Performance evaluation techniques. Measurement techniques and tools. Summarizing measured data. Data representation, Experimental design. Factorial designs. Simulation of computer-based systems. Analysis of simulation results. Analytical and queuing modeling. Operational laws and mean-value analysis. Decomposition of large queueing networks. The modeling cycle. Flow analysis. Bottleneck analysis. Hierarchical modeling. Case studies.

Prerequisite: Graduate Standing. **Not to be taken for credit with ICS 532.**

COE 588 Modeling and Simulation (3-0-3)

Approaches to the simulation problem (event scheduling, process-based, etc.). Modeling and simulation of queuing systems. Probability, stochastic processes, and statistics in simulation. Random number generation. Monte Carlo methods. Building valid and credible simulation models. Output data analysis. Simulation formalisms. Software techniques for building simulators. Using contemporary tools like Matlab and SimEvents. Case studies.

Prerequisite: Graduate standing. **Not to be taken for credit with: ICS 533, SE 518.**

COE 589 Special Topics in Computer Systems and Applications (3-0-3)

Advanced topics selected from current issues in the area of digital system design and automation.

COE 593 Multimedia Architectures (3-0-3)

Time-Frequency Representation, Predictive Coding, Speech Analysis and Synthesis, Image Understanding and Modeling, Image Compression Techniques, Color Models and Color Applications, 3-D Representation, Illumination Models, Graphics Systems, MPEG Standards, Video Compression, Video Conferencing, Digital Rights Management.

Prerequisite: Graduate standing and consent of instructor. **Not to be taken for credit with ICS 538**

COE 596 Intelligent Computing (3-0-3)

Introduction to the Fundamental Principles and Practices of Intelligent Computing. The Use of Intelligent Computing Algorithms such as Artificial Neural Networks, Instance-based Learning

Techniques, Uncertain reasoning, Machine Learning, Intelligent Agents, Evolutionary Algorithms, Associative Memories and Contemporary Bio-Inspired computing for Computer Engineering Applications such as Network topology design, Network Security, Thermal modeling of CPUs, and Digital Logic Functions.

Prerequisite: Graduate standing and Consent of Instructor[1].

COE 597 Real Time Systems (3-0-3)

Introduction and Concepts, System Specifications and Architecture, Types of Real Time System, Embedded RT Systems Modeling and Analysis with Time Constraints, Real-Time Systems Design, Performance metrics, Performance evaluation under extreme conditions, Hardware/Software trade off for Real Time Systems, Applications and Case Studies.

Prerequisite: Graduate standing and consent of instructor. The course requires some background in Algorithms and a few Computer Engineering / Science concepts. Depending on the school where the student is coming from, he may or may not be able to grasp all concepts. Therefore, consent of instructor is required before registering for this course.

COE 599 Seminar (1-0-0)

Graduate students are required to attend the seminars by faculty members, visiting scholars, and fellow graduate students. Additionally, each student must present at least one seminar on a timely research topic. Among other things, this course is designed to give the students an overview of research in COE, and a familiarity with research methodology, journals and professional societies in his discipline. Graded on a Pass or Fail basis.

Prerequisite: Graduate standing

COE 601 Massively Parallel Computing (3-0-3)

Introduction to massively parallel multiprocessors and their programming models. Streaming multiprocessor, SIMD and multithreading. Highly multithreaded architectures, thread-level parallelism, resources sharing, thread scheduling, score-boarding, transparent scalability. Data dependence analysis, recurrences, races. Shared-memory, atomicity, mutual exclusion, barrier, and synchronization. Memory hierarchy optimization, locality and data placement, data reuse, loop reordering transformations, shared-memory usage, global memory bandwidth and accesses. Control-flow, SIMD, thread blocks partitioning, vector parallel reduction, tree-structured computation, serialized gathering, Predicted execution, and dynamic task queues. Applications of static, semi-static, and dynamic parallel computations: dense and sparse linear Algebra, bucket sorting, N-body simulation, and ray-tracing.

Prerequisite: COE 501 or equivalent

COE 602 Design and Modeling of Massively Parallel Architectures (3-0-3)

The MIMD and SPMD models, Multithreading, Mapping to Massively Parallel Architectures (MPA), The Application-specific vs. Multi-purpose Architectures, Interconnection Networks, Computation Scheduling and Distribution Paradigms, Memory hierarchy models, Core complexity, System Modeling, Architecture Exploration using system C, The untimed model, the TLM model, Mixing models to explore architectures, The system modeling design flow, From modeling to prototyping: FPGAs as a platform for MPA and FPGA infrastructure.

Prerequisite: COE 501 or equivalent

COE 603 Parallel Computer Architecture (3-0-3)

Parallel computer architecture and programming models. Shared memory multiprocessors and message passing. Data-parallel and vector processing. Memory hierarchy design, cache coherence, and memory consistency. Synchronization and scalability. Network design. Students are expected to carry out a research project in their related field of study.

Prerequisite: COE 501 or equivalent

COE 604 Interconnection Networks (3-0-3)

This course explores the architecture and design of interconnection networks including topology, routing, flow control, and router microarchitecture. Impact on communication requirements of various parallel architectures and cache coherence mechanisms. Recent research on interconnection networks used in multiprocessor systems and on-chip many-core designs.

Prerequisite: COE 501 or equivalent

COE 605 Reliability and Fault Tolerance of Computer Systems (3-0-3)

Reliability and fault-tolerance of computer networks such as FDDI, double loop, hypercube, multi-stage interconnection network, multiprocessor systems, etc. Reliable and fault-tolerant routing, Reliability evaluation algorithms, Availability and survivability of computer systems, Reliability models of JPL-STAR, FTMP, ESS No. 1, PLURIBUS, etc. Software fault tolerance and reliability. Projects using network reliability evaluation tools such as SYREL, SHARPE and SPNP.

Prerequisite: Graduate Standing.

COE 606 Independent Research (3-0-3) (P/F)

This course is intended to allow the student to conduct research in advanced problems in his M.S. research area. The faculty offering the course should submit a research plan to be approved by the Graduate Program Committee at the academic department. The student is expected to deliver a public seminar and a report on his research outcomes at the end of the course. Graded on a Pass or Fail basis.

COE 610: Computer Engineering Master Thesis (0-0-6) (P/F)

The student has to undertake and complete a research topic under the supervision of a faculty member in order to probe in depth a specific problem in Computer Engineering.

Prerequisite: COE 599.

COE 642 Computer Systems Performance (3-0-3)

Queuing theory. Stochastic Petri nets and Markov Chains. Separable queuing networks. Priority queuing systems. Queuing networks, product forms and various solution techniques. Matrix geometric solutions to queuing theory. Bounds and approximations. Fluid analysis and diffusion processes. Evaluation studies: monitoring techniques, modeling methods and model validation. Simulations and variance reduction techniques. Application of queuing theory to computer time sharing & multi-access systems, multiprocessor systems, interconnection networks. Computer communication networks. Case studies of several distributed and network system configurations.

Prerequisite: COE 520 or SE 541.

COE 644 Radio Resource Management (3-0-3)

Radio resource management and performance analysis in transporting homogenous/ heterogeneous traffic in wireless communication networks. Traffic characteristics, connection admission control, packet scheduling, access control, and mobility and handoff management. Case studies on mobile wireless networks and wireless sensor networks.

Prerequisite: COE 543.

COE 645 Wireless Network Security (3-0-3)

Security for contemporary wireless communication networks such as cellular networks, wireless LANs, mobile ad-hoc networks, wireless sensor and mesh networks. Study of diverse attack types such as radio signal jamming, MAC-layer attacks, routing attacks, Sybil, Blackhole attacks, and O/S dependent attacks. Study of countermeasures and scope for each of these attacks. Light-weighted security for resource-constrained wireless devices. Secure multi-casting. Key management techniques for wireless networks.

Prerequisite: COE 551.

COE 647 Multimedia Networks (3-0-3)

Fundamental concepts in multimedia systems. Resource management issues in distributed/networked multimedia systems, QoS routing and multicasting. Traffic shaping, Traffic engineering, Task and message scheduling, Internet QoS. Adaptive multimedia applications over the Internet. Operating system support for multimedia. Storage architecture and scalable media servers. Compression techniques, synchronization techniques, processor architectures for multimedia.

Prerequisites: COE 540.

COE 661 System-on-Chip Modeling and Design (3-0-3)

A current-day system on a chip (SoC) consists of several different microprocessor subsystems together with memories and I/O interfaces. This course covers SoC design and modeling techniques with emphasis on architectural exploration, assertion-driven design and the concurrent development of hardware and embedded software. This is the 'front end' of the design automation tool chain.

Prerequisite: COE 561.

COE 663 Applied Functional Verification of Digital Systems (3-0-3)

This is a hands-on project-based course using state of the art EDA tools covering complex system verification (e.g. SoC). Functional specifications, the verification plan. Simulation-Based Verification, HDLs and simulation-based verification, test benches and Verification Coverage, stimulus generation, Re-Use Strategies and System Simulation, Regression1, Problem Tracking, Tape-Out Readiness, Escape Analysis. Formal Verification, Comprehensive Verification; case studies.

Prerequisite: COE 561.

COE 665 Hardware/Software Co-design of Embedded Systems (3-0-3)

Embedded System Design Considerations, Classical Design Methods, Co-representation, Performance Modeling, Co-design Trade-offs, Functional Decomposition, Partitioning, Design methodologies, Co-design Environments, Abstract Models, Recent Techniques in Co-design, Case Studies.

Prerequisite: COE 561.

COE 683 Information Systems Planning (3-0-3)

Concepts of organizational planning related to IT Systems. The IT planning process. Understanding information systems planning: functions, processes, information groups, subject databases. Information systems planning strategies and standards. Information needs analysis. Strategic planning of information systems. IS planning for office automation and industrial automation. Make or Buy strategy. Students should conduct a research project.

Prerequisite: Graduate Standing

COE 684: Robotics (3-0-3)

Computational approaches to motion, vision, and robotic intelligence. Configuration space, algebraic decompositions, motion coordination, trajectory planning under uncertainty, and task-level planning. Robotic programming models. Models of cognitive systems, robotic intelligent control and programming, and behavior design and programming. Multi-robot cooperation systems.

Prerequisite: Graduate Standing.

COE 686 Applied Cryptography: Techniques and Architectures (3-0-3)

Hardware and architecture of cryptosystems, crypto-processors and accelerators. Stream ciphers, Block ciphers, the Advanced Encryption Standard (AES), Feistel network-based block ciphers, modes of operation, hardware implementation and tradeoffs. Public-Key Cryptosystems, the RSA

crypto-processors, the discrete logarithm problem, Diffie-Hellman key exchange protocol and Elgamal Cryptosystem, elliptic-curve cryptography (ECC), digital signatures, hash functions, Message Authentication Codes (MACs). The course focuses on communicating the essentials and keeping the Mathematics to a minimum, quickly moving from explaining the foundations to describing practical implementations, including recent topics such as lightweight ciphers for RFIDs and mobile devices.

Prerequisite: COE 561

COE 691 Special Topics in Computer Engineering - I (3-0-3)

Advanced selected topics in computer engineering.

Prerequisite: Graduate standing and consent of instructor.

COE 692 Special Topics in Computer Engineering – II (3-0-3)

Advanced selected topics in Computer Engineering.

Prerequisite: Graduate Standing and consent of instructor.

COE 693 Selected Topics in Computer Engineering – III (3-0-3)

Advanced selected topics in Computer Engineering.

Prerequisite: Graduate Standing and consent of instructor

COE 696 Advanced Intelligent Computing (3-0-3)

Use of Advanced Intelligent Computing Concepts such as Mimetic Algorithms, Particle Swarm Optimization, Ant Colony Optimization, Fuzzy Logic (Type-1 and Type2), Fuzzy Neural Networks, Adaptive Resonance Theory for Computer Engineering Applications such as Network Routing Tree Designs, Network Security, Wireless Sensor Network Topology Design, and Computer Network Load Balancing.

Prerequisite: COE 596.

COE 699: Ph.D. Seminar (1-0-0)

Ph.D. students are required to attend departmental seminars delivered by faculty, visiting scholars and graduate students. Additionally, each Ph.D. student should present at least one seminar on a timely research topic. Ph.D. students should pass the comprehensive examination as part of this course. This course is a pre-requisite to registering the Ph.D. Pre-dissertation COE 711. The course is graded as Pass or Fail. An IC grade is awarded if the Ph.D. comprehensive exam is not yet passed.

Prerequisite: Graduate Standing.

COE 701 Directed Research I (3-0-3) (P/F)

This course is intended to allow students to conduct research in advanced problems in their Ph.D. area of specialization. Among other things, this course is designed to give the student an overview of research in COE, and a familiarity with research methodology, journals and professional societies in his discipline. At the end of the course, the student must deliver a public seminar to present his work and findings. The course is graded on a Pass or Fail basis. To select a suitable subject, prior arrangement with the instructor is required.

COE 702 Directed Research II (3-0-3) (P/F)

This course is intended to allow students to conduct research in advanced problems in their Ph.D. area of specialization. Among other things, this course is designed to give the student an overview of research in COE, and a familiarity with research methodology, journals and professional societies in his discipline. At the end of the course, the student must deliver a public seminar to present his work and findings. The course is graded on a Pass or Fail basis. To select a suitable subject, prior arrangement with the instructor is required.

COE 711 Computer Engineering Ph.D. Pre-Dissertation (0-0-3)

This course enables the student to submit his Ph.D. Dissertation Proposal and defend it in public. The student passes the course if the Ph.D. Dissertation Committee accepts the submitted dissertation proposal report and upon successfully passing the dissertation proposal public defense. The course grade can be NP, NF or IC.

Prerequisite: Ph.D. Candidacy, **Co-requisite:** COE-699.

COE 712 Computer Engineering Ph.D. Dissertation (0-0-9)

This course enables the student to submit his Ph.D. Dissertation Proposal and defend it in public. The student passes the course if the Ph.D. Dissertation Committee accepts the submitted dissertation proposal report and upon successfully passing the dissertation proposal public defense. The course grade can be NP, NF or IP.

Prerequisite: COE 711.

COMPUTER NETWORKS

CSE 550 Computer Network Design (3-0-3)

Network Development Life Cycle. Network Analysis and Design Methodology. Traffic Flow Analysis and Performance Evaluation. Network Simulation and Traffic Measurement Tools. Topology Design. Terminal Assignment. Concentrator Location and Servers Placement. Traffic Engineering. Structured Enterprise Network Design. Hierarchical Network Design Model. LAN and WAN Network Design. Backbone Design: Centralized vs. Distributed. Addressing and Routing. Network Management and Security. Network Reliability. Technology Choices. Structured Cabling Systems. Case Studies.

Prerequisite: COE 540 and ICS 353 (or equivalent) or Consent of the Instructor. **Equivalent To:** COE 546

CSE 551 Computer and Network Security (3-0-3)

Overview of Online Attacks, Malware, Social engineering, Physical and Communication security, Access Control techniques, Cryptography: Classical cipher, Mathematical cipher, Stream cipher, Block cipher, public key. Other Information security: Steganography, Hashing, Secret Sharing, Software reverse engineering & Program Security, Firewalls & IP sec, Security Policy & Risk Management , Advanced security topics.

Prerequisite: COE 540 and Good Math Background or consent of the instructor. **Equivalent To:** COE 551

CSE 552 Network Management (3-0-3)

Network Management Standards and Models. Network Management Protocols. Network Management Applications. Network Management Tools and Systems. Abstract Syntax Notation One (ASN.1). Structure of Management Information (SMI). Management Information Base (MIB). Simple Network Management Protocol (SNMP). SNMPv2 and SNMPv3. Remote Monitoring (RMON).RMON 1 and 2.Web-Based Management. Recent Network Management Advances

Prerequisite: COE 540 and ICS 431 (or equivalent) or consent of the instructor. **Equivalent To:** COE 547

CSE 553 Fault Tolerance and Reliability in Computer Networks (3-0-3)

Introduction to concepts of faults, errors, and failures. Basic concepts of dependable computing including dependability attributes, means, and validation. Stochastic modeling techniques in the context of network reliability analysis. Error detection and correction techniques. Fault-tolerant topology design. The practices of reliable and fault-tolerant computer networks design. Case studies.

Prerequisite: COE 540 and ICS 431 (or equivalent) or consent of the instructor. **Equivalent To:** COE 553

CSE 554 Modeling and Analysis of Computer Networks (3-0-3)

Numerical and analytical modeling. Performance evaluation and prediction. Exponential queuing systems; single and multiple servers, finite and infinite system size. Queuing networks. Cost-effective design and operation. Characterization of relations between system parameters. Conventional and non-conventional measures of system performance. Using modern computational packages like Mathematica and Matlab for building models and performing analysis. Case studies in areas like resource sharing, multiplexing and stochastic control.

Prerequisite: COE 540 or consent of the instructor. **Equivalent To:** COE 554

COE 555 Protocol Engineering (3-0-3)

Protocols and languages. Protocol structure. Structured protocol design. Fundamentals of Protocol Engineering. Specification and modeling. State Machines and Reachability Analysis. Formulation of desirable properties of protocols. Formal Logic and Deduction. Verification techniques. Formal description languages. Protocol synthesis. Protocol Design. Validation and conformance testing. Computer-aided design tools for protocol engineering (simulation and validation tools). A major project involving comprehensive design and verification of a non-trivial protocol.

Prerequisite: COE 540 and ICS 252 (or equivalent) or consent of the instructor. **Equivalent To:** COE 555

CSE 559 Special Topics in Computer Network Design and Management (3-0-3)

State-of-the-art topics in areas of computer network design and management, security and reliability.

Prerequisite: Consent of the instructor.

DEPARTMENTOF INFORMATION AND COMPUTER SCIENCE

Chairman

Dr. Abdulaziz Alkhoraidly

Faculty

Adam	Ahmad	El-Alfy
Alvi	Arafat	Aslam
El-Attar	Azzedin	Balah
El-Bassuny	Darwish	Elish
Faisal	Garout	Ghouti
Hasan	Hassine	Al-Jasser
Kamledin	Al-Khatib	Al-Khoraidly
Mahmoud	Mlaih	Al-Muhammadi
Al-Muhtaseb	Al-Mulhem	Niazi
Ramadan	Said	Sajjad
Al-Shayeb	Al-Suhaim	Al-Turki
Yazdani	Zhioua	

The vision of the Department of Information and Computer Science (ICS) is to be a "regional leader that is recognized worldwide in education, research and professional competence. In the light of this vision, the department is producing high quality specialized Computer Science graduates who are contributing immensely through their expertise in research and industry both within and outside the Kingdom. The ICS Department offers graduate programs leading to the degrees of Master of Science in Computer Science (M.S.CS), Ph.D. in Computer Science and Master of Science in Software Engineering (M.S.SWE) and Master of Science in Security & Information Assurance (M.S.SIA).

Teaching & Research Facilities

Software Engineering Lab

The software engineering lab provides a teaching and research environment to undergraduate and graduate students to conduct high-quality experiments and research in software engineering related areas such software metrics and measurement, software design, empirical software engineering, and software quality predictive models. The lab is equipped with Linux and Windows machines with uni- and multi-core processors. The lab is also equipped with many popular software engineering software and tools.

Database and Data Warehousing Lab

The aim of this lab is mainly to serve students and support their research in the field of databases and related areas. This lab is equipped with Linux, windows, and Intel XEON multi-core processors machines. Though some of the work is performed through widely available open-source frameworks and libraries, several propriety software packages and state-of-the-art database software and tools are also available at the researcher's disposals.

Multimedia Systems & Graphics Lab

Visualization research lab provides equipment and facilities to support research by graduate student and faculty members. Research in Visualization and Human Computer Interface (HCI) are the primary fields this lab serves. The lab is equipped with high-end visual and graphic computing systems with dual Quad-Core processor, high memory workstation with high-end SLI-ready multiple Graphic Processing Units. The configuration provides the ideal environment to develop high-level and low-level graphics code and test visualizations of large data.

Operating Systems Lab

The aim of the Systems Laboratory is to provide teaching and research support for systems related for undergraduate and graduate students. In particular, it provides tools for courses on operating systems, compilers, and other system software topics. The lab consists of a LINUX installation server and a number of other machines. The machines here are primarily used to experiment with system software.

Multimedia Lab

This lab is used by faculty, graduate students, and senior undergraduates working on research and development of multimedia & hypermedia applications such as computer based learning, games, and reference systems. The lab has several state-of-the-art PC based workstations with multimedia equipment, color scanner, video and audio card.

Intelligence Systems & Arabization Lab

This lab is a multifaceted research facility being used for research on natural language processing, knowledge representation, Arabization, Expert system tools and applications, and other aspects of Artificial Intelligence. In addition to the software packages and tools, the lab includes several workstations, and several state-of-the-art PCs.

Computer & Network Security Lab

A new state-of-the-art modern laboratory of a budget of around one-million Saudi Riyals is being proposed and will be constructed to support the hands-on experiments and exercises to be given

by the M.S.SIA core and elective courses. The lab will include state of-the-art security network appliances which include Cisco firewalls, IPS, routers, switches, network taps, rogue Wi-Fi AP in addition to Linux and Windows machines with uni- and multi-core processors. The lab also has many commercial and open-source software utilities related to application and network security auditing, penetration testing, software reverse engineering, password cracking, metasploit framework, Snort IDS, rootkits, and AV products. Also popular computer forensics tools like EnCase, FTK, ProDiscover, SIFT, and Sleuth Kit will be available.

Security Research Group Lab

The security research lab was established in 2005 and is used mainly by M.S. and Ph.D. students for conducting variety of research experiments related to computer and network security. The lab is equipped with two Cisco firewalls, routers, switches, and network taps in addition to Linux and Windows machines. The lab also has software utilities related to software reverse engineering, metasploit framework, Snort IDS, rootkits products.

Computer Network Lab

The computer network lab is aimed to support undergraduate and graduate students with their teaching as well as research material. The lab is a suitable environment for students to carry learn and investigate network features such as VLANs, STP, VoIP, Security, Layer 3 routing, Etherchannels, trunking, etc. This lab has a capacity of 30 PCs along with Routers, Switches, and Hubs.

General Purpose PC Lab

The Personal Computer Lab has more than ninety state of the art PCs which are networked to the College of Computer Science & Engineering network. The PC lab provides Dual Quad Core processor, high memory workstations. The configuration provides the ideal environment for graduate students to use Windows-based applications as well as terminal sessions to connect to UNIX/LINUX machines,

M.S. PROGRAM IN COMPUTER SCIENCE

The M.S.CS program is designed with the objective of providing a well-balanced breadth and depth knowledge at the graduate level. The program is designed such that students graduate with adequate advanced breadth in the discipline, while simultaneously allowing for emphasis in a desired area of specialization.

Admission Requirements

An M.S. applicant must have a B.S. in engineering or science from an institution whose undergraduate programs are comparable to those of KFUPM in both content and quality. All applicants must have a cumulative GPA of at least 3.0 out of 4.

All M.S. applicants should have a satisfactory background in the following core areas of computer science: Data Structures, Computer Architecture, Algorithms, Programming Languages, Database Systems, Computer Networks, and Operating Systems. Insufficient background in any of these areas is considered a deficiency. Provisional admission may be granted to otherwise qualified students with core background deficiencies. Students with deficiencies must take the appropriate course(s) at KFUPM. Each deficiency course must be completed with a grade of B or better before a change of status to regular is realized.

Program Objectives

The objectives of the M.S.CS program are:

- To prepare students for further research in their field of specialization.
- To provide information & computer professionals needed in the country's development plans.
- To provide specialized expertise through which advanced technologies and their applications can be enhanced, transferred, and utilized.

Degree Requirements

All candidates for the M.S. degree in Computer Science must satisfy the overall requirements of KFUPM in addition to the following:

- All students enrolled in the M.S.CS program are required to successfully complete 30 credit hours of coursework and thesis. The coursework includes a total of 24 credit hours and a thesis of 6 credit-hours.
- The coursework must consist of 8 courses (3 credit hours each) of which two courses must be in CS core and Major elective area respectively and one course on research methods. The table below shows this required minimum course work for the completion of the degree in detail:

CS Core (Two Courses):	ICS 553 and ICS 535.
Major Area Electives (Two Courses):	Must be taken from the selected Major area (area A or area B given in Table 1).
Research Methods (One Course):	ICS 500.
General Electives (Three Courses):	Can be taken from alist of subject areas given in Table 1. Elective courses can also be taken from outside the list. At least one course should be from outside area A and B. Also, at least one course should be from area C or area D given in Table 1.

- Students are required to attend and pass ICS 599 Seminar course which carries no credit hours.
- Each student must complete the ICS 610 Thesis of 6 credit hours on an approved research topic under the supervision of his graduate thesis committee.
- The approved thesis research topic must be related to a subject area in which the student has taken at least two graduate courses.
- A cumulative and major GPA of 3.0 or better must be maintained in all graduate and deficiency courses.
- All requirements of the Master’s degree for a full-time student must be completed during a total elapsed period of three calendar years.

Degree Plan for M.S. in Computer Science

Course No.		Title	LT	LB	CR
First Semester					
ICS	553	Algorithms and Complexity	3	0	3
ICS	xxx	Major Area Elective I	3	0	3
ICS	500	Research Methods & Experiment Design in Computing	3	0	3
			9	**0**	**9**
Second Semester					
ICS	535	Theory & Design of Programming Languages	3	0	3
ICS	xxx	Major Area Elective II	3	0	3
XXX	xxx	General Elective I	3	0	3
ICS	599	Seminar	1	0	0
			10	**0**	**9**
Third Semester					
XXX	xxx	General Elective II	3	0	3
XXX	xxx	General Elective III	3	0	3
ICS	610	M.S. Thesis	0	0	IP
			6	**0**	**6**
Fourth Semester					
ICS	610	M.S. Thesis	0	0	6
			0	**0**	**6**
Total credit hours:					**30**

Notes:

- Each student is expected to submit his detailed degree plan according to the above generic degree plan shown above for approval by Department and Deanship of Graduate Studies within the 8th week of the second semester of enrollment.
- Students are required to adhere to the regulations of the degree plan. No relaxations will be given to any student, and courses taken in conflict with the degree plan will not be counted towards the degree.
- The order of taking the courses can be different from above, but students must take the core courses before electives.
- The ICS elective courses should be taken exclusively from the provided list of electives. Any CSE course is considered elective.
- Free elective courses should be taken from graduate courses of departments like: Computer Science (ICS), Computer Engineering (COE), Systems Engineering (SE), Electrical Engineering (EE), or Mathematics (MATH) and should be approved by the ICS department.
- Under certain conditions courses carrying identification codes in the 400-level may be taken for graduate credit (towards a Master's program only). No more than two courses of 400-level may be counted for credit towards the requirements of an advanced degree provided that they are permitted in the approved graduate program. Also, these two courses must be approved by the student's graduate advisor, the department chairman, and the Dean of Graduate Studies.

Table 1: List of four subject areas and their respective courses.

Courses of Area A: Algorithms & Applications

ICS 545: Arabic Computing
ICS 546: Multimedia Information Management
ICS 547: Digital Image Processing
ICS 553: Algorithms and Complexity
ICS 557: Advanced Machine Learning
ICS 558: Introduction to Bioinformatics & Biomedicine
ICS 582: Natural Language Processing
ICS 583: Pattern Recognition
ICS 611: Combinatorial, Approximation & Probabilistic Algorithms
ICS 614: Advanced Pattern Recognition
ICS 615: Advanced Computer Vision

Courses of Area B: Systems and Languages

ICS 531: Advanced Operating Systems
ICS 532: Performance Analysis & Evaluation
ICS 533: Modeling & Simulation of Computing Systems
ICS 535: Theory & Design of Programming Languages
ICS 541: Database Design & Implementation
ICS 630: Distributed Systems
ICS 633: Semantics of Programming Languages

Courses of Area C: Security & Net-centric Computing

ICS 555: Cryptography & Data Security
ICS 570: Computer Communication Network
ICS 571: Client Server Programming
ICS 572: Distributed Computing
ICS 573: High Performance Computing
ICS 575: Application Development for Internet Based Services
ICS 576: Concurrent & Parallel Processing
ICS 654: Advanced Topics in Computer Networking
COE 541: Local & Metropolitan Area Networks
COE 542: High Speed Networks
COE 543: Mobile Computing & Wireless Networks
CNW 550: Computer Network Design
CNW 554: Modeling & Analysis of Computer Networks
CNW 555: Protocol Engineering
SEC 511: Principles of Information Assurance & Security
SEC 521: Network Security
SEC 524: Computer & Network Forensics
SEC 528: Security in Wireless Networks
SEC 531: Secure Software
SEC 534: Database Security
SEC 536: Web Application Security
SEC 538: Trusted Computing
SEC 544: Biometric Systems
SEC 546: Embedded Systems Security
SEC 548: Watermarking & Steganography
SEC 595: Special Topics in Information Assurance & Security
SEC 611: Cryptographic Computations

SEC 621: Advanced Network Security
SEC 631: Security in Operating Systems and Cloud Computing
SWE 531: Secure Software

Courses of Area D: Software Engineering
SWE 505: Principles of Software Engineering
SWE 515: Software Requirements Engineering
SWE 516: Software Design
SWE 526: Software Testing & Quality Assurance
SWE 531: Secure Software
SWE 532: Web Applications Security
SWE 536: Software Architecture
SWE 539: Software Metrics
SWE 566: Software Agents
SWE 585: Empirical Software Engineering
SWE 587: Software Project Management
SWE 595: Special Topics in Software Engineering
SWE 634: Software Re-use
SWE 638: Software Maintenance & Re-Engineering
SWE 670: Formal Methods and Models in Software Engineering
SWE 671: Global Software Engineering

M.S. PROGRAM IN SOFTWARE ENGINEERING

The aim of the M.S. in Software Engineering (M.S.SWE) Program is to provide a well-trained software engineers to cope with the increasing complexity in software development for both critical and non-critical systems which is increasing in the Kingdom.

Admission Requirements

The applicant should have the equivalent degree of an undergraduate software engineering of King Fahd University of Petroleum and Minerals. In general, applicants with a four year degree in related fields in science and engineering (e.g. computer science, computer engineering, systems engineering, electrical engineering, information technology, etc.) may be considered for admission. However, an applicant lacking an adequate undergraduate training may be admitted if recommended by the Department’s Graduate Committee and the Chairman, with the understanding that the course work taken to remove the deficiency in the undergraduate training may not be credited towards the degree.

The priority for the enrollment in M.S.SWE program is for applicants who hold BS in software engineering. Applicants who hold BS in other related information technology disciplines should have a satisfactory background in the following core areas of software engineering and computer science such as: software requirements engineering, software design and architecture, software testing, project management, database systems, operating systems, and design and analysis of algorithms.

Insufficient background in any of these areas is considered a deficiency. Provisional admission may be granted to qualified students. Such students must take the appropriate deficiency course(s) at KFUPM with a grade of B or better before a change of status to regular graduate student.

These admission requirements are in addition to the general University admission requirements set by the Deanship of Graduate Studies at KFUPM.

Program Objectives

The objectives of the M.S.SWE program are to enable graduates to:

- Have the necessary core skills based on the core body of knowledge in software engineering so that the individual can formulate research models, select the best solution to solve real world problem,
- Exhibit leadership in the Software Engineering.
- Have strong foundation for further research and to pursue a Ph.D. degree.

Learning Outcomes

Graduates of the M.S.SWE program will be able to:

- Apply proper theoretical and practical knowledge of software requirements engineering and software systems design. This includes feasibility analysis, negotiation, and good communication with stakeholders.
- Self-learn new models, techniques, and technologies as they emerge.
- Analyze the current significant software technology; articulate its strengths and weaknesses, and improvements.
- Recognize the relationships between core body of knowledge in software engineering and other related engineering disciplines (e.g. systems and computer engineering) and to be able to apply software engineering techniques to solve problems in related engineering disciplines.
- Reconcile conflicts in software project objectives, finding acceptable compromises within limitations of cost, time, and organization's core business.
- Carry out literature review, develop research proposal, and conduct research in specific topics related to software engineering core areas/develop an approach to analyze and solve specific software engineering problem

Academic Program

The M.S.SWE is offered with thesis and requires thirty (30) credit hours that include twenty four (24) credit hours of course work (i.e. 8 courses) and six (6) credit hours of thesis work. Nine (9) credit hours are selected from the core courses. Out of the remaining fifteen (15) credit hours, six (6) credit hours are to be taken from software engineering elective courses, three (3) credit hours of elective from computer science courses, and six (6) credit hours of elective courses from graduate courses (e.g. Computer Science (ICS), Computer Engineering (COE), Systems Engineering (SE), Electrical Engineering (EE), or Mathematics (MATH) courses) approved by the ICS department.

Core Courses

SWE 515 Software Requirements Engineering

SWE 516 Software Design

SWE 526 Software Testing and Quality Assurance

SWE 599 Graduate Seminar

SWE 610 M.S. Thesis

Major Elective Courses

SWE 531 Secure Software

SWE 532 Web Applications Security

SWE 536 Software Architecture

SWE 539 Software Metrics

SWE 566 Software Agents

SWE 585 Empirical Software Engineering

SWE 587 Software Project Management

SWE 595 Special Topics in Software Engineering

SWE 606 Independent Research

SWE 634 Software Re-use

SWE 638 Software Maintenance and Re-Engineering

SWE 670 Formal Methods and Models in Software Engineering

SWE 671 Global Software Engineering

Degree Plan for M.S. Program in Software Engineering

Course No.		Title	LT	LB	CR
First Semester					
SWE	515	Software Requirements Engineering	3	0	3
SWE	516	Software Design	3	0	3
SWE	5xx	Software Engineering Elective Course I	3	0	3
			9	**0**	**9**
Second Semester					
SWE	526	Software Testing and Quality Assurance	3	0	3
ICS	5xx	Computer science elective	3	0	3
XXX	5xx	Elective Course	3	0	3
SWE	599	Seminar	1	0	0
			10	**0**	**9**
Third Semester					
SWE	5xx	Software Engineering Elective Course II	3	0	3
XXX	5xx	Elective Course	3	0	3
SWE	610	M.S. Thesis	0	0	IP
			6	**0**	**6**
Fourth Semester					
SWE	610	M.S. Thesis	0	0	6
			0	**0**	**6**
Total					**30**

Notes:

- Each student is expected to submit his detailed degree plan according to the generic degree plan showm above for approval by the Department and the Deanship of Graduate Studies within the 8th week of the second semester of enrollment.
- Students are required to adhere to the regulations of degree plan. No relaxations will be given to any student, and courses taken in conflict with the degree plan will not be counted towards the degree.
- The order of taking courses can be different from above, but students must take the core courses before electives.
- The SWE elective courses should be taken exclusively from the provided list of electives.
- Free elective courses should be taken from graduate courses of departments like: Computer Science (ICS), Computer Engineering (COE), Systems Engineering (SE), Electrical Engineering (EE), or Mathematics (MATH) and should be approved by the ICS department.
- Under certain conditions courses carrying identification codes in the 400-level may be taken for graduate credit (towards a Master’s program only). No more than two (2) courses of 400-level may be counted for credit towards the requirements of an advanced degree provided that they are permitted in the approved graduate program. Also, these two courses must be approved by the student’s graduate advisor, the department chairman, and the Dean of Graduate Studies.

M.S. PROGRAM IN SECURITY AND INFORMATION ASSURANCE

The Master of Science program in Security and Information Assurance (M.S.SIA) is conceived, thought, and formulated as an answer to the increasing trend of cyber-attacks in the field of information exchange across the networks. The area of Security and Information Assurance has become one of the largest concerns today. As such, universities as well as research institutions are working on establishing programs and centers designed to increase the number of information security experts in the work field. This has been complemented by the fact that the demand for the Information Assurance and Security experts is increasing in the kingdom.

The main features of this graduate program are:

- It is an advanced-knowledge program targeting and tailored to meet the needs of information security practitioners, network engineers, computer scientists, information technologists as well as software engineers.
- The program has a synergy of theory, practice and research by providing multitude of specialized courses that cover all related aspects of the field.
- Since Information Assurance and Security draws its foundations from a wide variety of disciplines, the program is designed to be interdisciplinary by allowing students to take elective courses from the existing courses in Computer Science and other related graduate programs. This will ensure a balance between depth and breadth of the gained knowledge.
- The program offers students the opportunity to specialize in the fast-growing field of Information Assurance and Security. Students will be able to earn an advanced degree from the University with a lead-role of Information Assurance and Security experts and faculty.
- An advanced degree in Information Assurance and Security will indeed provide the needed leaders and professionals who will be capable of securing and protecting KSA cyber network and critical infrastructure from inside and outside threats and attacks that now face KSA and the Gulf Cooperation Council (GCC) region.

Admission Requirements

The applicant should have an equivalent degree of an undergraduate computer science of King Fahd University of Petroleum and Minerals. In general, applicants with a four year degree in related fields in science and engineering (e.g. computer science, computer engineering, systems engineering, electrical engineering, information technology, etc.) may be considered for admission.

In particular the following minimum requirements for possible admission as a regular student to pursue a M.S. degree in engineering or science are as follows:

- A four-year Bachelor’s (B.S.) Degree in engineering or science from a recognized institution with a major in the proposed field or evidence of suitable background for entering the proposed field.
- A Grade-Point Average (GPA) of 3.00 or higher on a scale of 4.00 or equivalent, and a GPA of 3.00 in the subject of the major field.
- Acceptable TOEFL and GRE score.

Unsatisfactory background in any of these areas is considered as deficiency. Provisional admission may be granted to qualified students. Such students must take the appropriate deficiency course(s) at KFUPM with a grade of B or better before a change of status to regular graduate student.

Academic Program

Program Objectives

Graduates of the Master of Science in Information Assurance and Security will:

- Meet the local needs for researchers and professionals who would uphold high knowledge, skills, and ethics in the field of Information Assurance and Security.
- Adapt and adjust to rapid advancement and continuous evolvement of the rapidly changing field of Information Assurance and Security
- Have strong foundation and knowledge to conduct research and discovery leading to a Ph.D. degree related to security or other related field.

Program Outcomes

Graduates of the M.S.SIA program will be able to:

- Research and investigate advanced problems related to the field of Information Assurance and Security.
- Analyze, implement, and select the most appropriate solution to advanced problems related to the field of Information Assurance and Security.
- Ability to write a security policy and put in place an effective security architecture that comprises modern hardware and software technologies and protocols.
- Use effective proper and state-of-the-art security tools and technologies

Degree Requirements

The Master of Science in Information Assurance and Security (M.S.SIA) requirement is thirty (30) credit hours that include twenty four (24) credit hours of course work (i.e., 8 courses) and six (6) credit hours of thesis work. Nine (9) credit hours are designated as major core courses. The program has another fifteen (15) credit hours out of which nine (9) credit hours must be taken from Information Assurance and Security elective courses and other (6) credit hours are electives to be taken from graduate courses (e.g. Mathematics (MATH), Computer Science (ICS), Computer Engineering (COE), Systems Engineering (SE), Electrical Engineering (EE) courses, etc.) subject to the approved student's degree plan. In short, the M.S.SIA formula for the required eight (8) courses (or 24 credits) is:

2 SEC Core + ICS 555 + 3 SEC Elective + 2 Elective + Thesis.

Two senior level courses may be taken for credit but subject to the approval of the student's Advisor, Graduate Committee, and Department Chairman. The details of the two options are shown in the degree plans below.

List of all Subject Courses in Security and Information Assurance

SEC 511	Principles of Information Assurance and Security
ICS 555	Cryptography and Data Security
SEC 521	Network Security
SEC 524	Computer and Network Forensics
SEC 528	Security in Wireless Networks
SEC 531	Secure Software
SEC 534	Database Security
SEC 536	Web Application Security
SEC 538	Trusted Computing
SEC 544	Biometric Systems
SEC 546	Embedded Systems Security
SEC 548	Watermarking and Steganography
SEC 595	Special Topics in Information Assurance and Security

SEC 611	Cryptographic Computations
SEC 621	Advanced Network Security
SEC 631	Security in Operating Systems and Cloud Computing
SEC 599	Graduate Seminar
SEC 606	Independent Research
SEC 610	M.S. Theses

Core Courses

SEC 511	Principles of Information Assurance and Security
ICS 555	Cryptography and Data Security
SEC 521	Network Security
SEC 599	Graduate Seminar

Elective Courses

SEC 524	Computer and Network Forensics
SEC 528	Security in Wireless Networks
SEC 531	Secure Software
SEC 534	Database Security
SEC 536	Web Application Security
SEC 538	Trusted Computing
SEC 544	Biometric Systems
SEC 546	Embedded Systems Security
SEC 548	Watermarking and Steganography
ICS 531	Advanced Operating Systems
SEC 595	Special Topics in Information Assurance and Security
SEC 611	Cryptographic Computations
SEC 621	Advanced Network Security
SEC 631	Security in Operating Systems and Cloud Computing

Recommended Graduate Elective Courses[3]

ICS 5xx and	ICS 6xx
SWE 5xx and	SWE 6xx
EE 562	Digital Signal Processing I
EE 563	Speech and Audio Processing
EE 575	Information Theory
EE 576	Error Control Coding
EE 577	Wireless and Personal Communications
EE 578	Simulation of Communication Systems
EE 663	Image Processing

[3]Other graduate courses subject to the approved student's degree plan.

EE 664	Wavelet Signal Processing
EE 665	Signal and Image Compression
COE 502	Parallel Processing Architectures
COE 503	Message Passing Multiprocessing Systems
COE 504	Heterogeneous Computing
COE 543	Mobile Computing and Wireless Networks
MATH 421	Introduction to Topology
MATH 450	Modern Algebra I
MATH 455	Number Theory
MATH 521	General Topology I
MATH 523	Algebraic Topology
MATH 552	Fields and Galois Theory
MATH 586	Design and Analysis of Experiment
ISE 502	Probabilistic Modeling ISE
ISE 509	Reliability Engineering
ISE 522	Advanced Stochastic Simulation
ISE 531	System Reliability/Maintainability
ISE 536	Human Factor Engineering

Degree Plan for M.S. in Security & Information Assurance

Course No.		Title	LT	LB	CR
First Semester					
SEC	511	Principles of Information Assurance and Security	3	0	3
ICS	555	Data Security and Encryption	3	0	3
SEC	5xx or 6xx	SEC Elective I	3	0	3
			9	**0**	**9**
Second Semester					
SEC	521	Network Security	3	0	3
SEC	5xx or 6xx	SEC Elective II	3	0	3
SEC	5xx or 6xx	SEC Elective III	3	0	3
SEC	599	Seminar	1	0	0
			10	**0**	**9**
Third Semester					
XXX	5xx or 6xx	Elective I	3	0	3
XXX	5xx or 6xx	Elective II	3	0	3
SEC	610	Graduate Seminar	0	0	IP
			6	**0**	**6**
Fourth Semester					
SEC	610	M.S. Thesis	0	0	6
			0	**0**	**6**
Total Credit Hours					**30**

Notes:

- Each student is expected to submit his detailed degree plan according to the above generic degree plan shown above for approval by the department and the Deanship of Graduate Studies within the 8^{th} week of the second semester of enrollment.
- Students are required to adhere to the regulations of degree plan. No relaxations will be given to any student, and courses taken in conflict with the degree plan will not be counted towards the degree.
- Under certain conditions courses carrying identification codes in the 400-level may be taken for graduate credit (towards a Master's program only). No more than two (2) courses of 400-level may be counted for credit towards the requirements of an advanced degree provided that they are permitted in the approved graduate program. Also, these two courses must be approved by the student's graduate advisor, the department chairman, and the Dean of Graduate Studies.
- The order of taking the courses can be different from above, but students must take the core courses before electives.

PH.D. PROGRAM IN COMPUTER SCIENCE

The primary emphasis of the Ph.D. program is to develop quality computer professionals who are capable of serving as researchers, faculty, specialized computer professionals and could be involved in integrating computer systems for constructive use in the society. The program provides advanced knowledge in all fields related to computer and information sciences such as programming languages, software engineering, computer networks, computer & network security, information systems, distributed system, artificial intelligence and foundations of computer science.

Admission Requirements

All applicants for admission to the Ph.D. program must have earned an M.S. degree with a minimum GPA of 3 out of 4, and the academic program of the degree awarding institution must be comparable with that of the KFUPM academic program. A student can apply for admission as Research Assistant (only foreign nationals), Graduate Assistant (only Saudi nationals), Full time graduate student, or a Part time graduate student. All applicants must fill all related forms obtained forms (to be obtained from College of Graduate Studies, or downloaded from http://www.kfupm.edu.sa/gs), and provide with their application the following documents:

- A letter of intent
- Graduation certificates
- Transcripts
- At least three reference letters
- Official TOEFL scores report
- General GRE scores report

Degree Requirements[4]

Students enrolled in this program are required to complete 30 credit hours of courses for graduate credits and 12 credit hours of dissertation. The courses should be according to each student's degree plan approved by the Department's Graduate Committee, the Department Chairman, and the Dean of Graduate Studies. The Ph.D. degree will be awarded to candidates who fulfill the requirements specified by the Deanship of Graduate Studies, as well as the following additional requirement imposed by the Information and Computer Science Department:

- Satisfactory removal of provisional status requirements, if any,
- Satisfactory completion of the coursework requirements,
- Passing the written comprehensive examinations by the end of the 4th semester after joining the program (This comprehensive exam is graded on pass/fail basis and a student is allowed to retake the exam at most twice),
- Passing the oral proposal public defense (ICS 711) in conjunction with the Seminar Course (ICS 699) by the end of the 5th semester after joining the program, and successful completion and defense of original dissertation research work (ICS 712).

[4]The requirements of the proposed Ph.D. program in Computer Science are summarized in Table 2.

Table 2: Summary of Minimum requirements for Ph.D. program in Computer Science

	Min Requirements	Notes
Major Area1	3 Courses	At least 1 of the 3 courses must be 600-level
Breadth Coverage	3 Courses from at least two areas other than the major area	
CS Elective	1 Course from any of the four CS areas	
General Electives	3 Courses - Could be from ICS or related disciplines; at least two courses from outside the lists under the four CS subject areas	At least 2 of these must be taken from outside the lists under the four areas. Elective course can be taken from, for example, COE, EE, SE and MATH etc.
Seminar	ICS 699: Seminar	Zero credit hour (P/F)
Comprehensive Exam	Comprehensive Exam	
Proposal	ICS 711: Ph.D. Pre-Dissertation	3 credit hour
Dissertation	ICS 712: Ph.D. Dissertation	9 credit hour

Program Design

The Ph.D. Program in Computer Science is designed to ensure breadth coverage up to the level of the awarded degree as well as depth coverage to emphasize the area of specialization for the awardee. The program provides breadth coverage of Computer Science topics through the arrangement of courses into four subject areas A, B, C and D. These subject areas are listed in Table 1. Each student is expected to select one of these subject areas as his major area in which he will conducts research and compile Ph.D. dissertation.

As far as the course work is concerned, each student must select one of the subject areas as his major area. The student may take for credit any of the CS 500-level (or higher) courses listed under the four subject areas, provided that such courses have not been taken for credit by the student for a previous degree at KFUPM. To ensure depth of knowledge, a minimum of three courses must be taken from the student's selected major area with, at least, one of these courses being a 600-level course. To provide breadth of knowledge, the student must take courses from at least two CS Ph.D. areas other than his major. In addition, the student is required to take three graduate elective courses two of which must be taken from outside the lists under the subject areas. The Comprehensive Exam covers three subject areas according to the student's preference in consultation with his advisor.

Each student is also required to present a seminar that describes recent research findings in Computer Science as well as to attend the technical seminar series organized by the ICS Department. This requirement is fulfilled by the zero credit hour seminar course ICS 699 (1-0-0).

Note: The required 600-level course cannot be replaced by the 700-level directed research or other self-study 600-level courses.

Degree Plan for PH.D. in Computer Science

Course No.		Title	LT	LB	CR
First Semester					
ICS	xxx	Students' Major Area	3	0	3
ICS	xxx	Students' Breadth Area	3	0	3
ICS	xxx	Students' Breadth Area	3	0	3
			9	**0**	**9**
Second Semester					
ICS	xxx	Student's Major Area	3	0	3
ICS	xxx	Students' Breadth Area	3	0	3
ICS	xxx	CS Elective	3	0	3
			9	**0**	**9**
Third Semester					
ICS	xxx	Students' Major Area	3	0	3
XXX	xxx	General Elective I	3	0	3
XXX	xxx	General Elective II	3	0	3
ICS	699	Seminar	1	0	0
			10	**0**	**9**
Fourth Semester					
XXX	xxx	General Elective III	3	0	3
ICS	711	Ph.D. Pre-Dissertation	0	0	3
			3	**0**	**6**
Fifth Semester					
ICS	712	Ph.D. Dissertation	**0**	**0**	IP
Sixth Semester					
ICS	712	Ph.D. Dissertation	**0**	**0**	**9**
Total Credit Hours					**42**

Notes:

- Each student is expected to submit his detailed degree plan according to the generic degree plan shown above for approval by the department and the Deanship of Graduate Studies within the 8th week of the second semester of enrollment.
- Students are required to adhere to the regulations of degree plan. No relaxations will be given to any student, and courses taken in conflict with the plan will not be counted towards the degree.
- The order of taking the courses can be different from above, but students must take the core courses before electives.
- All courses must be graduate level courses.
- ICS 500 Research Methods and Experiment Design in Computing or adequate publication record is a pre-requisite for admission.
- One of the student major area courses must be a 600-level course.

COURSE DESCRIPTIONS

COMPUTER SCIENCE

Area A. Algorithms and Applications

ICS 545 Arabic Computing (3-0-3)

Contemporary concepts and research in the field of Arabic Computing. Arabic characteristics and standardization. Arabic systems and tools. Arabic programming languages. Arabic character recognition. Arabic speech synthesis and recognition. Natural Arabic processing.

ICS 546: Multimedia Information Management (3-0-3)

Multimedia data representation and management in the context of content based retrieval, audio, image and video data representation, Information retrieval from text. Content based retrieval of audio, image and video data, Similarity measures. Query formulation and evaluation, Multi-dimensional indexing algorithms and data structures. Multimedia compression. Multimedia data mining.

Prerequisites: Consent of Instructor

ICS 547 Digital Image Processing (3-0-3)

Continuous Image. Mathematical Characterization. Psychovisual Properties. Photometry and Colorimetry. Superposition and Convolution. Image Transforms. Linear Processing Techniques. Image Enhancement. Morphological Image Processing. Edge Detection. Image Feature Extraction. Image Segmentation. Shape Analysis.

Prerequisites: Consent of Instructor

ICS 553 Algorithms and Complexity (3-0-3)

Computational complexity: P-space and EXP classes, Reduction, NP-complete problems, Cook's theorem, Randomized algorithms, Approximation algorithms, Branch-and-Bound, Amortized analysis; Max flow, Bipartite matching; Geometric algorithms: Convex hull, Closest pairs; Computability: Turing machines, Church-Turing thesis, Rice's theorem, Undecidability.

Prerequisite: ICS 353 or Equivalent

ICS 557 Advanced Machine Learning (3-0-3)
Linear and logistic regression. Regularization. Generalized linear models. Learning theory. Support vector machines. Kernel methods. Principal component analysis. Independent component analysis. Hidden Markov models. Random forests. Design of learning systems. Recommender systems. Online Learning. Ensemble learning models. Bootstrapping techniques.
Prerequisites: ICS 485 or Consent of the Instructor

ICS 558 Introduction to Bioinformatics and Biomedicine (3-0-3)

This course offers an introduction to bioinformatics with an emphasis on biomedical aspects. Topics include bioinformatics databases, sequence alignments, protein domains, protein-protein interaction, gene expression, gene ontology, pathways, disease state analysis, and computational methods in biomedicine.

Prerequisites: Consent of the Instructor

ICS 582 Natural Language Processing (3-0-3)

Components of a natural languages processing system. Natural language models: Mathematical, psychological. Lexical, syntactic, and semantic analysis. Phrase-structured grammars. Transformational grammars. Transition networks. Semantic networks. Conceptual parsing. Conceptual dependency. Systemic and case grammars. Scripts, plans and goals. Knowledge representation. Sentence generation. Recent trends.

Prerequisite: ICS 381 or Equivalent

ICS 583 Pattern Recognition (3-0-3)

Various methods of pattern recognition, extraction methods, statistical classification, minmax procedures, maximum likelihood decisions, data structures for pattern recognition, and case studies.

Prerequisite: Consent of the Instructor

ICS 611 Combinatorial, Approximation and Probabilistic Algorithms (3-0-3)

Representation and generation of combinatorial objects, Graph algorithms, Greedy method and the theory of matroids. Graph matching and applications. Network flows and applications. Approximation algorithms to combinatorial problems like scheduling, bin-packing, knapsack, vertex cover, TSP, clique partitioning, graph compression, Steiner problem on networks. Randomized algorithms: Monte-Carlo, Las-Vegas, algorithms, occupancy problems, randomized sorting and pattern matching, Markov chains and random walks.

Prerequisites: ICS 553 or Consent of the Instructor

ICS 614 Advanced Pattern Recognition (3-0-3)

The course covers advanced topics in pattern recognition and machine learning. Recent conference and journal papers will be discussed in depth. Tentative topics: Classification and discriminant analysis, feature generation using transformations. Feature selection, data transformation and dimensionality reduction, Classifier evaluation, Kernel methods, error rate estimation techniques and performance evaluation. Actual topics covered will depend on time available and students' interests.

Prerequisites: ICS 583 or equivalent

ICS 615 Advanced Computer Vision (3-0-3)

This course intends to provide an in-depth overview of the current state-of-the-art of computer vision by covering a set of advanced topics that are actively investigated. Recent conference and journal papers will be discussed in depth. Tentative topics: Low level vision: Image Segmentation, Stereo, Optical flow, de-noising and texture analysis; Higher level vision: Object Detection and Recognition/Pose Estimation; geometrical and 3D vision, stereo, 3D scene reconstruction, motion analysis, visual tracking, object recognition and human motion analysis, capturing and recognition. Actual topics covered will depend on time available and students' interests.

Prerequisites: ICS 547 or Consent of the Instructor

Area B. Systems and Languages

ICS 531 Advanced Operating Systems (3-0-3)

Advanced concepts in operating systems design; multiprocessing model, inter-process communication; synchronization mechanisms; resource management and sharing; scheduling in multiprocessor system; Process migration; Operating system-level virtualization; Special-purpose operating systems: Real-time, Distributed and network operating systems; Distributed deadlock handling; Distributed file system; Distributed shared memory; Replication & consistency; In addition, students will be exposed to recent developments in operating systems through research projects and papers.

Prerequisites: Consent of the Instructor

ICS 532 Performance Analysis & Evaluation (3-0-3)

Performance measures. Modeling methodologies: queuing models, graph models, dataflow models, and Pertinent models. Mathematical models of computer systems: CPU and computer subsystems such as memory and disks. Bottleneck analysis. Modeling multi-server systems. Model validation methods. Case studies. Project(s). *Equivalent to:* COE 587

Prerequisite: STAT 319 or Equivalent

ICS 533 Modeling and Simulation of Computing Systems (3-0-3)

Basic probability and statistics. Review of discrete-event simulation tools and methodologies. Simulation languages. Random Number generation. Developing Simulation Models. Simulation Validation. Output Data Analysis. Applications to computer systems. Project(s).

Equivalent to: COE 588

Prerequisite: STAT 319 or Equivalent

ICS 535 Theory and Design of Programming Languages (3-0-3)

Fundamentals of type systems, type inference, control structures, and storage management. Formal syntax specification. Semantic specification models: axiomatic, operational and denotational. Project(s) to design a programming language.

Prerequisites: ICS 410 or Equivalent

ICS 541 Database Design and Implementation (3-0-3)

Database development life cycle. Data modeling. Database design theory. Query processing Concurrency control and transaction management. Recovery. Security. Database applications: data warehousing, data mining, web pages, and others. Various types of database systems: object relational, object-oriented, distributed, client/server, and others. Current trends in database research. Project(s).

Prerequisite: ICS 334 or Equivalent

ICS 630 Distributed Systems (3-0-3)

Taxonomy of distributed systems: Client-server, cluster systems, Grid systems, P2P systems, cloud systems, volunteer-based systems. Distributed systems service models. Modeling, performance, scalability, elasticity and trust/reputation issues in distributed systems. Project(s).

Prerequisites: ICS 531 or Consent of Instructor.

ICS 633 Semantics of Programming Languages (3-0-3)

Formal methods for the description of programming languages. Advanced semantics models, attribute grammar, two-level grammars, fixed-point theory of computation, and Program verification techniques.

Prerequisites: ICS 535 or Consent of the Instructor

Area C. Security and Net-Centric Computing

ICS 555 Cryptography and Data Security (3-0-3)

Mathematical principles of cryptography and data security. A detailed study of conventional and modern cryptosystems. Zero knowledge protocols. Information theory, Number theory, Group theory, Complexity Theory concepts and their applications to cryptography.

Prerequisites: Consent of Instructor

ICS 570 Computer Communication Network (3-0-3)

Examination of modern computer networking and data communications. Contemporary concepts, facilities, practices, implementations, and issues. Data Link and media access layer protocols. Introduction to Gigabit Ethernet, ATM and Frame Relay. Protocols of TCP/IP suite. IP routing, flow and congestion control. Application Layer. Introduction to modeling and analysis of data networks: Queueing theory, Little’s Law, Single Queues, and Jackson Networks.

Equivalent to: COE 540 or EE 674
Prerequisite: ICS 432 or Equivalent

ICS 571 Client Server Programming (3-0-3)

An introduction to Clients, Servers, and Protocols. Client-Server Architectures. Software Architectures for Clients and Servers. Network and Operating System Support for Client-Server Applications. Programming language support. Standard interfaces and API. Examples of clients and servers for several popular protocols such as X, POP3, news, ftp, and http. Project(s).

Prerequisite: (ICS 570 and ICS 431) or Consent of Instructor

ICS 572 Distributed Computing (3-0-3)

An introduction to parallel and distributed computation models. Mapping a parallel solution to a distributed computing platform. Programming issues. Operating system support for distributed computing. Message passing environments such as PVM and MPI. Load balancing. Migration. Agent architectures. Performance and complexity measures. Services. Service driven design of distributed applications. Timing and Synchronization. Remote procedure invocation. Project(s).

Prerequisite: (ICS 570 and ICS 431) or Consent of Instructor

ICS 573 High-Performance Computing (3-0-3)

Theory and practice of parallel computing. Analytical models of parallelism and performance evaluation. Parallel architectures. Software tools for parallel programming. Design and implementation methodologies for parallel high performance applications. Design, analysis, and implementation of parallel solutions for various scientific problems such as linear algebraic problems, fast Fourier transform, Monte Carlo techniques, boundary value problems, finite element techniques, and iterative systems. Project(s).

Prerequisite: (ICS 353 or Equivalent) or Consent of Instructor

ICS 575 Application Development for Internet Based Services (3-0-3)

Application Development for Deployment over the WWW. Application protocols. Connection and Session Objects. Authentication Services. Integrating Database Services. Component Architectures. Scripting Languages. Modern applications and application architectures such as Digital Cash and E-Commerce. Making use of the state-of-art tools, a major project will be developed by the students.

Prerequisite: ICS 571

ICS 576 Concurrent and Parallel processing (3-0-3)

Concepts and foundation of parallel processing. Computational models. Parallel algorithms. Parallelization techniques. Parallel software characteristics and requirements: languages, compilers, operating systems, and inter-process communication support. Parallel computer architectures. Case studies. Project(s).

Prerequisite: ICS 431 or Equivalent

ICS 599 Seminar (1-0-0)
Graduate students are required to attend seminars given by faculty members, visiting scholars, and fellow graduate students. Additionally, each student must give at least a presentation on a timely research topic. Among other things, this course is designed to give the student an overview of research, research methodology, journals and professional societies. Graded on a Pass or Fail basis.

Prerequisite: Graduate standing

ICS 610 M.S. Thesis (0-0-6)

The student has to undertake and complete a research topic under the supervision of a faculty member in order to probe in depth a specific problem in Computer Science.

Prerequisite: ICS 599 or Consent of Instructor

ICS 654 Advanced Topics in Computer Networking (3-0-3)

This course explores recent research trends and developments in computer networks and their applications covering state-of-the-art topics and case studies.

Prerequisites: ICS 570 or equivalent

Other courses belong to area C are listed under M.S. program in Security and Information Assurance.

Area D. Software Engineering

Courses belonging to area D are listed under M.S. program in software engineering.

Common Courses

ICS 500 Research Methods and Experimental Design in Computing (3-0-3)

Integrated treatment to models and practices of experimental computer science. Topics include scientific methods applied to computing, computational problem/solution characterization, quality metrics and performance estimation of computation systems, uses of analytic and simulation models, design of experiments, interpretation and presentation of experimental results, hypothesis testing, and statistical analyses of data.

Prerequisites: STAT 319 or equivalent

ICS 511 Principles of Software Engineering (3-0-3)

Software Requirements: Modern SRS for Enterprise Application and Performance-Critical Systems. Software Process: Personal Software Process, Team Software Process. Software Design: Architecture Tradeoff Analysis, Enterprise Architecture, COTS Architecture, Service Oriented Architecture, RAD. Software Planning: Software Acquisition, Software Engineering Measurement and Analysis (SEMA). Software Quality Assurance: 6-Sigma. Software Integration: Enterprise Application Integration, COTS Integration.

Prerequisite: ICS 413 or Equivalent

ICS 512 Software Requirements Engineering (3-0-3)

The course gives state of the art and state of the practice in software requirements engineering. In-depth research-oriented study of methods, tools, notations, and validation techniques for the analysis, specification, prototyping, and maintenance of software requirements. Topics include study of object-oriented requirements modeling, using state of the art modeling techniques such as the Unified Modeling Language (UML). The course work includes a project investigating or applying approaches to requirements engineering.

Prerequisite: ICS 413 or Equivalent

ICS 513 Software Design (3-0-3)

Concepts and methods for the architectural design of large-scale software systems. Fundamental design concepts and design notations are introduced. Several design methods are presented and compared. In-depth research-oriented study of object-oriented analysis and design modeling using state of the art modeling techniques such as Unified Modeling Language (UML). Students participate in a group project on object-oriented software design.

Prerequisite: ICS 413 or Equivalent

ICS 514 Software Validation, Verification, and Quality Assurance (3-0-3)

In-depth research-oriented study of Verification and Validation throughout the development lifecycle. Techniques for validation and verification. Quality assurance at the requirements and design phases. Software testing at the unit, module, subsystem, and system levels. Automatic and manual techniques for generating and validating test data. Testing process: static vs. dynamic analysis, functional testing, inspections, and reliability assessment.

Prerequisite: ICS 413 or Equivalent

ICS 515 Software Project Management (3-0-3)

Lifecycle and process models; process metrics; planning for a software project; mechanisms for monitoring and controlling schedule, budget, quality, and productivity; and leadership, motivation, and team building. Topics cover quantitative models of the software lifecycle, process improvement techniques, cost-effectiveness analysis in software engineering, multiple-goal decision analysis, uncertainty and risk analysis, software cost estimation, software engineering metrics; and quantitative lifecycle management techniques.

Prerequisite: ICS 413 or Equivalent

ICS 519 Special Topics in Software Engineering. (3-0-3)

Advanced topics selected from current journals of Software engineering that deal with theoretical development or applications in the field. Topic include: Reusable Software Architectures, Software Engineering, Experimentation, Concurrent Software Systems, Software Metrics Software Engineering for the World Wide Web, Formal Methods and Models in Software Engineering, etc.

Prerequisite: Consent of Instructor

ICS 590 Special Topic in Computer Science I (3-0-3)

Advanced topics selected from current literature that deals with theoretical foundations and advances in computer science. The specific content of an offering of the course should focus on a specific area of computer science.

Prerequisites: Consent of Instructor

ICS 592 Special Topic in Computer Science II (3-0-3)

Advanced topics selected from current literature that deals with theoretical foundations and advances in computer science. The specific content of an offering of the course should focus on a specific area of computer science.

Prerequisites: Consent of Instructor

ICS 599 Seminar (1-0-0)

Graduate students are required to attend seminars given by faculty members, visiting scholars, and fellow graduate students. Additionally, each student must give at least a presentation on a timely research topic. Among other things, this course is designed to give the student an overview of research, research methodology, journals and professional societies. Graded on a Pass or Fail basis.

Prerequisites: ICS 500

ICS 606 Independent Research (0-0-3)

This course is intended to allow the student to conduct research in advanced problems in his M.S. research area. The faculty offering the course should submit a research plan to be approved by the Graduate Program Committee at the academic department. The student is expected to deliver a public seminar and a report on his research outcomes at the end of the course. Graded on a Pass or Fail basis.

Prerequisites: Prior arrangement with an instructor

ICS 610 M.S. Thesis (0-0-6)

The student has to undertake and complete a research topic under the supervision of a faculty member in order to probe in depth a specific problem in Computer Science.

Prerequisites: ICS 599

ICS 690 Special Topic in Computer Science III (3-0-3)

Advanced topics selected from current literature that deals with theoretical foundations and advances in computer science. The specific content of an offering of the course should focus on a specific area of computer science.

Prerequisites: Consent of Instructor

ICS 691 Special Topic in Computer Science IV (3-0-3)

Advanced topics selected from current literature that deals with theoretical foundations and advances in computer science. The specific content of an offering of the course should focus on a specific area of computer science.

Prerequisites: Consent of Instructor

ICS 699: Ph.D. Seminar (1-0-0)

Ph.D. students are required to attend Departmental seminars delivered by faculty, visiting scholars and graduate students. Additionally, each Ph.D. student should present at least one seminar on a timely research topic. Ph.D. students should pass the comprehensive examination as part of this course. The course is graded on Pass or Fail basis. IC grade is awarded if the Ph.D. Comprehensive exam is not yet passed.

Prerequisite: Graduate Standing.

ICS 701 Directed Research I (3-0-3)

This course is intended to allow students to conduct research in advanced problems in their Ph.D. area of specialization. Among other things, this course is designed to give the students an overview of research in computer science, and a familiarity with research methodology, journals and professional societies in his discipline. At the end of the course, the student must deliver a public seminar to present his work and findings. The course is graded on Pass or Fail

basis.

Prerequisites: Prior arrangement with Instructor

ICS 702 Directed Research II (3-0-3)

This course is intended to allow students to conduct research in advanced problems in their Ph.D. area of specialization. Among other things, this course is designed to give the students an overview of research in computer science, and a familiarity with research methodology, journals and professional societies in his discipline. At the end of the course, the student must deliver a public seminar to present his work and findings. The course is graded on Pass or Fail basis.

Prerequisites: Prior arrangement with Instructor

ICS 711 Ph.D. Pre-Dissertation (0-0-3)

This course enables the student to submit his Ph.D. Dissertation Proposal and defend it in public. The student passes the course if the Ph.D. Dissertation Committee accepts the submitted dissertation proposal report and upon successfully passing the Dissertation Proposal Public Defense. The course grade can be NP, NF or IC.

Prerequisites: Ph.D. Candidacy, **Co-requisite**: ICS 699

ICS 712 Ph.D. Dissertation (0-0-9)

This course enables the student to work on his Ph.D. Dissertation as per submitted dissertation proposal, submit its final report and defend it in public. The student passes this course if the Ph.D. Dissertation Committee accepts the submitted final dissertation report and upon successfully passing the Dissertation Public Defense. The course grade can be NP, NF, or IP.

Prerequisites: ICS 711

SECURITY & INFORMATION ASSURANCE

SEC 511 Principles of Information Assurance and Security (3-0-3)

An introduction to information assurance and security. Information confidentiality, availability, protection, and integrity. Security systems lifecycle. Risks, attacks, and the need for security. Legal, ethical, and professional issues in information security. Risk management including identification and assessment. Security technologies and tools. Security laws, audit and control. Cryptography foundations, algorithms and applications. Physical security, security and personnel, security implementation and management. Securing critical infrastructure. Trust and security in collaborative environments.

Prerequisite: Graduate standing

ICS 555 Cryptography and Data Security(3-0-3)

Mathematical principles of cryptography and data security. A detailed study of conventional and modern cryptosystems. Zero knowledge protocols. Information theory, Number theory, complexity theory concepts and their applications to cryptography.

Prerequisite: Graduate standing

SEC 521 Network Security (3-0-3)

Network infrastructure security issues, including perimeter security defenses, firewalls, virtual private networks, intrusion detection systems, wireless security, and network security auditing tools. Secure network applications. Network security protocols such as SSL, SSL/TLS, SSH, Kerberos, IPSec, IKE. Network threats and countermeasures. Network auditing and scanning. VoIP Security. Remote exploitation and penetration techniques. Network support for securing critical infrastructure. Design and development of software-based network security modules and tools based on hands-on experiences and state-of-the-art technologies.

Note: SEC 521 cannot be taken for credit with CSE 551

Prerequisite: ICS 555

SEC 524 Computer and Network Forensics (3-0-3)

Methodical approaches for collecting and preserving evidence of computer crimes, laws/regulation, and industry standards. Hands-on experience on identifying, analyzing, recreating, and addressing cyber based crimes. Ethical issues associated with information systems security. Foundational concepts such as file system structures, MAC times, and network protocols. Use of tools for evidence recovery. Use of established forensic methods in the handling of electronic evidence. Rigorous audit/logging and date archival practices. Prevention, detection, apprehension, and prosecution of security violators and cyber criminals, and general legal issues.

Prerequisite: SEC 521

SEC 528 Security in Wireless Networks (3-0-3)

Security of wireless networks such as cellular networks, wireless LANs, mobile ad hoc networks, wireless mesh networks, and sensor networks. Overview of wireless networks. Study of threats and types of attacks, including attacks on MAC protocols. Selfish and malicious behavior in wireless routing protocols. Countermeasures/ solutions and their limitations. Encryption and authentication. Secure hand-off techniques. Energy-aware security mechanisms. Secure multicasting. Key pre-distribution and management in wireless networks.

Prerequisite: SEC 521

SEC 531 Secure Software (3-0-3)

Software security development lifecycle including security requirements analysis, design, coding, review, and testing. Construction of secure and safe C/Unix programs. Vulnerabilities in C

source code. Stack and heap buffer overflows. Overview of secure web application development with consideration for SQL injection, cookies, and forceful browsing. Techniques for software protection, such as code obfuscation, tamper-proofing, and water-marking. Analysis of software based attacks and defenses, timing attacks and leakage of information. Type safety and capability systems. Numerous hands-on exercises and projects on writing secure code and unbreakable code and other related topics.

Equivalent to: SWE 531

Prerequisite: Graduate standing

SEC 534 Database Security (3-0-3)

A study of database security and auditing issues, challenges and protection methods. A review of relational and object database concepts. Database security and auditing issues. Authentication methods. Authorization based on privileges, roles, profiles, and resource limitations, and role-based authorization constraints. A study of access control mechanisms for current DBMSs, content-based and fine-grained access control, access control systems for object-based design and XML. Data confidentiality and privacy for databases. Secure statistical databases. Integrating databases and applications security. Database security protection via inference detection. Security implementation and administration, with applications to ecommerce, and emerging research in database security.

Prerequisite: SEC 511

SEC 536 Web Application Security (3-0-3)

Web applications security requirements, threats and countermeasures. Contemporary web application vulnerabilities and exploitation techniques, based on the Open Web Application Security Project (OWASP). Web defacement and server penetration techniques. Content-based attacks and effective countermeasures. Intellectual property protection and watermarking. Auditing and scanning Web applications and infrastructure for security weaknesses. Analysis of Web applications for key vulnerabilities and attacks. Security mechanisms and protocols and their roles in securing Web applications. Secure Web programming mechanisms in ASP.NET, Java, PHP, XML and SQL. Secure Web applications for e-commerce, e-banking and e-government transactions. Numerous hands-on exercises and projects on using tools and writing secure Web applications.

Prerequisite: SEC 511

SEC 538 Trusted Computing (3-0-3)

A comprehensive overview of trusted computing technology and its applications, TPM chips, secure boot, attestation, DRM, sealed storage, nature of trust, methods for characterizing, establishing, and attesting trust of a system. Trusted Virtualization. Operating system and hardware support for TC. Key management. Code signing. Identity management. Implications of certification. Trusted Mobile Platforms. Trust negotiation, transitive trust, trust evaluation and reputation systems. Trust computing architectures and modeling. Trust computing in P2P and cloud computing paradigms. Design and development of software applications and components to utilize trust computing for protecting information providers and end users.

Prerequisite: SEC 511, ICS 555

SEC 544 Biometric Systems (3-0-3)

Theory of signal processing, especially image and sound processing, for purposes of biometric system design. An introduction to basic methods and techniques for the study of authentication based on static biometric features such as fingerprints, hand geometry, facial features, thermograms, iris and retina, voice, and handwriting. Study of recognition based on dynamic features including lip movements, typing, and gait, study of standards and applications of biometry.

Prerequisite: Graduate standing

SEC 546 Embedded Systems Security (3-0-3)

Theory of signal processing, especially image and sound processing, for purposes of biometric system design. An introduction to basic methods and techniques for the study of authentication based on static biometric features such as fingerprints, hand geometry, facial features, thermograms, iris and retina, voice, and handwriting. RFID security and e-governance and e-passport security. Study of recognition based on dynamic features including lip movements, typing, and gait, study of standards and applications of biometry. Development and implementation of core components of biometric systems (mainly the feature and matching modules).

Prerequisite: Graduate standing

SEC 548 Watermarking and Steganography (3-0-3)

A study of enabling technologies for digital watermarking and steganography including the history of information hiding, basic principles and techniques such as still images, video, and 3-D video objects, and their applicability to owner authentication, content authentication, information embedding and communication with side information. Evaluation and benchmarking of watermarking and steganography mechanisms. Study of malicious attacks inclusive of bit rate limitation, counterfeiting marks and removal attacks. An overview of attempts to formalize watermarking. Steganography vs. watermarking. Applications of steganography. Software for steganography, and steganalysis techniques.

Prerequisite: Graduate standing

SEC 595 Special Topics in Information Assurance and Security (3-0-3)

Advanced topics selected from current journals of Information Assurance and Security and that deal with theoretical development or applications in the field.

Prerequisite: Consent of Instructor

SEC 599 Graduate Seminar (1-0-0)

Graduate students are required to attend seminars given by faculty members, visiting scholars, and fellow graduate students. Additionally, each student must deliver at least one presentation on a contemporary research topic. Among other things, this course is designed to give the student an overview of how to conduct research, research methodology, journal specifications and submission requirements, and on professional societies. The course grade is on Pass or Fail basis.

Prerequisite: Graduate standing

SEC 606 Independent Research (Pass/Fail) (3-0-3)

This course is intended to allow the student to conduct research in advanced problems in his M.S. research area. The faculty offering the course should submit a research plan to be approved by the Graduate Program Committee at the academic department. The student is expected to deliver a public seminar and a report on his research outcomes at the end of the course. Graded on a Pass or Fail basis.

Prerequisite: Graduate Standing

SEC 610 M.S. Thesis (0-0-6)

The student has to undertake research at an in-depth level under the supervision of a faculty member for a specific problem in the area of Information Assurance and Security.

Prerequisite: SEC 599

SEC 611 Cryptographic Computations (3-0-3)

Introduction to number theory and set algebra. Finite fields. Computations in finite fields using standard and non-standard bases. High performance algorithms and architectures for cryptographic applications. Side channel analysis attack resistant computations.

Prerequisite: ICS 555

SEC 621 Advanced Network Security (3-0-3)

Intrusion detection and prevention systems. Security engineering processes. Advanced firewall considerations. Honeynets. Network forensics. Distributed denial of service attacks (Botnet, Rootkits, Zero-Day Exploits). Cyber crime and cyber war. Enterprise security policy development. Complex enterprise security infrastructure design and integration. Web and email security. P2P network security, and trust management.

Prerequisite: SEC 521

SEC 631 Security in Operating Systems and Cloud Computing (3-0-3)

Advanced security research topics in operating systems and emerging computing paradigm such as grid and cloud computing. Secure operating system requirements, fundamentals and definitions. Security in traditional and popular operating systems such as Unix, Linux, Open BS, D and Windows. Security kernels. Verifiable security goals, trusted processes, and information flow integrity. Secure capability systems. Security in virtualization and secure virtual machine systems. Security issues and countermeasures in cloud computing. Data security and storage in the Cloud. Security management in the cloud services: PaaS, SaaS, and IaaS. Case Studies of secure systems, design, and evaluation: SELinux and Solaris.

Prerequisite: SEC 521

SOFTWARE ENGINEERING

SWE 505 Principles of Software Engineering (3-0-3)

Software Requirements: Modern SRS for Enterprise Application, Software Process: Personal and Team Software Process, Traditional Software Processes and Agile Processes. Software Design: Architecture Tradeoff Analysis and patterns. Software Project Management: project initiation, planning, executing, monitoring control and closing. Software Engineering Measurement and Analysis, Software Quality Assurance: 6-Sigma. Software Integration: Enterprise Application Integration, COTS Integration.

Note: This course is for non SWE students, it cannot be taken for credit toward an M.S. degree by SWE graduate students.

SWE 515 Software Requirements Engineering (3-0-3)

The course gives state-of-the-art and state-of-the-practice in software requirements engineering. In-depth research-oriented study of methods, tools, notations, and validation techniques for the analysis, specification, prototyping, and maintenance of software requirements. Topics include study of object-oriented requirements modeling, using state of the art modeling techniques such as the Unified Modeling Language (UML). The course work includes a project investigating or applying approaches to requirements engineering.

Note: SWE 515 cannot be taken for credit with ICS 512

SWE 516 Software Design (3-0-3)

Concepts and methods for the architectural design of large-scale software systems. Fundamental design concepts and design notations are introduced. Several design methods are presented and compared. In-depth research-oriented study of object-oriented analysis and design modeling using state of the art modeling techniques such as Unified Modeling Language (UML). Students participate in a group project on object-oriented software design.

Note: SWE 516 cannot be taken for credit with ICS 513

SWE 526 Software Validation, Verification, and Quality Assurance (3-0-3)

In-depth research-oriented study of verification and validation throughout the development lifecycle. Techniques for validation and verification, quality assurance at the requirements and

design phases, software testing at the unit, module, subsystem, and system levels. Automatic and manual techniques for generating and validating test data. Testing process: static vs. dynamic analysis, functional testing, inspections, and reliability assessment.

Note: SWE 526 cannot be taken for credit with ICS 514

SWE 531 Secure Software (3-0-3)

Software security development lifecycle including security requirements analysis, design, coding, review, and testing. Construction of secure and safe C/Unix programs. Vulnerabilities in C source code. Stack and heap buffer overflows. Overview of secure web application development with consideration for SQL injection, cookies, and forceful browsing. Techniques for software protection, such as code obfuscation, tamper-proofing, and water-marking. Analysis of software based attacks and defenses, timing attacks and leakage of information. Type safety and capability systems.

SWE 532 Web Applications Security (3-0-3)

Study of contemporary web application vulnerabilities, based on the OWASP (Open Web Application Security Project). Study of exploitation techniques for server and client web applications, and techniques that lead to web defacement and server penetration. Auditing and scanning web applications and servers for security weaknesses and vulnerabilities. Contemporary attack scenarios exploiting web vulnerabilities such as cross-site scripting, SQL injection, cookies, and forceful browsing. Content-based attacks and effective countermeasures. Secure programming for the following technologies: .NET, ASP.NET, ActiveX, JAVA, Secure Sockets, and XML, and a study of web security protocols such as SSL and HTTPS.

SWE 536 Software Architecture (3-0-3)

Advanced principles, methods and best practices in building software architecture and the architecture design process are discussed. Architectural styles and patterns are presented and compared. Software architecture analysis and evaluation methods such as ATAM and CBAM, tradeoffs among conflicting constraints in building high quality architecture are also discussed. Architecture documentation is also presented.

SWE 539 Software metrics (3-0-3)

Software metrics history and current practice, basics of measurement theory for software metrics, framework for software measurement, product, application, and process metrics. The course includes introduction to foundations of measurement theory, models of software engineering measurement, software products metrics, software process metrics and measuring management.

SWE 566 Software Agents (3-0-3)

Agent-based programming; elements of distributed artificial intelligence; beliefs, desires and intentions; component based technology; languages for agent implementations; interface agents; information sharing and coordination; KIF; collaboration; communication; ontologies; KQML; autonomy; adaptability; security issues; mobility; standards; agent design issues and frameworks; applications in telecommunications.

Prerequisite: Consent of Instructor

SWE 585 Empirical software engineering (3-0-3)

The course discusses how empirical studies are carried out in software engineering. The distinction between analytical techniques and empirical techniques is reviewed. Other topics include empirical studies required in software engineering, kinds of problems that can be solved empirically, methods used to control variables and eliminate bias in empirical studies, and analysis and presentation of empirical data for decision making.

SWE 587 Software Project Management (3-0-3)

Lifecycle and process models; process metrics; planning for a software project; mechanisms for monitoring and controlling schedule, budget, quality, and productivity; and leadership,

motivation, and team building. Topics cover quantitative models of the software lifecycle, process improvement techniques, cost-effectiveness analysis in software engineering, multiple-goal decision analysis, uncertainty and risk analysis, software cost estimation, software engineering metrics; and quantitative lifecycle management techniques.

Note: SWE 587 cannot be taken for credit with ICS 515

SWE 595 Special Topics in Software Engineering (3-0-3)

Advanced topics selected from current journals of software engineering that deal with theoretical development or applications in the field. Topic include: Reusable Software Architectures, Software Engineering, Experimentation, Concurrent Software Systems, Software Metrics, Web Engineering or Formal Methods and Models in Software Engineering, etc.

Prerequisite: Consent of Instructor

SWE 599 Seminar (1-0-0)

Graduate students are required to attend the seminars given by faculty members, visiting scholars, and fellow graduate students. Additionally, each student must give at least a presentation on a timely research topic. Among other things, this course is designed to give the student an overview of research, research methodology, journals and professional societies. Graded on a Pass or Fail basis.

Prerequisite: Graduate standing

SWE 606 Independent Research (3-0-3)

This course is intended to allow the student to conduct research in advanced problems in his M.S. research area. The faculty offering the course should submit a research plan to be approved by the Graduate Program Committee at the academic department. The student is expected to deliver a public seminar and a report on his research outcomes at the end of the course. Graded on a Pass or Fail basis.

Prerequisite: Prior arrangement with an instructor

SWE 610 M.S. Thesis (0-0-6)

The student has to undertake and complete a research topic under the supervision of a faculty member in order to probe in depth a specific problem in Computer Science.

Prerequisite: SWE 599 or Consent of Instructor.

SWE 634 Software Re-use (3-0-3)

In-depth research based study of the concepts and engineering principles of software reuse with a focus on component-based reuse, domain analysis and modeling, service-oriented architectures; quality aspects of reuse, economic models of reuse; and reuse of non-code artifacts.

Prerequisites: Consent of Instructor

SWE 638 Software Maintenance & Re-Engineering (3-0-3)

Software evolution and reengineering approaches and abstraction techniques to extract specifications and design from existing code are discussed. Major maintenance activities are presented including estimating maintenance costs, managing change and predicting maintainability with software quality metrics. Organizational issues relative to product maintenance are discussed. Principles of reverse engineering techniques are also presented.

Prerequisite: Consent of Instructor

SWE 670 Formal Methods and Models in Software Engineering (3-0-3)

In-depth advanced formal mechanisms for specifying, validating, and verifying software systems. Program verification. Formal specification via algebraic specifications and abstract model specifications, including initial specification and refinement toward implementation. Integration of formal methods with existing programming languages, and the application of formal methods

to requirements analysis, testing, safety analysis, and object-oriented approaches. Model-driven architectures. Formal methods using the Object Constraint Language (OCL).

Prerequisites: Consent of Instructor

SWE 671 Global Software Engineering (3-0-3)

Topics include: Essentials of global software engineering, Software engineering outsourcing (Onshore outsourcing, Nearshore Outsourcing, Offshore outsourcing), Outsourcing models (Simple Dyadic Outsourcing, Multi-Vendors Outsourcing, Co-Sourcing and Complex Outsourcing), Global software project management concepts, tools, and techniques, Managing virtual teams, Cross-cultural collaboration, Global project leadership, Measuring organizations readiness for global software development, Software quality in global software development (CMMI, ISO 9001:2000), Global software engineering challenges, Professional practices for global software engineering (Intellectual Property Rights, Group working, conflict and negotiations management, Presentations, writing and referencing)

Prerequisites: Consent of Instructor

DEPARTMENT OF SYSTEMS ENGINEERING

Chairman

Dr. Fouad AL-Sunni
Faculty

Abdur-Rahim	Abouhedaf	AlDurgam
Al-Amer	Andijani	Ayar
Ben-Daya	Cheded	Al-Dajani
Al-Dhaifallah	Duffuaa	Al-Fares
El-Ferik	Al-Haboubi	Haroun
Kara	Magdi	Mujahid
Mysorewala	Nahas	Osman
Pirim	Rougi	Al-Saif
Selim	El-Shafei	Al-Sunni
Al-Turki	Vaqar	

The Department of Systems Engineering offers graduate programs leading to the Master of Science, the Master of Engineering (non-thesis) and Doctor of Philosophy in two majors. The objective of the Systems Engineering programs is to prepare engineers who can function well in large scale, interdisciplinary projects and can do independent research to analyze, improve, design and install engineering systems. Currently the Department of Systems Engineering offers graduate programs in Industrial and Systems Engineering (ISE) and Systems & Control Engineering (SCE).

In ISE programs, the scientific methods applied to decision-making, allocation of resources and optimization of systems will be emphasized. Operations Research models and techniques such as Linear Programming, Non-Linear Programming, Dynamic Programming, Queuing Theory, Network, Scheduling and Simulation are studied. In the Industrial Engineering programs, Quality, Reliability, Production and Inventory, Maintenance, Supply Chain Management, Human Factors and Work Measurements are essential elements of the programs. The overall emphasis is to integrate knowledge to operate, optimize, and improve systems productivity.

The SCE major emphasizes the analysis, design, synthesis, and optimization of systems in order to provide the best means of controlling their dynamic behavior to produce specified outputs. Automation, Control Theory, Process Control, etc. are essential parts of SCE programs. The current graduate programs provide students with advanced courses in the area of Automatic Control Systems as well as in Intelligent Instrumentation, Robotics, and Industrial Automation. The programs provide a wide variety of electives in different areas of concentration with flexibility in electives selection.

Teaching and Research Facilities

Systems engineering is a constituent department of the College of Computer Sciences & Engineering (CCSE). In addition to the college laboratories, the Department of Systems Engineering has ten laboratories for teaching and research. These laboratories are equipped with assorted equipment for running the experiments for students learning of practical concepts involved therein. Qualified technicians look after and maintain these laboratories. Four of these labs are used both for teaching and research purposes as mentioned against their names below; these are also used by graduate students for their study and research work.

- Condition based Maintenance & DSP lab (R)[5]
- Digital & Embedded Control Systems Lab
- Industrial Automation Lab
- Control Systems Lab (R)
- Mechatronics Lab (R)
- Senior Project Lab
- Analog & Discrete Simulation Lab
- Instrumentation Lab
- Human Factor Lab
- Process Control Lab (R)

[5]R represents research Labs.

M.S. PROGRAM IN INDUSTRIAL AND SYSTEMS ENGINEERING

Admission Requirements

Graduates from Engineering, Computer Science and Mathematics from recognized institutions are eligible to apply for admission for the Master programs provided they satisfy the requirements set by the Deanship of Graduate Studies.

Degree Requirements

The Master of Science (M.S.) requirement is thirty (30) credit hours that include twenty four (24) credit hours of course work and six (6) credit hours of thesis work. Six credit hours are designated as ISE core courses that must be taken by all students enrolled for the master program in ISE. The ISE MS program has another twelve (12) credit hours to be taken from ISE listing and six credit hours of them must be taken from ISE core areas within the department. The six (6) credit hours left are free electives. Three credit hours from the free elective should be outside the ISE listing. Thesis work must be in the master thesis area. The credit hours in the area or major may include a maximum of three credit hours of independent study. Two senior level courses may be taken for credit subject to the approval of the student advisor. The details are shown in the degree plan.

Degree Plan for M.S. in Industrial & Systems Engineering

Course No.	Title	LT	LB	CR
First Semester				
ISE 501	Deterministic Operations Research	3	0	3
ISE 502	Probabilistic Modeling in ISE	3	0	3
ISE xxx	ISE Elective	3	0	3
		9	**0**	**9**
Second Semester				
ISE 5xx	ISE Areas core	3	0	3
ISE 5xx	ISE Areas core	3	0	3
ISE 5xx	ISE Elective	3	0	3
ISE 599	Seminar	1	0	0
		10	**0**	**9**
Third Semester				
ISE xxx	ISE Elective	3	0	3
XX xxx	Free Elective	3	0	3
ISE 610	M.S. Thesis	0	0	IP
		6	**0**	**6**
Fourth Semester				
ISE 610	M.S. Thesis	0	0	6
		0	**0**	**6**
Total Credit Hours				**30**

Notes:

- Each student is expected to submit his detailed degree plan according to the generic degree plan for approval by the department and the Deanship of Graduate Studies within the 8^{th}week of the second semester of enrollment.
- Students are required to adhere to the regulations of degree plan. No relaxations will be given to any student, and courses taken in conflict of the above will not be counted towards the degree.
- Up to two 400-level courses may be allowed as electives subject to the approval of the advisor.
- The order of taking the courses can be different from above, but students must take the core courses before electives.

M.ENG. PROGRAM IN INDUSTRIAL & SYSTEMS ENGINEERING

Admission Requirements

Graduates from Engineering, Computer Science and Mathematics from recognized institutions are eligible to apply for admission for the Master programs provided they satisfy the requirements set by the Deanship of Graduate Studies. In addition, the applicant must fulfill the minimum criteria and other conditions set for admission by the Deanship of Graduate Studies.

Degree Requirements

The Master of Engineering (M.Eng.) requirement is forty two (42) credit hours that include thirty six (36) credit hours of course work and six (6) credit hours of independent research and Master of Engineering report. The ISE ME program has another eighteen (18) credit hours to be taken from ISE listing and (12) credit hours from them must be taken from ISE core areas within the department. The twelve (12) credit hours left are free electives that must be approved by the student advisor. Two of the free elective courses should be outside the ISE listing. The credit hours in the area or major may include a maximum of six credit hours of independent study. Two senior level courses may be taken for credit subject to the approval of the student advisor. The reports work must be in the master core area and graded on Pass or Fail basis. The details are shown in the degree plan.

Degree Plan for M.Eng. in Industrial & Systems Engineering

Course No.	Title	LT	LB	CR
First Semester				
ISE 501	Deterministic Operations Research	3	0	3
ISE 502	Probabilistic Modeling in ISE	3	0	3
ISE 5xx	ISE core areas	3	0	3
		9	**0**	**9**
Second Semester				
ISE 5xx	ISE core areas	3	0	3
ISE 5xx	ISE core areas	3	0	3
XX 5xx	Free Elective	3	0	3
ISE 606	Independent Research	0	0	3
		9	**0**	**12**
Third Semester				
ISE 5xx	ISE core areas	3	0	3
ISE xxx	ISE Elective	3	0	3
XX 5xx	Free Elective	3	0	3
		9	**0**	**9**
Fourth Semester				
ISE 5xx	ISE Elective	3	0	3
XX xxx	Free Elective	3	0	3
XX 5xx	Free Elective	3	0	3
ISE 600	Master of Engineering Report	0	0	3
		0	**0**	**12**
Total Credit Hours				**42**

Notes:

- Each student is expected to submit his detailed degree plan according to the above generic degree plan for approval by the department and the Deanship of Graduate Studies within the 8thweeks of the second semester of enrollment.
- Students are required to adhere to the regulations of degree plan. No relaxations will be given to any student, and courses taken in conflict of the above will not be counted towards the degree.
- Up to two 400-level courses may be allowed as electives subject to the approval of the advisor.
- The order of taking the courses can be different from above, but students are expected to take the core courses before electives.

SYSTEMS AND CONTROL ENGINEERING

The Department of Systems Engineering offers graduate programs leading to the Master of Science, the Master of Engineering (non-thesis) and Doctor of Philosophy in Systems and Control Engineering (SCE). The current graduate programs provide students with advance courses in the area of Automatic Control Systems as well as in Intelligent Instrumentation, Robotics, and Industrial Automation. The programs provide a wide variety of electives in different areas of concentration with flexibility in electives selection. There are three main areas of the program. The following is a brief description of these three broad areas:

A. Systems & Control Theory

Systems and Control Engineering is a broad multidisciplinary area concerned with modelling of physical systems, analysis of behavior, and design of controllers which influence that behavior to take some desired form. The research work includes control theory, computer simulation, and advanced process control. It touches all divisions of engineering, applied Mathematics and other applications areas such as process control, robotics, economics, aerospace, automotives and medicines. The analysis and design often involves sophisticated use of Mathematics, numerical analysis and computer-aided methods. The current research interests include: Systems modelling, simulation, optimization, and control, Linear and non-linear control, robust and adaptive control, time-delay systems, and advanced process control and its applications. The research in this area is of great importance to explore new frontiers in advanced control theory and applications in such fields as petrochemical industry, energy sources, economic management, military and biomedical engineering.

B. Control Applications and Industrial Automation

In the 21st century, Automation, Control, and Systems engineering will continue to have a major impact on the industrial scenario. This is because the performance requirements for manufacturing and process plants have become harder to satisfy. Stronger competition, tougher environmental and safety regulations, and rapidly changing economic conditions have been key factors in the tightening of product quality specifications. The development and application of the various tools of control and automation, and their integrated use provides process operations with a competitive edge in today's global economy. Problems that require a multi-disciplinary systems approach to integrate technologies from the different disciplines are typically researched.

C. Automation, Robotics and Machine Intelligence

The research objectives in this area are to pursue advanced engineering and computer based research in manufacturing automation, robotics, and machine intelligence. Application areas include Automated Guided Vehicles, autonomous systems, control of industrial robotic manipulators, manufacturing automation systems, mechatronics, flexible and intelligent manufacturing systems, machine vision, and Man-Machine Interface.

M.S. PROGRAM IN SYSTEMS AND CONTROL ENGINEERING

Degree Requirements

The Master of Science in SCE requirement is thirty 30 credit hours that include 24 credit hours of course work and 6 credit hours of thesis work. Twelve (12) credit hour are core courses. Two of core courses are fixed and two courses can be selected from a list of six courses. A maximum of two free electives can be taken. The following constitute the program requirements:

Core Courses

SCE 507 Linear Multivariable Control

SCE 513 System Identification

Two courses to be selected from the following courses:

SCE 517 Control of Nonlinear Systems

SCE 518 Process Modeling and Control

SCE 527 Adaptive Control

SCE 534 Digital Signal Processing

SCE 540 Intelligent Instrumentation Systems

SCE 560 Soft computing for Control and Automation

In addition, the student must take the seminar course SCE 599.

Major Elective Courses

A student can take courses from SCE 5xx or SCE 6xx. A student may take one Independent Research course (SCE 606) as one of the elective courses.

Free Elective Courses

A maximum of two courses can be taken from non-SCE courses. At least one course must be taken from outside the Department of Systems Engineering. The selected courses need the approval of the graduate advisor or the student advisor.

Degree plan for the M.S. in Systems & Control Engineering

Course	#	Title	LT	LB	CR
First Semester					
SCE	507	Linear multivariable control Systems	3	0	3
SCE	513	System Identification	3	0	3
SCE/XXX	xxx	Major Elective/Free Elective*	3	0	3
			9	**0**	**9**
Second Semester					
SCE	5xx	Core course	3	0	3
SCE	5xx	Core course	3	0	3
XXX	xxx	Free Elective	3	0	3
SCE	599	Seminar	1	0	0
			10	**0**	**9**
Third Semester					
SCE	xxx	Major Elective/Independent Research	3	0	3
SCE/XXX	xxx	Major Elective/Free elective2	3	0	3
SCE	610	M.S. Thesis	0	0	IP
			6	**0**	**6**
Fourth Semester					
SCE	610	M.S. Thesis	0	0	6
Total Credit Hours					**30**

Notes:

- Each student is expected to submit his detailed degree plan according to the above generic degree plan for approval by the Department and the Deanship of Graduate Studies within the 8th week of the second semester of enrollment.
- Students are required to adhere to the regulations of degree plan. No relaxations will be given to any student, and courses taken in conflict of the above will not be counted towards the degree.
- Up to two 400-level courses may be allowed with the approval of the advisor.
- The order of taking the courses can be different from above, but students must take the core courses before electives.

M. ENG. PROGRAM IN SYSTEMS AND CONTROL ENGINEERING

The Master of Engineering in SCE is a non-thesis program. Forty two (42) credit hours are required. Six core courses are required in addition to the seminar and Master of Engineering project. The following constitute program requirements:

Degree Requirements

Core Courses

SCE 507 Linear Multivariable Control

SCE 513 System Identification

Four courses to be selected from the following course:

SCE 517 Control of Nonlinear Systems

SCE 518 Process Modeling and Control

SCE 527 Adaptive Control

SCE 534 Digital Signal Processing

SCE 535 Distributed Computer Control and Field Buses

SCE 540 Intelligent Instrumentation Systems

SCE 542 Condition-Based Maintenance

SCE 560 Soft computing for Control and Automation

In addition the student must take the following two courses:

SCE 600 Master of Engineering Project-I

SCE 599 Seminar

Major Elective Courses

The student can take up to six courses from SCE 5xx or SCE 6xx. A student may optionally take up to two courses from the following as electives.

SCE 601 Master of Engineering Project –II

SCE 606 Independent Research

Free Elective Courses

A maximum of 4 courses can be taken from non-SCE courses. At least one course must be taken from outside the Department of Systems Engineering. The selected courses need the approval of the graduate advisor or the student advisor. A maximum of two 400-level courses can be taken for credit.

Degree plan for M.Eng. in Systems & Control Engineering

(Non-Thesis Option)

Course	#	Title	LT	LB	CR
First Semester					
SCE	507	Linear Multivariable Control	3	0	3
SCE	513	System Identification	3	0	3
SCE/XXX	xxx	Major elective / Free elective	3	0	3
			9	**0**	**9**
Second Semester					
SCE	5xx	Core course	3	0	3
SCE	5xx	Core course	3	0	3
XXX	xxx	Free elective	3	0	3
SCE	599	Seminar	1	0	0
			10	**0**	**9**
Third Semester					
SCE	5xx	Core course	3	0	3
SCE	5xx	Core course	3	0	3
SCE	600	M.Eng. Project-I	3	0	3
			9	**0**	**9**
Fourth Semester					
SCE	5xx	Major elective course	3	0	3
SCE/XXX	xxx	Major elective / Free elective	3	0	3
SCE/XXX	xxx	M.Eng. Project-II / Independent Research / Free elective	3	0	3
			9	**0**	**9**
Fifth Semester					
SCE/XXX	xxx	Major elective/Free elective	3	0	3
SCE	xxx	M.Eng. Project-II / Independent Research / Free elective	3	0	3
			6	**0**	**6**
Total Credit					**42**

Notes:

- Each student is expected to submit his detailed degree plan according to the above generic degree plan for approval by the Department and the Deanship of Graduate Studies within the 8^{th} week of the second semester of enrollment.
- Students are required to adhere to the regulations of degree plan. No relaxations will be given to any student, and courses taken in conflict of the above will not be counted towards the degree.
- Up to two 400-level elective courses may be allowed with approval of the advisor.
- The order of taking the courses can be different from above, but students must take the core courses before electives.

MASTER OF SUPPLY CHAIN MANAGEMENT

Supply Chain Management (SCM) focuses on effective planning and management of highly integrated product and information flows from the supplier's suppliers to the customer's customers. The MS-SCM program is offered in a cohort-based format and requires 4 semesters for completion. The main features of the proposed M-SCM program are:

- The first advanced supply chain management degree in the region
- A supply chain program that delivers the integrative thinking on SCM necessary to operate in today's competitive national and international environment.
- A program that combines business strategy, engineering, and IT.
- A convenient four semester program that keeps participants on the job

Admission Requirements

Successful Candidates should have:

- Received a bachelor's degree or its equivalent from a recognized university and secured a GPA of at least 2.5.
- Demonstrated an analytical ability through a strong scholastic performance and/or work experience in a technically demanding position, and college-level Mathematics (basic calculus and algebra) are required.
- Earned an acceptable TOEFL score or other evidence of English proficiency.
- Accrued a minimum of 2 years work experience in SCM related areas.

Degree Requirements

The Master of Supply Chain Management requirement is forty two (42) credit hours whose details are shown in the degree plan given below:

Degree Plan for Master of Supply Chain Management

Course #	Title	LT	LB	CR
First Semester				
SCM 500	Supply Chain Management	4	0	4
SCM 510	Quantitative Methods for Decision Making	3	0	3
SCM 520	Materials and Production Management	3	0	3
SCM 530	Quality Management	2	0	2
		12	**0**	**12**
Second Semester				
SCM 550	Logistics and Distribution Management	3	0	3
SCM 540	IT and Supply Chain Management	3	0	3
SCM 552	Reverse Logistics	2	0	2
SCM 590	Independent Reading/Research	3	0	3
		11	**0**	**11**
Third Semester				
SCM 532	Supply Chain Cost Management	2	0	2
SCM 560	Strategic Procurement and Outsourcing	3	0	3
SCM 570	Supplier Relationship Management	3	0	3
SCM 580	Organization Change Management	2	0	2
		10	**0**	**10**
Fourth Semester				
SCM 572	Customer Relationship Management	3	0	3
SCM 582	Global supply Chain Management	3	0	3
SCM 600	Integrative project	3	0	3
		9	**0**	**9**
Total Credit Hours				**42**

Notes:

- Students are required to adhere to the regulations of degree plan. No relaxations will be given to any student, and courses taken in conflict of the above will not be counted towards the degree.

PH.D PROGRAM IN INDUSTRIAL AND SYSTEMS ENGINEERING

Admission Requirements

For the Ph.D. programs, students with Master degree in the above-mentioned disciplines from recognized institutions are eligible to apply. In addition, the applicant must fulfill the minimum criteria and other conditions set for admission by the Deanship of Graduate Studies**.**

Degree Requirements

Every Ph.D. student in industrial and systems engineering (ISE) has to take ten courses and undertake a dissertation in his major that counts for 12 credit hours. The ten courses are composed of eight courses in the major area and two in the minor that will be selected by the student in consultation with his advisor. The Ph.D. courses will be from the 500 and 600 levels. A Ph.D. student may complete the ten courses by taking two directed research courses. Students from other areas or who complete their master in other institutions may be required to take more courses. Details on core, major and free elective courses are as follows:

(a) **Major Elective Courses**(24 Credit Hours)

(To be selected by the student in consultation with his advisor.)

(b) **Free Electives**(6 Credit Hours)

(To be selected by the student in consultation with his advisor).

(c) **Ph.D.Comprehensive Exam**

After completing the course work each student is required to pass a written comprehensive examination as required by the University Graduate Study regulations. This examination is to be passed by the 4th semester of the enrolment in the Ph.D. program and is graded on Pass or Fail basis. A student is entitled to two attempts to pass the comprehensive examination.

(d) **Ph.D. Pre-Dissertation: ISE 711** (3 Credit Hours)

Ph.D. Dissertation: ISE 712 (9 Credit Hours)

Degree Plan for Ph.D. in Industrial & Systems Engineering

Course #		Title	LT	LB	CR
First Semester					
ISE	5xx	Elective I - ISE	3	0	3
ISE	5xx	Elective II - ISE	3	0	3
XXX	5xx	Elective III – (Minor Area)	3	0	3
			9	**0**	**9**
Second Semester					
ISE	5xx	Elective IV - ISE	3	0	3
ISE	6xx	Elective V- ISE	3	0	3
ISE	6xx	Elective VI - ISE	3	0	3
			9	**0**	**9**
Third Semester					
ISE	5xx	Elective VII – ISE	3	0	3
XXX	5xx	Elective VIII-(Minor Area)	3	0	3
ISE	5xx	Elective IX - ISE	3	0	3
ISE	699	Seminar	1	0	0
			10	**0**	**9**
Fourth Semester					
ISE	6xx	Elective X-ISE	3	0	3
ISE	711	Ph.D. Pre-Dissertation	0	0	3
			3	**0**	**6**
Fifth Semester					
ISE	712	Ph.D. Dissertation			IP
Sixth Semester					
ISE	712	Ph.D. Dissertation	0	0	9
			0	0	**9**
Total Credit Hours					**42**

Notes:

- Each student is expected to submit his detailed degree plan according to the above generic degree plan for approval by the Department and the Deanship of Graduate Studies within the 8th week of the second semester of enrollment.
- Students are required to adhere to the regulations of degree plan. No relaxations will be given to any student, and course taken in conflict of the above will not be counted towards the degree.
- Two of the ISE courses may be replaced with two directed research courses.
- The order of taking the courses can be different from above, but students must take the core courses before electives.
- Ph.D. Students are required to adhere to the guidelines for preliminary and comprehensive exams upon joining the program.

PH.D. PROGRAM IN SYSTEMS AND CONTROL ENGINEERING

Admission Requirements

Applicants for the SCE Ph.D. from the SCE program are required to have completed the M.S. degree with thesis option and to have a cumulative GPA in the M.S. courses of 3.0 or above. Applicants from other majors are required to have completed an M.S. degree thesis option in an engineering field with close relevance to the systems and control major, and to have a cumulative GPA in the M.S. courses of 3.0 or better. In addition, their course work should contain the equivalence of the SCE M.S. core courses, otherwise remedial courses and/or an entrance exam may be required to be taken and the student must score 'B' or better in each of these courses to be officially admitted into the SCE Ph.D. program.

Degree Requirements

A student in the Ph.D. Program is required to finish a minimum of 30 credit hours (10 courses) plus 12 credit hours of Ph.D. dissertation work. The Ph.D. courses are built on the M.S. courses, and are broadly clustered on the systems theory area and two application-oriented course areas. Courses counted towards the Ph.D. degree are to be taken from the 500/600 level courses other than those taken for the M.S. degree or those taken as a remedial deficiency make-up courses. At least two of these courses should be taken from the 600/700 level courses. A Ph.D. student may complete the ten courses by taking up to two Directed Research courses. A student may also take up to 3 courses in allied areas from outside the program subject to approval by the Department Graduate Committee and provided that at least 2 of them contribute to building a minor.

A student transferred from other universities may transfer up to 12 credit hours of post graduate courses subject to the approval of the Department Graduate Committee, and provided that the student had scored at least B in each course.

Core Course Requirements

It is highly recommended that students complete at least two courses from the SCE 600 level courses scoring a least a grade of 'B' in each one. At least three (3) courses should be chosen from an area of concentration.

Comprehensive Exam

After completing the course work students are required to successfully pass a written comprehensive Ph.D. exam as required by the University Graduate Study regulations. The exam is to be passed, in at most two attempts, by the 4th semesterof their admission.

Ph.D. Dissertation

Students are required to present their approved dissertation proposal in public. Students are required to complete a Ph.D. dissertation which must be presented and defended in public according to the requirements of the Deanship of Graduate Studies.

Ph.D. Areas and Courses

In order to prepare the Ph.D. graduates to work in the rapidly developing fields of Systems Science and Automation, the SCE program is structured to offer a wide selection of courses and seminars. Following is a brief description of the various course areas:

A. Systems & Control Theory

The purpose of this set of courses is to provide fundamentals of control and systems theory. This set includes:

SCE 612 Advanced Methods for Control Systems

SCE 614 Robust Control Systems

SCE 616 Nonlinear Filtering

SCE 691 Special Topics in Systems & Control

SCE 507 Linear Multivariable Control

SCE 529 Decentralized Control

SCE 513 System Identification

SCE 514 Optimal and Robust Control

SCE 515 Stochastic Control Systems

SCE 516 Linear Estimation
SCE 517 Control of Nonlinear Systems

SCE 518 Process Modeling and Control

SCE 527 Adaptive Control

SCE 591 Special Topics in Control Systems Engineering

B. Control Applications and Industrial Automation

The objective of this area is to provide the training and background to handle specific applications which depend on the student's interests and thesis. Students are required to build an appropriate background in a minor area in which he is expected to achieve a novel interdisciplinary contribution, e.g. (Process control, Geophysics, Petroleum Engineering, Bioinformatics, etc.) The courses include:

SCE 630 Distributed Process Control Systems

SCE 634 Advanced Techniques in Digital Signal Processing

SCE 636 Speech Processing and Recognition

SCE 692 Special Topics in Instrumentation and DSP

SCE 530 Monitoring and Detection

SCE 532 Industrial Automation

SCE 534 Digital Signal Processing

SCE 535 Distributed Computer Control and Field Buses

SCE 540 Intelligent Instrumentation Systems

SCE 542 Condition-Based Maintenance

SCE 544 Safety-Instrumented Systems

SCE 546 Wireless and Internet for Instrumentation & Control

SCE 593 Special Topics in Control Applications

C. Automation, Robotics and Machine Intelligence

The objective here is to provide the foundations for study and research in the field of Intelligent Automation Systems. Courses include:

SCE 660 Advanced Topics in Intelligent Control

SCE 662 Machine Vision and Pattern Recognition in Automation

SCE 668 Guided Systems Control

SCE 672 Advanced Robotics

SCE 694 Special Topics in Intelligent Automation and Robotics

SCE 555 Real-Time Computer Systems

SCE 556 Microcomputer-based Measurement techniques

CSE 560 Soft Computing for Control and Automation

SCE 562 Intelligent Systems and Control

SCE 571 Robot Dynamics and Control

SCE 572 Industrial Robots

SCE 574 Advanced Mechatronics

SCE 594 Special topics in Robotics and Intelligent Automation

SCE 701 Directed Research I

SCE 702   Directed Research II

Degree Plan for Ph.D. in Systems and Control Engineering

Course #		Title	LT	LB	CR
First Semester					
SCE	xxx	Major Elective	3	0	3
SCE	xxx	Major Elective	3	0	3
XX	xxx	Major/Free Elective	3	0	3
			9	**0**	**9**
Second Semester					
SCE	xxx	Major Elective	3	0	3
SCE	701/ xxx	Directed Research I /Major Elective	3	0	3
XX	xxx	Major Elective/Free Elective	3	0	3
			9	**0**	**9**
Third Semester					
XX	xxx	Major/Free Elective	3	0	3
SCE	xxx	Major Elective	3	0	3
SCE	xxx	Major Elective	3	0	3
SCE	699	Seminar	1	0	0
			10	**0**	**9**
Fourth Semester					
SCE	7xx/xxx	Directed research II/Major Elective	3	0	3
SCE	711	Ph.D. Pre-Dissertation	3	0	3
			6	**0**	**6**
Fifth Semester					
SCE	712		0	0	IP
Sixth Semester					
SCE	712	Ph.D. Dissertation	0	0	9
			0	**0**	**9**
Total Credit Hours					**42**

Notes:

- Each student is expected to submit his detailed degree plan according to the above generic degree plan for approval by the Department and the Deanship of Graduate Studies within the 8^{th}week of the second semester of enrollment.
- Students are required to adhere to the regulations of degree plan. No relaxations will be given to any student, and courses taken in conflict of the above will not be counted towards the degree.
- The order of taking the courses can be different from above, but students must take the core courses before the electives.
- Ph.D. Students are required to consult with the guidelines for preliminary and comprehensive exams upon joining the program.

COURSE DESCRIPTIONS

INDUSTRIAL & SYSTEMS ENGINEERING

ISE 501 Deterministic Operations Research (3-0-3)

Model construction and modelling issues. Linear programming (LP) formulation, Simplex method: two-phase algorithm, dual simplex method, network simplex method. Duality, sensitivity analysis, economic interpretation and applications. Integer programming (IP), modelling techniques using zero-one variables. Branch and bound algorithm for integer programming. Various applications of integer programming. Computer packages and case studies.

Prerequisite: Graduate standing.

ISE 502 Probabilistic Modeling in ISE (3-0-3)

Introduction to probability, random variables, single and joint probability distributions, conditional probability, expectations, variances and co-variances, correlation, multi-dimensional random variables, Markov chains, Poisson processes, renewal theory, applications in queuing, reliability, inventory and production problems.

Prerequisite: Graduate standing.

ISE 503 Linear and Integer Programming (3-0-3)

Linear programming solution algorithms; Simplex method. Interior point methods. Exterior methods. The decomposition principal. Application of the decomposition principal to solve large scale linear programs. Multi-commodity flow problem. Advanced models in integer programming. Branch and bound and branch and cut methods. Case studies.

Prerequisite: ISE 501 or equivalent.

ISE 505 Supply chain management (3-0-3)

This course introduces supply Chain Management (SCM) concepts and issues. The major content of the course is divided into three modules: supply chain integration, supply chain decisions, and supply chain management and control. A variety of instructional tools including lectures, case discussions, and group projects and presentations are employed.

Prerequisite: Graduate standing

ISE 507 Mathematical Models in Maintenance (3-0-3)

This course focuses on mathematical models in maintenance. Topics include: review of mathematical models for maintenance, capacity planning models, planning and scheduling models, inspection models, preventive maintenance models, component replacement models, Block replacement models, models for spare parts provisioning, models for condition based models including proportional hazard models. Integrated models that include maintenance, production and quality.

Prerequisite: ISE 501 and ISE 502

ISE 508 Advanced Production Systems and Inventory Control (3-0-3)

Analysis of production and inventory systems, forecasting, single and multi-period deterministic inventory models, stochastic inventory models, deterministic and stochastic production planning, Multistage and dynamic production planning models, MRP systems, Pull, Push and Just-in-Time Systems.

Prerequisites: Graduate Standing.

ISE 509 Reliability Engineering (3-0-3)

Reliability engineering applications, reliability measures, static and dynamic reliability models. Bath-tub curve, reliability; series, parallel and r-out-of-n configuration. Reliability data analysis

using the exponential, Weibull and lognormal distributions, catastrophic failure models: hazard rate models. System reliability: approximation methods and reliability bounds. Accelerated life testing. Case studies and applications.

Prerequisite: ISE 502

ISE 511 Condition Monitoring Technologies (3-0-3)

Condition monitoring technologies in predictive maintenance, in depth study of the use of vibration analysis, acoustic emission, infrared thermograph, leak detection, oil analysis, and emission monitoring. Devices and products for condition monitoring. Data acquisition and use of predictive maintenance software to analyze and interpret the results of condition monitoring, base line database development. Case studies and computer applications

Prerequisite: Graduate Standing.

ISE 512 Advanced Supply chain Modeling (3-0-3)

This course adopts a modeling approach to supply chains problems. Topics covered include supply chain design, multi-location inventory-distribution models, transportation and vehicle routing, supply chain distribution network design, integrated production, inventory and distribution problem, and reverse logistics. The key insights provided by such system-wide models will be illustrated through the use of spreadsheets and software packages such as CPLEX, presentations of research papers for emerging supply chain optimization problems.

Prerequisites: ISE 501 and 502

ISE 514 Warehousing and Material Handling (3-0-3)

Types of warehouses and distribution centers, outsourcing warehousing. Warehouse performance analysis· storage systems, order-picking, Shipping, Warehouse layout, including product placement, forward-reserve planning, and slotting. Warehouse management systems, including bar code systems, radio frequency systems, light-directed transactions, voice systems.

Prerequisite: Graduate standing

ISE 517 Logistics and Distribution (3-0-3)

Transportation and distribution systems in supply chains. Modes of transportations. Technology for logistics such as bar coding and RFID. Logistics and distribution key processes. Economics of logistics and distribution. Organization of logistics. In house versus outsourcing of logistics. Third and fourth party logistics. IT application in various logistics and distribution functions. Logistics performance evaluation and benchmarking.

Prerequisite: ISE 505

ISE 518 Supply chain information systems (3-0-3)

Information requirement in a supply chain, review of various information management technology resources used in supply chain. Various source data capture hardware, communication applications, database products, and planning tools used in today’s decision-making within distribution systems. Overview of warehouse management systems, Enterprise Resource Planning, routing/dispatch software, shipment tracing, and satellite tracking.

Prerequisite: Graduate Standing

ISE 520 Analytical Methods in Facility Location and Layout (3-0-3)

Application of mathematical programming to the facility location, and layout. Location and layout problems in continuous and discrete spaces, location allocation problems.

Prerequisite: ISE 501

ISE 521 Non-Linear Programming & Applications-I (3-0-3)

Formulation of engineering problems as nonlinear programs; Optimality conditions for nonlinear programs; Algorithms for unconstrained optimization; algorithms for constrained non-linear

program; methods of feasible directions (Sequential unconstrained minimization techniques), comparison of algorithms for nonlinear programs. Case Studies.

Prerequisite: Graduate Standing

ISE 522 Advanced Stochastic Simulation (3-0-3)

Fundamental concepts of mathematical and simulation models; efficient generation of random variants, construction of discrete event simulation models, discussion of available computer languages, variance reduction techniques, Jacknifying and classical methods, output analysis.

Prerequisite: Graduate standing

ISE 523 Forecasting Systems (3-0-3)

The course covers the nature, scope, and importance of forecasting, with techniques for forecasting and time series analysis. Topics include regression, moving averages, exponential smoothing, correlation and least square technique, analysis of forecast errors, Box-Jenkins models and Bayesian methods in forecasting. The design of forecasting systems will be emphasized with application oriented examples.

Prerequisite: Graduate Standing

ISE 525 Network Modeling and Algorithms (3-0-3)

Modeling with graphs and networks, data structures for network and graphs, shortest path algorithms, properties of the matrix, label setting and label correcting algorithms, spanning tree algorithms, maximum flow algorithms, maximum flow minimum cut theorem, algorithms for the assignment, semi-assignment and the transportation problems, minimum-cost flow algorithms, the simplex method on a graph, out-ofkilter algorithm, embedded networks, constrained network and generalized network, multi-commodity network. Modeling with network includes cases from production, facility location, distribution and inventory and human resource planning. **Prerequisite:** ISE 501 or equivalent

ISE 527 Decision Making (3-0-3)

Structuring decision problems: single criterion versus multiple criteria, certainty versus risk and uncertainty versus conflict, criteria and attributes, payoffs and losses. Utility function for decision making. Decision making with single and multiple criteria under certainty: selected discrete MCDM models. Decision making under risk: decision trees, single and multiple stages. Value of information. Decision making under uncertainty. Decision making under conflict: game theory. Decision support systems. Case studies.

Prerequisites: Graduate standing.

ISE 529 Maintenance Management (3-0-3)

Maintenance Strategy, Organizing the maintenance structure, Maintenance management techniques, Designing maintenance organization, maintenance processes, planning and scheduling, quality assurance in maintenance systems, maintenance management information systems, measuring and benchmarking maintenance performance, auditing and improving maintenance systems. Case studies.

Prerequisite: Graduate standing.

ISE 530 Computer-Aided Manufacturing (3-0-3)

Numerical control. Computer control in NC machine tool. Group technology. Computer aided planning, computer integrated production management. Shop floor control and computer process monitoring systems. Computer integrated manufacturing systems. CAD/CAM implementation.

Prerequisite: Graduate standing.

ISE 531 Systems Reliability/Maintainability (3-0-3)

Tools for reliability analysis such fault trees, failure mode and effect analysis and root cause

analysis. Maintainability concepts and measures, system effectiveness and operational readiness, Repairable systems: methods based on renewal theory, system availability. Reliability centered maintenance, Design for maintainability. Practical applications and case studies.

Prerequisite: ISE 509

ISE 533 Advanced Work Measurement and Analysis (3-0-3)

Design of industrial operations with emphasis on the effective uses of the human body. An examination of the problems of establishing time standards and proposed solutions. Learning curves, fatigue allowances, variations of the MTM system, computerized work measurement systems, staffing problems. Term project on industrial methods design.

Prerequisites: Graduate Standing

ISE 534 Advanced Quality Control (3-0-3)

Statistical methods in the design and analysis of quality control systems: sampling inspection plans, attributes and variables; inspection errors; comparison of sampling plans; control charts design; adaptive quality control; total quality control. Machine and process capability studies; organizing for quality; machine case studies/projects with local industries.

Prerequisites: Graduate Standing

ISE 535 Design of Experiments (3-0-3)

A scientific and engineering approach to experimentation and analysis of data. Single-factor experiments; Latin squares etc., factorial experiments. Missing data analysis; nested factorial design; multifactor design; fractional replications. Case studies.

Prerequisite: Graduate standing. Cross listed with MATH 560

ISE 536 Human Factors Engineering (3-0-3)

Design of man-machine systems utilizing results from various disciplines including anthropometric data and engineering research. Emphasis is placed on making optimal use of human capabilities. Includes consideration of research techniques in human factors engineering.

Prerequisite: Graduate Standing

ISE 537 Quality management in supply chain (3-0-3)

Supply chain processes, value and costs associated with quality, the dimensions of quality in supply chain, the application of practical statistical process control (SPC) methods to supply chain processes, quality policy, establishment of quality improvement programs, and quality improvement reporting.

Prerequisite: Graduate standing

ISE 539 Systems Safety Engineering (3-0-3)

A basic methodology course in Occupational Safety and Health. Topics cover a spectrum of contemporary safety and risk management problems drawn from process as well as manufacturing industries. Problems will be handled using methods of Operations Research and Simulation. A project is a part of the course.

Prerequisites: Graduate Standing

ISE 541 Queuing Models & Theory-I (3-0-3)

Queuing Systems; some important random processes, birth-death queuing systems in equilibrium; Markovian queues in equilibrium. Network of queues.

Prerequisite: ISE 502 or Equivalent

ISE 543 Stochastic Processes-I (3-0-3)

Introduction to stochastic process, stationary, ergodicity, Poisson process, linear models, Markov chains, renewal theory, Markov renewal processes, semi-Markov processes and Applications in

queuing and other areas.

Prerequisite: ISE 502. (Not to be taken for credit with EE 570)

ISE 548 Sequencing and Scheduling (3-0-3)

Variety of sequencing and scheduling problems in O.R., job shop and flow shop scheduling, discussion of performance measures, dynamic programming, integer programming, computational complexity and NP-completeness results, discussion of well solved problems, branch and bound methods, variety of heuristic approaches for intractable practical problems, guaranteed accuracy heuristics.

Prerequisites: Graduate Standing and Consent of the Instructor.

ISE 567 Work Physiology (3-0-3)

An evaluation of various factors affecting human physical performance in industrial environment. Topics include anthropometry, bio-mechanics, energy expenditure, heat stress fatigue.

Prerequisite: Graduate Standing.

ISE 569 Human Factors in Computing Systems (3-0-3)

User characteristics, Design of keyboards, Controls, and VDT's; Human factors in personal computers, Computer aided design, Computer-aided manufacturing and Control rooms; Human error in computer systems.

Prerequisite: Graduate Standing

ISE 570 Optimization Methods for Engineering Designs (3-0-3)

Examples of optimization problems in engineering design: flexural systems, stressed systems, mechanical systems, digital filters. Optimality conditions. Single and multivariable unconstrained optimization. Constrained optimization. Survey of global optimization: exact and non-exact methods. Each student is expected to solve an optimal design problem related to his background.

Prerequisite: Graduate standing. (Not open to credit for SE majors).

ISE 571 Heuristic Search Methods (3-0-3)

Examples of combinatorial optimization problems in engineering. Simulated annealing, genetic algorithms, tabu search, evolutionary methods and neural networks. Hybrid methods. Application to large engineering optimization problems. Term project.

Prerequisite: Graduate standing (Both ISE 571 and EE 556 cannot be taken for credit)

ISE 590 Special Topics in Industrial and Systems Engineering (3-0-3)

This course covers new and recent topics in Industrial and Systems Engineering. A faculty member shall propose the independent study topics and shall be approved by the department council and the graduate council.

ISE 599 Seminar (0-0-0)

Graduate students working towards either M.S. or Ph.D. degrees, are required to attend the seminars given by faculty, visiting scholars, and fellow graduate students. Additionally, each student must present at least one seminar on a timely research topic. Among other things, this course is designed to give the student an overview of research in the department, and a familiarity with the research methodology, journals and professional societies in his discipline. Graded on Pass or Fail basis.

Prerequisite: Graduate standing

ISE 600 Master of Engineering Report (0-0-3)

The student has to apply knowledge gained in course work to a problem in his area. This course requires a final project presentation and a report.

Prerequisite: ISE 599

ISE 603 Linear Programming and Applications-II (3-0-3)

Large scale LP, decomposition principle, computational complexity of the simplex method, the ellipsoid method, review of penalty methods in nonlinear programming, numerical solution of large scale positive definite linear system of equation, interior point methods for linear programming and their efficient implementation for large scale LP, computer project.

Prerequisite: ISE 501.

ISE 606 Independent Research (0-0-3)

This course is intended to allow the student to conduct research in advanced problems in his M.S. research area. The faculty offering the course should submit a research plan to be approved by the Graduate Program Committee at the academic department. The student is expected to deliver a public seminar and a report on his research outcomes at the end of the course. Graded on Pass or Fail basis.

Prerequisite: ISE 502, ISE502 and prior arrangement with an instructor.

ISE 608 Advanced Production Systems (3-0-3)

Advanced forecasting models including Box and Jenkins approach. Advanced aggregate production planning models includes linear, quadratic and nonlinear programming models. Desegregation schemes. Lot sizing techniques for material requirement planning. Nervousness and freezing just-in-time manufacturing philosophy. Group technology. Algorithms for part family formation. Flexible manufacturing systems. World-class manufacturing. Effects of maintenance and quality on production. Research papers from various journals in the field are covered. Term projects.

Prerequisite: ISE 508

ISE 610 M.S.Thesis (0-0-6)

Prerequisite: ISE 599

ISE 621 Advanced Nonlinear Programming & Applications-II (3-0-3)

Elements of Convex analysis, optimality conditions for smooth optimization problems, formulation of quadratic programs as linear complementarity problems (LCP), successive linear programming or quadratic programming methods for NLP, convergence of nonlinear programming algorithms, complementary pivot method for LCP, complementary pivot methods for fixed point computing and their application to NLP, survey of other methods for constrained NLP (Frank-Wolte method, methods of feasible directions, reduced gradient methods, penalty and barrier methods, gradient projection methods, active set methods and others), case studies.

Prerequisite: ISE 521 or equivalent

ISE 623 Global Optimization Using Interval Analysis (3-0-3)

Interval arithmetic. Functions of intervals. Systems of interval linear and nonlinear equations and inequalities. Unconstrained global optimization. Inequality and equality constraints global optimization problems.

Prerequisite: ISE 501 or equivalent

ISE 625 Network Algorithms (3-0-3)

Extension to the classical network problem formulation including constrained, multi-commodity and nonlinear networks. Uni-modularity property, assignment and matching, Lagrangian relaxation and network optimization. The decomposition approach for solving constrained and multi-commodity network. Traveling salesman problem, routing models, branch and bound and heuristics for routing problems. Polynomial time scaling algorithms, strongly polynomial algorithm for network problems. Algorithms for nonlinear networks. Complexity of network algorithms.

Prerequisite: ISE 525

ISE 626 Stochastic Programming (3-0-3)

Different formulations of the stochastic programming problem. Chance constrained problems, the recourse problem, linear programming under uncertainty. Decision rules in chance constrained programming, deterministic equivalence in stochastic programming, multi-stage stochastic programming, Duality and Computational issues in stochastic programming, Problems of existence of solution and optimality conditions in stochastic programming, stability of solutions in stochastic programming.

Prerequisites: ISE 501 and ISE 502

ISE 627 Multiple Criteria Decision Making (3-0-3)

Structuring decision problems with multiple criteria. Fundamentals and recent advances in multiple criteria decision making (MCDM) models. Selected approaches for discrete MCDM. Multiple criteria optimization: schemes for generating efficient solutions selected approaches: Goal programming, interactive approaches, surrogate worth tradeoff. Group decision making and negotiation. MCDM support systems. Case studies.

Prerequisites: ISE 501 or Equivalent and Consent of the Instructor

ISE 636 Human Factor Engineering-II (3-0-3)

Advanced concepts in the identification, design, analysis, development and implementation of human operated systems; existing and emerging systems identified from industry. Case examples of theories of communication, decision and control.

Prerequisite: ISE 536

ISE 641 Queuing Models and Theory-II (3-0-3)

The queue G/M/m, the method of collective marks, the queue G/G/1. Bounds, inequalities and approximation, priority queues. Application in computers.

Prerequisite: ISE 541

ISE 643 Stochastic Processes-II (3-0-3)

Characterization and Specification of stochastic processes, stationary and ergodicity, correlation function and power spectra, wiener, Poisson, Markov and Gaussian processes; Martingales; orthogonally principle and mean square estimation; stochastic integrals. Introduction to stochastic differential equations and stochastic calculus.

Prerequisite: ISE 543

ISE 651 Integer Programming (3-0-3)

Formulation examples, computational complexity of algorithms and problems, P, NP-complete and NP-hard classes of problems, cutting plane theory, branch and bound, knapsack problem, Bender decomposition, partial enumeration and implicit enumeration methods, Lagrangian relaxation, local search and other heuristic approaches, simulated annealing, computer project.

Prerequisite: ISE 503

ISE 653 Dynamic Programming (3-0-3)

Multi-Stage problems and recursive algorithms, application in a variety of areas, Markov renewal programming and discrete dynamic programming, applications to optimal control.

Prerequisite: ISE 501

ISE 659 Advanced Materials Management (3-0-3)

Analysis of production and inventory systems, deterministic inventory models, stochastic inventory models, deterministic and stochastic production planning, process selection, multistage and dynamic production planning models, modern materials management techniques like Just-in-Time, Kanban etc., single and multiple source models.

Prerequisite: ISE 508

ISE 661 Manufacturing Costs and Production (3-0-3)

Analysis of costs of manufacture and discussion of the economics of low, medium, and high volume manufacture with emphasis on the factors of production. Economics of replacement.

Prerequisite: ISE 508

ISE 663 Productivity Measurement, Evaluation, Planning, and Improvement (3-0-3)

Systematic presentation of conceptual and pragmatic metrologies, tools, and techniques for productivity measurement, evaluation, planning, and improvement. Focus is on productivity engineering and management as ongoing, consistent process through a formalized, rational, and unified treatment of the productivity fourphases cycle.

Prerequisite: ISE 508

ISE 665 Advanced Manufacturing Processes (3-0-3)

A quantitative study of the non-traditional material removal and forming processes. Economic aspects, theoretical and industrial applications. Electro-chemical machining, electrical discharge machining, high energy forming, and laser and electron beam machining.

Prerequisite: Graduate standing (cross listed with ME 572)

ISE 691 Special Topics in Operations Research (3-0-3)

The objective of this course is to select a specific area in Operations & Research, and study cases and research papers to enable the student to conduct research at the frontier of this area. The specific contents of the special topics will be given in detail at least one semester in advance of that in which it will be offered. It is also subject to the approval of the graduate council.

Prerequisite: Admission to the Ph.D. program

ISE 693 Special Topics in Production Systems & Quality Control (3-0-3)

The objective of this course is to select a specific area in Production Systems and Quality Control, and study cases and research papers in it to enable the student to conduct research at the frontier of the area. The specific contents of the special topic will be given in detail at least one semester in advance of that in which it will be offered. It is also subject to the approval of the Graduate Council.

Prerequisite: Admission to the Ph.D. program

ISE 695 Special Topics in Man-Machine Systems (3-0-3)

The objective of this course is to select a specific area in Man-Machine Systems, and study cases and research papers in it to enable the student to conduct research at the frontier of the area. The specific contents of the special topic will be given in detail at least one semester in advance of that in which it will be offered. It is also subject to the approval of the Graduate Council.

Prerequisite: Admission to the Ph.D. program

ISE 696 Independent Study in Industrial and Systems Engineering (0-0-3)

This course has a variable content and usually will be on a recent topic or an area not covered in the ISE courses. A faculty member shall propose the independent study topics and shall be approved by the department council. A student in M.S.shall take a maximum of three credit hours of independent studies.

Prerequisite: Admission to Ph.D. Program

ISE 699: Ph.D. Seminar (1-0-0)

Ph.D. students are required to attend Departmental seminars delivered by faculty, visiting scholars and graduate students. Additionally, each Ph.D. student should present at least one seminar on a timely research topic. Ph.D. students should pass the comprehensive examination as

part of this course. This course is a pre-requisite to registering the Ph.D. Pre-dissertation ISE 711. The course is graded on Pass or Fail basis. IC grade is awarded if the Ph.D. Comprehensive exam is not yet passed.

Prerequisite: Graduate Standing.

ISE 701 Directed Research I (0-0-3)

This course is intended to allow the student to conduct research in advanced problems in his research area. The faculty offering the course should submit a research plan to be approved by the Graduate Program Committee. The student is expected to deliver a public seminar and a report on his research outcomes at the end of the courses. Graded on Pass or Fail basis.

Prerequisite: Prior arrangement with an instructor

ISE 702 Directed Research II (0-0-3)

This course is intended to allow the student to conduct research in advanced problems in his research area. The faculty offering the course should submit a research plan to be approved by the Graduate Program Committee. The student is expected to deliver a public seminar and a report on his research outcomes at the end of the courses. Graded on Pass or Fail basis.

Prerequisite: Prior arrangement with an instructor

ISE 711 Ph.D. Pre-Dissertation (0-0-3)

This course enables the student to submit his Ph.D. Dissertation Proposal and defend it in public. The student passes the course if the Ph.D. Dissertation Committee accepts the submitted dissertation proposal report and upon successfully passing the Dissertation Proposal Public Defense. The course grade can be NP, NF or IC.

Prerequisite: Ph.D. Candidacy, **Co-requisite:** ISE 699

ISE 712 Ph.D. Dissertation (0-0-9)

This course enables the student work on his Ph.D. Dissertation as per the submitted dissertation proposal, submit its final report and defend it in public. The student passes this course if the Ph.D. Dissertation Committee accepts the submitted final dissertation report and upon successfully passing the Dissertation Public Defense. The course grade can be NP, NF or IP.

Prerequisite: ISE 711

SYSTEMS AND CONTROL ENGINEERING

SCE 500 Principles of Feedback Control Systems (3-0-3)

Linear systems, modeling of physical systems, Ordinary Differential equations models, Laplace Transform, transfer functions, block diagram manipulation. Open loop and closed loop systems, time domain analysis, response of systems to different test signals, Steady state analysis. Transient and Steady-State analysis and design specifications. Root locus, Concept of stability, Design using Root locus. Frequency Response Techniques, Bode plot, Nyquist plot, Specifications and controller Design in the Frequency domain. State-space model, analysis of the state-space model, Controllability and Observability, state feedback control systems.

Note: This course is intended to be a deficiency makeup course for students with inadequate background in the SCE field. The course will not be counted for credit in the SCE undergraduate, Master, or Ph.D. programs.

SCE 507 Linear Multivariable Control (3-0-3)

An integrated treatment of linear continuous-time control theory; Input/output representations and state space realizations; Canonical forms, Transformations: Nerode equivalence, Geometric interpretations; Matrix Fraction Descriptions: observability, controllability matrices, minimal realizations, polynomial matrices; Concepts and structural properties: stability/stabilizability,

controllability/ reachability, and observability/detectability; State feedback and compensator design; full and reduced order state-observer; Output feedback; Time-variant state equations: controllability and observability Gramians.

Prerequisite: Graduate Standing (cross-listed with EE 550)

SCE 513 System Identification (3-0-3)

This course gives theoretical and practical knowledge of methods to develop mathematical models from experimental data. Parametric and non-parametric methods; Review of modeling principles; Process identification from step response; Frequency response identification; Commonly used Signals, spectral Properties, persistent excitation; Correlation methods; Least squares identification; Recursive LS techniques; determining model orders; model validation; AR, MA modeling of system, linear prediction; Multidimensional systems; Application and case studies.

Prerequisite: Graduate Standing (Not to be taken for credit with EE551)

SCE 514 Optimal and Robust Control (3-0-3)

Performance measures for dynamic control problems: minimum time, regulator, servo mechanisms, minimum energy; System norms and transformation; Dynamic programming; Linear quadratic (LQ) and Linear quadratic Gaussian (LQG) regulators; Hardy spaces; Uncertainty and robustness; H_2 Optimal control; H_∞ control; Tracking and Set-point optimal Regulator; Discrete-time systems; Case Studies.

Prerequisite: SCE 507 or equivalent (cross-listed with EE 552)

SCE 515 Stochastic Control Systems (3-0-3)

Review of multivariable probability distributions, stochastic systems, Correlation and power spectral density functions, Conditional probability, Baye’s theorem, Statistical independence, Expectation and conditional expectation. Stochastic processes, ergodicity, stationarity, 1st, 2nd and higher order statistics (HOS), Spectral factorization, Minimum variance control problem, LQG, optimal control, Bellman equation.

Prerequisite: SCE 514

SCE 516 Linear Estimation (3-0-3)

Stochastic state space model; properties of Wiener process; stochastic differential equation; linear optimal filtering and prediction; Kalman filter and Wiener-Hopf filter; fixed lag smoothing and fixed point smoothing; filtering and prediction using stochastic ARMA model; extended Kalman filter; parameter estimation for stochastic dynamic systems; adaptive filtering and prediction.

Prerequisites: SCE 513 or equivalent

SCE 517 Control of Nonlinear Systems (3-0-3)

Introduction to nonlinear models; Second-order systems: phase portraits, equilibrium, limit cycles, bifurcation; Stability of equilibrium points; Liapunov Stability; Passivity: models and criteria; IS and IO Stability: ultimate bounds, L2 gain and small-gain theorems; Nonlinear forms; Stabilization; Tracking; Observers and integral control; Engineering case studies.

Prerequisite: SCE 507 or equivalent (cross-listed with EE652)

SCE 518 Process Modeling and Control (3-0-3)

Fundamental laws, mathematical modeling; modeling and simulation of typical processes, e.g., CSTR, Gas phase CSTR, Vaporizers, Batch reactors, binary column, multi-component distillation columns, heat exchangers, boilers, compressor-turbine units, etc., and model linearization. Review of time domain analysis, feedback control, PID tuning, feed- forward, cascade control, ratio control, process decoupling, discrete systems, systems identification, IMC, Model predictive control, DMC, Neural Network modeling and control.

Prerequisites: Graduate Standing, cannot be taken for credit with CHE 562

SCE 527 Adaptive Control (3-0-3)

General approach to controller design; Adaptive control methods; Model reference adaptive systems, parametric optimization methods; Lyapunov function method; Hyperstability and positivity concepts; Self-tuning controllers; minimum variance self-tuner; explicit and implicit algorithms; pole assignment regulators; variable structure systems; sliding motion; choice of control function; control of phase canonic models; Applications.

Prerequisites: SCE 507 or equivalent (cross-listed with EE 651)

SCE 529 Decentralized Control (3-0-3)

Characteristic of large scale systems; Analysis and design procedures; Model aggregation and perturbations; Concepts of decentralized control; Time and frequency domain techniques; Interconnected linear regulator problem; System decomposition and multilevel coordination; Hierarchical control methods; Singularly-perturbed systems; Overlapping techniques.

Prerequisite: SCE 514 or equivalent (Not to be taken for credit with EE 654)

SCE 530 Monitoring and Detection (3-0-3)

Dynamic Systems models; FIR, AR, ARX, ARMA, State space, Multiple models, nonlinear models, System performance evaluation, abnormality / loss of performance detection. Detection techniques; Filtering, CUSUM, Likelihood tests, change point estimation, whiteness test, parity checks, residuals autocorrelation tests. Applications and case studies.

Prerequisite: SCE 513 or equivalent

SCE 532 Industrial Automation (3-0-3)

Industrial instrumentation: measurement techniques in industrial processes. Computer data acquisition. NC and CNC machine tools. Computer process interfacing and control. Feedback control systems. Group technology. Flexible manufacturing systems. Automated assembly. Industrial robots. Computer-aided inspection and testing. Automated factories. Case studies.

Prerequisites: Graduate Standing

SCE 534 Digital Signal Processing (3-0-3)

Review of 1-D time- and frequency-domain representation of signals and systems; Transformation representation of LTI systems; Digital filter (FIR and IIR) design and structures; Analysis of finite-length effects in Digital filters; Spectral Analysis; Introduction to multi-rate DSP; DSP applications and hardware.

Prerequisite: Graduate Standing (cross listed with EE 562)

SCE 535 Distributed Computer Control and Field Buses (3-0-3)

Distributed control systems configuration, Plant control hierarchy; Control networks; Internet SCADA systems; Field buses; OPC; Reliability and Safety Instrumented Systems; Function blocks and Software components in DCS systems, Future trends in distributed computer control.

Prerequisite: Graduate Standing

SCE 540 Intelligent Instrumentation Systems (3-0-3)

Principles of intelligent measurement devices. Signal conditioning; typical measurement systems; temperature, pressure, force, and motion sensors; Sensors for oil logging, Resistivity measurements, neutron absorption, gamma ray methods, photo electric methods, acoustic methods; sensors networking; sensor fusion, softsensing, sensor communications; wireless sensors networks.

Prerequisite: Graduate Standing

SCE 542 Condition Based Maintenance (3-0-3)

The objective of the course is to provide students with the latest developments in the area of condition-based maintenance. The course will emphasize modeling, diagnosis and use of CBM in industries such as petrochemical, electrical power and aerospace.

Prerequisite: Graduate Standing

SCE 544 Safety Instrumented Systems (3-0-3)

Maintainability, fault trees and failure mode analysis. Combinatorial reliability; series, parallel and r-out-of-n configuration; general computation techniques. Catastrophic failure models: hazard rate models. System reliability: Safety Integrity Level (SIL). Safety standards IEC 61508, IEC 61511 & ISA 84.01, basic process control system (BPCS) and Safety Instrumented System (SIS), functional safety, analysis of safety integrity level (SIL), case studies of SIS design.

Prerequisite: SCE 535 or equivalent

SCE 546 Wireless & Internet for Instrumentation & Control (3-0-3)

Remote control systems and SCADA architecture of heterogamous systems; introduction to network layers structure; transmission media; Internet; effect of time delay and packet loss; Radio propagation fundamentals; Signal modulation and coding, communication protocols, radio transmitter/receivers, PWM, DSSS, FHSS, OFDM; Wireless networks for Automation; determinism and reliability; Cluster Tree and Mesh networks; Standards for WL in automation; GPRS, RFID; IEE802.15.4; Wireless HART; ISA 100.11; Security measures for Wireless and Internet in SCADA and control applications. Communication, command, and control systems; unmanned air vehicles.

Prerequisite: Graduate Standing

SCE 555 Real-Time Computer Control Systems (3-0-3)

The course explores in detail the interrelationships between the architecture and systems software of a modern minicomputer: configuration; real-time operating systems; memory management; interactive editor, program scheduling; priority levels; swapping; input/output control; resource management. Real time programming languages.

Prerequisite: Graduate Standing

SCE 556 Microcomputer-Based Measurement Techniques (3-0-3)

SCADA systems; industrial computer systems; Computer buses; Signal conditioning; ultrasonic measurement; vibration measurements; Special purpose sensors; MEMs; gas chromatography; mass spectroscopy; infrared Systems, Fiber optics sensors.

Prerequisite: Graduate Standing

SCE 560 Soft Computing for Control and Automation (3-0-3)

Introduction to soft computing for Control and Automation, Neural models and network architectures; basic and advanced architectures and algorithms. Neural networks for control and identification, Adaptive neuro-control. Fuzzy systems, Construction of fuzzy inference systems; Objective vs. subjective fuzzy modeling and fuzzy rule generation, examples, Fuzzy control and identification, Stability analysis and design of fuzzy control system, Hybrid soft computing, construction of a hybrid soft computing system, Application of hybrid soft computing to control systems and automation, Case studies and projects in control and automation.

Prerequisite: Graduate standing

SCE 562 Intelligent Systems and Control (3-0-3)

Introduction to Intelligent systems, model and knowledge based systems, Adaptive systems and learning systems, Modeling using dynamic neuron-fuzzy networks, Expert and Fuzzy systems. Evolutionary programming and design, Hybrid neural networks with Bayesian belief networks and HMMs techniques, Hierarchical evolutionary neuron-fuzzy systems, Application of neuro-

fuzzy systems to control and optimization of large scale systems, Hybrid neuro-fuzzy systems for smart machine design, examples, Multi-objective control system and optimization, Neuron-fuzzy predictive control systems. Intelligent systems in real world applications

Prerequisite: Graduate standing (cross listed with EE556)

SCE 571 Robot Dynamics and Control (3-0-3)

Basic concepts in robotics. Mathematical description of multi-joint robots. Homogeneous transformation. Forward and reverse kinematics. Mathematical modeling of multi-joint Dynamics. Newton-Euler and Lagrange Formulation. Generalized D'Alembert Equations of Motion. Robot Dynamic Control.

Prerequisite: Graduate Standing (Cross listed with EE656)

SCE 572 Industrial Robots (3-0-3)

Dynamic and Kinematic analysis of robot manipulators; sensors (position, velocity, force, vision, tactile) actuators and power transmission; direct drive and indirect drive; point to point control; straight and curved path following; industrial practice in servo control; application of optimal linear quadratic control; nonlinear control and compliance control; collision avoidance; modeling and control of robots in the manufacture environment. Guided vehicles and their industrial applications.

Prerequisite: SCE 571 or Equivalent

SCE 574 Advanced Mechatronics (3-0-3)

Modeling of mechatronic system composed of mechanical, electronic, fluid, and thermal components. Sensors, IR, optical encoders, acoustic/ultrasonic, light/color sensor, thermal sensors; robotics vision; Motors DC/AC, stepper, motor modeling and control; actuators; embedded systems and real-time systems; Mobile robot platform; motion planning and guidance; mission management; Guided and autonomous systems.

Prerequisite: Graduate Standing

SCE 591 Special Topics in Systems and Control Theory (3-0-3)

Advanced topics are selected from the broad area of Systems and Control Theory. The contents of the course are given in detail one semester in advance of that in which it is to be offered. The approval of the Graduate Council will be necessary for offering this course.

SCE 592 Special Topics in Instrumentation and DSP (3-0-3)

Advanced topics are selected from the broad area of Instrumentation and DSP. The contents of the course are given in detail one semester in advance of that in which it is to be offered. The approval of the Graduate Council will be necessary for offering this course.

SCE 593 Special Topics in Control Applications (3-0-3)

Advanced topics are selected from the broad area of Control Applications. The contents of the course are given in detail one semester in advance of that in which it is to be offered. The approval of the Graduate Council will be necessary for offering this course.

SCE 594 Special Topics in Intelligent Automation and Robotics (3-0-3)

Advanced topics are selected from the broad area of Intelligent Automation and Robotics. The contents of the course are given in detail one semester in advance of that in which it is to be offered. The approval of the Graduate Council will be necessary for offering this course.

SCE 599 Seminar (1-0-0)

Graduate students working towards their M.S. or Ph.D. degrees are required to attend the seminars given by faculty, visiting scholars, and fellow graduate students. Additionally, each student must present at least one seminar on a timely research topic. Among other things, this course is designed to give the student an overview of research in the department, and a familiarity

with the research methodology, journals and professional societies in his discipline. Graded on Pass or Fail basis.

Prerequisite: Graduate standing

SCE 600 Master of Engineering Project-I (0 -0-3)

This advanced project course is arranged between a faculty member and a student to train students in undertaking implementation projects and to explore new technologies in their fields. Students are asked to prepare a study and submit a report on a feasible application of advanced knowledge in the SCE field. This report should include an introduction to the topic, literature review, research methodology, analysis of data, conclusions and recommendations, appendices and references. The report will be presented and orally examined by a faculty committee. (Must be taken by all M.Eng., open for M.Eng. option only).

Co-requisites: SCE 599

SCE 601 Master of Engineering Project –II (0 -0-3)

The Advanced project courses are arranged between a faculty member and a student to train students in undertaking implementation projects and to explore new technologies in their fields. In these courses students are asked to prepare a feasible application of advanced knowledge in the SCE field. The work will be evaluated based on a report, a seminar and/or an oral examination. (Open to M.Eng. option only)

SCE 606 Independent Research (0-0-3)

This course is intended to allow the student to conduct research in advanced problems in his M.S. research area. The faculty offering the course should submit a research plan to be approved by the Graduate Program Committee at the academic department. The student is expected to deliver a public seminar and a report on his research outcomes at the end of the course. Graded on Pass or Fail basis.

Prerequisite: Prior arrangement with an instructor

SCE 610 M.S. Thesis (0-0-6)

Prerequisite: SCE 599

SCE 612 Advanced Methods for Control Systems (0-0-3)

Introduction to Hilbert Spaces; Banach Spaces; and Hardy Spaces; Laurent, Hankel, and Toeplitz Operators; parameterization of all stabilizing controllers (Youla's parameterization); factorization theory; model matching problem; Nehari's Theorem; Wiener–Hopf optimal controllers; $H\infty$ optimization problem; model reduction; l1-optimal control and other state of the art control system synthesis methods.

Prerequisites: SCE 507 or Equivalent

SCE 614 Robust Control Systems (3-0-3)

Argument principle; Rouche's Theorem; chordal metric; Concepts of uncertainty and robustness in control systems design; unstructured uncertainty; structured uncertainty; real parameter uncertainty; necessary and sufficient conditions for robust stability; structured singular value (μ, time varying uncertainty, etc.); H_2, H_∞ and H_2/H_∞ design methods; Engineering Applications

Prerequisites: SCE 514 or equivalent

SCE 616 Nonlinear Filtering (3-0-3)

Theory of nonlinear filtering, propagation of the conditional probability density function, moment closure problem, nonlinear filtering approximations, EKF, Gaussian sum approximation, higher order approximations. Particle filtering and UKF techniques. Computational aspects of nonlinear filtering.

Prerequisites: SCE 516

SCE 630 Distributed Process Control Systems (3-0-3)

Synthesis and implementation of digital control systems for complex systems; control configurations; process modeling and identification; dynamic matrix control and internal model control; adaptive control systems; Supervisory and optimizing control; applications and case studies for distillation, combustion, heat exchangers, and flow reactors; recent developments in computer process control.

Prerequisite: SCE 518 or equivalent

SCE 634 Advanced Techniques in Digital Signal Processing (3-0-3)

2-D time and frequency-domain representation of signals and systems, discrete random process. Linear prediction. Least squares (LS) and Recursive Least (RLS) Techniques with applications to Filter Design, System Modeling and array signal processing. Power spectrum Estimation. Cepstral Analysis, Selective Coverage of latest tools used in signal processing such as Neural nets, Higher-Order Statistics and Wavelets. Applications.

Prerequisite: SCE 534

SCE 636 Speech Processing and Recognition (3-0-3)

Speech production models; acoustical properties of vocal tract; classification of speech sounds, application to Arabic speech; time and frequency domain models for speech production; linear prediction methods; pitch detection algorithms; formant frequency trajectories; homomorphic speech processing; acoustic properties of Arabic sounds; allophone and Diphone techniques for speech synthesis; speech coding techniques; vector quantization; vocoders; speech recognition; distance measures; dynamic programming for template matching; Hidden Markov Model HMM techniques, application to phonetics based Arabic speech recognition.

Prerequisite: Graduate standing (Not to be taken for credit with EE563)

SCE 660 Advanced Topics in Intelligent Control (3-0-3)

Basic problem and methods; pattern classification; feature extraction and learning methods; heuristic search techniques; goal directed and ordered search; representation techniques; production systems; semantic networks and frames; input/output systems; problem solving and expert systems; expert systems in automation systems, CAD/ CAM, material handling, scheduling, and process control.

Prerequisite: SCE 560

SCE 662 Machine Vision and Pattern Recognition in Automation (3-0-3)

Computer processing and recognition of pictorial data; mathematical description of images and human perception picture digitization and encoding; image processing hardware; unitary transforms and image compression; image enhancement, restoration, and segmentation; shape description and pattern recognition; application to motion estimation. Robot automatic guidance, image tracking systems, feature extraction similarity measures, clustering techniques, syntactic methods in pattern recognition and applications.

Prerequisite: SCE 534

SCE 668 Guided Systems Control (3-0-3)

Dynamic equations of rigid bodies; missile dynamic equations; introduction to missiles aerodynamics; linearization of the equations of motion; gain scheduling techniques; longitudinal equations of motion, longitudinal autopilot; missiles lateral dynamics; lateral autopilot; inertia cross coupling; advanced control systems; measurement of missile motion, gyros, laser gyros; guidance systems techniques and design, UAV system components and control issues

Prerequisite: Graduate standing (cannot be taken for credit with AE 540)

SCE 672 Advanced Robotics (3-0-3)

Intelligent robots, Sensor-based Estimation, Vision and Image Analysis, Probabilistic Robotics, localization, navigation, and mapping, SLAM Problem, Principles of Decision-Making, Neuro-Fuzzy and soft computing systems in Robotics, Special Topics in Advanced Robotics, Autonomous systems, Hybrid architectures, Complex robotic systems, Multi-Robot Systems, Intelligent learning and control of multi-robot systems, case studies and projects

Prerequisite: Graduate Standing

SCE 691 Special Topics in Systems & Control (3-0-3)

The objective of this course is to select a specific area in Systems & Control, and study cases and research papers in it to enable the student to conduct research at the frontier of the area. The specific contents of the special topic will be given in detail at least one semester in advance of that in which it will be offered. The approval of the Graduate Council will be necessary for offering this course.

SCE 692 Special Topics in Instrumentation and DSP (3-0-3)

The objective of this course is to select a specific area in Instrumentation or Digital Signal Processing, and study cases and research papers in it to enable the student to conduct research at the frontier of the area. The specific contents of the special topic will be given in detail at least one semester in advance of that in which it will be offered. The approval of the Graduate Council will be necessary for offering this course.

SCE 693 Special Topics in Control Applications (3-0-3)

The objective of this course is to select a specific area in Control Applications, and study cases and research papers in it to enable the student to conduct research at the frontier of the area. The specific contents of the special topic will be given in detail at least one semester in advance of that in which it will be offered. The approval of the Graduate Council will be necessary for offering this course.

SCE 694 Special Topics in Intelligent Automation and Robotics (3-0-3)

The objective of this course is to select a specific area in Automation, Robotics and Intelligent System, and study cases and research papers in it to enable the student to conduct research at the frontier of the area. The specific contents of the special topic will be given in detail at least one semester in advance of that in which it will be offered. The approval of the Graduate Council will be necessary for offering this course.

SCE 699: Ph.D. Seminar (1-0-0)

Ph.D students are required to attend Departmental seminars delivered by faculty, visiting scholars and graduate students. Additionally, each Ph.D student should present at least one seminar on a timely research topic. Ph.D. students should pass the comprehensive examination as part of this course. This course is a pre-requisite to registering the Ph.D. Pre-dissertation SCE 711. The course is graded on Pass or Fail basis. IC grade is awarded if the Ph.D. Comprehensive exam is not yet passed.

Prerequisite: Graduate Standing.

SCE 701 Directed Research I (0-0-3)

This course is intended to allow the student to conduct research in advanced problems in his Ph.D. research area. The faculty offering the course should submit a research plan to be approved by the Graduate Program Committee and the graduate school. The student is expected to deliver a public seminar and a report on his research outcomes at the end of the courses. Graded on Pass or Fail basis.

Prerequisite: Admission to Ph.D. Program,Prior arrangement with an instructor

SCE 702 Directed Research II (0-0-3)

This course is intended to allow the student to conduct research in advanced problems in his Ph.D. research area. The faculty offering the course should submit a research plan to be approved by the Graduate Program Committee and the graduate school. The student is expected to deliver a public seminar and a report on his research outcomes at the end of the courses. Graded on Pass or Fail basis.

Prerequisite: Admission to Ph.D. Program,**P**rior arrangement with an instructor

SCE 711 Ph.D. Pre-Dissertation (0-0-3)

This course enables the student to submit his Ph.D. Dissertation Proposal and defend it in public. The student passes the course if the Ph.D. Dissertation Committee accepts the submitted dissertation proposal report and upon successfully passing the Dissertation Proposal Public Defense. The course grade can be NP, NF or IC.

Prerequisite: Ph.D. Candidacy, **Co-requisite:** SCE 699

SCE 712 Ph.D. Dissertation (0-0-9)

This course enables the student work on his Ph.D. Dissertation as per the submitted dissertation proposal, submit its final report and defend it in public. The student passes this course if the Ph.D.dissertation Committee accepts the submitted final dissertation report and upon successfully passing the Dissertation Public Defense. The course grade can be NP, NF or IP.

Prerequisite: SCE 711

SUPPLY CHAIN MANAGEMENT

SCM 500 Supply Chain Management

This course introduces fundamental supply Chain Management (SCM) concepts and issues. The major content of the course is divided into three modules: supply chain integration, supply chain decisions, and supply chain management and control. A variety of instructional tools including lectures, case discussions, and group projects and presentations are employed.

SCM 510 Quantitative Methods for Decision Making

Introduction to the theory, algorithms, and applications of optimization; Optimization methodologies include linear programming, network optimization, integer programming, decision trees, and waiting lines. Applications in logistics, manufacturing, transportation are emphasized including problem formulation and interpretation of results using spreadsheets and optimization software.

SCM 520 Materials and Production Management

This course is designed to give students the ability to use the basic techniques of materials and production management for modeling, analyzing, and solving production/inventory problems within a supply chain management framework. These techniques include: forecasting in production systems, aggregate production/capacity planning, deterministic and stochastic inventory systems, materials requirement planning (MRP), in addition to production scheduling and line balancing.

SCM 530 Quality Management

Quality Management and lean enterprise principles, practices, and techniques. Implementation of quality and lean enterprise improvement programs including total quality management philosophy, statistical and other quality improvement tools, six sigma and lean six sigma. The focus is on the practical application of the underlying principles of quality – how to define it, how to measure it and how to continuously improve.

SCM 532 Supply Chain Cost Management

This course provides an overview of strategic cost management in the supply chain and introduces students to many of the tactical tools required to understand and manage internal and supply chain costs, strategic design and development of supply chains. It also focuses on cost-management tools applied to supply chain design and supplier management.

Prerequisite: SCM 500.

SCM 540 IT and Supply Chain Management

This course introduces information technology (IT) concepts and applications for supply chain management (SCM). Particular attention is paid to using Enterprise Resource Planning (ERP) as an integrated information management system for improving the effectiveness of SCM. Topics include integrated enterprise resource management and IT-enabled operations management functions. Additional ERP selection and implementation issues include determining ERP system requirements, ERP system selection, and ERP implementation. Case studies and ERP applications in different types of industry are presented.

Prerequisite: SCM 500.

SCM 550 Logistics and Distribution Management

This course will offer an overview of the structure and management of logistics and physical distribution system including supply chain network design, distribution strategies, warehousing, order processing, packaging, inventory management across echelons and organizations, classifications and material handling, transportation modes and costing and international logistics.

Prerequisite: SCM 500.

SCM 552 Reverse Logistics

The course will discuss the strategic points in the design of reverse supply chain network, the acquisition/collection of returned or used products, the testing/grading operations, the reprocessing, redistribution and reverse logistics information system. The course will also include various cases studies for selected topics.

Co-requisite: SCM 550.

SCM 560 Strategic Procurement and Outsourcing

Fundamentals of strategic procurement and supply chain management. The course addresses the Integration and coordination of product innovation, sourcing, E-Procurement and Procurement Strategies to achieve global competitiveness.

Prerequisite: SCM 540.

SCM 570 Supplier Relationship Management

The Course is designed to provide an understanding of the criteria for supplier selection, evaluation and re-evaluation process, and supplier relationship management. Using cases and exercises the course will address the following topics: strategic role of purchasing, supplier selection, supply contracts, supplier relationship management, international sourcing, price determination, purchasing services, and auctions and negotiation skills. Integration with customer relationship management is emphasized.

SCM 572 Customer Relationship Management

This course introduces participants to concepts, issues, and challenges in the development and utilization of Customer Relationship Management (CRM) systems and processes to build long-term mutually-beneficial partnerships with customers. The course adopts a relationship marketing perspective, in contrast to the Information Technology (IT) perspective that is commonly associated with the term CRM. The course content is divided into four modules addressing the following: CRM concepts and issues, CRM technologies and tools, marketing and sales applications of CRM, organizational factors in CRM implementation. Integration with supplier

relationship management is emphasized. The course content will be delivered through a combination of lectures, case analysis and discussion, and participant independent project work

SCM 580 Organization Change Management

This course introduces fundamental organization change and development (OCD) concepts and issues. The major content of the course is divided into three modules: organization change and development foundations, organization development interventions and key considerations in organization change and development in the Saudi companies. A variety of instructional tools including lectures, case discussions, and group/individual projects and presentations are employed.

SCM 582 Global supply Chain Management

This course introduces the theory and applications of global supply chain management and international logistics. Topics include global operations management, global sourcing and trade, import/export operations, and logistics management. Global freight transportation management is also discussed, including land, maritime, air, and intermodal transportation. Real-world case studies are presented to illustrate the experiences of several countries and organizations in moving materials around the world.

Prerequisite: SCM 500

SCM 590 Independent Reading/Research

This course requires conducting extensive research about emerging issues in SCM and also identifying a project relevant to sponsoring companies and getting approval for the topic from the company. A final presentation, proposal for the project and paper for the emerging issue are required to fulfill the requirement of this course. The student is supervised by a faculty member in the area of the project.

Prerequisite: SCM 500.

SCM 600 Integrative project

This project requires students to apply knowledge gained in coursework to a real world problem preferably at a sponsoring organization. The sponsored project is the vehicle for applied learning and it provides the link between theoretical and applied learning. A faculty member, together with the SCM program Coordinator, facilitates these students in fulfilling the requirement of the Integrative Project course. This course requires a final team project presentation and paper to demonstrate the integration of all aspects of the program.

COLLEGE OF ENGINEERING SCIENCES

DEPARTMENT OF AEROSPACE ENGINEERING

Chairman

Dr. Ahmed Al-Garni

Faculty

Abdelrahman	Ahmed	Edi
Ibrahim	Saeed	

The Aerospace Engineering Department offers a well-established graduate Program leading to Master of Science (M.S.) in Aerospace Engineering. The Department started its Master of Science program in (2004-05). The Program focuses on academic excellence as well as the professional development of graduate students, rather than just completing a prescribed set of courses. The graduate students are expected to demonstrate competence in a series of professional requirements that need creativity. The AE M.S. Program emphasizes the application of theoretical principles to practical problems in the field of Aerospace Engineering and helps in providing KSA with high caliber professional engineers, who are needed for the development of the country. The M.S. Program offers specialization in four major fields of Aerospace Engineering:

- Aerodynamics and Gas Dynamics,
- Flight Dynamics and Control,
- Aerospace Structures and
- Propulsion.

In addition, the M.S. Program offers a wide selection of graduate courses and research activities with a flavor of aviation, which is needed by the local industry. These include, but not limited to, water desalination, renewable energy applications, and aviation maintenance. Thereby the student can fulfill his degree requirements, and complete and defend his thesis based on the original work in one of the major areas of Aerospace Engineering.

The AE M.S. Program has been designed to continually evolve by taking account of modern trends and the latest developments in the area of Aerospace Engineering. The graduate courses are designed to provide the student with the opportunity to deepen and broaden his knowledge base in the respective subjects that becomes the source of motivation for the student to sharpen his skills in problem solving, creative thinking, research, technical report writing and presentation.

Teaching & Research Facilities

The research activities of the department of Aerospace Engineering are exceptionally diverse and broad. Research is conducted in the following major Aerospace fields: Aerodynamics and Gas Dynamics, Aerospace Structures, Flight Dynamics and Control, Propulsion and Aviation. The Aerospace Engineering Department has the following laboratories with advanced equipment for teaching and research purposes:

1. Aerodynamic and Flight Dynamic Laboratory

The laboratory is equipped with several small-scale sub-sonic wind tunnels and is primarily used to complement the concepts covered in Aerospace Engineering courses. The lab can be used for teaching and research in many aspects such as measurements of lift and drag for an airfoil, smoke visualization of flow over variously shaped bodies, and static pressure measurements.

2. Aerospace Propulsion Lab

The lab has a pulse jet test unit to study the concepts of jet propulsion and reaction power. It also houses a self-contained SR-30 Turbojet engine to demonstrate and explore all aspects of gas turbine theory, fluids and thermodynamics.

3. Wind Tunnel Laboratories

These laboratories are primarily designed to carry out both fundamental and applied research in shear flows, aerodynamics of streamlined and bluff bodies, super-sonic flow, etc. The department has two sub-sonic wind tunnels, one with a 0.8 m x 1.1 m test-section with a maximum flow speed of 40 m/s and the other is a closed loop wind tunnel with a 0.8 m x 0.8 m x 2 m test region with a maximum flow speed of 65 m/s. The laboratories have an internal six-component wind tunnel strain gauge balance, with attitude mechanisms, computerized software operation & calculation and graphical analysis; a shock tube and a Ludwig-tube supersonic-tunnel capable of producing a jet of a Mach number 2.57; measurement equipment includes a multi-channel hot-wire anemometer system, an intelligent flow analyzer, frequency analyzers, filters, correlators, a

data acquisition and storage system, a remote controlled traverse system, load cells, oscilloscopes, manometers, scanivalves and a flow visualization system with a laser light source.

4. Airplane Laboratory

AE Department is equipped with a Royal Saudi Air Force aircraft BAC-167 (Strike Master). Students will use this lab to become familiar with the principles of the real aircraft and to do several measurements related to aerodynamic performance, Flight Dynamics & Control, Flight Structures, Propulsion and avionics system.

5. Aerospace Structures and Materials Laboratory

This laboratory contains several equipment such as different structures of different materials, engine, landing gears and other aircraft parts that are used for demonstration, inspection and experimental purposes. The lab also contains several machines for manufacturing and construction of aircraft structures, such as bending, rolling, and cutting machines. For research purposes, the lab is equipped with state of the art piezoelectric patches, a sophisticated FFT analyzer, and several transducers.

6. Aircraft Avionics Labs

The labs house a complete radar system that is used for conducting practical training for students. They also contain a full cockpit instrument trainer with a complete Instrument Flight Rules (IFR) avionics package configured and wired exactly as in an airworthy aircraft, In addition to this, the lab contains several gyroscopes for illustration purposes.

7. AE Computer Lab

The AE Computer Lab has a good number of state-of-the-art computers equipped with up to date software packages and enjoys sophisticated LAN (Local Area Network) system through which all the computers are inter-connected inside the KFUPM and worldwide.

8. Other Facilities Inside and Outside the University

- Inside the University, the Department has links and cooperation with different departments in the College of Engineering and other colleges, such as Mechanical Engineering Department, which has many laboratories such as Advanced Materials Science Laboratory, Dynamics Laboratory, Fluid Mechanics Laboratory, Heat Transfer Laboratory and Materials Science Laboratory. Moreover, the AE Department has cooperation with the Research Institute of the University, which is an excellent and well established research center.

- Outside the University, the Department has close working cooperation with the aerospace and aviation industry. The University is located next to King Abdul-Aziz Air Force Base and Dhahran Airport and a few kilometers from King Fahd International Airport and Saudi Aramco Aviation. The AE Department utilizes the wide spectrum of technical facilities offered by these excellent organizations.

M.S. PROGRAM IN AEROSPACE ENGINEERING

The sole purpose of the AE M.S. Program is to serve the University, the country and the region. The AE M.S. Program aims at acquiring, establishing and expanding the base of engineering and scientific knowledge through advanced educationand productive research and serving the society according to its needs by enabling it to develop new technology through collaborative research with the industry. The Program is designed to provide the students with substantial depth and breadth of knowledge in Aerospace Engineering and prepare them to cope with the latest engineering and scientific developments in this field and related field such as aviation. The Program focuses on providing favorable grounds and competitive environment for pure research work. Finally, the Program also intends to offer technical courses for the industry to help sharpen the skills of professionals in the fields of Aerospace Engineering and Aviation.

Admission Requirements

The minimum requirements for possible admission to the Master of Science program in the Deanship of Graduate studies as regular graduate student with full standing in Aerospace Engineering are:

- A Bachelor's degree in Aerospace Engineering or other engineering or sciences from an institution whose undergraduate program is equivalent in length, content and quality to that of KFUPM. An applicant whose academic credentials do not meet regular admission requirements may be given some deficiency courses depending on individual cases.
- A Grade Point Average of 3.00 or higher (on a 4-point scale) and
- Acceptable scores in TOEFL and GRE general.

Degree Requirements

To complete the M.S. degree, a candidate must complete 30 credit hours as follows:

1. Complete twenty four (24) credit hours with the following limitations:
   - At least nine (9) credit hours in core courses *AE 530,* AE 540, and advanced MATH 5xx.
   - At least six (6) credit hours in major electives, with 3 each from AE xxx and AE 5xx
   - At least six (6) credit hours in technical electives,
   - Three (3) credit hours of free electives.
2. Take a seminar course AE599 under the guidance provided in the graduate bulletin.
3. A thesis according to the general procedures of the Deanship of Graduate Studies. The thesis work earns a student 6 credit hours, thus bringing the total to 30 credit hours to complete the M.S. degree.

The list of core, major electives and technical elective courses is given below:

Core Courses	
Aerodynamics of Compressible Flow	AE 530
Flight Dynamics and Control I	AE 540
Advanced Mathematics*	MATH 5xx
Major Elective Courses	
AE Elective I**	AE xxx
AE Elective II**	AE 5xx
Technical Elective Courses	
Technical Elective I**	XX xxx
Technical Elective II**	XX xxx
Free Electives	
Free Elective ***	XX 5xx

***.**MATH 513/ MATH 514/ MATH 550 MATH 513/514/550 depends on the emphases of the Program; other mathematics courses can be considered with the approval of AE Department.

**. AE xxx (AE Elective I) and XX xxx (Technical Elective I) are 500 level. However, maximum of two undergraduate courses can be taken for credit with approval of AE Department.

***.One free elective course from AE Department or any other Department

Degree Plan for M.S. in Aerospace Engineering

Course No.	Title	LT	LB	CR
First Semester				
AE 520	Aerodynamics of Compressible Flow	3	0	3
AE xxx	AE Elective I*	3	0	3
MATH 5xx	Advanced Mathematics**	3	0	3
		9	**0**	**9**
Second Semester				
AE 540	Flight Dynamics and Control I	3	0	3
AE 5xx	AE Elective II*	3	0	3
XX xxx	Technical Elective I*	3	0	3
AE 599	Seminar	1	0	0
		10	**0**	**9**
Third Semester				
XX xxx	Technical Elective II*	3	0	3
XX 5xx	Free Elective***	3	0	3
AE 610	M.S. Thesis	0	0	IP
		6	**0**	**6**
Fourth Semester				
AE 610	M.S. Thesis	0	0	6
		0	**0**	**6**
Total				**30**

Notes:

- Each student is expected to submit his detailed degree plan according to the above generic degree plan for approval by the department and the Deanship of Graduate Studies within the 8th week of the second semester of enrollment.
- Students are required to adhere to the regulations of the degree plan. No relaxations will be given to any student, and courses taken in conflict of the above will not be counted towards the degree.
- Up to two 400-level elective courses can be taken with the approval of the advisor.
- The order of taking the courses can be different from above, but students must take the core courses before electives.

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*. AE xxx (AE Elective I) and XX xxx (Technical Elective I) are 500 level.

**. MATH 513/514/550 depends on the emphases of the Program; other Mathematics courses can be considered with the approval of AE Department.

***. One free elective course from AE Department or any other Department

COURSE DESCRIPTIONS

AE 520 Aerodynamics of Compressible Flow (3-0-3)

A review of compressible inviscid gas dynamics. Unsteady wave motion; linearized flow. Numerical techniques for steady supersonic flow; three-dimensional flow; transonic flow; hypersonic flow; high-temperature flow. An introduction to computational aerodynamics.

Prerequisite: AE 325 or Equivalent

AE 524 Aerodynamics of Viscous Flow (3-0-3)

A review of potential flow. Dynamics of viscous flow; laminar boundary layer for incompressible and compressible flows; flow instabilities and transition flow; turbulent flow. Airfoil design and flow about three-dimensional bodies. Navier-Stokes equation. Numerical solutions of viscous flow with aerospace application.

Prerequisite: AE 333 or Equivalent

AE 528 Aerospace Computational Fluid Dynamics (3-0-3)

Introduction to computational fluid dynamics. Partial differential equations impact on CFD. Grids, discretization and transformation with CFD techniques. Numerical solutions in aerospace applications.

Prerequisite: AE 325 or Equivalent and Graduate Standing

AE 530 Aerospace Structures I (3-0-3)

Analysis of stress and strain; constitutive relations of elastic materials, isotropic and anisotropic; beam, plate and shell theories. Introduction to composite structures. Modeling of thermal stresses and practical applications in aerospace structures. Numerical solutions in aerospace structures.

Prerequisite: AE 328 or Equivalent

AE 534 Aerospace Structures II (3-0-3)

Discrete systems structural vibration; dynamics of continuous structures; vehicle structural dynamics; flutter of elastic structures exposed to aerodynamic loading. An introduction to aero-elastic phenomenon and methods of analysis. Case studies of aerospace structural vibration and flutter. Numerical solutions in aerospace structures.

Prerequisite: AE 530

AE 540 Flight Dynamics and Control I (3-0-3)

Review of the equation of motion, static and dynamic stability. Response to control or inputs. Classical approach for automatic control theory. Modern control theory and application to auto pilot design. Numerical solutions in flight dynamics and control.

Prerequisite: AE 426 or Equivalent

AE 544 Flight Dynamics and Control II (3-0-3)

Review of atmospheric flight. Dynamic effects of structural flexibility. Flying and handling qualities. Parametric optimization and optimal control design. Altitude, flight path and tracking, active, digital adaptive control systems. Helicopter flight control. Application on atmospheric and space vehicles. Numerical solutions in flight dynamics and control.

Prerequisite: AE 540

AE 546 Fundamentals of Helicopter Flight (3-0-3)

Introduction to hovering theory; hovering and axial flight performance; concepts of blade motion and control; aerodynamics and performance of forward flight. Introduction to aeroacoustics. Methods to solve rotor dynamics problems. Helicopter stability and control.

Prerequisite: ME 201 or Equivalent and Graduate Standing

AE 548 Aerospace Avionics, Navigation and Guidance (3-0-3)

Principles of avionics, navigation and guidance. Deterministic and stochastic linear perturbation theory. Position fixing and celestial navigation with redundant measurements. Recursive navigation and Kalman filtering. Pursuit guidance, proportional navigation, ballistic guidance and velocity-to-be-gained guidance. Hardware mechanization.

Prerequisite: Graduate Standing and Consent of the Instructor

AE 550 Aircraft Propulsion (3-0-3)

Advanced analysis of aircraft propulsion; gas turbine cycles for aircraft propulsion. Engine off-design performance. The environmental impact. Aircraft propulsion case study design. Numerical solutions in aircraft propulsion.

Prerequisite: AE 422 or Equivalent

AE 554 Rocket Propulsion (3-0-3)

Advanced analysis of rocket propulsion; multi stage rockets, trajectories in power flight; electric propulsion, space propulsion. The environmental impact. Rocket propulsion case study design. Numerical solutions in rocket propulsion.

Prerequisite: AE 422 or Equivalent

AE 560 Aerospace and Aviation Maintenance (3-0-3)

General regulations for aerospace and aviation maintenance. Hydraulic, power, electrical and electronic, instrument landing and support systems maintenance. Troubleshooting procedures, evaluation, repair, installation and inspection techniques. Aviation maintenance systems management, maintenance planning, forecasting and cost control, reliability; safety and flight schedule. Field project.

Prerequisite: Graduate Standing

AE 564 Air Traffic Control (3-0-3)

Fundamental of air traffic control (ATC) system. Federal aviation administration (FAA). Navigational aids, airspace, communication, federal aviation regulations (FARs), ATC procedures control tower operations; non-radar operations, radar operations. Instrument flight rules (IFR) in the enroute and terminal ATC facilities; human factors; air traffic safety and management. Aviation weather. Field Project.

Prerequisite: Graduate Standing

AE 566 Flight and Aviation Safety (3-0-3)

Personal **a**nd organizational safety procedures and goals; safety philosophies, human factors. Principles of accident investigation, aircraft accident reports; accident prevention programs and accident statistics; impact of accident on aviation industry. Air traffic control factors. Aviation and airport securities. Field project.

Prerequisite: Graduate Standing

AE 568 Flight and Aviation Law (3-0-3)

Bilateral and multilateral agreements and security interest in aircraft; international conferences; airline dispatch operations; federal aviation regulations; flight management for aviation/aerospace systems; airport planning and design standards; airport administration and finance; airline management; international aviation management; airline/airport marketing; role of transportation engineering. Field Project.

Prerequisite: Graduate Standing

AE 570 Fundamentals of Astronautics (3-0-3)

An introduction to the solar system, launching. Fundamental law of astrodynamics (space mechanics); orbit maneuvering and determination. Applications in rocket trajectories; optimal trajectories. Communication satellite and space craft altitude. Re-entry and hypersonic heating **consideration.**

Prerequisite: Graduate Standing and Consent of the Instructor

AE 590 Special Topics (3-0-3)

Advanced topics are selected from the broad area of aerospace engineering to provide the student with knowledge of recent advances in the analysis and design in aerospace engineering and in aviation including optimization of aerospace engineering designs, aerodynamics and gas dynamics, aerospace structures and materials, flight dynamics and control, propulsion, helicopter flight, avionics, navigation and guidance, aircraft maintenance, flight and aviation safety, air traffic control, aviation law, astronautics and other related fields such as marine engineering. The contents of the course will be provided in detail one semester before the offering. Approval of the Department Graduate Committee and the graduate council must be secured before offering this course.

Prerequisite: Graduate Standing

AE 606 Independent Research (3-0-3)

This course is intended to allow the student to conduct research in advanced problems in his M.S. research area. The faculty offering the course should submit a research plan to be approved by the Graduate Program Committee at the academic department. The student is expected to deliver a public seminar and a report on his research outcomes at the end of the course. Graded on Pass or Fail basis.

AE 599 Seminar (1-0-0)

Graduate students working towards the M.S. degree in any emphasis area of aerospace engineering (aerodynamics and gas dynamics, aerospace structures, flight dynamics and control, and propulsion) and aviation are required to attend the seminars given by faculty, visiting scholars and fellow graduate students. Additionally each student must present at least one seminar on a timely research topic. Among other things, this course is designed to give the student an overview of research in the department, and a familiarity with the research methodology, journals and professional societies in his discipline. This course is graded on a pass or fail basis.

AE 610 M.S. Thesis (0-0-6)

Involves individual studies by students in the field of aerospace engineering and aviation. The work should be original and the concept, data and the conclusions should contribute new knowledge to the field of aerospace engineering. The quality of the work should reflect the student’s proficiency in research and creative thinking. Following preliminary studies and a literature survey on the thesis subject, each student will present his proposed thesis subject orally and also submit a written proposal to the college of graduate studies for approval. On satisfactory completion of his thesis work, the student is required to make a formal defense of his research thesis.

Prerequisite: AE 599

DEPARTMENT OF CHEMICAL ENGINEERING

Chairman

Dr. Mohammed S. Ba-Shammakh

Faculty

Aboghander	Abussaud	Al-Ali
Alsaifi	Al-Matar	Al-Amer
Amin	Atieh	Al-Baghli
Binous	Al-Jundi	Al-Harthi
Hossain	Hussein	Al-Juhani
Al-Khattaf	Mahjoub	Malaibari
Mohmmed	Al-Mubaiyedh	Al-Mutairi
Muraza	Redhwi	Shaikh A A
Shaikh A R	Ba-Shammakh	Al-Shammari
Shawabkeh	Al-Yousaf	

The department offers graduate programs leading to the degrees of Master of Science in Chemical Engineering, Master of Science in Oil & Gas Surface facilitiesand Doctor of Philosophy in Chemical Engineering. The M.S. program in Oil & Gas Surface facilities is conducted in collaboration between King Fahd University of Petroleum & Minerals, Saudi Arabia and IFP School, France, a renowned institution having worldwide reputation for its programs on Oil and Gas surface Facilities.

The department hosts over 1100 graduate and undergraduate students and maintains well equipped teaching and research laboratories. University facilities available include an excellent information technology center, a central analytical laboratory complex, a sophisticated surface science laboratory and a modern computerized library. A research institute is also attached to the University.

The department has 28 faculty members involved in research in several areas that include Adsorption and Ion Exchange, Catalysis and Kinetics, Corrosion Inhibition, Fluid Mixing, Reaction Engineering, Materials Characterization, Mathematical Modeling, Petrochemicals and Petroleum Technology, Polymers, Separation Processes, Simulation and Computer Applications, Thermal Cracking of Hydrocarbons, Thermodynamics, Transport Phenomena, Process Control, and Electrochemical Reaction Engineering.

M.S. PROGRAM IN CHEMICAL ENGINEERING

The Master of Science program in chemical engineering is designed to provide a strong background in fundamental subjects, including scientific and mathematical principles, as well as the opportunity to define and investigate novel and challenging research problems through experimental and computational techniques.

Admission Requirements

Applicants who have a Bachelor's degree in engineering or science from an institution whose undergraduate programs are substantially equivalent in length, content and quality to those of King Fahd University of Petroleum & Minerals, are invited to apply for admission as regular graduate students in the Department of Chemical Engineering at King Fahd University of Petroleum & Minerals. Applicants should also satisfy the general admission requirements of the Graduate School.

Degree Requirements

The Chemical Engineering Master's Program includes a series of courses in thermodynamics, transport phenomena, kinetics, applied Mathematics and numerical methods in chemical engineering. The Master's degree requires a successful completion of twenty four (24) credit hours of course work, a seminar courseof zero credit hour and a thesis of six (6) credit hours. Of the 24 credit hours of course work, nine credit hours are technical electives to be selected from advanced chemical engineering or other fields of science and engineering with appropriate consultation and approval of the Graduate Advisor. Graduate students are also obliged to participate in all departmental seminars and present a seminar after two terms in the program.

Degree Plan for M.S. in Chemical Engineering

Course #	Title	LT	LB	CR
First Semester				
CHE 501	Transport Phenomena	3	0	3
CHE 513	Advanced Thermodynamics	3	0	3
MATH 513	Mathematical Methods for Engineers	3	0	3
		9	**0**	**9**
Second Semester				
CHE 530	Advanced Reaction Engineering	3	0	3
CHE 560	Numerical Methods in Chemical Engineering	3	0	3
XXX 5xx	Elective I - CHE or Technical	3	0	3
CHE 599	Seminar	1	0	0
		10	**0**	**9**
Third Semester				
CHE 5xx	Elective II - CHE	3	0	3
XXX 5xx	Elective III - CHE or Technical	3	0	3
CHE 610	M.S. Thesis	0	0	IP
		6	**0**	**6**
Fourth Semester				
CHE 610	M.S. Thesis	0	0	6
		0	**0**	**6**
Total Credit Hours				**30**

Notes:

- Each student is expected to submit his detailed degree plan according to the above generic degree plan for approval by the Department and the Deanship of Graduate Studies within the 8^{th} week of the second semester of enrollment.
- Students are required to adhere to the regulations of degree plan. No relaxations will be given to any student, and courses taken in conflict of the above will not be counted towards the degree.
- The order of taking the courses can be different from above, but students must take the core courses before electives.

M.ENG. PROGRAM IN OIL AND GAS SURFACE FACILITIES (OGSF)

The Master of Engineering Program in Oil and Gas Surface Facilities (OGSF) is being jointly offered by the Department of Chemical Engineering, KFUPM, Saudi Arabia and IFP School, France. The Program is a new specialization in the Kingdom. No similar program is available at any of the Kingdom's respectable schools. This program offers a unique opportunity for the students to receive a higher education degree in a much needed area of specialization.

The Program offers both local and regional industries an excellent opportunity to benefit from specialized training locally instead of outsourcing the same to institutions overseas. Saudi Aramco, as a leading global company in the Oil and Gas sector is the main customer of this program. The first two batches of this program are sponsored by Saudi Aramco. The Program aims to provide participants with a comprehensive understanding of all processes in oil and gas surface facilities. This Program is competency based program which is designed to prepare engineering professionals for process engineering specialties in surface production, refining and petrochemicals and equips engineers with the skills necessary to solve chronic industrial challenges.This customized program is intended to accelerate the development of highly qualified engineers in their respective areas and meet Saudi Arabia's overall industrial development requirements. The program's design enables participants to apply a multidisciplinary approach and specialized knowledge in their plant responsibilities. The industry-specific research project component of the program is the best example of the action learning model to address chronic challenges faced by the engineers in the Kingdom.

Degree Plan for M.Eng.in Oil & Gas Facilities

Course #	Title	CR
First Semester: Applied Process Engineering Fundamentals		
OGS 501	Physico-Chemistry and Applied Thermodynamics	2
OGSF 502	Separation Processes	2
OGSF 503	Energy Management, Utilities and Process	3
OGSF 504	Industrial Equipment	3
OGSF 505	Mathematical Methods for Engineers	3
		13
Second Semester: Surface Production, Refining, Gas & Petrochemicals		
OGSF 506	Surface Production	2
OGSF 507	Treatment of Effluents	2
OGSF 508	Refining I	3
OGSF 509	Refining II and Petrochemicals	3
OGSF 510	Transport Phenomena	3
		13
Third Semester: Projects, Safety and Economics		
OGSF 511	Engineering and Safely	4
OGSF 512	Economics	4
OGSF 513	Numerical Methods in Chemical Engineering	3
OGSF 601	Preparation of Industrial Projects	0
		11
Fourth Semester: Industry Internship		
OGSF 602	Industrial Project and Final Defense	**5**
Total Credit Hours		**42**

PH.D. PROGRAM IN CHEMICAL ENGINEERING

The Doctor of Philosophy program is designed to prepare each student to take an active part in the development and growth of the field of chemical engineering at all levels in industry and research organizations or in research and teaching in a university. The awarding of a Ph.D. acknowledges an individual's ability to perform original and creative research.

Admission Requirements

Applicants who have an M.S. degree from a university of recognized standing may be admitted to the doctoral program, provided they satisfy the Graduate School requirements for Ph.D. admission. Applicants should provide evidence of a suitable scientific background to enter the proposed field and should make up any deficiencies in their prior program within two semester of enrollment.

Degree Requirements

Towards the end of their first semester in residence, students should select their research topic and advisor. The program requires a course requirements of 30 credit hours, maintaining a cumulative GPA of at least 3.00 at all times. Students shall select their course program in consultation with their advisor to prepare them to carry out their research in their chosen topic. Departmental requirements for the 30 course credits are:

- A minimum of twenty one (21) credit hours must be chemical engineering courses,
- A minimum of two 600 level courses in chemical engineering must be taken for credit,
- A maximum of nine (9) credit hours is allowed out of the core M.S. courses, and
- A minimum of nine (9) credit hours must be taken in a minor field or combination of fields in consultation with the students' research advisor.

The minor should be in a field related to the professional activities of the chemical engineer and should be selected from specific areas in chemistry, physics, mathematics, computer science, civil engineering, mechanical engineering, petroleum engineering, or systems engineering.

The Ph.D. student is allowed to take two research based courses as electives. Students must pass the Ph.D. comprehensive examination not later than the end of the second year from student's enrolment in the program. For students majoring in chemical engineering, the subject areas for the written examination are:

- Paper I Physical Rate Processes,
- Paper II Chemical Rate Processes.

On the basis of the comprehensive examination, a student may be admitted to the Ph.D. Degree Candidacy. A graduate student is permitted to take the Comprehensive Examination twice only. After successful completion of the course work and the comprehensive exam, the student will register for his Ph.D. Pre-Dissertation. After passing the Ph.D. Pre Dissertation (CHE 711), the student will then register for his Ph.D. Dissertation (CHE 712). After successful completion of his Ph.D. research, the student will publically defend his dissertation based on original and scholarly research conducted by him and judged to be a significant contribution to his area of specialization.

Degree Plan for Ph.D. in Chemical Engineering

Course #	Title	LT	LB	CR
First Semester				
CHE 5xx	Elective I - CHE	3	0	3
CHE 5xx	Elective II - CHE	3	0	3
CHE 5xx	Elective III - CHE	3	0	3
		9	**0**	**9**
Second Semester				
CHE 5xx	Elective IV - CHE (core M.S. excluded)	3	0	3
CHE 5xx	Elective V - CHE (core M.S. excluded)	3	0	3
CHE 6xx	Elective VI - CHE	3	0	3
		9	**0**	**9**
Third Semester				
XXX 5xx	Elective VII - Technical	3	0	3
CHE 6xx	Elective VIII - CHE	3	0	3
XXX 5xx	Elective IX - Technical	3	0	3
CHE 699	Seminar	1	0	0
		10	**0**	**9**
Fourth Semester				
XXX 5xx	Elective X - Technical	3	0	3
CHE 711	Ph.D Pre-Dissertation	0	0	3
		3	**0**	**6**
Fifth Semester				
CHE 712	Ph.D. Dissertation	0	0	IP
Sixth Semester				
CHE 712	Ph.D. Dissertation	0	0	9
		1	**0**	**9**
Total Credit Hours				**42**

Notes:

- Each student is expected to submit his detailed degree plan according to the above generic degree plan for approval by the Department and the Deanship of Graduate Studies within the 8^{th} week of the second semester of enrollment.
- Students are required to adhere to the regulations of degree plan. No relaxations will be given to any student, and courses taken in conflict of the above will not be counted towards the degree.
- The order of taking the courses can be different from above, but students must take the core courses before electives.

List of Graduate Courses in Chemical Engineering

Fluid and Thermal Sciences Group

CHE 501 Transport Phenomena

CHE 503 Advanced Fluid Mechanics

CHE 505 Computational Fluid Dynamics

CHE 507 Advanced Heat Transfer

CHE 603 Turbulence Modeling

CHE 605 Process Heat Transfer

Thermodynamics Group

CHE 513 Advanced Thermodynamics

CHE 515 Statistical Thermodynamics

CHE 517 Phase Equilibria

CHE 617 Non-Equilibrium Thermodynamics

Separations Group

CHE 521 Diffusion Principles

CHE 523 Advanced Mass Transfer

CHE 525 Rate Controlled Separation Processes

CHE 625 Adsorption

Reaction Engineering Group

CHE 530 Advanced Reaction Engineering

CHE 532 Heterogeneous Catalysis

CHE 534 Bioreaction Engineering

CHE 536 Process Analysis in Semiconductor Manufacture

CHE 637 Advanced Reactor Analysis

Materials Group

CHE 541 Processing in the Materials Industry

CHE 543 Polymeric Materials

CHE 545 Corrosion Science and Engineering

CHE 547 Applied Surface Analysis

Process Modeling & Control

CHE 560 Numerical Methods in Chemical Engineering

CHE 561 Process Optimization

CHE 562 Advanced Process Dynamics and Control

CHE 564 Digital Process Control

CHE 565 Non-linear Dynamics in Chemical & Biochemical Systems

CHE 566 Process Synthesis

CHE 569 Simulation of Chemical Processes

General Courses

CHE 571 Process Water Pollution Control

CHE 573 Process Air Pollution Control

CHE 575 Pollution Prevention in Process Industry

CHE 590 Special Topics in Chemical Engineering

CHE 599 Seminar

CHE 606 Independent Research

CHE 610 M.S. Thesis

CHE 699 Seminar

CHE 701 Directed Research I

CHE 702 Directed Research II

CHE 711 Ph.D. Pre- Dissertation

CHE 712 Ph.D. Dissertation

COURSE DESCRIPTIONS

CHEMICAL ENGINEERING

CHE 501 Transport Phenomena (3-0-3)

Continuum theory of momentum, energy and mass transfer. Viscous behavior of fluids. Molecular transport mechanisms. General property balance. Laminar and Turbulent flow. Convective transport. Momentum, heat and mass applications of transport phenomena.

Prerequisite: Graduate Standing

CHE 503 Advanced Fluid Mechanics (3-0-3)

Laminar boundary layers and their solutions. Laminar stability and transition to turbulence. Basic equations of turbulent flow. Pipe turbulent flows and turbulent boundary layers. Non-Newtonian fluids. Pipe flow of power law fluids. Pipe flow of a Bingham plastic. Constitutive equations for viscoelastic fluids. Two phase flows. Computational fluid dynamics.

Prerequisite: CHE 501 or equivalent

CHE 505 Computational Fluid Dynamics (3-0-3)

Governing equations of fluid dynamics. Introduction to CFD. Grid generation, discretization. Numerical approximations: finite differencing and finite volume techniques. CFD tools: adapted programs and commercially available general purpose packages. Applications to incompressible and compressible fluid flow.

Prerequisites: CHE 501, CHE 560 or Consent of the Instructor

CHE 507 Advanced Heat Transfer (3-0-3)

Solution of steady and transient conduction and convection problems analytically and numerically. Fundamentals of convection boundary layer in laminar and turbulent flow. Free and forced convection in ducts and over surfaces. Heat transfer with phase change. Combined mechanisms of conduction and convection.

Prerequisite: CHE 501 or equivalent

CHE 513 Advanced Thermodynamics (3-0-3)

Basic postulates of classical thermodynamics. Applications to transient, open and closed systems. Properties of fluids and prediction of thermodynamic properties Criteria of equilibrium and stability. Single phase, simple systems of mixtures. Phase and chemical equilibria.

Prerequisite: Graduate Standing

CHE 515 Statistical Thermodynamics (3-0-3)

Probability and statistics of microscopic systems. A study of microcanonical, canonical and grand canonical ensembles. Ideal and non-ideal gases, distribution function and computer simulation of fluids applied to pure components and mixtures. A solution of electrolytes and non-homogeneous systems.

Prerequisite: Graduate Standing

CHE 517 Phase Equilibria (3-0-3)

Classical thermodynamics of phase equilibrium and stability. The phase rule. Ideal and non-ideal systems. Fugacity and activity. Phase equilibrium at moderate and high pressure. Activity coefficient models of local composition and group contribution. Equation of states and phase equilibrium. Liquid-liquid equilibrium. Vapor-liquid equilibrium. Solid-liquid equilibrium. Solid-Vapor equilibrium. Phase equilibrium by simulation.

Prerequisite: Graduate Standing

CHE 521 Diffusion Principles (3-0-3)

The Maxwell-Stefan relations, generalized Maxwell-Stefan formulation of irreversible thermodynamics, Fick's law, estimation of diffusion coefficients, solution of multicomponent diffusion problems by the linearized rate theory and effective diffusivity methods. Diffusion as a random walk; Monte Carlo simulation and molecular dynamics.

Prerequisite: CHE 501

CHE 523 Advanced Mass Transfer (3-0-3)

Advanced coverage of laminar and turbulent mass transfer theory and applications for binary and multicomponent systems. The coupling between mass transfer, heat transfer, fluid flow and chemical reactions. Interphase mass transfer coefficients in different equipment. The applications for mass transport drawn from various fields shall be discussed from the viewpoint of transport equations single or coupled.

Prerequisite: CHE 501

CHE 525 Rate Controlled Separation Processes (3-0-3)

A study of traditional as well as contemporary rate controlled separation processes such as crystallization, chromatography, sorption, membranes, etc. Rate based models for distillation. Selective coupled rate processes will be discussed.

Prerequisite: Graduate Standing

CHE 530 Advanced Reaction Engineering (3-0-3)

A study of the effect of temperature on conversion, stability, and product distribution in complex homogeneous reactions. Analysis of flow and mixing patterns and residence time distributions in chemical reactors. kinetics of catalytic gas-solid reactions, mass and heat transport effects in catalysis. Design of catalytic fixed-bed reactors.

Prerequisite: Graduate Standing

CHE 532 Heterogeneous Catalysis (3-0-3)

Molecular theories of adsorption and catalysis. Solid-state and surface chemistry of catalysts. Diffusion and reaction in porous catalysts. Design, preparation and characterization of catalysts. Catalyst deactivation and regeneration. Catalytic process engineering: examples and case studies.

Prerequisite: Graduate Standing

CHE 534 Bioreaction Engineering (3-0-3)

Enzyme kinetics and immobilized enzymes systems. Cellular growth, bioreactions, transport processes, intracellular reactions, stoichiometry of microbial reactions. Analysis of bioreaction rates. Bioreactors modeling and design. Immobilization and immobilized packed bed bioreactors.

Inhibitory effects in bioreactors and the use of selective membranes. Extractive fermentation.Optimization and on-line control of bioreactors.

Prerequisite: Graduate Standing

CHE 536 Process Analysis in Semiconductor Manufacture (3-0-3)

Solids device fabrication, process modeling, cleanliness of the process environment, designing the architectured of crystal fabrication including oxidation, doping by diffusion, chemical vapor deposition etc.

Prerequisite: Graduate Standing

CHE 541 Processing in the Materials Industry (3-0-3)

Principles of processing materials into components. Technology, theory and analysis of the major unit processing operations for metals, polymers, ceramics and composite materials.

Prerequisite: Graduate Standing

CHE 543 Polymeric Materials (3-0-3)

The structure, morphology, and properties of polymers. Polymerization reactions, molecular weight and polymer rheology. Rubber elasticity and mechanical properties. Thermodynamics of polymer solutions.

Prerequisite: Graduate Standing

CHE 545 Corrosion Science and Engineering (3-0-3)

Fundamentals of electrochemical thermodynamics and kinetics pertinent to corrosion processes. Corrosion inhibition, passivity, anodic and cathodic protection, pitting, stress corrosion and hydrogen embrittlement.

Prerequisite: Graduate Standing

CHE 547 Applied Surface Analysis (3-0-3)

Principles of electron and mass spectroscopy. Major elemental and/or structural surface analysis techniques, such as Electron Spectroscopy for Surface Analysis, X-ray Photoelectron Spectroscopy, Auger Electron Spectroscopy, Secondary Ion Mass Spectroscopy, Thermal Desorption Spectroscopy, Infrared Spectroscopy and Electron Energy Loss Spectroscopy. Recent advances in surface analysis techniques. Practical applications using Research Institute equipment.

Prerequisite: Graduate Standing

CHE 560 Numerical Methods in Chemical Engineering (3-0-3)

Visualization of profiles, analysis of models of chemical processes, normalization of models, non-linear finite difference techniques, orthogonal collocation, non-linear algebraic equations, initial value and final value problems in chemical engineering, software packages for solving such problems.

Prerequisite: Graduate Standing

CHE 561 Process Optimization (3-0-3)

A review of computerized material and energy balances, modeling of chemical and biochemical processes, Formulation of optimization problems, nature and organization of optimization problems in the process industry, optimization theory and techniques (basic concepts, optimization of unconstrained functions, unconstrained multivariable optimization, constrained optimization, linear programming and nonlinear programming), Real Time Optimization (RTO) Calculus of variation and Pontryagin maximum principle, Energy Integration (EI), Mass Integration (MI) and Pinch Technology.

Prerequisite: Graduate Standing

CHE 562 Advanced Process Dynamics and Control (3-0-3)

This course examines advanced non-linear dynamics of chemical/biochemical reacting and non-reacting systems and their practical implications on different processes and their control systems design. A number of advanced control topics will be covered, e.g.: model predictive control, non-linear supervisory and expert control, MIMO control systems design, stabilization and regulation control problems and their interaction, analogue vs. digital control systems, structural design of modern computer control systems.

Prerequisite: Graduate Standing

CHE 564 Digital Process Control (3-0-3)

Components of digital control systems, stability theorem and its application to digital control systems, Digital control of simple distillation columns and CSTR's, Z-transform and the design of digital control systems, sampled-data systems, tools for discrete-time systems analysis, Typical digital control designs for chemical and biochemical separation units and reactors, Structure of digital control systems for petrochemical and petroleum refining complexes.

Prerequisite: Graduate Standing

CHE 565 Non-linear Dynamics in Chemical & Biochemical System (3-0-3)

A review of elementary dynamics of chemical & biochemical systems. Modeling and non-chaotic dynamics. Chaotic behavior in chemical & biochemical systems. Case studies: fluid catalytic cracking (FCC), carbon monoxide oxidation, fermenters, etc.

Prerequisite: Graduate Standing

CHE 566 Process Synthesis (3-0-3)

Computerized material and energy balances for actual industrial process flow diagrams. Use of spreadsheets and commercial simulators for conceptual developments of process flow sheets and process calculations with special emphasis on downstream petrochemical industries. Use of computer packages for process synthesis and optimization.

Prerequisite: Graduate Standing

CHE 569 Simulation of Chemical Processes (3-0-3)

Mathematical modeling of a chemical plant. Sparse matrices techniques. Tearing of matrices. Construction of a steady state simulator. In depth discussion of the available simulators including application of these simulators to local industry. Simulation of unsteady state processes.

Prerequisite: CHE 560

CHE 571 Process Water Pollution Control (3-0-3)

Wastewater treatment objectives and methods. Design of facilities for physical and chemical treatment of wastewater. Ecology of biochemical reactors, kinetics of biochemical systems, modeling of ideal biochemical reactors, design of facilities for the biological treatment of wastewater.

Prerequisite: Graduate Standing

CHE 573 Process Air Pollution Control (3-0-3)

Production, emission and transfer of contaminants through the atmosphere from stationary sources. Mathematical models of air pollution. Control concepts. Theory and design of control devices. Integration of pollution control in chemical engineering processes. Current research and development in air pollution control.

Prerequisite: Graduate Standing

CHE 575 Pollution Prevention in Process Industry (3-0-3)

Main characteristics of pollution problem in the process industry. End of pipe versus in-process modifications. Pollution Prevention (P2) strategy and its applications in: Chemical, Biochemical,

Petrochemical and Petroleum Refining Industries. Pollution Prevention (P2) methodologies for energy generation, separation, process reactors, bioreactors, complete plants and entire industrial complexes.

Prerequisite: Graduate Standing; Must complete two CHE graduate courses first or equivalent.

CHE 590 Special Topics in Chemical Engineering (3-0-3)

Advanced topics are selected from the broad area of chemical engineering. The contents of the course are given in detail one semester in advance of that in which it is to be offered. The approval of the Graduate Council will be necessary for offering this course.

Prerequisite: Graduate Standing

CHE 599 Seminar (1-0-0)

Graduate students working towards M.S. degree, are required to attend seminars given by faculty, visiting scholars and fellow graduate students. Additionally each student should present at least one seminar on a timely research topic. Among other things, this course is designed to give the student an overview of research in the department, and a familiarity with the research methodology, journals and professional societies in his discipline. Graded on Pass or Fail basis.

Prerequisite: Graduate Standing

CHE 603 Turbulence Modeling (3-0-3)

Introduction to turbulence. The equations of motion. Scaling laws for mixing layers, jets and wakes. Description of turbulent shear flows. Turbulence modeling: constant eddy viscosity, mixing length, k-epsilon models. Reynolds stresses models. Application using CFD packages.

Prerequisite: CHE 503

CHE 605 Process Heat Transfer (3-0-3)

Topics in heat transfer of interest to both students and faculty will be considered in depth. As examples, conduction, composite regions, non-linear boundary-value problem of heat conduction; convection, heat transfer in packed or fluidized beds, techniques to augment heat transfer; combined phase change problems such as, condensation, heat pipes, cooling towers and ponds; radiation, such as furnaces, radiant interchange between surfaces separated by non-absorbing and non-emitting media.

Prerequisite: CHE 507

CHE 606 Independent Research (3-0-3)

This course is intended to allow the student to conduct research in advanced problems in his M.S. research area. The faculty offering the course should submit a research plan to be approved by the Graduate Program Committee at the academic department. The student is expected to deliver a public seminar and a report on his research outcomes at the end of the course. Graded on Pass or Fail basis.

Prerequisites: Graduate Standing

CHE 610 M.S. Thesis (0-0-6)

Involves individual studies by students in the field of chemical engineering. The work should be original and the concept, data and the conclusions should contribute new knowledge to the field of engineering. The quality of the work should reflect the student's proficiency in research and creative thinking. Following preliminary studies and a literature survey on the thesis subject, each student will present his proposed thesis subject orally, and also submit a written proposal to the College of Graduate Studies for approval. On satisfactory completion of his thesis work, the student is required to make a formal defense of his research thesis.

Prerequisite: CHE 599

CHE 617 Non-equilibrium Thermodynamics (3-0-3)

Foundations of non-equilibrium thermodynamics. Linear non-equilibrium thermodynamics. Postulate of local thermodynamic equilibrium. Linear phenomenological equations. Balance equations of mass, momentum, energy, and entropy. Dissipation function. Second law analysis. Exergy analysis. Heat and mass transport. Diffusion and reaction. Extended non-equilibrium thermodynamics.

Prerequisite: CHE 501

CHE 625 Adsorption (3-0-3)

Adsorptive separation processes, structure and physical properties of adsorbents. Classical and statistical thermodynamic equilibrium models for pure and multicomponent sorption. A study of individual and combined kinetic resistances in sorption on single adsorbent particles. Classification of adsorption column dynamic systems. Models for isothermal, non-isothermal, single and multicomponent, linear and non-linear sorption in columns. Asymptotic behavior in columns. Discussion of adsorptive separation processes involving kinetic and equilibrium selectivity, cyclic two bed processes optimization, and continuous counter-current both moving and simulated moving bed type.

Prerequisite: CHE 501

CHE 637 Advanced Reactor Analysis (3-0-3)

Macro- and micro-mixing effects in homogenous reactors. Steady-state multiplicity & stability in homogeneous reactors. Transport/reaction interactions in gas-liquid, liquid-liquid reactions, and design of two-phase reactors. Theory of gas-solid fluidization and fluidized-bed reactors. Three-phase slurry and tricklebed reactors.

Prerequisite: CHE 530 or Consent of the Instructor

CHE 690 Special Topics in Chemical Engineering (3-0-3)

The contents of this course will be in one of the specific areas of interest in Chemical Engineering. The specific contents of the special topics course will be given in detail at least one semester in advance of that in which it is offered. It is also subject to the approval of the Graduate Council.

Prerequisite: Another graduate course may be required when needed another graduate and graduate standing

CHE 699: Ph.D. Seminar (1-0-0)

Ph.D. students are required to attend Departmental seminars delivered by faculty, visiting scholars and graduate students. Additionally, each Ph.D. student should present at least one seminar on a timely research topic. Ph.D. students should pass the comprehensive examination as part of this course. This course is a pre-requisite to registering the Ph.D. Pre-dissertation CHE 711. The course is graded on Pass or Fail basis. IC grade is awarded if the Ph.D. comprehensive examination is not yet passed.

Prerequisite: Graduate Standing.

CHE 701 Directed Research I (3-0-3)

This course is intended to allow students conduct research in advanced problems in their Ph.D. area of specialization. Among other things, this course is designed to give the students an overview of research in CHE, and a familiarity with research methodology, journals and professional societies in his discipline. At the end of the course, the student must deliver a public seminar to present his work and findings. The course is graded on Pass or Fail basis. To select adequate subject, prior arrangement with the instructor is required.

Prerequisite: Prior arrangement with an instructor

CHE 702 Directed Research II (3-0-3)

This course is intended to allow the student to conduct research in advanced problems in his Ph.D. research area. The faculty offering the course should submit a research plan to be approved by the Graduate Program Committee at the academic department. The student is expected to deliver a public seminar and a report on his research outcomes at the end of the course. This course is graded on Pass or Fail basis.

Prerequisite: CHE701 and Prior arrangement with an instructor

CHE 711 Ph.D. Pre-Dissertation (0-0-3)

This course enables the student to submit his Ph.D. Dissertation Proposal and defend it in public. The student passes the course if the Ph.D. Dissertation Committee accepts the submitted dissertation proposal report and upon successfully passing the Dissertation Proposal Public Defense. The course grade can be NP, NF or IC.

Prerequisite: Ph.D. Candidacy,**Co-requisite:** CHE 699

CHE 712 Ph.D. Dissertation (0-0-9)

This course enables the student work on his Ph.D. Dissertation as per the submitted dissertation proposal, submit its final report and defend it in public. The student passes this course if the Ph.D. Dissertation Committee accepts the submitted final dissertation report and upon successfully passing the Dissertation Public Defense. The course grade can be NP, NF or IP.

Prerequisite: CHE711

OIL & GAS SURFACE FACILITIES

OGSF 501 Physico-Chemistry and Applied Thermodynamics(4-0-2)

Upstream and downstream context and facilities, safety industrial hygiene and environment, surface production and refining principles, physical and chemical properties of hydrocarbon and petroleum cuts, crude oils petroleum products, fluid properties, liquid vapor equilibria of hydrocarbon mixtures, Liquid vapor equilibria of non-ideal mixtures.

OGSF 502 Separation Processes(6-0-2)

Study of traditional as well as contemporary rate controlled separation processes such as crystallization, chromatography, sorption, membranes, etc. Rate based models for distillation. Selective coupled rate processes will be discussed.

OGSF 503 Energy Management, Utilities and Process Control(8-0-3)

The technology of the various types of heat exchangers is described. The thermal and hydraulic engineering methods relevant to heat exchangers are covered. The selection of the appropriate TEMA heat exchanger from process specifications is studied. The design and construction characteristics of heat exchanger on the thermal and hydraulic aspects are tackled. The technology, performances and safety operation of furnaces, boilers and cogeneration systems are reviewed. The operating conditions of furnaces and boilers as well as the different relevant parameters in energy management of an industrial petroleum site are introduced. An overview of utilities production and distribution networks is given aiming at mastering operating conditions and economical criteria for steam, electricity production and use. The operating principles and technologies of the main sensors and control valves are reviewed in order to understand the process control strategy, the PID controllers and tuning. Advanced control systems are covered.

OGSF 504 Industrial Equipment(3)

An overview of static equipment, metallurgy, corrosion and corrosion prevention in oil and gas industries is exposed. The pumps operating characteristics and technology are introduced in order to analyze technical options, to bring essential elements to pump selection and to establish diagnosis of incidents. Compressors, Turbine, gas turbines and turbo expanders operating

characteristics are studied in order to adapt to process operating conditions, with emphasis on the technology and main operating problems.

OGSF 505 Mathematical Methods for Engineers(3)

Laplace transforms including the convolution theorem, error and gamma functions. The method of Frobenius for series solutions to differential equations. Fourier series, Fourier-Bessel series and boundary value problems, Sturm-Liouville theory. Partial differential equations: separation of variables and Laplace transforms and Fourier integrals methods. The heat equation. Laplace equation, and wave equation. Eigenvalue problems for matrices, diagonalization.

OGSF 506 Surface Production(3)

An overview of the current Exploration & Production Technology is exposed, including main terminology specific to the E&P activities, summary of required operations and disciplines for hydrocarbon exploration and production Oil & Gas offshore technologies are reviewed, including technology and selection criteria for the different structures used for offshore production activities, typical offshore development architecture, technology of pipelines, laying techniques, main operation and flow assurance problems, SHE constraints for offshore activities.

OGSF 507 Treatment of Effluents(6-0-2)

Oil and water field treatment processes are tackled: problems posed by undesirable components present in the well effluent and the required treatments, oil treatment processes and main operating conditions, design methods of main equipment used for oil processing, operating problems encountered and main available technical solutions, production and injection water quality requirements and the necessary treatments. An overview of the techniques involved in natural gas processing and transport is given: raw natural gas characteristics, quality specifications and required field treatments to conform to specifications, the different processes applicable to gas processing and associated operating conditions, the operating problems encountered in effluent processing and main available technical solutions, the transport and storage techniques of natural gas (LNG technology and gas pipes) and their specific constraints. The common Oil & Gas field treatment processes are analyzed through the different elementary process operations combined with the use of the HYSYS process simulation software.

OGSF 508 Refining I(8-0-3)

Operating parameters of crude oil Atmospheric Distillation Unit, Vacuum Distillation Unit and base oil refining processes are reviewed. Desalter operations and corrosion monitoring are studied, as well as detection of potential problem root causes. Secondary processes (Catalytic Reforming, Isomerization, Hydrotreatments and Sulfur Recovery) are reviewed, including feed characteristics, products, operating parameters, catalyst operation, units operation, troubleshooting, and recent technology developments.Industrial chemical reactions and catalysts are thoroughly studied: preparation of catalysts, problems associated with their utilization, unit start-up and industrial performance control, investigation of typical incidents, unit shut down and catalyst regeneration.

The general principles of chemical kinetics, mass and heat transfer involved in the design of various types of industrial reactors are developed.

OGSF 509 Refining II and Petrochemicals(3)

An introduction to the different conversion processes available for heavy cuts upgrade is given. Their operating principles, technical characteristics (design and operating) and recent technology developments are studied. Linear programming is presented in order to provide an in-depth understanding of the techniques used to optimize refining operation and help decision making Planning techniques and evaluation of the validity of optimum solutions boundaries are analyzed. The main industrial processes used to produce olefins, aromatics, main polymers, synthesis gas, methanol and ammonia are presented, with a special focus on steam cracking process. Main industrial safety and operational problems are discussed. Being the main petrochemical industry production, the global technical and economic structure of commodity polymers is explained.

Links between product slate and process selection vs. company marketing strategy are discussed. Main industrial commodity polymers processes available for licensing, and their main characteristics are presented.

OGSF 510 Transport Phenomena(3)

Continuum theory of momentum, energy and mass transfer. Viscous behavior of fluids. Molecular transport mechanisms. General property balance. Laminar and Turbulent flow. Convective transport. Momentum, heat and mass applications of transport phenomena.

OGSF 511 Engineering and Safety(4)

Objectives, roles and techniques of project management are presented. Proven practices applicable to most kind of projects are highlighted. Contracting strategy and project execution plan are studied. The use of past and current projects' data is presented for better estimate of new projects and associated cost control. Special focus is made on project technical content, experience of previous projects results as key elements to improve cost control. Tools for process hazard assessment are described: HAZOP, What-if and/or Check-List techniques. Hazards and risks related to products and equipment are analyzed. Preventive measures to ensure safe operations are reviewed. Special attention is given to hazards in the decommissioning, commissioning and start-up phases. The most appropriatebehaviors in normal operation and in the event of incidents are discussed. Environmental issues in oil and gas surface facilities are tackled. Main ways of evaluating environmental damages are discussed. Main processes and operating conditions for treatment of aqueous or atmospheric effluents are studied. Key principles of an environmental management system are exposed.

OGSF 512 Economics(10-0-4)

The fundamental aspects of petroleum economics are covered: from energy supply/demand, E&P value chain and contracts to oil and gas international markets and prices. The fundamental trends of the refining and petrochemical industries are introduced. The corresponding economic aspects from refining margins and costs to markets and pricing are studied. Concepts behind the theory of capital budgeting are introduced to improve investment profitability studies. Current trends in maintenance policy (TPM, RCM…) are presented, including reliability analysis and improvement techniques, and conditions for successful turnaround management. The various types of constraints (technical, economic, environmental and regulatory) for refinery to gas station logistic are discussed.

OGSF 513 Numerical Methods in Chemical Engineering(3-0-3)

Visualization of profiles, analysis of models of chemical processes, normalization of models, non-linear finite difference techniques, orthogonal collocation, non-linear algebraic equations, initial value and final value problems in chemical engineering, software packages for solving such problems.

OGSF 601Industrial Project and Final Defense(0-0-5)

At the end of the course, students are required to do a one semester industrial internship. The company offering the internship provides the subject for this professional thesis. The subject has to be validated by KFUPM and IFP School before the beginning of the internship period and must be chosen in order to make it possible to give a real evaluation of the trainee's knowledge and skills developed during this period in the company. The industrial internship gives the participants the opportunity to apply their knowledge to a real case and to deepen their knowledge and know-how in a specific technical area. It also gives them the possibility to show their organizational skills through the way they handle the subject they have to work on and to develop specific skills in communication and reporting. This zero-credit course is meant for preparation and building background for the project.

OGSF 602 Industrial Project and Final Defense(0-0-5)

The work done by the student during the internship is supervised by a member of the company with the follow-up by a supervisor from KFUPM and IFP School France. This internship work culminates in the writing of a technical report called “Professional Thesis”, and an oral technical presentation in front of a board of professors and experts from KFUPM and IFP School France.

DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

Chairman

Dr. Nedal T. Ratrout

Faculty

Al-Abdul Wahhab	Abduljauwad	Ahmadi
Aiban	Al-Amoudi	Al-Attas
Azad	Bader	Baig
Baluch	Bouchama	Bukhari
Chowdhury	Al-Dulaijan	Ebrahim
Essa	Al-Gadhib	Al-Gahtani, A.
Al-Gahtani, H	Al-Ghamdi	Al Hajyaseen
Khathlan	Al-Malack	Al-Ofi
Osta	Ratrout	Al-Senan
Shamshad	Sharif	Al-Shayea
Al-Sughaiyer	Al-Suwaiyan	Vohra
Al-Zahrani, M.A.	Al-Zahrani, M.M.	

The Department of Civil and Environmental Engineering offers graduate programs leading to Master of Science, Master of Engineering and Doctorate Degrees in Civil Engineering in four options:

- Structural Engineering
- Water Resources and Environmental Engineering
- Geotechnical Engineering
- Transportation Engineering

Research in structures and materials focuses on concrete behavior with a blend of computational and experimental modeling to characterize diversified phenomena such as corrosion, durability modeling, shrinkage, creep, repair and fatigue. Other areas of research include concrete durability; finite element modeling of intact or damaged structures for assessment, strengthening and/or repair, nonlinear finite element analysis of mitered bends, laminated shell elements, steel connections, reinforced concrete and slabs on grade; structural optimization, boundary elements, structural dynamics, and nondestructive testing.

Water-resources projects include recharge problems, groundwater contamination problems and sea water intrusion, numerical techniques, remote sensing applications in water resources, watershed modeling of rain-fall-runoff relationships, evapotranspiration studies in arid zones, and urban hydrology. Research in the environmental engineering area emphasizes petrochemical and hazardous waste treatment, evaluation of wastewater treatment plants, disinfection and biological treatment, removal of viruses through slow sand filtration, and reuse of wastewater effluents for desert greening.

Research in the geotechnical engineering area includes soil-structure interaction, local soil and foundation problems, mineralogy and fabric of soils, constitutive modeling of soils, nonlinear numerical analysis, soil stabilization, soil dynamics and geoenvironment.

Research in transportation includes areas of highway safety, intersection safety, pedestrian safety, signal optimization, intercity transportation demand modeling, disaggregate behavior modeling, pavement materials specification, modification, modeling, analysis and pavement management system, and quality control and quality assurance.

Teaching and Research Facilities

The department has the following laboratories which are all equipped with state of the art equipment.

- Structural Laboratories: Concrete testing laboratory, stress analysis laboratory, structural mechanics laboratory, heavy structures laboratory, building research station, and corrosion laboratory.
- Highway Materials Laboratory
- Graphics Laboratories
- Water Resources/Environmental Laboratories: Open channel laboratory, hydraulics laboratory, and environmental and sanitary laboratory
- Traffic Engineering Laboratory
- Photogrammetry Laboratory
- Surveying Laboratory
- Geotechnical Engineering Laboratory

The department has an array of over forty microcomputers for data processing, data acquisition, plotting, and research functions. The department also maintains a computer laboratory and has terminals to the University's IBM 390-150E mainframe computer within the civil engineering

building.

Admission Requirements

Graduates in engineering and science from recognized institutions are eligible to apply for admission as regular students in the Master's program. To be considered for admission to the doctoral program, an application must hold a Master of Science degree from a university of recognized standing in Civil Engineering. Holder of Master of Engineering degree (non-thesis) can be considered for admission for doctoral program with certain deficiency courses. For admission into either program, the general University admission regulations set out by the Deanship of Graduate Studies must also be satisfied.

Degree Requirements

The M.S. program requires 24 hours of approved course work, a seminar course and an acceptable thesis. A Ph.D. student of the department will be required to satisfy residency requirements, successful completion of 30 credit hours of course work beyond the M.S. and passing a comprehensive examination. The Ph.D. is conferred after successful completion and publicity defending his dissertation. The details of the academic programs are given below:

M.S. PROGRAM IN CIVIL ENGINEERING

The Master of Science in Civil Engineering is available to students who meet the requirements for admission to the University with a Bachelor's Degree in Civil Engineering Science or equivalent. A candidate fulfills the requirements for the M.S. degree by successful completion of a minimum of 24 credit hours of graduate course work plus 6 credit hours of research toward the preparation of an acceptable thesis. Of the 24 course credits, 18 must be in Civil Engineering. Of the 18 credit hours in Civil Engineering, 15 are expected to be in one of the four options namely: Structures, Water Resources and Environmental Engineering, Geotechnical Engineering, and Transportation.

Under certain conditions courses carrying identification codes in the 400-level may be taken for graduate credit (towards a Master's program only). No more than two (2) courses of 400-levels may be counted for credit towards the requirements of an advanced degree. These two courses must be approved by the student's Graduate Committee, the Department Chairman, and the Dean of Graduate Studies. Degree plans for Master of Science in various options are given next.

Degree Plan for M.S. in Civil Engineering:

(Geotechnical Engineering Option)

Course	#	Title	LT	LB	CR
First Semester					
MATH	5xx	Advanced Mathematics*	3	0	3
CE	550	Nature and Behavior of Soils	3	0	3
CE	551	Advanced Geotechnical Engineering	2	3	3
CE	599	Seminar	1	0	0
			9	**3**	**9**
Second Semester					
CE	552	Foundation Engineering	3	0	3
CE	5xx/6xx	Geotechnical Elective	3	0	3
CE	5xx/6xx	Geotechnical Elective	3	0	3
			9	**0**	**9**
Third Semester					
CE	5xx/6xx	CE Elective**	3	0	3
XX	5xx/6xx	Technical Elective***	3	0	3
CE	610	M.S. Thesis	0	0	IP
			6	**0**	**6**
Fourth Semester					
CE	610	M.S. Thesis	0	0	6
			3	**0**	**6**
Total Credit Hours					**30**

Notes:

- Each student is expected to submit his detailed degree plan according to the above generic degree plan for approval by the Department and the Deanship of Graduate Studies within the 8th week of the second semester of enrollment.
- Students are required to adhere to the regulations of degree plan. No relaxations will be given to any student, and courses taken in conflict of the above will not be counted towards the degree.
- At most two 400-level elective courses may be allowed with the approval of the advisor.
- The order of taking the courses can be different from above, but students must take the core courses before electives.

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*. MATH 513 or MATH 560.

**. From Civil Engineering courses (including Geotechnical option).

***. From relevant graduate courses offered university wide with the consent of graduate advisor.

Degree Plan for M.S. in Civil Engineering

(Structural Engineering Option)

Course	#	Title	LT	LB	CR
First Semester					
CE	501	Concrete Materials	2	3	3
CE	510	Advanced Structural Mechanics	3	0	3
CE	511	Advanced Structural Analysis	3	0	3
CE	599	Seminar	1	0	0
			9	**3**	**9**
Second Semester					
MATH	5xx	Advanced Mathematics	3	0	3
CE	521	Advanced Reinforced Concrete Design	3	0	3
CE	5xx/6xx	Structures Elective	3	0	3
			9	**0**	**9**
Third Semester					
CE	5xx/6xx	CE Elective*	3	0	3
XX	5xx/6xx	Technical Elective**	3	0	3
CE	610	M.S. Thesis	0	0	IP
			6	**0**	**6**
Fourth Semester					
CE	610	M.S. Thesis	0	0	6
			0	**0**	**6**
Total Credit Hours					**30**

Notes:

- Each student is expected to submit his detailed degree plan according to the above generic degree plan for approval by the Department and the Deanship of Graduate Studies within the 8^{th}week of the second semester of enrollment.
- Students are required to adhere to the regulations of degree plan. No relaxations will be given to any student, and courses taken in conflict of the above will not be counted towards the degree.
- At most two 400-level elective courses may be allowed with the approval of the advisor.
- The order of taking the courses can be different from above, but students must take the core courses before electives.

*. From Civil Engineering courses (including Structural Engineering option).

**. From relevant graduate courses offered university wide with consent of graduate advisor

Degree Plan for M.S. in Civil Engineering

(Transportation Engineering Option)

Course	**#**	**Title**	**LT**	**LB**	**CR**
First Semester					
MATH	560	Applied Regression and Exptl. Design	3	0	3
CE	574	Pavement Structures	3	0	3
CE	571	Urban Transp. Planning and Modeling	3	0	3
CE	599	Seminar	1	0	0
			10	**0**	**9**
Second Semester					
CE	5xx/6xx	Transportation Elective	3	0	3
CE	5xx/6xx	Transportation Elective	3	0	3
CE	5xx/6xx	Transportation Elective	3	0	3
			9	**0**	**9**
Third Semester					
CE	5xx/6xx	CE Elective*	3	0	3
XX	5xx/6xx	Technical Elective**	3	0	3
CE	610	M.S. Thesis	0	0	IP
			6	**0**	**6**
Fourth Semester					
CE	610	M.S. Thesis	0	0	6
			0	**0**	**6**
Total Credit Hours					**30**

Notes:

- Each student is expected to submit his detailed degree plan according to the above generic degree plan for approval by the Department and the Deanship of Graduate Studies within the 8thweek of the second semester of enrollment.
- Students are required to adhere to the regulations of degree plan. No relaxations will be given to any student, and courses taken in conflict of the above will not be counted towards the degree.
- UP to two 400-level elective courses may be allowed with the approval of the advisor.
- The order of taking the courses can be different from above, but students must take the core courses before electives

*. From Civil Engineering courses (including Transportation Engineering option).

**. From relevant graduate courses offered university wide with consent of graduate advisor.

Degree Plan for M.S. in Civil Engineering

(Water Resources & Environmental Engineering Option)

Course	#	Title	LT	LB	CR
First Semester					
MATH	5xx	Advanced Mathematics*	3	0	3
CE	533	Groundwater Flow & Cont. Transport	3	0	3
CE	541	Chemistry in Environmental Eng.	3	0	3
CE	599	Seminar	1	0	0
			10	**0**	**9**
Second Semester					
CE	5xx/6xx	Water Resources/Env. Elective[1,2]	3	0	3
CE	5xx/6xx	Water Resources/Env. Elective	3	0	3
CE	5xx/6xx	CE Elective**	3	0	3
			9	**0**	**9**
Third Semester					
CE	5xx/6xx	Water Resources/Env. Elective	3	0	3
CE	5xx/6xx	Water Resources/Env. Elective	3	0	3
CE	610	M.S. Thesis	0	0	IP
			6	**0**	**6**
Fourth Semester					
CE	610	M.S. Thesis	0	0	6
			0	**0**	**6**
Total Credit Hours					**30**

Notes:

- Each student is expected to submit his detailed degree plan according to the above generic degree plan for approval by the department and the Deanship of Graduate Studies within the 8th week of the second semester of enrollment.
- Students are required to adhere to the regulations of the degree plan. No relaxations will be given to any student, and courses taken in conflict of the above will not be counted towards the degree.
- At most two 400-level elective courses may be allowed with the approval of the advisor.
- The order of taking the courses can be different from above but, students must take the core courses before electives.

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*. MATH 513 or 560.

**. From Civil Engineering courses (including Water Resources & Environmental Engineering option).

***.From relevant graduate courses offered university wide with consent of advisor.

1. CE 531 is mandatory for candidates pursuing research in Water Resources.
2. CE 547 is mandatory for candidates pursuing research in Environmental Eng.

M. ENG. PROGRAM IN CIVIL ENGINEERING

The objective of Master of Engineering (M.Eng.) program is to prepare professionals empowered with knowledge and skills to take leadership role in the development of the Kingdom in the fields of engineering science, environmental design and business. The program is an outstanding opportunity for the practicing civil engineers to develop professionally and to earn higher degrees without relinquishing their jobs. Four options of civil engineering namely: Structures and Materials, Geotechnical, Transportation, and Water Resources and Environmental Engineering are available for M.Eng. degree, by taking suitable Civil Engineering core courses.

The Master of Engineering in Civil Engineering is available to students who meet the requirements for admission to the University with a Bachelor's Degree in Civil Engineering or equivalent. A candidate fulfills the requirement for the MEng. Degree by successful completion of a minimum of 36 credit hours of graduate course plus six credit hours of engineering work towards completion of a project (CE 598) and a master of engineering report (CE 600). Of 36 credit hours, 30 credit hours must be in civil engineering with 9 credit hours allocated to core courses. A total of 6 credit hours must be earned in elective courses taken outside the department.

Degree Plan for M.Eng. in Civil Engineering

Course	#	Title	LT	LB	CR
First Semester					
CE	xxx	CE Core	3	0	3
CE	xxx	CE Core	3	0	3
CE	500	Concept of Engineering Practice	3	0	3
			9	**0**	**9**
Second Semester					
CE	xxx	CE Core	3	0	3
CE	xxx	CE Elective*	3	0	3
XX	xxx	Elective**	3	0	3
			9	**0**	**9**
Summer					
CE	598	Master Design Project	**0**	**6**	**3**
Third Semester					
CE	xxx	CE Elective*	3	0	3
XX	xxx	Elective**	3	0	3
XX	xxx	Elective**	3	0	3
			9	**0**	**9**
Fourth Semester					
CE	xxx	CE Elective*	3	0	3
XX	xxx	Elective	3	0	3
XX	xxx	Elective**	3	0	3
			9	**0**	**9**
Summer					
CE	600	M.Eng. Report	**0**	**6**	**3**
Total Credit Hours					**42**

Notes:

- Each student is expected to submit his detailed degree plan according to the above generic degree plan for approval by the Department and the Deanship of Graduate Studies within the 8thweek of the second semester of enrollment.
- Students are required to adhere to the regulations of degree plan. No relaxations will be given to any student, and courses taken in conflict of the above will not be counted towards the degree.
- Up to two 400-level elective courses may be allowed with the approval of the advisor.
- The order of taking the courses can be different from above, but students must take the core courses before electives.

***.** From the list of major electives.

****.** Two of which should be from outside the department according to the approved degree plan.

PH.D. PROGRAM IN CIVIL ENGINEERING

The program leading to the degree of Doctor of Philosophy involves advanced studies in Civil Engineering and related areas. Formal study in terms of advanced courses coupled with independent research prepares the student for leadership in the option of Structures, Water Resources and Environmental Engineering, Geotechnical Engineering or Transportation. The program is administered under the general regulations of the Deanship of Graduate Studies with regard to admission, residence, examinations, and the dissertation.

Degree Requirements

The program requires the completion of a minimum of 30 credit hours of courses, beyond the M.S. degree, with a cumulative GPA of 3.00 or more at all times. Of the 30 credit hours, 18 should be in his major area of interest and 12 in related minor area(s). Within the minor area(s), at least six credit hours should be completed outside the Civil Engineering Department.

Comprehensive Examination: A Civil Engineering Ph.D. student has to successfully pass a comprehensive examination by the end of the second year of his enrolment in the Ph.D. program. The Ph.D. student will be allowed to take the Comprehensive Examination only twice which will be graded on Pass or Fail basis.

Dissertation: After passing the Comprehensive Examination and the pre-Dissertation (CE 711), the student will register for his Ph.D. Dissertation (CE 712). The student, upon completion of his research work, will defend his dissertation before the Dissertation Committee and in public. The Ph.D. degree will be conferred only upon the recommendation of his Dissertation Committee.

A typical breakdown of Credit Hours for All Options

The breakdown of credit hours for each of the available four options of study, namely, Structural, Water Resources and Environmental, Geotechnical, and Transportation Engineering, is as follows:

Areas	**Courses***	**Credits**
Major Area		18
Minor Area(s)	Minimum two graduate courses from outside CE Department	12
	Seminar (CE 699)	0
	Ph.D. Pre- Dissertation (Ph.D. proposal defense)	03
	Ph.D. Dissertation	09
Total Credit Hours		**42**

*All courses must be selected in consultation with the Graduate Coordinator of the CE department.

Degree Plan for Ph.D. in Civil Engineering

Course	#	Title	LT	LB	CR
First Semester					
CE	5xx/6xx	Core Elective I	3	0	3
CE	5xx/6xx	Core Elective II	3	0	3
CE	5xx/6xx	Core Elective III	3	0	3
			9	**0**	**9**
Second Semester					
CE	5xx/6xx	Core Elective IV	3	0	3
CE	5xx/6xx	Core Elective V	3	0	3
CE	5xx/6xx	Core Elective VI	3	0	3
			9	**0**	**9**
Third Semester					
XX	5xx/6xx	Technical Elective I*	3	0	3
XX	5xx/6xx	Technical Elective II*	3	0	3
XX	5xx/6xxX	Free Elective I	3	0	3
CE	699	Seminar	1	0	0
			10	**0**	**9**
Fourth Semester					
XX	5xx/6xx	Free Elective II**	3	0	3
CE	711	Ph.D. Pre-Dissertation	0	0	3
			3	**0**	**6**
Fifth Semester					
CE	712	Ph.D. Dissertation	0	0	IP
Sixth Semester					
CE	712	Ph.D. Dissertation	**0**	**0**	**9**
Total Credit Hours					**42**

Notes:

- Each student is expected to submit his detailed degree plan according to the above generic degree plan for approval by the Department and the Deanship of Graduate Studies within the 8th week of the second semester of enrollment.
- Students are required to adhere to the regulations of the degree plan. No relaxations will be given to any student and courses taken in conflict of the above will not be counted towards the degree.
- The order of taking the courses can be different from above but students must take the core courses before electives.

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*. Must be from outside the CE department.
**. Can be chosen from CE or non-CE courses.

COURSE DESCRIPTIONS

CE 500 Concept of Engineering Profession (3-0-3)

The role of the civil engineering profession in society, professional ethics and code of conduct; building codes, byelaws and regulations, professional responsibilities and liabilities; sustainable design and development and their impact on environment and ecology; project management including management of human resources and finance; professional societies and membership, and the need forlifelong learning.

Prerequisite: Graduate Standing

CE 501 Concrete Materials (2-3-3)

Properties of concrete constituents; types of cements and their composition; cement hydration; microstructure of hydrated cement paste and its influence on strength, shrinkage and creep; chemical admixtures; alternate cement matrices; concrete durability and sustainability; introduction to repair materials.

Prerequisite: Graduate Standing

CE 502 Evaluation and Testing of Concrete Structures (2-3-3)

Introduction to in-situ testing and planning of test programs; various nondestructive tests (NDT), tests for concrete strength, quality, composition and durability; measurement of corrosion activity; chemical tests for cement, chloride and sulphate contents; cracking of concrete; in-situ load tests; condition assessment with case studies; types of concrete repair; repair strategy, compatibility and selection of repair materials, patch repair, corrosion repair and crack repair.

Prerequisite: Graduate Standing

CE 504 Corrosion in Reinforced Concrete (2-3-3)

Corrosion mechanisms including corrosion cells, electrochemical reactions, polarization and passivity; forms of corrosion, corrosion mechanisms of reinforcing steel in concrete structures; environmental effects; effect of concrete properties; corrosion testing; corrosion protection including cathodic protection, corrosion inhibitors, chloride extraction, re-alkalization, and protective coatings.

Prerequisite: CE 501

CE 510 Advanced Structural Mechanics (3-0-3)

Unsymmetrical bending of beams; shear center; bending of curved beams; torsion of prismatic bars; beams on elastic foundations; introduction to Cartesian tensors; tensorial transformation of stress; Mohr's circle for 3-D stress transformation; dyadic symbols; finite and infinitesimal strain tensors; Mohr's circle for 3-D strain; constitutive equations for anisotropic materials and application to composite laminates; theories of yield and fracture.

Prerequisite: Graduate Standing

CE 511 Advanced Structural Analysis (3-0-3)

Matrix algebra, solution of equations, review of energy principles, virtual work; degree of redundancy, choice of redundants, flexibility method, kinematic indeterminacy, development of element stiffness matrices, stiffness method of analysis of structures, computer applications and software development, axial force effects and eigenvalue analysis, introduction to the finite element method.

Prerequisite: Graduate Standing

CE 512 Elasticity and Plasticity I (3-0-3)

Basic equations of continuum mechanics; plane elasticity; Airy's stress function; polynomial and generalized Fourier series solution to biharmonic equation; plane elasticity in polar coordinates; general foundation of plasticity theories including yield criteria, plastic flow rule, and generalized

elasto-plastic shear strain relations; application of finite elements in elasticity and plasticity.

Prerequisite: Graduate Standing

CE 513 Plates and Shells (3-0-3)

Static analysis of elastic plates, including rectangular and circular geometry; energy methods; finite difference for plates with straight and curved boundaries; introduction to finite element for plate bending; thermal stresses in plates; application of STRUDL to plate bending; membrane theory of shells of surface of revolution; bending theory of circular cylindrical shells; discontinuity stresses in pressure vessels; axisymmetric bending of spherical shells.

Prerequisite: CE 510

CE 514 Structural Stability (3-0-3)

Introduction to common areas of stability problems in structures, conservative and nonconservative loads, elastic and inelastic buckling of columns; stability of members under combined bending and axial loads; buckling of frames; torsional buckling of open sections; lateral stability of beams and buckling of thin plates and shells; design consideration for stability; computer applications.

Prerequisite: CE 511

CE 515 Structural Dynamics (3-0-3)

Equations of motion; free and forced vibrations of single degree of freedom systems; multi-degree of freedom systems; free vibrations, forced vibrations by harmonic, generalized, impulsive and random loadings; numerical solution of dynamic problems; introduction to earthquake engineering; introduction to probabilistic vibrations; linear and nonlinear problems; computer applications.

Prerequisite: CE 511 or equivalent

CE 516 Numerical Methods of Structural Analysis (3-0-3)

Introduction to finite difference calculus; applications in computing bending moments; shear force and deflection of beams; critical loads for columns and analysis of beams on elastic foundations; plate bending by finite difference; finite difference software development; introduction to modeling and applications with emphasis on software development.

Prerequisites: CE 510, CE 511

CE 517 Finite Element Methods (3-0-3)

Basic equations of elasticity; virtual work; stiffness properties of structural elements; variational and weighted residual methods, applications to trusses, beams, plane frames, two-dimensional, axi-symmetric and three-dimensional solids; higher order and isoparametric elements; field and time-dependent problems of fluid and heat flow; software development.

Prerequisites: CE 510, CE 511, or Consent of the Instructor

CE 518 Continuum Mechanics (3-0-3)

Tensors, indicial notation, transformation of coordinates; analysis of stress, principal stresses; 3D Mohr's circle; analysis of deformation and strain; velocity fields and compatibility conditions; constitutive equations; isotropy; mechanical properties of solids and fluids; field equations; applications to elasticity, viscoelasticity, plasticity, and fluid mechanics; introduction to continuum damage mechanics.

Prerequisite: Graduate Standing

CE 519 Boundary Element Method (3-0-3)

Weighted residual methods; weak formulations; inverse formulations, fundamental solutions; one-dimensional problems; two-dimensional problems of steady-state potential flow; two-dimensional problems of elastostatics; time dependent problems; algorithm design and software

development; application in various engineering fields.

Prerequisite: Graduate Standing

CE 521 Advanced Reinforced Concrete (3-0-3)

Moment-curvature for RC members, design and behavior of continuous flexural members, two-way floor systems, design of slender columns, beam-column joints; deflection of RC members; design for shear and torsion; foundation design; computer modeling for analysis and design of RC structures, designs of shear walls.

Prerequisite: Graduate Standing

CE 522 Prestressed Concrete (3-0-3)

Prestressing systems; materials; behavior of prestressed concrete beams; criteria for analysis and design; losses; analysis of stresses; flexural design; shear; end blocks; deflection; composite members; continuous beams; partial prestressing, design applications; introduction to segmental construction.

Prerequisite: Graduate Standing

CE 523 Behavior and Design of Steel Structures (3-0-3)

Elastic-plastic concepts of structural behavior; plastic design of beams and frames; design of plate girders, compression members with large width-thickness ratio and stiffened plate; composite design and behavior, behavior of rigid and semirigid connections; design considerations for fracture and fatigue; design of rigid frames; behavior of multistory frames and second-order analysis.

Prerequisite: CE 408 or equivalent

CE 530 Experimental Hydraulics (1-6-3)

Experiments for model calibration and verification; flow characteristics of weirs, flumes, spillways, self-regulated siphons, roughened beds, and cylindrical piles; determination of lift and drag on models; model study approaches to diffusion in transport problems; experiment in groundwater flow and well hydraulics.

Prerequisite: Graduate Standing

CE 531 Advanced Engineering Hydrology (3-0-3)

Introduction to the elements of the hydrologic cycle; frequency analysis of precipitation and runoff; relationship between rainfall and runoff; flood routing; watershed modeling and urban hydrology.

Prerequisite: Graduate Standing

CE 532 Hydrodynamics (3-0-3)

Kinematics of fluid; continuity: plane flow, axi-symmetric flow, streamflow functions, circulation, velocity potential; dynamics of frictionless fluids: Eulerian equations of motion, irrotational incompressible flow, some elementary symmetric and axisymmetric flow, rotational flow, equations in a moving coordinate system, flow past spheres and cylinders; two-dimensional complex variables and applications.

Prerequisite: Graduate Standing

CE 533 Groundwater Flow and Contaminant Transport (3-0-3)

Properties of porous media, fluid storage and flow in saturated media, transport equations in porous media, equation of motion, Darcy’s law, continuity and conservation equation, well hydraulics, principle of superposition, transport of contaminants by advection, modeling of advective transport.

Prerequisite: Graduate Standing

CE 534 Hydraulics of Closed Conduits (3-0-3)

Concept of water hammer and unsteady flow through conduits; method of characteristics; algebraic water hammer; flow through highly flexible tubing; transients caused by pumps and turbines; computer models; case studies.

Prerequisite: Graduate Standing

CE 535 Design of Dams and Hydraulic Structures (3-0-3)

Types of hydraulic structures; classification of dams; problems of foundation; selection of sites; feasibility studies; design of gravity, arch, earth and rockfill dams; barrages and dams on permeable foundation and their design criteria; spillway types; energy dissipation devices; syphon aqueducts; design criteria for transitions from trapezoidal to rectangular flumes.

Prerequisite: Graduate Standing

CE 537 Water Resources and Environmental Systems Analysis (3-0-3)

Applications of system engineering techniques to water and environmental problems; optimization techniques, linear programming, integer programming, goal programming, non-linear programming, dynamic programming; multi-objective decision analysis; simulation methods.

Prerequisite: Graduate Standing

CE 538 Advanced Open Channel Flow (3-0-3)

Basic concepts of fluid flow; the energy and momentum principles in open channel flow; critical flow; flow resistance in uniform and non-uniform flow; normal depth analysis; flow profiles in gradually varied flow; rapidly varied flow; channel controls and channel transitions; flow of waves and equation of motion in unsteady flow; computer applications in open channel.

Prerequisite: Graduate Standing

CE 539 Coastal Engineering (2-3-3)

An introduction to the mechanics of coastal environment; linear wave theory, kinematics, dispersion, mass transport radiation stress, energy flux, current; shoaling, refraction, diffraction; real sea states; wind wave prediction; wave climate; wave loading; tides and tidal circulation; storm tides; limited laboratory experiments.

Prerequisite: Graduate Standing

CE 541 Chemistry in Environmental Engineering (2-3-3)

Environmental aspects of physical, organic, and inorganic chemistry including applications in environmental engineering of the phenomena of precipitation, buffering capacity, chemical equilibria, and adsorption.

Prerequisite: Graduate Standing

CE 542 Microbiology in Environmental Engineering (2-3-3)

Role of microorganisms in wastewater treatment; aerobic and anaerobic digestion or municipal sludges, and degradation of water quality in drinking water systems; disinfection of wastewater and drinking water for removal of viruses, bacteria and protozoa that cause waterborne diseases.

Prerequisite: Graduate Standing

CE 543 Air Pollution Engineering (3-0-3)

Introductory course in air pollution and its control; air pollution and effects, source dispersion models, engineering controls, and air quality legislation.

Prerequisite: Graduate Standing

CE 544 Unit Operations and Processes Laboratory (1-6-3)

Analytical methods utilized for assessment of water and wastewater quality; laboratory evaluation for the design of physical, chemical, and biological unit operations and processes in water and wastewater treatment.

Prerequisites: CE 541, CE 542 (can be taken concurrently)

CE 546 Industrial Water and Wastewater Treatment (3-0-3)

Water quality and quantity for industrial uses, characteristics of wastewater; application of standard and special treatment processes; effluent quality and water reuse; conditioning and disposal of sludges; case studies.

Prerequisite: CE 541 or equivalent

CE 547 Physical and Chemical Processes (3-0-3)

Theory and applications of physical and chemical processes in water treatment; coagulation; softening; desalting; stabilization; filtration; adsorption; fluoridation; gas transfer.

Prerequisite: CE 541

CE 548 Biological Processes (3-0-3)

Theory and applications of biological processes in wastewater treatment; kinetic models; aeration and oxygen transfer; suspended-growth and fixed-film processes; aerobic and anaerobic digestion; sludge thickening, dewatering and disposal.

Prerequisite: CE 542 (can be taken concurrently)

CE 549 Selected Topics in Environmental Engineering (2-3-3)

Study of the dynamic role of environmental engineering in maintaining environmental quality. A comprehensive study of any phase of environmental engineering.

Prerequisite: Graduate Standing

CE 550 Nature of Behavior of Soils (3-0-3)

Soil formation, composition, crystallography, and mineralogy; soil-water-electrolyte system; physio-chemical nature of soil; soil fabric and structure; relationship between soil composition and mechanical behavior; time-deformation processes; compressibility and value change in clay soils; conduction phenomena.

Prerequisite: Graduate Standing

CE 551 Advanced Geotechnical Engineering (2-3-3)

Introduction to testing (instrumentation, data collection, precision, analysis and interpretation); triaxial and plane strain testing taking into account dilation, back pressure, pore pressure parameters, stress path, permeability testing and flow nets; oedometer testing and consolidation; subsurface investigation; in-situ investigation methods (CPT, SPT, pressuremeter, vane shear, geophysical and plate bearing tests).

Prerequisite: Graduate Standing

CE 552 Foundation Engineering (3-0-3)

Bearing capacity of shallow foundations; factors affecting bearing capacity; immediate and consolidation settlement of shallow foundations; mat foundations; analysis, design, and installation of pile foundations; capacity and settlement of piles and pile groups; drilled piers and caissons.

Prerequisite: CE 551 or Consent of the Instructor

CE 553 Soil and Site Improvement (3-0-3)

Behavior of natural soils; shallow and deep mechanical modifications; improvement by

admixtures; grouting; hydraulic modifications; thermal and electrical treatments; modifications by inclusions and confinement; development of marginal lands; treatment of local problematic soils; landfills.

Prerequisite: CE 551 or Consent of the Instructor

CE 555 Modeling in Geomechanics (3-0-3)

Stress and strain in soils; strength and stress-strain behavior or soils; critical state soil mechanics; constitutive laws for soils; soil plasticity including concept of yield surface, stress space, failure criteria, plastic potential, and normality; constitutive models and numerical implementation.

Prerequisite: CE 551

CE 556 Earth Structures (3-0-3)

Shear strength of soils and its relevance to earth structures; methods of analysis including limit analysis, limit equilibrium and numerical methods; earth pressure theories taking into account seepage and pore pressure dissipation; design and analysis of retaining structures (slopes, retaining walls, sheet piles, and braced excavation).

Prerequisite: CE 551 or Consent of the Instructor

CE 557 Designing with Geosynthetics (2-3-3)

Functions of geosynthetics (separation, reinforcement, filtration, drainage and liquid containment); geosynthetics properties and their measurements; design and construction using geotextiles, geogrids, geonets, geomembranes, geosynthetic clay linears and geocomposites.

Prerequisite: CE 556 or Consent of the Instructor

CE 558 Environmental Geotechnics (3-0-3)

Geotechnical engineering of land disposal of hazardous and nonharzardous wastes; fate and transport of contaminants; compacted clay and synthetic linears; leachate collection and removal system; landfill cover and gas venting systems; design and stability of landfill elements; construction quality assurance and control performance monitoring; remediation technologies.

Prerequisite: Graduate Standing

CE 559 Rock Engineering (2-3-3)

Geological classification and index properties of rocks; strength and deformability behavior of intact and jointed rock masses; in-situ stresses; lab and field test methods; aspects of structural geology; stability of rock slopes; applications to surface excavations, underground openings and tunnels; foundations on rocks.

Prerequisite: Graduate Standing

CE 571 Urban Transportation Planning & Modeling (3-0-3)

Transportation planning processes, transportation land use interaction, travel evaluation and demand estimation, traffic generation theories and assignment models, and transit analysis.

Co-requisite: MATH 560 or CRP 505

CE 572 Methods of Analysis for Planners (3-0-3)

Some basic statistical properties; use of matrices in planning; linear regression analysis and analysis of variance with their applications; hypothesis testing; questionnaire design; sampling; factor, discriminant and logit analyses with applications; linear programming; applications to planning using computer packages.

Prerequisite: MATH 560

CE 573 Transportation System Analysis (3-0-3)

Application of systems approach to transportation; the determination of transportation demand and supply; the equilibrium process; transportation system evaluation; cost-effectiveness

techniques; use of optimization techniques in transportation.

Prerequisite: CE 571

CE 574 Pavement Structures (3-0-3)

Fundamentals of pavement-vehicle interaction and the mechanics of pavement response; stress analysis in flexible and rigid pavements; material characterization; design of flexible and rigid pavements for highways and airports; surface, base and subgrade courses evaluation and design; modern design techniques and their applications; cost analysis and pavement selection; computer applications in pavement analysis and design.

Prerequisite: Graduate Standing

CE 575 Pavement Evaluation, Maintenance and Rehabilitation (2-3-3)

New concepts, methods and practices for the evaluation, maintenance, and rehabilitation of highway and airport pavement systems; nondestructive techniques for structural evaluation of pavements to assess performance; back calculation of pavement material properties for rehabilitation design; recycling and overlay design; quality control/assurance; computer applications in pavement evaluation and maintenance; selection of cost effective alternative.

Prerequisite: CE 574

CE 576 Geometric Design of Highways (2-3-3)

Geometric configuration of streets, expressways, busways to meet the characteristics of vehicle performance and operator limitations; level of service concept, roadside and guardrail design; safety issues. Application of road design softwares.

Prerequisite: Graduate Standing

CE 577 Airport Planning and Design (3-0-3)

Planning and design of airport facilities; aircraft geometric and operational characteristics; passenger demand analysis; air-traffic control procedures; configuration and orientation of runway; geometric and structural design of runways and taxiways; terminal design; airport capacity; airport noise; airport master planning.

Prerequisite: Consent of the Instructor

CE 578 Highway Capacity Analysis (2-3-3)

Capacity analysis of all highways and intersections; design and analysis of traffic signals including warrants, cycle length, timing, phasing and coordination; fundamentals and hands-on application of existing tools and softwares and laboratory assignment are included.

Prerequisite: Consent of the Instructor

CE 579 Pavement Materials (2-3-3)

The nature, engineering characteristics, and selection of materials for highway and airport pavements; composition, physical behavior, production and performance of bituminous materials and mixtures; concrete mixes for rigid pavements; durability of concrete and asphalt mixes; polymer materials and additives; recent developments in pavement materials.

Prerequisite: Graduate Standing or Consent of the Instructor

CE 580 Geometric Design of Highway Terminals (2-3-3)

Geometric configuration of highway terminals including intersections, interchanges, and parking facilities; level of service concept; and application of design softwares and hand-on laboratory assignments are included.

Prerequisite: CE 576

CE 581 Public Transportation System (3-0-3)

Mass transit operation and management; transit characteristics and vehicle technology; land-use

impact. Public policy and financing.

Prerequisite: CE 571

CE 590 Advanced Topics in Structural Engineering (3-0-3)

Advanced topics selected from the broad area of structural engineering to provide the student with knowledge of recent advances in the analysis and design of structures including optimization of engineering designs, dynamics of structures and design of special structures.

Prerequisite: Graduate Standing

CE 591 Advanced Topics in Water Resources and Environmental Engineering (2-3-3)

Advanced topics selected from the broad area of water resources and environmental engineering to provide the student with knowledge of recent applications and developments in the specialty.

Prerequisite: Graduate Standing

CE 592 Advanced Topics in Geotechnical Engineering (3-0-3)

Advanced topics selected from the broad area of geotechnical engineering to provide the students with knowledge of recent applications and developments in this specialty.

Prerequisite: Consent of the Instructor

CE 593 Advanced Topics in Transportation Engineering (3-0-3)

Advanced topics selected from the broad areas of transportation engineering to provide the students with knowledge of recent applications and developments.

Prerequisite: Graduate Standing

CE 598 Masters Design Project (0-6-3)

Application of knowledge and skills acquired during the tenure of the graduate program in the solution of open-ended, advanced-level design problems from a technical, environmental and socio-economic viewpoint. Use of computer-aided engineering in a project environment will be emphasized. Students can work with senior engineers from industry on a specific design project. The project should be completed under the supervision of a faculty member and examined by a committee.

Prerequisite: Consent of the Advisor

CE 599 Seminar (1-0-0)

This course is designed to give the student an overview of research in the department, and a familiarity with the research methodology, journals and professional societies in his discipline. For this purpose graduate students working towards their M.S. degree are required to attend departmental seminars. Graded on a Pass or Fail basis.

Prerequisite: Graduate standing

CE 600 Master of Engineering Report (0-6-3)

This will be prepared as an informative report based on a professional work related to analysis, design or construction of a facility that has particular significance or interest. It may also include collection of data or methodologies for design & construction or application of innovative technology. The report will be completed under the supervision of a faculty member and examined by a committee.

Prerequisite: Consent of the Advisor

CE 601 Advanced Concrete Materials (3-0-3)

Special concretes including high strength, high performance, fiber reinforced, lights weight; local durability problems and various methods of protection; concept of durable design and code specifications. Emphasis will be placed on state of the art developments in the area.

Prerequisite: CE 501

CE 602 Environmental Effects on Concrete (3-0-3)

Macro and micro environmental factors affecting concrete strength and durability; local durability problems; performance of concrete under wet-dry and thermal cycles; cracking phenomena; mechanisms of deterioration due to salt-weathering, sulfate attack, carbonation and reinforcement corrosion; modeling of transport phenomena.

Prerequisite: CE 501

CE 603 Repair and Rehabilitation of Concrete Structures (3-0-3)

Characteristics and compatibility of repair materials; shrinkage and creep mechanisms in repair mortars; modeling of structural cracking due to constraints; design of steel and carbon fiber plate bonding for repair and strengthening; durability and fatigue resistance of plate-bonded RC members.

Prerequisites: CE 501, CE 521

CE 604 Instrumentation in Materials Research (1-6-3)

X-ray diffraction; scanning electron microscopy; absorption spectroscopy; IR and far IR absorption and Raman scattering spectroscopy; transmission electron microscopy; electron microprobe analysis; petrograph and thin sectioning analyses; emphasis on individual student projects.

Prerequisite: CE 501

CE 606 Independent Research (0-0-3)

This course is intended to allow the student to conduct research in advanced problems in his M.S. research area. The faculty offering the course should submit a research plan to be approved by the Graduate Program Committee at the academic department. The student is expected to deliver a public seminar and a report on his research outcomes at the end of the course. Graded on a Pass or Fail basis.

Prerequisite: Prior arrangement with an instructor.

CE 610 M.S. Thesis

Prerequisite: CE 599

CE 611 Advanced Structural Dynamics (3-0-3)

Dynamic analysis of distributed parameter systems including beams, plates and shells; effects of shear deformations and rotary inertia; discretization of continuous systems; numerical solutions of eigen-value problems; nonlinear analysis of MDOF systems; probabilistic structural dynamics; earthquake engineering.

Prerequisite: Graduate Standing

CE 612 Elasticity and Plasticity II (3-0-3)

Plane thermoelasticity; three-dimensional elasticity, deformational theories versus incremental theories; application of Prandtl-Reuss equations to pure bending of beams, thick walled spheres and tubes; theorems of limit state analysis and their applications to plastic analysis of frames; theory of slip-line fields; ductile and brittle material models; application of finite elements in plasticity problems.

Prerequisite: CE 512 or CE 518

CE 613 Advanced Finite Element Methods (3-0-3)

Special isoparametric beam elements; plate and shell elements; introduction to geometric nonlinearities including buckling and large deformation; introduction to material nonlinearities (nonlinear elastic, plastic and fracture/cracks); accuracy, convergence, and errors.

Prerequisite: CE 517

CE 614 Advanced Computational Mechanics (3-0-3)

Application of computer/numerical procedures to advanced topics in mechanics; these include buckling of structures, large deformation and rotation, higher order theories, nonlinear elastic, plastic, and cracking materials; software development.

Prerequisites: CE 510, CE 517

CE 616 Fracture of Materials (3-0-3)

Stress intensity computations in linear elastic fracture mechanics (LEFM); finite element including singularity elements in LEFM, compliance calibration for critical energy release rate computations, mixed mode fracture criteria, elasto-plastic fracture principles, crack propagation under cyclic loading; fracture mechanics design process; applications of fracture mechanics to plain and reinforced concrete.

Prerequisite: CE 510

CE 618 Analysis of Bridge Systems (3-0-3)

Bridge loadings and bridge systems; deck structures and idealization; orthotropic plate theory and its application; use of finite difference and finite strip methods; composite bridges; pseudo slab, girder-slab and multi-beam type prestressed concrete bridges, design considerations for substructures; analysis of horizontally curved bridge decks; software applications in bridge analysis.

Prerequisite: CE 521

CE 622 Limit State Design of Concrete Structures (3-0-3)

Concept of limit state design; moment-curvature and load deflection characteristics; plastic analysis and rotational capacity of hinges; upper and lower bound theorems; limit state design of continuous beams and frames; rigid plastic theory, flow rule and applications; yield line and strip method for slabs; shear strengths of beams and slabs; limit states of serviceability; deflection and crack control.

Prerequisite: CE 521

CE 623 Constitutive Modeling of Materials (3-0-3)

Deviatoric stress and strain tensors; geometric representation of stress and concept of Pi-plane; strain energy and complementary energy density in elastic solids; nonlinear elastic stress-strain relations; Cauchy and hyperelastic models; incremental (hypoelastic) model for isotropic materials; variable moduli incremental stress-strain models; multi-parameter failure criteria; elastic perfectly plastic fracture models; finite elements in elastoplastic problems.

Prerequisite: CE 510

CE 625 Mechanics of Composite Materials (3-0-3)

Stress-strain for orthotropic lamina, effective moduli and strength of a continuous fiber-reinforced lamina, laminate analysis, delamination, matrix cracking and durability; analysis of lamina hygrothermal behavior; analysis of laminated beams and plates; deflection and buckling of laminates; fracture mechanics of composite materials; finite element applications.

Prerequisite: CE 510

CE 630 Damage Mechanics (3-0-3)

Phenomological aspects of damage; manifestation of damage and measurement and mechanical representation of damage; thermodynamics and micromechanics of damage; potential dissipation function and strain-damage coupled constitutive equations; damage evolution equations; brittle versus ductile damage; anisotropic damage of concrete; fatigue damage; local and averaged damaged; scale effect and characteristic length; elasto-plastic damage of concrete structures;

finite element modeling of damage.

Prerequisite: CE 510

CE 633 Mechanics of Heterogeneous Fluids in Porous media (3-0-3)

Characteristics of porous media and fluid mixtures; capillarity; heterogeneous fluids in static systems; mechanical equilibrium; Brooks-Corey and Van Genuchtenmodels; hysteresis; relative permeability; soil-water-air system; flux equation; tortuosity; Kozeny-Carman equation; generalized Darcy's equation; steady and unsteady two-phase flow; infiltration theory.

Prerequisite: CE 533

CE 635 Water Resources Planning (3-0-3)

Development of supply-demand relationships and projection; analysis of projects for water supply, flood control, irrigation, drainage or quality control; benefit cost analysis; economic feasibility studies; multipurpose projects and cost allocation techniques.

Prerequisite: Graduate Standing

CE 637 Application of Numerical Methods in Water Resources Engineering (3-0-3)

Application of numerical methods to water resources engineering problems; computations of water surface profile; flood routing; flow resistance in conduits; water hammer; groundwater and contaminant migration.

Prerequisite: Graduate Standing

CE 638 Stochastic Hydrology (3-0-3)

Introduction to probabilistic hydrology; random variables correlated in time and space; applications to rainfall, streamflow, groundwater, water use and storage; time series analysis; and stochastic data generation models.

Prerequisite: CE 531

CE 639 Risk Analysis in Water Resources and Environmental Systems (3-0-3)

Risk and uncertainty; random variables and random events; CDFs and PDFs; population moments, moments of non-linear functions of random variables, first order analysis of uncertainty; methods of estimating parameters of distribution functions; goodness of fit tests; ANOVA; risk analysis applied to hydrology, hydraulics, groundwater, water resources, and environmental engineering systems.

Prerequisite: Graduate Standing

CE 640 Advanced Contaminant Transport in Porous Media (3-0-3)

Advection with mixing; hydrodynamic dispersion, non-conservative solutes, field scale contaminant transport, groundwater contamination by LNAPLS and DNAPLS, containment and cleanup.

Prerequisite: CE 533

CE 641 Chemical Processes in Environmental Engineering (3-0-3)

Application of chemical equilibria, surface chemistry and kinetics to water and wastewater systems; reactor design and kinetics; chemistry and coagulation, corrosion, hardness reduction and disinfection; theory and applications of mass transfer in concurrent and countercurrent operations.

Prerequisite: Consent of the Instructor

CE 645 Hazardous Waste Management (3-0-3)

Classification, chemistry, and toxicology of hazardous wastes; examination of control technologies, regulatory policies and management strategies.

Prerequisite: CE 541 or equivalent

CE 646 Water Quality Modeling (3-0-3)

Evaluation and control of water quality in streams, lakes, and estuaries. Mathematical analyses of patterns of water movement and their relationship to water quality.

Prerequisite: Consent of the Instructor

CE 647 Municipal Solid Waste Management (3-0-3)

Problems, regulations, collection, handling, recycling and disposal of municipal solid wastes in the urban and rural sectors; integrated waste management system with resource recovery, composting, incineration, landfill disposal and their costs.

Prerequisite: Graduate Standing

CE 651 Dynamics of Soils and Foundations (3-0-3)

Theory of vibration; wave propagation in elastic media; dynamic properties of soils and their measurement; vibration transmission and attenuation through soils; foundation vibration theories; dynamic earth pressure; dynamic bearing capacity of shallow foundations; dynamic analysis of foundations; design of machine foundations; vibration isolation; soil liquefaction; introduction to geotechnical earthquake engineering.

Prerequisite: CE 555

CE 652 Advanced Foundation Engineering (3-0-3)

Soil-structure interaction; numerical methods for analysis of foundation; bearing capacity and settlement of foundation using in-situ tests; load-deformation behavior of axially-loaded piles; prediction of pile capacity during driving; beams and plates on foundations; laterally-loaded piles; foundation on difficult soils.

Prerequisite: CE 552 or equivalent

CE 656 Seepage Through Soil and Rocks (3-0-3)

Principles governing the flow of water through soils and rocks and their applications in geotechnical engineering; seepage through porous and jointed media; filter and drain design; foundation dewatering; seepage control in slopes; earth dams and levees.

Prerequisite: CE 551 or Consent of Instructor

CE 658 Geotechnics of Problematic Soils (3-0-3)

Types of problematic soil conditions and their local distributions; geological factors; site investigation; behavior of unsaturated soils; expansive soils; collapsing soils; sabkha soils; calcareous sediments; uncontrolled and deep fills; limestone solution cavities; case studies.

Prerequisite: CE 552 or Consent of Instructor

CE 670 Advanced Pavement Design (3-0-3)

Non-linear analysis; fatigue and permanent deformation; back calculation of layer moduli; mechanistic empirical design methods; theories of pavement behavior; application of theory to the analysis and design of airport and highway pavement systems including rehabilitation design and computer applications; development of improved design and rehabilitation practices and procedures.

Prerequisite: CE 574

CE 671 Advanced Pavement Materials (3-0-3)

Pavement material characterization procedures; simulation of in-service conditions; experimental program for fatigue cracking modeling and plastic deformation modeling under repetitive loading; development of constitutive laws; advancement in accelerated environmental conditioning and loading simulation, durability testing, and material performance based

evaluation.

Prerequisite: CE 579

Techniques of network and project level pavement management; introduction to mapping/faculty management system; field evaluation methods and equipment; performance modeling; maintenance and rehabilitation strategies; priority ranking procedures; overlay design procedures; maintenance specifications; computer applications in pavement management.

Prerequisite: CE 575

CE 673 Optimization of Urban Traffic Flows (3-0-3)

Advanced traffic data measurement techniques and interpretation; traffic control devices and systems; freeway surveillance, metering and control; offline and online optimization of traffic signal timing; urban traffic management; intelligent transportation systems.

Prerequisite: Consent of the Instructor

CE 674 Advanced Transportation Modeling (3-0-3)

Introduction to the behavioral techniques and other new approaches to transportation planning. In-depth analysis of transportation modeling process, including probabilistic choice models, statistical estimation techniques, error propagation and parameters sensitivity analysis. Introduction to computer packages related to transportation planning and modeling.

Prerequisite: CE 571

CE 675 Advanced Traffic Engineering (3-0-3)

Macroscopic and microscopic characteristics of flow, speed and density; statistical distribution of traffic characteristics; shock wave analysis; queuing theory; application of theory of traffic flow to design and control of traffic; applications of existing tools and softwares.

Prerequisite: CE 571 or Consent of the Instructor

CE 676 Environmental Impacts of Transportation Facilities (3-0-3)

Effect of environmental impacts on transportation planning and design decisions; legislation; measurement and prediction of air, noise, and water pollution; visual intrusion; assessment of environmental costs and benefits; assessment of social and economic impact; environmental impact statements.

Prerequisite: CE 571 or Consent of the Instructor

CE 699: Ph.D. Seminar (1-0-0)

Ph.D. students are required to attend departmental seminars delivered by faculty, visiting scholars and graduate students. Additionally, each Ph.D. student should present at least one seminar on a timely research topic. Ph.D. students should pass the comprehensive examination as part of this course. This course is a pre-requisite to registering the Ph.D. Pre-dissertation CE 711. The course is graded as pass or fail. IC grade is awarded if the Ph.D. Comprehensive exam is not yet passed.

Prerequisite: Graduate Standing.

CE 701 Directed Research I (0-0-3)

This course is intended to allow the student to conduct research in advanced problems in his research area. The faculty offering the course should submit a research plan to be approved by the Graduate Program Committee. The student is expected to deliver a public seminar and a report on his research outcomes at the end of the courses. Graded on a pass or fail basis.

Prerequisite: Prior arrangement with an instructor

CE 702 Directed Research II (0-0-3)

This course is intended to allow the student to conduct research in advanced problems in his research area. The faculty offering the course should submit a research plan to be approved by the Graduate Program Committee. The student is expected to deliver a public seminar and a report on his research outcomes at the end of the courses. Graded on a pass or fail basis.

Prerequisite: Prior arrangement with an instructor

CE 711 Ph.D. Pre-Dissertation (0-0-3)

This course enables the student to submit his Ph.D. Dissertation Proposal and defend it in public. The student passes the course if the Ph.D. Dissertation Committee accepts the submitted dissertation proposal report and upon successfully passing the Dissertation Proposal public defense. The course grade can be NP, NF or IC.

Prerequisite: Ph.D. Candidacy, **Co-requisite**: CE 699

CE712 Ph.D. Dissertation (0-0-9)

This course enables the student to work on his Ph.D. Dissertation as per the submitted dissertation proposal, submit the final report and defend it in public. The student passes this course if the Ph.D. Dissertation Committee accepts the submitted final dissertation report and upon successfully passing the Dissertation public defense. The course grade can be NP, NF or IP.

Prerequisite: CE 711

DEPARTMENT OF ELECTRICAL ENGINEERING

Chairman

Dr. Ali Ahmad Al-Shaikhi

Faculty

Al-Abeedi	Abido	Al-Absi
Abu Al-Saud	Abuelmaatti	Al-Ahmadi
Al-Ahmari	Al-Akhdar	El-Amin
Ashraf	Al-Awami	Al-Baiyat
Bakhshwain	Balghonaim	Al-Battal
Chokri	Deriche	Al-Dohan
Al-Duwaish	Al-Ghadban	Al-Ghahtani
Al-Ghamdi	Habiballah	Hammi
Al-Hamouz	Hassan	Hussein
Ibrir	Al-Jamid	Jauwad
Johar	Kassas	Kousa
Landolsi	Maghrabi	Mahnashi
Masoud	Masoudi	Mesbah
Mohandes	Mousa	Al-Muhaini
Muqaibel	Al-Nafouri	Noman
Nuruzaman	Al-Ohali	Al-Qahtani
Qureshi	Ragheb	Al-Saihati
Shafi	Al-Shahrani	Al-Shaikhi
Sharawi	Sheikh S	Shohail
Sorour	Al-Sunaidi	Al-Suwailem
Al-Zaher	Zerguine	Zidouri
Zummo		

The Department of Electrical Engineering offers a wide selection of graduate courses and activities leading to the degrees of Master of Science (M.S.), Master of Science in Telecommunication Engineering (M.S.T.E.), and Doctor of Philosophy (Ph.D.).

These programs allow students to choose a program of study suited to their interests, individual needs and talents. The programs are broad in perspective and maintain a balance between scholarly excellence and practical relevance.

The programs are oriented towards strengthening the student's background in the area of their specialization but are so designed as to deepen their understanding in one or more selected areas in electrical engineering. Particular emphasis is placed on developing research potential and fostering and encouraging original research and professional competence in the field of concentration. The Department of Electrical Engineering currently offers graduate courses and research activities in a variety of areas that span the full breadth of Electrical Engineering including power systems, electromagnetics, digital systems, electronics, control systems, signal processing, and communications.

For all three programs, the students are required to complete successfully a carefully selected sequence of courses and conduct supervised research where the results will culminate in a written M.S. thesis, M.S.T.E. thesis, or a Ph.D. dissertation, which must be defended by the student.

Teaching and Research Facilities

The Department has a variety of excellent laboratory facilities to support teaching and research in the areas of power systems, electromagnetics, digital systems, electronics, control systems, signal processing, and communications. The Department has special facilities for research which include a Telecommunications Research Laboratory (TRL), an indoor computer-controlled antenna test range, a process control laboratory, a programmable logic controller laboratory, PCB plotters that generate printed circuit prototypes, state of the art simulator software based on the HPC (high performance computing) platform, and several computer laboratories.

Graduate students have opportunities to participate in existing research efforts in areas that include, but are not limited to, antennas and propagation; microwave; digital communication systems; digital and optical signal processing; information theory; applied digital signal processing; seismic signal processing; image processing; pattern recognition; sign language recognition; artificial intelligence; automatic control systems (adaptive, robust, non-linear, digital); process control; instrumentation; computer architecture; power systems; smart interconnected grids; renewable energy; distributed generation; electricity markets and deregulation; power quality & system reliability; high voltage engineering; HVDC transmission; power electronics; power system protection; applied ultrasonic; fiber optic communications; numerical electromagnetics; VLSI systems; electromagnetic fields and wave; analog and digital electronics; computer communication networks; wireless communication; digital filtering; robot simulation and control.

Admission Requirements

All applicants for admission to the department must satisfy the general Graduate School admission requirements. In particular, applicants must hold a B.S. degree in electrical engineering or equivalent when applying for the master's degree or the master's degree in telecommunication engineering. Applicants for the Ph.D. must hold a master's degree.

M.S. PROGRAM IN ELECTRICAL ENGINEERING

The master's program in electrical engineering consists of a total of thirty (30) credit hours: nine (9) credit hours of core courses in the department's technical specialty areas to provide breadth, three (3) credit hours of MATH elective courses at the 500 or 600 level offered by the Mathematics Department or EE 570, twelve (12) credit hours of elective courses in one subject area to provide depth, at least nine of which are in Electrical Engineering, and six (6) credit hours for the thesis.

The core courses include Power System Analysis, Radiation and Propagation of Electromagnetic

Waves, Design of Digital Systems, Analog Integrated Circuits Design, Linear Control Systems, Digital Signal Processing I, and Digital Communication I.

Core Courses

All students are required to take at least three of the following seven courses:

Course #	Title
EE 520	Power System Analysis
EE 530	Radiation and Propagation of Electromagnetic Waves
EE 541	Design of Digital Systems
EE 542	Analog Integrated Circuit Design
EE 550	Linear Control Systems
EE 562	Digital Signal Processing I
EE 571	Digital Communications I

A wide range of elective courses exists in all disciplines of electrical engineering including Communications, Electromagnetics, Electronics, Power Systems, Signal and Image Processing, Control Systems, and Digital Systems. In addition, the student can take one technical elective course from other departments.

Degree Plan for M.S. in Electrical Engineering

Course #	Title	LT	LB	CR
First Semester				
EE 5xx	EE Core Course 1	3	0	3
MATH 5xx	Math Course	3	0	3
EE 5xx	EE Core Course 2	3	0	3
		9	**0**	**9**
Second Semester				
EE 5xx	EE Core Course 3	3	0	3
XX xxx	Free Technical Elective	3	0	3
EE xxx	EE Elective	3	0	3
EE 599	Seminar	1	0	0
		10	**0**	**9**
Third Semester				
EE xxx	EE Elective	3	0	3
EE xxx	EE Elective	3	0	3
EE 610	M.S. Thesis			IP
		6	**0**	**6**
Fourth Semester				
EE 610	M.S. Thesis	0	0	6
		0	**0**	**6**
Total Credit Hours				**30**

Notes:

- Each student is expected to submit his detailed degree plan according to the above generic degree plan for approval by the department and the Deanship of Graduate Studies within the 8th week of the second semester of enrollment.
- Students are required to adhere to the regulations of the degree plan. No relaxations will be given to any student and the courses taken in conflict of the above will not be counted towards the degree.
- At most two 400-level courses (as electives) may be allowed on approval of the advisor.
- The order of taking the courses can be different from above but students must take the core courses before electives.

M.S. PROGRAM IN TELECOMMUNICATION ENGINEERING

The program is open to students holding a B.S. degree in EE, COE or equivalent. Students enrolled in this program are required to complete 24 credit hours of courses (eight 3-credit hour courses), plus a 6 credit hour of thesis, in excess of any remedial courses to rectify possible deficiencies in a student's undergraduate education. The eight courses include four required courses, three technical elective courses, and a non-technical elective course. The following list enumerates courses in each of the three categories:

Core Courses

All students are required to take four courses from the following list:

Course #	Title
EE 570	Stochastic Processes
EE 571	Digital Communications I
EE 573	Digital Communication II
EE 674	Telecommunication Networks, **or**
COE 540	Computer Communication Networks

The complete degree plan is to be prepared with the approval of the advisor.

Technical Elective Courses

Each student must take three courses from the following list, which contains courses from the EE, COE and ICS Departments. Courses not in the list from these departments or courses from other departments are subject to the approval of the Graduate Program Committee.

EE Courses

Course #	TITLE
EE 532	Antenna Theory and Applications
EE 562	Digital Signal Processing I
EE 563	Speech and Audio Processing
EE 574	Detection and Estimation
EE 575	Information Theory
EE 576	Error Control Coding
EE 577	Wireless and Personal Communications
EE 578	Simulation of Communication Systems
EE 633	Optical Fiber Communication
EE 636	Theory and Applications of Antenna Arrays
EE 662	Adaptive Filtering and Applications
EE 663	Image Processing
EE 665	Signal and Image Compression
EE 672	Satellite Communications
EE 679	Special Topics in Communications

COE & ICS Courses

Course #	Title
COE 563	Design and Analysis of Local Area Networks

COE 590	Network Security[6]
COE 591	Neural Networks
ICS 555	Data Security and Encryption
ICS 583	Pattern Recognition

Non-Technical Elective Courses

Each student must take one non-technical course from a set of courses related to the management of the telecommunication systems. The list of non-technical courses includes:

Course #	**Title**
MIS 502	Management Information System
MIS 510	Information Ressource Management

[6] (offered under special topics)

Degree Plan for M.S. in Telecommunication Engineering

Course #	Title	LT	LB	CR
First Semester				
EE 570	Stochastic Processes	3	0	3
EE 571	Digital Communications I	3	0	3
MIS 5xx	Non-Technical Elective	3	0	3
		9	**0**	**9**
Second Semester				
EE 573	Digital Communication II	3	0	3
EE 674	Telecommunication Networks, or (COE 560)	3	0	3
XX xxx	Technical Elective Course I	3	0	3
EE 599	Seminar	1	0	0
		10	**0**	**9**
Third Semesters				
XX xxx	Technical Elective II	3	0	3
XX xxx	Technical Elective III	3	0	3
EE 610	M.S. Thesis	0	0	IP
		6	**0**	**6**
Fourth Semester				
EE 610	M.S. Thesis	0	0	6
		0	0	6
Total Credit Hours				**30**

Notes:

- Each student is expected to submit his detailed degree plan according to the above generic degree plan for approval by the department and the Deanship of Graduate Studies within the 8th week of the second semester of enrollment.
- Students are required to adhere to the regulations of degree plan. No relaxations will be given to any student and the courses taken in conflict of the above will not be counted towards the degree.
- The order of taking the courses can be different from above but students must take the core courses before electives.

PH.D. PROGRAM IN ELECTRICAL ENGINEERING

The program leading to the degree of Doctor of Philosophy in Electrical Engineering is intended for those exceptional individuals who plan to pursue a career in fundamental applied research. The program requires course work and the successful completion of a research dissertation, which is an original and significant contribution to knowledge in the discipline.

The Ph.D. Program consists of 30 credit hours of course work beyond the M.S. Degree, and 12 hours of dissertation. The student has to abide by the EE department policies regarding the distribution of the course work. The student must declare a major area and a minor area from the different research areas available in the department, namely power systems, electromagnetics, digital systems, electronics, control systems, signal processing, and communications. Minor areas can be declared from other departments as well (e.g. MATH, COE, …).

A Ph.D. student is also required to pass a comprehensive examination covering his area of study, a preliminary dissertation proposal defense, and presentation and defense of the dissertation.

This comprehensive examination is permitted only twice and its purpose is to ensure that the student has a sufficient breadth and depth of knowledge and to evaluate a student's ability to research a specific topic. The examination is managed by an ad hoc departmental committee. Decisions of Pass/Fail are taken by the Graduate Program Committee based on the student's score, according to the policies of the department.

In case of failure in the Comprehensive Examination for the first time, the student can take the examination asecond time in the following semester.

A candidate who successfully passes the Comprehensive Examination may proceed with his research work under the supervision of his dissertation advisor. The student, in consultation with his dissertation advisor, prepares a dissertation proposal. The student must make a public defense of the preliminary proposal and must incorporate the comments raised during this defense in his preliminary proposal.

Upon completion of his research work, the candidate is required to defend his dissertation before the Dissertation Committee and in public.

Note: Graduate students working towards M.S., M.S.T.E., or Ph.D. degrees are required to register for EE 599 (Seminars) before finishing the degree requirements.

Typical Ph.D. Program in Power

(Minor in Control)

Course #	**TITLE**
EE 522	Power System Dynamic Analysis
EE 523	Analysis and Control of Electrical Machines
EE 552	Optimal Control Theory and Applications
EE 556	Intelligent Control
EE 620	High Voltage Engineering
EE 622	Power System Operation
EE 651	Adaptive Control
EE 623	HVDC Transmission Systems
MATH 534	Complex Variables I
EE 654	Large Scale Systems

Typical Ph.D. Program in Communications

(Minor in Signal Processing)

Course #	**Title**
EE 573	Digital Communications II
EE 574	Detection and Estimation
EE 577	Wireless and Personal Communications
EE 672	Satellite Communications
EE 674	Telecommunication Networks
EE 661	Digital Signal Processing II
EE 662	Adaptive Filtering and Applications
EE 663	Image Processing
MATH 571	Numerical Methods I
ICS 555	Data Security and Encryption

Degree Plan for Ph.D. in Electrical Engineering

Course #	Title	LT	LB	CR
First Semester				
EE 5xx	EE Elective I	3	0	3
EE 5xx	EE Elective II	3	0	3
EE 6xx	EE Elective III	3	0	3
		9	**0**	**9**
Second Semester				
EE 5xx	EE Elective IV	3	0	3
EE xxx	EE Elective V	3	0	3
XXX xxx	EE Elective	3	0	3
		9	**0**	**9**
Third Semester				
EE 6xx	EE Elective VI	3	0	3
EE 6xx	EE Elective VII	3	0	3
XX xxx	Free Technical Elective	3	0	3
EE 699	Seminar	1	0	0
		10	**0**	**9**
Fourth Semester				
EE 6xx	EE Elective VIII	3	0	3
EE 711	Ph.D. Pre-Dissertation	0	0	3
		3	**0**	**6**
Fifth Semester				
EE 712	Ph.D. Dissertation	0	0	IP
Sixth Semester				
EE 712	Ph.D. Dissertation	0	0	9
		0	**0**	**9**
Total Credit Hours				**42**

Notes:

- Each student is expected to submit his detailed degree plan according to the above generic degree plan for approval by the Department and the Deanship of Graduate Studies within the 8th week of the second semester of enrollment.
- Students are required to adhere to the regulations of degree plan. No relaxations will be given to any student and the courses taken in conflict of the above will not be counted towards the degree.
- The order of taking the courses can be different from above but students must take the core courses before electives.

COURSE DESCRIPTIONS

The description of all EE graduate courses in the six areas of research is presented next. All courses' numbers start with either a 5 or a 6. The second digit in a course number indicates the area.

Area	Code
Power Systems	EE 52x or EE 62x
Electromagnetics	EE 53x or EE 63x
Electronics and Digital Systems	EE 54x or EE 64x
Control Systems	EE 55x or EE 65x
Signal Processing	EE 56x or EE 66x
Communication Systems	EE 57x or EE 67x

EE 520 Power System Steady State Analysis (3-0-3)

Steady state modeling and simulation techniques. Large-scale power systems. Sparsity programming. Short-circuit and load-flow studies. Introduction to transient stability. Introduction to state estimation.

Prerequisite: EE 463 or equivalent

EE 522 Power System Dynamic Analysis (3-0-3)

Dynamic model of synchronous machines. Excitation and governor systems. Nonlinear and linear modeling of single machine infinite bus systems. Stability analysis and control design. Direct method of stability determination. Multimachine system modeling. Power system dynamic equivalents.

Prerequisite: EE 520 or equivalent

EE 523 Analysis and control of Electrical Machines (3-0-3)

Steady-state and dynamic analysis of electrical machines: direct and quadrature axis transformation. Linear and nonlinear state space representation. Regulation and control devices. Simulation of electromechanical subsystems.

Prerequisite: EE 462 or equivalent

EE 524 Power System Planning (3-0-3)

Mathematical methods and modern approaches to power system planning. Demand forecasting. Generation system planning: deterministic and probabilistic methods. Transmission system planning: heuristic and stochastic methods. Optimization methods for transmission planning. Route selection: environmental and other considerations. Distribution system planning: system layout, and choice of components

Prerequisite: Consent of the Instructor

EE 525 Transmission of Electrical Energy (3-0-3)

Introduction to power system transients. Transmission lines/cable parameters, Propagation on loss-free lines, effects of termination and junctions. Transform methods of solution of T.L. Laplace transform and Fourier transform. Transients on T.L., potential and current distribution: standing waves. Traveling wave method: Lattice and graphical methods. Lighting and switching applications. Voltage limitation on power-handling capacity and T.L. effects. Transmission system protection.

Prerequisite: Consent of the Instructor

EE 527 Reliability Assessment of Power Systems (3-0-3)

Concepts of power system reliability: Review of basic techniques, modeling in repairable systems, network approach, Markov modeling, frequency and duration. Generation capacity: loss of load indices, loss of energy indices, frequency and duration. Interconnected systems. Operation reserve. Composite systems. Distribution systems. Substations and switching stations. Reliability cost/worth.

Prerequisite: Consent of the Instructor

EE 528 Advanced Power Electronics (3-0-3)

Review of power semiconductor devices: thyristors, GTO, power transistor, and MOSFET. Power control converters. Drive specifications. Rectifier control of DC motors. Fully controlled single-phase and three-phase drives. Multiquadrant operation of DC motors. Closed-loop control of DC motors. Induction motors by voltage controllers. Frequency controlled induction motor drives. Slip power control. Self-controlled synchronous motors. Current/voltage source inverter drives. Introduction to microcomputer control of AC and DC drives.

Prerequisite: EE 460 or equivalent

EE 530 Radiation and Propagation of Electromagnetic Waves (3-0-3)

Review of Maxwell’s equations and solutions. Electromagnetic waves in lossy, and anisotropic media. Waves at plane boundaries. Guided waves. Duality, uniqueness, image theory, equivalence principle, and reciprocity. Introduction to radiation and scattering. Problem formulation using Green’s function and integral equations.

Prerequisite: EE 340 or equivalent

EE 531 Applied Electromagnetic Theory (3-0-3)

Analytical solution of the wave equation in Cartesian, cylindrical and spherical coordinate systems. Applications to common boundary value problems (guidance, resonance, scattering and radiation). Perturbational and variational techniques. Numerical formulation and solution of selected boundary value problems.

Prerequisite: EE 530

EE 532 Antenna Theory and Applications (3-0-3)

Properties and characteristics of antennas. Polynomial representation of linear arrays. Pattern synthesis. Chebyshev array distributions. Thin linear antennas. Microstrip radiators and arrays. Huygen’s principle. Radiation from apertures. Reflector type antennas. Frequency independent antennas. Reciprocity theorem and receiving antennas. Radar antennas. Antenna measurements.

Prerequisite: EE 340 or equivalent

EE 533 Microwave Integrated Circuits (3-0-3)

An overview of microwave integrated circuits (MIC). Hybrid and monolithic MIC. Analysis of microstrip lines. Slot lines and coplanar waveguides. Coupled microstrip and directional couplers. Microstrip circuit design: couplers, Hybrids and filters. Lumped elements. Ferrite components. Active devices for MIC: MESFET, Gunn diode, avalanche diode, Schottky-barrier diode and PIN diode. MIC modules: oscillators, amplifiers, mixers and phase shifters. TR modules.

Prerequisite: EE 407 or equivalent

EE 541 Design of Digital Systems (3-0-3)

Hardware organization of digital systems. Synchronous sequential machines. Arithmetic and logic units: high speed addition, multiplication and division algorithms and implementation. Control units: control, status, timing and clocking schemes and circuits. Digital memories. System controllers using RAMs, ROM, PAL, and FPLAs. Iterative networks and modular design procedures.

Prerequisite: EE 390 or equivalent

EE 542 Analog Integrated Circuit Design (3-0-3)

Review of device-level models. Basic equations and higher-order effects. Basic building blocks of bipolar, MOS and CMOS analog circuits: current mirrors, differential pairs, level-shift stages, gain stages, references and Op-Amp circuits. The translinear principle and applications. Typical examples of IC amplifier design.

Prerequisite: EE 303 or equivalent

EE 543 Computer Architecture (3-0-3)

Study of advanced microprocessors: instruction set and data format, architecture, register organization, programming aspects, CPU architecture, pipelining, etc. Memory hierarchy and management. I/O buses architecture. Microprocessor interfacing. RISC and CICS processors.

Prerequisite: EE 541 (crosslisted with COE 520)

EE 544 Embedded System Design and Applications (3-0-3)

Microprocessors, Microcontrollers and DSP hardware and software architectures. Advanced programming and interrupts. Interface to real-time systems. Applications and case studies including projects

Prerequisite: EE 541

EE 545 Advanced Analog Electronics (3-0-3)

Small-signal equivalent circuits and noise models of active devices. Design and analysis of linear wide-band low-noise feedback amplifiers. High frequency design using operational amplifiers and operational transconductance amplifiers. Application of specialized electronic systems in analog signal processors. Introduction to emerging technologies and advanced topics from recent literature.

Prerequisite: EE 303 or equivalent

EE 546 Semiconductor Device Theory (3-0-3)

Electronic states in semiconductors. Carrier transport models and current equations. Analysis of pn junctions, bipolar and FET transistors. Introduction to microwave devices and semiconductor optoelectronics.

Prerequisite: EE 403 or equivalent

EE 550 Linear Control Systems (3-0-3)

State space representation of systems. Theory of multivariable systems. Jordan canonical forms. Transformation matrices. Realization theory. Controllability and observability. Stability. State estimators. Output and state feedback. Compensation. Decoupling and model matching. Introduction to optimal control.

Prerequisite: EE 380 or equivalent (crosslisted with SE 507)

EE 551 System Identification (3-0-3)

Introduction to dynamic systems, models, and identification process. Models of linear time-invariant systems. Models of time-varying and nonlinear systems. Parametric estimation methods. Convergence and consistency of solutions. Asymptotic distribution. Recursive and non-recursive computation methods. Model selection and validation.

Prerequisite: EE 380 or equivalent

EE 552 Optimal Control Theory and Applications (3-0-3)

Nonlinear optimal control of continuous-time systems. Minimum time and constrained input problems. Linear quadratic regulator. Optimal output-feedback. Optimal state estimation.

Linear quadratic Gaussian design. Case studies.

Prerequisite: EE 550 or equivalent (crosslisted with SE 514)

EE 554 Advanced Digital Control Systems (3-0-3)

Digital controller design. Pole-assignment design and state-estimation. Linear quadratic optimal control. Sampled-data transformation of Analog filters. Digital filter structures. Microcomputer implementation of digital filters.

Prerequisite: EE 432 or equivalent

EE 555 Neural Networks Theory and Applications (3-0-3)

Introduction, background and biological inspiration. Survey of fundamentals methods of artificial neural networks: single and multi-layer networks; Perceptions and back propagation. Associative memory and statistical networks. Supervised and unsupervised learning. Merits and limitations of neural networks. Applications.

Prerequisite: Consent of the Instructor (cross-listed with SE 507 and COE 591)

EE 556 Intelligent Control (3-0-3)

Intelligent control strategies: Expert systems, fuzzy logic control, neural networks. Optimization control techniques: genetic algorithms, simulated annealing, tabu search. Hybrid systems. Applications

Prerequisite: Consent of the Instructor (Not to be taken for credit with SE 571)

EE 562 Digital Signal Processing I (3-0-3)

Classification of discrete-time signals and systems. Basic and lattice structures, Finite-word length effects. Discrete Fourier Transform and its efficient implementations. Introduction to spectral analysis. FIR and IIR filter design techniques: Windowing techniques, Analog-to-Digital transformation techniques, Computer-aided design techniques.

Prerequisite: EE 406 or equivalent

EE 563 Speech and Audio Processing (3-0-3)

Speech analysis, Digital processing of wave forms, Wavelet transformation Waveform coding, Parametric coding of speech: linear predictive coding, Text-to-Speech synthesis, Recognition, Stochastic modeling of speech signals, Pattern recognition and its application to speech, Speech coding for Packet Networks, Echo removal.

Prerequisite: EE 562 or equivalent (crosslisted with SE 524)

EE 570 Stochastic Processes (3-0-3)

Review of fundamentals of probability, Sequences of random variables and convergence, Stationarity and ergodicity; second-order properties and estimation; Gaussian random processes, Poisson and renewal processes, Markov processes. Queuing Theory. Applications to communications and signal processing.

Prerequisite: EE 315 or equivalent (Not to be taken for credit with SE 543)

EE 571 Digital Communications I (3-0-3)

Time and frequency representation of signals. Spectral density and autocorrelation. A/D and D/A conversion. PAM and PCM systems. Detection of binary and M-ary signals in Gaussian noise. Matched filter and correlator receivers. Pulse shaping. Band pass modulation and demodulation techniques. Error performance for binary and M-ary systems. Spectral Analysis of digital signals. Communication link analysis.

Prerequisite: EE 370 or equivalent, EE 315 or equivalent

EE 573 Digital Communications II (3-0-3)

Review of digital transmission over AWGN channels. Spectral analysis of digital signals. Digital,

transmission over band-Limited channels. Intersymbol Interference. Signal design for band-limited channels. Channel equalization. Adaptive equalizers. Characterization of fading multipath channels. Performance of digital transmission over fading channels. Diversity techniques. Spread spectrum. Multi-user communication. Overview of Advanced Communications Systems (satellite, mobile, optical, ...).

Prerequisite: EE 571

EE 574 Detection And Estimation (3-0-3)

Binary and M-hypotheses detection techniques: Maximum likelihood, Newman Pearson, Minimum probability of error, Maximum a posteriori probability, Bayes' decision and minimax detection. Parameter estimation: weighted least squares, BLUE, Maximum likelihood, Mean square estimation. Signal estimation and filtering: Wiener filtering, Kalman filtering and estimation. Simultaneous detection and estimation. Application to system identification and communication systems.

Prerequisite: EE 570

EE 575 Information Theory (3-0-3)

Measures of information, Entropy, Source Coding theory, Lossless data compression, Huffman Codes, Ziv-Lempel and Elias Codes, Arithmetic Codes, Run-length Encoding, Sources with memory, Lossy data compression, Rate distortion theory, Mutual Information, Memoryless channels, Channel capacity, Channel coding theory, Differential Entropy, Capacity of AWGN channels.

Prerequisite: EE 370 or equivalent, EE 315 or equivalent

EE 576 Error Control Coding (3-0-3)

Finite field arithmetic, Linear codes, Block codes, Cyclic codes, BCH and Reed-Solomon codes, Encoding and decoding methods, Performance analysis of block and cyclic codes, Convolutional codes, Trellis representation, The Viterbi algorithm, Performance analysis of convolutional codes, Coded modulation, Turbo codes.

Prerequisite: EE 370 or equivalent, EE 315 or equivalent

EE 577 Wireless and Personal Communications (3-0-3)

The Cellular concept, Propagation modeling, Digital transmission techniques, Multiple access techniques, Cellular frequency planning, Link control, Handoffs, Power control, Traffic capacity, Wireless networking, Privacy and security of wireless systems, Examples of current wireless systems standards.

Prerequisite: EE 571

EE 578 Simulation of Communication Systems (3-0-3)

Generation of pseudo-random signals and noise, Basic techniques for bit error rate estimation, Simulation of a binary system, Simulation of Intersymbol interference, Channel modeling, Signal-to-Noise Ratio estimation, Multi-rate simulation, Adaptive equalization and Coded systems simulation, Importance sampling.

Prerequisite: EE 573

EE 599 Seminar (1-0-0)

Graduate students working towards either M.S. in Electrical engineering, M. S. in Telecommunication Engineering, or Ph.D. degrees, are required to attend the seminars given by faculty, visiting scholars, and fellow graduate students. Additionally, each student must present at least one seminar on a timely research topic. Among other things, this course is designed to give the student an overview of research in the department, and a familiarity with the research methodology, journals and professional societies in his discipline. Graded on a Pass or Fail basis.

EE 606 Independent Research (3-0-3)

This course is intended to allow the student to conduct research in advanced problems in his M.S. research area. The faculty offering the course should submit a research plan to be approved by the Graduate Program Committee at the academic department. The student is expected to deliver a public seminar and a report on his research outcomes at the end of the course. Graded on a Pass or Fail basis.

Prerequisite: Prior arrangement with an instructor

EE 610 M.S. Thesis (0-0-6)

The student has to undertake and complete a research topic under the supervision of a faculty member in order to probe in depth a specific problem in Electrical Engineering.

Prerequisite: EE 599

EE 620 High Voltage Engineering (3-0-3)

Breakdown in gases, solids and liquids. Analysis of high voltage transmission: switching and lighting surges. Insulation coordination in electrical power system. Basic impulse levels. System grounding and insulation designs. High voltage generation and measurement.

Prerequisite: EE 464 or equivalent

EE 622 Power System Operation (3-0-3)

Mathematical methods and tools applied to power system operation. Characteristics of power generation units. Economic dispatch of generating units and methods of solution. Transmission system effects. Unit commitment, dynamic programming, Heuristic methods. Hydrothermal coordination. Maintenance scheduling. Power interchange production cost models. Generation control. Reactive power dispatch and allocation.

Prerequisite: EE 463 or equivalent

EE 623 HVDC Transmission System (3-0-3)

Comparison between AC and DC transmission. Converter circuit configuration. Converter operation and analysis. Misoperation of converter. Harmonics and filters. Ground return. Integration of HVDC links into power systems. AC-DC load flow, short circuit and stability calculations.

Prerequisite: EE 460 or equivalent

EE 629 Special Topics in Power Systems (3-0-3)

The contents of this course will be in one of the areas of interest in power systems. The specific contents of the special topics course will be given in detail at least one semester in advance of that in which it is offered. It is also subject to the approval by the Graduate Council.

Prerequisite: Consent of the Instructor.

EE 631 Microwave Measurements (1-6-3)

Microwave signal sources. Waveguide components. Network analyzer measurements. Scattering parameters of microwave planar transistors. Doppler effect. Time domain reflectometry. Microwave links. Antenna impedance and pattern measurements. Microstrip transmission lines. Resonant cavities.

Prerequisite: EE 405 or equivalent

EE 632 Scattering and Diffraction of Electromagnetic Waves (3-0-3)

Radiation condition and radar cross section. Cylindrical wave functions. Field of a line source. Plane wave and line field scattering by conducting circular cylinders. Spherical wave functions. Plane wave scattering by conducting and dielectric spheres. Approximate techniques applied to Rayleigh scattering. Application to a conducting sphere. High frequency approximation. Geometric theory of diffraction. Diffraction by a slit.

Prerequisite: EE 530

EE 633 Optical Fiber Communication (3-0-3)

Dielectric slab waveguides. Classification of mode types. Parabolic two-dimensional media. Circular waveguides. Step-index and graded-index optical fibers. Effect of loss. Dispersion effects. Fabrication methods in integrated optics and optical fibers. Light sources. Couplers. Opto-electronic devices. Applications in communication systems.

Prerequisite: EE 420 or equivalent

EE 635 Computational Electromagnetics (3-0-3)

Review of basic electromagnetic theory and partial differential equations (PDEs). Finite-difference approximation of PDEs. The finite-difference time domain (FDTD) in 2D and 3D. The Yee's mesh. Scalar formulation of the FDTD method. Related topics including numerical stability and dispersion, boundary conditions, materials, etc. Introduction to other methods such as the finite-element method, the method of lines, beam propagation method, and the method of moments. Applications and case studies.

Prerequisite: Consent of the Instructor

EE 636 Theory and Applications of Antenna Arrays (3-0-3)

Antenna array fundamentals. Analysis and synthesis of discrete linear arrays. Two-dimensional arrays. Concept of adaptive arrays. Adaptive beam forming and nulling. Superdirective array functions. Suppression of side lobes in linear arrays.

Prerequisite: EE 422 or equivalent

EE 639 Special Topics in Electromagnetics (3-0-3)

The contents of this course will be in one of the areas of interest in electromagnetics. The specific contents of the special topics of course will be given in detail at least one semester in advance of that in which it is offered. It is also subject to approval by the Graduate Council.

Prerequisite: Consent of the Instructor

EE 642 Analog VLSI Circuit Design (3-0-3)

MOS and CMOS technology: building blocks, devices, capacitors and limitations. Operational amplifiers and other analog systems. Application to filter design and data converters. Layout considerations and CAD tools.

Prerequisite: EE 542

EE 645 VLSI Architecture (3-0-3)

Review of MOS transistors: fabrication, layout and characterization. Review of CMOS circuit and logic design: fully complementary CMOS logic, pseudo-NMOS logic, dynamic CMOS logic, pass-transistor logic, clocking strategies. Subsystem design: ALUs, multipliers, memories, PLAs. Architecture design: iterative cellular design and systolic arrays. Application to system level designs.

Prerequisite: EE 541

EE 649 Special Topics in Digital Systems and Electronics (3-0-3)

The contents of this course will be in one of the areas that has the nature of research topics in digital and electronics systems. For example: VLSI architectures, Advanced analog ICs, Physics of ultra small devices, etc.

Prerequisite: Consent of the Instructor

EE 651 Adaptive Control (3-0-3)

Introduction to the various approaches of adaptive controller design. Real-time parameter estimation. Model reference adaptive control. Self-tuning controllers. Variable structure systems.

Gain Scheduling. Robustness issues. Practical aspects and implementation. Typical Industrial applications.

Prerequisite: EE 550 or equivalent (crosslisted with SE 537)

EE 652 Nonlinear Systems (3-0-3)

Introduction to nonlinear dynamics and control. Overview of phase plane analysis, describing function and limit cycles. Lyapunov stability. Input/output stability. Input/ output linearization. Stabilization and control of nonlinear systems.

Prerequisite: EE 550 or equivalent (cross-listed with SE 517)

EE 653 Robust Control (3-0-3)

Elements of robust control theory. Norms of signals and systems. Performance specifications. Stability and performance of feedback systems. Performance limitations. Model uncertainty and robustness. Parametrization of stabilizing controllers. Loop transfer recovery robust design. $H\infty$-control and filtering.

Prerequisite: EE 550 or equivalent (Not to be taken for credit with SE 654)

EE 654 Large Scale Systems (3-0-3)

Introduction to large scale systems. Classical Model reduction techniques. Component cost analysis method. L2 model reduction. Hankel norm approximation. Introduction to $H\infty$-model reduction. Relations between modeling and control. Closed loop model reduction. Decentralized control design schemes. System's interactions. Coordinated and hierarchical control. Case studies.

Prerequisite: EE 550 or equivalent (Not to be taken for credit with SE 509)

EE 655 Predictive Control (3-0-3)

Predictive control concept. Process models and prediction. Optimization criterion. Predictive control law. Performance and robustness. Minimum cost horizon. Disturbance model. Overview of well-known predictive controllers. Tuning of predictive controller design parameters. Predictive control with output constraints. Implementation issues. Industrial case studies.

Prerequisite: EE 550 or equivalent

EE 656 Robotics & Control (3-0-3)

Basic concepts of robotics. Mathematical description of industrial manipulator. Homogeneous transformation and the Denavit-Hartenberg notation. Transformation between frames. Forward, and inverse kinematics and dynamics. Newton - Euler and Lagrange formulations. Joint space, and Cartesian space trajectories and dynamic control. Trajectory planning. Advance control schemes.

Prerequisite: EE 550 or equivalent (cross listed with SE 632)

EE 659 Special Topics in Control (3-0-3)

The contents of this course will be in one of the areas of interest in control. The specific contents of the special topics the of course will be given in detail at least one semester in advance of that in which it is offered. It is also subject to the approval by the Graduate Council.

Prerequisite: Consent of the Instructor

EE 661 Digital Signal Processing II (3-0-3)

Optimal one-dimensional filter design techniques. Multidimensional digital signals and systems. Multidimensional Fourier transform. Analysis of multidimensional systems and digital filter design. Implementation issues. Parametric and non-parametric spectral estimation. Applications.

Prerequisite: EE 562 or equivalent

EE 662 Adaptive Filtering and Applications (3-0-3)

Introduction to adaptive Signal Processing. Fundamentals of Adaptive Filter Theory. The LMS Algorithm, LMS-based Algorithms. Conventional RLS Adaptive Filtering. Adaptive Lattice-based RLS Algorithms. Fast Algorithms. Implementation Issues. Adaptive IIR filters. HOS-based adaptive filtering. Introduction to nonlinear filtering. Applications to Echo cancellation, equalization, noise canceling and prediction.

Prerequisite: EE 570 or equivalent

EE 663 Image Processing (3-0-3)

Two-dimensional systems and mathematical preliminaries. Perception and human vision systems. Sampling and quantization. Image transforms. Image representation by stochastic models. Image data compression, enhancement, filtering, restoration. Reconstruction from projection. Analysis and computer vision.

Prerequisite: Consent of the Instructor (Not to be taken for credit with SE 662)

EE 664 Wavelet Signal Processing (3-0-3)

Cosine transform and short-time Fourier transform, Analysis of filter banks and wavelets, Sub-band and wavelet coding, Multirate signal processing, Wavelet transform, Daubechies wavelets, Orthogonal and biorthogonal wavelets, Time-frequency and time-scale analysis, Design methods. Applications of wavelets to audio and image compression, Medical imaging, Geophysics, Scientific visualization.

Prerequisite: EE 562 or equivalent

EE 665 Signal and Image Compression (3-0-3)

Principles and techniques of signal compression, Quantization theory, Linear prediction, Coding techniques: predictive, transform, entropy, and vector quantization, Fidelity, bit-rate, and complexity trade-offs. Compression standards, Applications to speech, audio, image, and video compression.

Prerequisite: EE 562 or equivalent

EE 669 Special Topics in Signal Processing (3-0-3)

The contents of this course will be in one of the areas of interest in signal processing. The specific contents of the special topics of the course will be given in detail at least one semester in advance of that in which it is offered. It is also subject to approval by the Graduate Council.

Prerequisite: Consent of the Instructor

EE 672 Satellite Communications (3-0-3)

Introduction to satellite communication systems. Satellite orbits. The satellite channel. Satellite links. Earth stations. Modulation and multiplexing. Digital modulation. Multiple access and demand assignment. Satellite cross links. VSAT and mobile satellite systems.

Prerequisite: EE 571

EE 674 Telecommunication Networks (3-0-3)

Introduction to modern communication networks, Data traffic, Queuing models, Multi-access channels, Mutiplexing, Packet switching, Circuit switching, Datagrams, Protocols, Media access control, Resource allocation, SONET, ATM, Performance analysis, Product-form queuing networks, Local area networks, Ethernet, Fiber-Distributed-Data-Interface (FDDI), Token rings, Token busses, Polling systems, Optimal routing and flow controls.

Prerequisite: EE 570 (crosslisted with COE 540)

EE 679 Special Topics in Communication (3-0-3)

The contents of this course will be in one of the areas of interest in communication. The specific contents of the special topics of the course will be given in detail at least one semester in advance

of that in which it is offered. It is also subject to the approval by the Graduate Council.

Prerequisite: Consent of the Instructor

EE 690 Advanced Electrical Engineering Projects (3-0-3)

Individual research projects to be approved by the supervising faculty members before registering for the course. An approved written report must be filed with the Graduate Committee before credit is accepted. Credit of this course may not be used towards the fulfillment of the M.S. Degree.

EE 699: Ph.D. Seminar (1-0-0)

Ph.D. students are required to attend departmental seminars delivered by faculty, visiting scholars and graduate students. Additionally, each Ph.D. student should present at least one seminar on a timely research topic. Ph.D. students should pass the Comprehensive Examination as part of this course. This course is a pre-requisite to registering the Ph.D. Pre-dissertation EE 711. The course is graded as pass or fail. IC grade is awarded if the Ph.D. Comprehensive exam is not yet passed.

Prerequisite: Graduate Standing.

EE 701 Directed Research (3-0-3)

This course is intended to allow the student to conduct research in advanced problems in his Ph.D. research area. The faculty offering the course should submit a research plan to be approved by the Graduate Program Committee at the academic department. The student is expected to deliver a public seminar and a report on his research outcomes at the end of the course. This course is graded on a Pass or Fail basis.

Prerequisite: Prior arrangement with an instructor.

EE 702 Directed Research (3-0-3)

This course is intended to allow the student to conduct research in advanced problems in his Ph.D. research area. The faculty offering the course should submit a research plan to be approved by the Graduate Program Committee at the academic department. The student is expected to deliver a public seminar and a report on his research outcomes at the end of the course. This course is graded on a Pass or Fail basis.

Prerequisite: Prior arrangement with an instructor.

EE 711 Ph.D. Pre-Dissertation (0-0-3)

This course enables the student to submit his Ph.D. Dissertation Proposal and defend it in public. The student passes the course if the Ph.D. Dissertation Committee accepts the submitted dissertation proposal report and upon successfully passing the Dissertation proposal public defense. The course grade can be NP, NF or IC.

Prerequisite: Ph.D. Candidacy, **Co-requisite**: EE-699

EE 712 Ph.D. Dissertation (0-0-9)

This course enables the student work on his Ph.D. Dissertation as per the submitted dissertation proposal, submit its final report and defend it in public. The student passes this course if the Ph.D. Dissertation Committee accepts the submitted final dissertation report and upon successfully passing the Dissertation public defense. The course grade can be NP, NF or IP.

Prerequisite: (EE-711)

DEPARTMENT OF MECHANICAL ENGINEERING

Chairman

Dr. Zuhair M. Gasem

Faculty

Abdul Aleem	Abdul Azeem	Abdul Khaliq
Abdul Samad	Abualhamayel	Abu-Dheir
Ahmed	Akthar	Albinmousa
Al-Athel	Anis	Antar
Al-Aqeeli	Arif	Al-Badour
Badr	Bahaidarah	Baig
Bashmal	Bazoune	Ben-Mansour, R.
Bin-Mansoor, S.	Al-Dini	Al-Farayedhi
Furquan	Gandhidasan	Gasem
Habib	Al-Hadhrami	Hasan F.
Hassan M.	Hawwa	Al-Kaabi
Khalifa	Khan S.	Khan Z.
Khulief	Laoui	Mahmood
Mekid	Merah	Mezghani
Mokheimer	Muhammad	El-Nakla
Al-Nassar	Nouari	Ouakad
Pashah	Patel	Al-Qahtani H.
Al-Qahtani M.	Al-Qutub	Raza
Al-Saeed	Sahin	Said
Al-Sarkhi	El-Shaarawi	El-Sharqawy
Shaukat	Sheikh	Shuaib
Shuja	Sorour	Al-Sulaiman
Sunar	Toor	Yaqub
Yilbas	Younas	Zubair

The department of Mechanical Engineering has well-established graduate programs leading to the Master of Science (M.S.) degree, and the Doctor of Philosophy (Ph.D.) degree in Mechanical Engineering. The graduate program offers specialization in three important branches of mechanical engineering: Thermofluid Sciences, Engineering Mechanics, and Materials and Manufacturing. The Mechanical Engineering Department also offers a Master of Science degree in Materials Science and Engineering. The graduate program has been designed to cope with the modern trends and developments in the area of mechanical engineering. The lower level (500-level) graduate courses are designed to provide the student with an opportunity to expand and broaden his knowledge-base in the respective subjects. However, the higher level (600-level) graduate courses are designed to address advanced subjects of Mechanical Engineering specializations.

Teaching & Research Facilities

The Mechanical Engineering Department has several laboratories equipped with teaching and research facilities. The thermofluids facilities include: a supersonic jet impingement set up, shock tubes, hot wire and laser Doppler anemometers, a pulsating flow set up, heat transfer testing equipment, a solar cooling equipment, oxy-combustion testing rig, gas emission analyzers, CFR gasoline test engine, biodiesel preparation and testing equipment, multi-phase flow testing rig, and thermal water desalination rigs. The materials testing facilities include: electron scanning microscope, a transmission electron microscope, X-ray diffractometers, an atomic force microscope, hardness testers, impact testers, tensile testers, torsion testers, creep testers, a scratch tester, a high temperature tribometer, a high temperature erosion tester, a differential scanning calorimeter, a micro-balance, potentiostats for DC and AC corrosion tests, an erosion/corrosion loop, dimensional metrology equipment, powder metallurgy facilities, membrane synthesis and testing, a central modern machine shop equipped with conventional and CNC machines. The dynamics testing facilities include: a potentiodyne analyzer, a vibration test rig, vibration meters, recorders, analyzers, amplifiers, accelerometers and transducers, laser measurement systems.

M.S. PROGRAM IN MECHANICAL ENGINEERING

Admission Requirements

The minimum requirements for possible admission to the Master of Science program in the College of Graduate Studies as a regular graduate student with full standing in Mechanical Engineering are:

- A Bachelor's Degree in Mechanical Engineering, or an equivalent degree of a suitable background, from an institution whose undergraduate program is equivalent in duration, content, and quality to that of KFUPM,
- An acceptable cumulative Grade-Point Average (GPA) of 3.00 or higher (on a 4-point scale) or a Major GPA of 3.00 (on a 4-point scale),
- Achieving a minimum score of 520 (PBT) or 190 (CBT) or 68 (IBT) in TOEFL,
- Achieving an acceptable score in GRE (Quantitative), and
- Satisfactorily meeting the University M.S. admission requirements.

If the minimum requirement in one area is not exactly met, consideration is given for a provisional admission when other credentials are satisfactory.

Academic Program

The M.S. degree requires the successful completion of core courses, elective courses, and a thesis.

Each student admitted to the M.S. program in Mechanical Engineering must select a research field from the three basic ME research fields listed below. Every M.S. student must take two core courses (6 credit hours) coherent to his research area from the core courses listed below. Students, who have not taken MATH 301 or equivalent in their undergraduate program, should take this course or its equivalent as a deficiency course without any credit. In addition, the program of study requires three Mechanical Engineering elective courses (9 credit hours) related to his research area, and three Technical Elective courses (9 credit hours). The technical electives could be taken from courses offered by the Mechanical Engineering Department or other departments in the College of Engineering Science, College of Science, and College of Computer Science and Engineering. To complete the 30 credit-hour program of study, each student must also complete a research thesis (6 credit hours) and seminar requirements. Each student should have a degree plan consisting of courses, which are required to be taken. The degree plan should be approved by the Mechanical Engineering Department.

The following are the three basic research fields in the M.S. program:

1. **Thermo-fluid Sciences:** This field covers thermodynamics, fluid mechanics, heat transfer, refrigeration and air-conditioning, energy conversion, water desalination and combustion areas.
2. **Engineering Mechanics:** This field covers solid mechanics, dynamics, vibrations, control, and design areas.
3. **Materials & Manufacturing:** This field covers manufacturing, composite materials behavior, corrosion and tribology areas.

(a). Core Courses Required for M.S. Program

1	Thermo-fluid Sciences	**ME 532**	Advanced Fluid Mechanics I
		ME 536	Convection Heat Transfer
2	Engineering Mechanics	**ME 551**	Continuum Mechanics
		ME 552	Advanced Dynamics
3	Materials & Manufacturing	**ME 572**	Analysis of Manufacturing Processes
		ME 574	Advanced Materials Science

(b). Major Elective Courses for the M.S. Program in Mechanical Engineering

1. **Thermo-fluid Sciences**

ME 501	Numerical Methods in Mechanical Engineering
ME 505	Computational Fluid Dynamics
ME 529	Advanced Thermal Desalination
ME 530	Advanced Compressible Fluid Flow
ME 531	Advanced Thermodynamics
ME 533	Ideal Fluid Flow
ME 534	Conduction Heat Transfer
ME 535	Radiation Heat Transfer
ME 537	Combustion and Emission
ME 539	Solar Energy Utilization

ME 546	Industrial Aerodynamics
ME 547	Thermal Environment and Energy Analysis
ME 548	Combustion Phenomena
ME 549	Thermal Design of Heat Exchangers
ME 591	Special Topics in Thermofluid Sciences I
ME 611	Statistical Thermodynamics
ME 612	Phase Change Heat Transfer & Two Phase Flow
ME 632	Advanced Fluid Mechanics II
ME 691	Special Topics in Thermofluid Sciences II

2. Engineering Mechanics

ME 543	Nonlinear Finite Element Analysis
ME 550	Fundamentals of Astronautics
ME 553	Advanced Vibrations
ME 554	Elasticity
ME 555	Plasticity
ME 557	Modern Control of Linear Systems
ME 558	Rotordynamics
ME 559	Random Vibrations
ME 560	Smart Materials and Structures
ME 562	Vibration Measurement and Analysis
ME 563	Ultrasonic Testing Techniques
ME 564	Noise and Vibration Control
ME 565	Dynamics of Multibody Systems I
ME 595	Special Topics in Engineering Mechanics I
ME 658	Fracture Mechanics
ME 661	Nonlinear Systems Dynamic Analysis
ME 665	Dynamics of Multibody Systems II
ME 666	Dynamics and control of Mechanical Systems
ME 695	Special Topics in Engineering Mechanics II

3. Materials & Manufacturing

ME 570	Experimental Methods in Materials and Processes
ME 573	Probabilistic Concepts in Design and Production

ME 575	Advanced Corrosion Engineering
ME 576	Tribology
ME 578	Mechanical Properties of Engineering Polymers
ME 579	Advanced Mechanical Behavior of Materials
ME 580	Principles of Metal Forming
ME 581	Computer Integrated Manufacturing
ME 583	Fatigue and Fracture of Engineering Materials
ME 584	Quality Engineering
ME 585	Advanced Physical Metallurgy
ME 586	Finite Element Analysis in Metal Forming Processes
ME 597	Special Topics in Materials & Manufacturing I
ME 671	Electrode Kinetics
ME 672	Control of Manufacturing Processes
ME 673	Metallurgical Processes & Thermodynamics
ME 675	Phase Transformation in Metals
ME 697	Special Topics in Materials & Manufacturing II

4. General Electives

ME 606	Independent Research (for M.S. program)
ME 701	Directed Research I (for Ph.D. program)
ME 702	Directed Research II (for Ph.D. program)

Degree Plan for M.S. in Mechanical Engineering
(Thermofluid Sciences Option)

Course No.	Title	LT	LB	CR
First Semester				
ME 532	Advanced Fluid Mechanics I	3	0	3
ME xxx	Elective I	3	0	3
XX xxx	Technical Elective I	3	0	3
		9	**0**	**9**
Second Semester				
ME 536	Convection Heat Transfer	3	0	3
ME xxx	Elective II	3	0	3
XX xxx	Technical Elective II	3	0	3
ME 599	Seminar	1	0	0
		10	**0**	**9**
Third Semester				
ME xxx	Elective III	3	0	3
XX xxx	Technical Elective III	3	0	3
ME 610	M.S. Thesis	0	0	IP
		6	**0**	**6**
Fourth Semester				
ME 610	M.S. Thesis	0	0	6
		0	**0**	**6**
Total Credits				**30**

Notes:

- Each student is expected to submit his detailed degree plan according to the above generic degree plan for approval by the department and the Deanship of Graduate Studies within the 8th week of the second semester of enrollment.
- Students are required to adhere to the regulations of the degree plan. No relaxation will be given to any student and the courses taken in conflict of the above will not be counted towards the degree.
- The order of taking the courses can be different from above but students must take the core courses before electives.
- The ME xxx Elective I course can be a 500 or a 400-level course, to be taken with the approval of the advisor.
- The ME xxx Elective II and III courses should be taken from the 500/600 level courses in the research field.
- The technical electives could be taken from 500/600 level courses offered by the Mechanical Engineering Department or other Departments in Colleges of Engineering Sciences, College of Sciences, and College of Computer Sciences and Engineering.
- One of the technical elective courses must be taken from other Departments according to the approved degree plan.

Degree Plan for M.S. in Mechanical Engineering
(Engineering Mechanics Option)

Course No.	Title	LT	LB	CR
First Semester				
ME 551	Continuum Mechanics	3	0	3
ME xxx	Elective I	3	0	3
XX xxx	Technical Elective I	3	0	3
		9	**0**	**9**
Second Semester				
ME 552	Advance Dynamics	3	0	3
ME xxx	Elective II	3	0	3
XX xxx	Technical Elective II	3	0	3
ME 599	Seminar	1	0	0
		10	**0**	**9**
Third Semester				
ME xxx	Elective III	3	0	3
XX xxx	Technical Elective III	3	0	3
ME 610	M.S. Thesis	0	0	IP
		6	**0**	**6**
Fourth Semester				
ME 610	M.S. Thesis	0	0	6
		0	**0**	**6**
Total Credits				**30**

Notes:

- Each student is expected to submit his detailed degree plan according to the above generic degree plan for approval by the department and the Deanship of Graduate Studies within the 8th week of the second semester of enrollment.
- Students are required to adhere to the regulations of the degree plan. No relaxation will be given to any students and the courses taken in conflict of the above will not be counted towards the degree.
- The order of taking the courses can be different from above but students must take the core courses before electives.
- The ME xxx Elective I course can be a 500 or a 400-level course, to be taken with the approval of the advisor.
- The ME xxx Elective II and III courses should be taken from the 500/600 level courses in the research field.
- The technical electives could be taken from 500/600 level courses offered by the Mechanical Engineering Department or other Departments in Colleges of Engineering Sciences, College of Sciences, and College of Computer Sciences and Engineering.
- One of the technical elective courses must be taken from other Departments according to the approved degree plan.

Degree Plan for M.S. in Mechanical Engineering
(Materials and Manufacturing Option)

Course No.	Title	LT	LB	CR
First Semester				
ME 572	Analysis of Manufacturing Processes	3	0	3
ME xxx	Elective I	3	0	3
XX xxx	Technical Elective I	3	0	3
		9	**0**	**9**
Second Semester				
ME 574	Advanced Material Sciences	3	0	3
ME xxx	Elective II	3	0	3
XX xxx	Technical Elective II	3	0	3
ME 599	Seminar	1	0	0
		10	**0**	**9**
Third Semester				
ME xxx	Elective III	3	0	3
XX xxx	Technical Elective III	3	0	3
ME 610	M.S. Thesis	0	0	IP
		6	**0**	**6**
Fourth Semester				
ME 610	M.S. Thesis	0	0	6
		0	**0**	**6**
Total Credits				**30**

Notes:

- Each student is expected to submit his detailed degree plan according to the above generic degree plan for approval by the department and the Deanship of Graduate Studies within the 8th week of the second semester of enrollment.
- Students are required to adhere to the regulations of the degree plan. No relaxation will be given to any students and the courses taken in conflict of the above will not be counted towards the degree.
- The order of taking the courses can be different from above but students must take the core courses before electives.
- The ME xxx Elective I course can be a 500 or a 400-level course, to be taken with the approval of the advisor.
- The ME xxx Elective II and III courses should be taken from the 500/600 level courses in the research field.
- The technical electives could be taken from 500/600 level courses offered by the Mechanical Engineering Department or other Departments in Colleges of Engineering Sciences, College of Sciences, and College of Computer Sciences and Engineering.
- One of the technical elective courses must be taken from other Departments according to the approved degree plan.

M.S. PROGRAM IN MATERIALS SCIENCE AND ENGINEERING

Academic Program

The Master of Science degree in Materials Science and Engineering requires successful completion of 24 credit hours of graduate level courses and a successful defense of a written research thesis. The research described in the thesis will be directed by a faculty advisor. The 24 credit hours represent 8 courses with 3 credit hours each. These must include:

- Three core courses
- Five courses from the elective courses list from any of the program major fields.

The following lists the courses offered under the M.S. program in Material Science and Engineering.

(a) Core Courses

MSE 501	Materials Structure and Defects
MSE 502	Thermodynamics of Materials
MSE 503	Materials Characterization

(b) Elective Courses

1. Corrosion

MSE 511	Corrosion in Oil and Petrochemical Industries
MSE 512	Fundamentals of Cathodic Protection Design
ME 575	Advanced Corrosion Engineering
CE 504	Corrosion in Reinforced Concrete

2. Failure Analysis

MSE 521	Deformation and Fracture Mechanics of Structural Materials
MSE 522	Failure Analysis in Materials Science
ME 578	Mechanical Behavior of Engineering Polymers
ME 675	Phase Transformation in Metals
ME 583	Fatigue and Fracture of Engineering Materials
CE 630	Damage Mechanics

3. Advanced Materials and Processing

MSE 531	Engineering Nanomaterials
MSE 532	Engineering Ceramics
MSE 533	Coatings and Surface Engineering
MSE 534	Engineering Composite Materials
MSE 535	Biomaterials
MSE 536	Nanotechnology: Synthesis, Structure and Properties

ME 479	Modern Materials
CHE 541	Polymeric Materials and Processing

4. General Electives

MSE 541	Electronic, Optical and Magnetic Properties of Materials
MSE 542	Advanced Metal Casting
MSE 543	Welding Processes & Metallurgy
MSE 544	Fundamentals of Heat Treatment
MSE 545	Non-Ferrous Extractive Metallurgy
MSE 546	Materials Selection and Design
MSE 547	Finite Element Analysis in Material Science & Engineering
MSE 590	Special Topics in Materials Science and Engineering I
MSE 591	Special Topics in Materials Science and Engineering II
ME 579	Advanced Mechanical Behavior of Materials
ME 585	Advanced Physical Metallurgy
MSE 606	Independent Research

Degree Plan for M.S. in Materials Science and Engineering

Course No.	Title	LT	LB	CR
First Semester				
MSE 501	Materials Structures and Defects	3	0	3
MSE 502	Thermodynamics of Materials	3	0	3
XX xxx	Elective I	3	0	3
		9	**0**	**9**
Second Semester				
MSE 503	Materials Characterizations	3	0	3
XX xxx	Elective II	3	0	3
XX xxx	Elective III	3	0	3
MSE 599	Seminar	1	0	0
		10	**0**	**9**
Third Semester				
XX xxx	Elective IV	3	0	3
XX 5xx	Free Elective	3	0	3
MSE 610	M.S. Thesis	0	0	IP
		6	**0**	**6**
Fourth Semester				
MSE 610	M.S. Thesis	0	0	6
		0	**0**	**6**
Total Credits				**30**

Notes:

- Each student is expected to submit his detailed degree plan according to the above generic degree plan for approval by the Department and the Deanship of Graduate Studies within the 8th week of the second semester of enrollment.
- Students are required to adhere to the regulations of the degree plan. No relaxation will be given to any student and the courses taken in conflict of the above will not be counted towards the degree.
- The order of taking the courses can be different from above but students must take the core courses before electives.
- The Elective (XX xxx) courses can be chosen from any of the program major fields.
- Only one 400-level course from the program major fields can be taken from the approved courses in the Materials Science and Engineering Program.
- The Free Elective course (XX5xx) can be taken from outside the approved courses in the Materials Science and Engineering Program.

PH.D. PROGRAM IN MECHANICAL ENGINEERING

The Ph.D. program is designed for full-time participation. The student is thus expected to engage himself in scholarly work on a full-time basis. The program consists of 30 graduate credit-hours of course work (beyond M.S. degree) in addition to the dissertation and seminar requirements. The maximum load for the Ph.D. student is 12 graduate credit-hours per semester and all the credited courses should be taken from 500 and 600 levels. Thus, the course work will require one and a half years, and the dissertation will require an additional year and a half. The maximum period allowed for obtaining the Ph.D. degree is five years.

Admission Requirements

Students applying to the doctoral program must provide evidence of exceptional scholastic ability, intellectual creativity, and research motivation.

The minimum requirements for possible admission to the Doctoral Program in the College of Graduate Studies as a regular student with full standing in Mechanical Engineering are:

- A Master's degree from a university of recognized standing,
- A major in mechanical engineering or evidence of suitable background for entering the fields of mechanical engineering, such as thermofluid sciences, engineering mechanics, materials and manufacturing,
- A cumulative GPA of 3.20 or above (on a 4-point scale),
- Achieving a minimum score of TOEFL, as required by the Deanship of Graduate Studies,
- Achieving a minimum score of GRE (Quantitative) as required by the ME Department, and
- Satisfactorily meeting the University Ph.D. admission requirements.

Academic Program

Each graduate student admitted to the Ph.D. program should select major and minor research areas related to his specialization and direction of research. Every Ph.D. student must take a minimum of seven courses (21 credit hours) from within the field of the selected major area. A major area is defined as one of the fields from the following three basic fields:

- **Thermofluid Sciences:** Includes research areas in Thermodynamics, Fluid Mechanics, Heat Transfer, Aerodynamics, Water Desalination, Combustion, Refrigeration and Air-Conditioning, and Energy Conversion.
- **Engineering Mechanics:** Includes research areas in Solid Mechanics, Dynamics, Vibration, Control, and Design.
- **Materials & Manufacturing:** Includes research areas in Manufacturing, Material Science, Composites, Corrosion and Tribology.

A minor area is defined as a relevant specialized area within any field related to the professional activities of the mechanical engineer. A minor area has to be constituted of a collection of three coherent courses (9 credit hours) that must be chosen from outside the field of the student's major area.

Prior to being granted their Ph.D. Degree, all students who have been admitted to the Ph.D. program with full standing are required to successfully complete the following:

Course Requirements: The Ph.D. students must complete 30 credit hours of 500 and 600 level courses and also a dissertation of 12 credit hours with a cumulative GPA of 3.00 or higher at all times.

Comprehensive Examination: An ME Ph.D. student has to successfully pass a comprehensive examination by the end of the second year from the student's enrolment in the Ph.D. program. The Comprehensive Examination will normally be given during the third semester after the student enrollment in the Ph.D. program. The Ph.D. student will be allowed to take the

Comprehensive Examination only twice. The Ph.D. Comprehensive Exam at the ME Department covers 4 topics from the courses taken by the student. Three topics should be from the student's major area of research and one topic should cover a minor area of research.

Dissertation: A candidate who successfully passes the Comprehensive Examination may proceed with his research work under the supervision of his dissertation advisor and in consultation with his dissertation committee. In consultation with the ME Graduate Coordinator, the Ph.D. student should select his Dissertation Advisor during the first semester of his enrollment onthe Ph.D. program. A Dissertation Committee must be formed for each student upon the recommendation of the Chairman of the Mechanical Engineering Department and approval of the Dean of the College of Graduate Studies. The membership of the committee is always an odd number. The committee include: the Dissertation Advisor (Chairman), Mechanical Engineering faculty members from the specified area of research, and one faculty member from outside the Department in a related area of research. After successful completion of the course work and the Comprehensive Exam, the student will register for his Ph.D. Pre-Dissertation (ME 711). After passing the Ph.D. Pre-Dissertation, the student will then register for his Ph.D. Dissertation (ME 712). Upon completion of his research work, the candidate is required to defend his dissertation before the thesis committee and in public. The Ph.D. degree will be conferred upon the recommendation of the dissertation committee.

Table: Breakdown of Credit Hours for Ph.D. Degree.

	Courses	**Credits**
Major area:	Seven ME courses (ME 5xx/ME 6xx)	21
Minor area(s):	Three graduate courses	9
	Ph.D. Pre-Dissertation (ME 711)	3
	Ph.D. Dissertation (ME 712)	9
ME 699	Seminar	0
	Total Credits	**42**

Degree Plan for Ph.D. in Mechanical Engineering

Course No.	Title	LT	LB	CR
First Semester				
ME xxx	Elective I – ME	3	0	3
ME xxx	Elective II – ME	3	0	3
ME xxx	Elective III – ME	3	0	3
		9	**0**	**9**
Second Semester				
ME xxx	Elective IV – ME	3	0	3
ME xxx	Elective V – ME	3	0	3
ME xxx	Elective VI – ME	3	0	3
		9	**0**	**9**
Third Semester				
XX xxx	Elective VII – Technical	3	0	3
ME xxx	Elective VIII – ME	3	0	3
XX xxx	Elective IX – Technical	3	0	3
ME 699	Seminar	1	0	0
		10	**0**	**9**
Fourth Semester				
XX xxx	Elective X – Technical	3	0	3
ME 711	Ph.D. Pre-Dissertation	0	0	3
		3	**0**	**6**
Fifth Semester				
ME 712	Ph.D. Dissertation	0	0	IP
Sixth Semester				
ME 712	Ph.D. Dissertation	0	0	9
		0	**0**	**9**
Total Credits				**42**

Notes:

- Each student is expected to submit his detailed degree plan according to the above generic degree plan for approval by the Department and the Deanship of Graduate Studies within the 8th week of the second semester of enrollment.
- Students are required to adhere to the regulations of the degree plan. No relaxation will be given to any student and the courses taken in conflict of the above will not be counted towards the degree.
- The order of taking the courses can be different from above but students must take the core courses before electives.
- All courses should be 500 level or above.

COURSE DESCRIPTIONS

MECHANICAL ENGINEERING COURSES

ME 501 Numerical Methods in Mechanical Engineering (3-0-3)

Concepts of consistency, stability, and convergence of numerical schemes. Initial and boundary value problems for ordinary differential equations. Various finite difference and finite element methods and their applications to fundamental partial differential equations in engineering and applied sciences. Case studies.

Prerequisite: SE 301 or Equivalent (not to be taken for credit with MATH 574)

ME 505 Computational Fluid Dynamics (3-0-3)

Governing equations of fluid dynamics (CFD). Introduction to CFD. Grid generation, discretization. Numerical approximations: finite difference and finite volume methods, CFD tools: adapted programs and commercially available general purpose packages. Applications to incompressible and compressible fluid flow.

Prerequisite: CHE 501 or ME 532; and CHE 560 or ME 501 or Consent the Instructor (not to be taken for credit with CHE 505)

ME 529: Advanced Thermal Water Desalination Systems (3-0-3)

This course includes studying seawater composition, The need for water desalination, Classification of desalination systems, Desalination using renewable energy sources such as solar stills and humidification dehumidification systems with various layouts, Economic analysis of desalination processes, Single effect evaporation, Multiple effect evaporation, Multistage flash distillation, once through Multistage flash systems, brine mixing and brine recirculation Multistage flash, Thermal vapor compression, Membrane distillation, New trends and fouling in desalination systems.

Prerequisite: ME315 or CHE 300 or consent of the instructor

ME 530 Advanced Compressible Fluid Flow (3-0-3)

Oblique shock waves. Expansion waves. General features of multidimensional compressible flow. Introduction to small perturbation theory. The method of characteristics with applications to steady and unsteady flows.

Prerequisite: ME 425/AE 325 or Equivalent

ME 531 Advanced Thermodynamics I (3-0-3)

Axiomatic presentation of fundamentals of classical thermodynamics. First law, equilibrium, Euler and Gibbs-Duhem relations. Entropy production, thermodynamic cycles. Legendre transformations and extremum principle. Maxwell relations and thermodynamic derivatives. Stability. Phase transitions. Nernst postulate. Chemical equilibrium. Applications.

Prerequisite: ME 204 or Equivalent

ME 532 Advanced Fluid Mechanics I (3-0-3)

Conservation equations for viscous fluids. Boundary layer concept. Navier-Stokes equations and some exact solutions. Stokesian flow. Laminar boundary layer equations and methods of solution. von Karman momentum integral equation. Theory of stability of laminar flows. Introduction to turbulent flow.

Prerequisite: ME 311 or Equivalent

ME 533 Ideal Fluid Flow (3-0-3)

Kinematics and dynamics of inviscid fluids in steady and unsteady motion. Two-dimensional and axisymmetric potential flows. Singularities. Complex potential and various transformation techniques. Free-stream line flow. Airfoils and wings.

Prerequisite: ME 311 or Equivalent

ME 534 Conduction Heat Transfer (3-0-3)

Thermal conductivity and law of thermodynamic equilibrium. General heat conduction equation. Boundary conditions involving specified temperature and heat flux, convection and grey body thermal radiation. Thermal circuit concept. Steady one-dimensional conduction: composite walls, heat source systems, extended surfaces. Steady multi-dimensional conduction applications. Unsteady one – and multidimensional heat conduction applications. Phase change with moving boundaries. Numerical and classical analytical solution methods.

Prerequisite: MATH 301 & ME 315 or Equivalent

ME 535 Radiation Heat Transfer (3-0-3)

Radiation from a black body. Definitions and estimation of radiative properties of non-black surfaces. Radiative properties of real materials. Radiation exchange between black and gray surfaces. Thermal radiation between non-diffusion gray surfaces. Radiation exchange between gases and enclosures. Combined convection and radiation heat transfer. Radiative behavior of windows, coatings, and solids. Applications and numerical solution methods.

Prerequisite: ME 315 or Equivalent

ME 536 Convection Heat Transfer (3-0-3)

Convection systems. Derivation of conservation equations and solutions for laminar and turbulent boundary layer flows. Forced convection, internal and external flows. Natural convection. Special topics and applications.

Prerequisite: ME 532

ME 537 Combustion and Emission (3-0-3)

Fundamentals of emission formation in combustion systems. Wall quenching and imperfect combustion. Unburned hydrocarbons, carbon monoxide, aldehydes, nitrogen oxides, species stratification in the combustion chamber, particulates. Effect of design parameters and engine operating variables on emission formation. Emission controls and instrumentation.

Prerequisite: ME 204 or Equivalent

ME 539 Solar Energy Utilization (3-0-3)

Design consideration of various concentrating collectors for thermal and photovoltaic applications. Solar thermal/electric power conservation. Solar thermal energy storage. Solar thermal design methods: f-chart utilizability. Solar space conditioning design and computer simulation models such as TRNSYS. Economic considerations. Solar desalination and other applications. Design projects in selected areas.

Prerequisite: ME 439 or Equivalent

ME 543 Nonlinear Finite Element Analysis (3-0-3)

Introduction, Finite Element Formulation. Small-Deformation Elastic-Plastic Analysis. Finite–Strain Formulation. Implementation of the Finite-Strain Formulation. Practical applications in metal forming processes and structural component design.

Prerequisite: ME 489 or CE 517 or consent of the instructor.

ME 546 Industrial Aerodynamics (3-0-3)

Planetary boundary layer and atmospheric characteristics. Bluff body aerodynamics; separation, vortex shedding, wakes, static and dynamic wind forces. Response of structures to dynamic loading. Applications to buildings, structures, vehicles, etc.

Prerequisite: ME 311 or Equivalent

ME 547 Thermal Environment and Energy Analysis (3-0-3)

Requirement of thermal environment and its effects. Solar radiation measuring techniques and estimation methodology. Heat transmission in buildings. HVAC load and system analyses; computerized techniques. Effects of building configuration, orientation, and systems operation on energy consumption.

Prerequisite: ME 315 or Equivalent

ME 548 Combustion Phenomena (3-0-3)

Flame propagation theories, structure of premixed hydrocarbon flames, mathematical formulations for flame propagation. Diffusion flames, droplet combustion. Detonation and deflagration wave theory.

Prerequisite: ME 204 or Equivalent

ME 549 Thermal Design of Heat Exchangers (3-0-3)

Classification of a variety of heat exchangers, various methods for the exchanger analysis and performance evaluation, pressure drop analysis including header design and flow maldistribution, fouling and its impact on the exchanger performance and life-cycle analysis. Special design considerations for regenerators, plate-fin, tube-and frame, shell-and-tube, reboilers, condensers, evaporators, and direct-contact heat exchangers.

Prerequisite: ME 315 or Equivalent

ME 550 Fundamentals of Astronautics (3-0-3)

Introduction to the solar system, launching, fundamental laws of astrodynamics (space mechanics), orbit maneuvering and determination, important applications in missile trajectories, optimal trajectories, communication satellite and spacecraft attitude, re-entry and hypersonic considerations.

Prerequisite: Graduate Standing

ME 551 Continuum Mechanics (3-0-3)

Tensors, indicial notation, transformation of coordinates. Stresses, principal stresses. Mohr's circles. Deformation and strain. Velocity fields and compatibility conditions. Constitutive equations. Isotropy. Mechanical properties of solids and fluids. Field equations: applications to elasticity, viscoelasticity, plasticity, and fluid mechanics.

Prerequisite: Graduate Standing (also offered under CE 518)

ME 552 Advanced Dynamics (3-0-3)

Fundamentals of Newtonian dynamics. Hamilton's Principle and Lagrange's equations. Relativistic dynamics. Central force motion, stability of circular orbits. Rigid body dynamics. Euler equations of motion, Euler angles, gyroscopic motion, spinning projectile, Hamilton's equations and phase space. Hamilton-Jacobi equation.

Prerequisite: Graduate Standing

ME 553 Advanced Vibrations (3-0-3)

Review of single degree of freedom oscillator: formulation using generalized stiffness, inertia and damping. Damping mechanisms: viscous, friction, and complex. Response to transient and general excitations. Multiple degrees of freedom systems: formulation and methods of solution. Direct stiffness, influence coefficients and variational approaches. Eigenvalue analysis. Vibration of continuous systems. Approximation methods of continuous systems. Modal reduction technique.

Prerequisite: Graduate Standing

ME 554 Elasticity (3-0-3)

Plane stress, plane strain, biharmonic solutions. Problem formulation in Cartesian and polar

coordinates; polynomial, Fourier series and complex variable solutions. Energy theorems and variational techniques. Three-dimensional elasticity. Saint-Venant torsion and bending theory. Navier equation and Galerkin vector.

Prerequisite: ME 551

ME 555 Plasticity (3-0-3)

The physics of plasticity: Plastic deformation, Stress-Strain relations, temperature and rate dependence, crystal plasticity. Constitutive theory: Viscoplasticity, rate-independent plasticity, yield criteria, flow rules and hardening rules, uniqueness theorems, limit analysis. Problems in contained plastic deformation: torsion of prismatic bars, thick walled cylinder, bending of beams. Problems in plastic flow and collapse. Large deformation plasticity. Numerical methods in plasticity.

Prerequisite: ME 551

ME 557 Modern Control of Linear Systems (3-0-3)

Overview of state space modeling of linear systems. Stability of time-invariant linear systems. Controllability and observability conditions. Formulation of tracking and regulator problems. Optimal linear state feedback control. The linear optimal regulator problems. Observers, full-order observers. The optimal observer design.

Prerequisite: ME 413 or Equivalent

ME 558 Rotordynamics (3-0-3)

The basic rotor components, disk, shaft, and bearings. Simple rotor models, natural frequencies, Campbell diagram, instability, and mass unbalance. Finite element modeling of rotor components. Dynamic modal characteristics of rotors, modal transformations, reduced-order equations. Numerical solution of the rotor equations.

Prerequisite: ME 552

ME 559 Random Vibrations (3-0-3)

Introduction to random vibrations and stochastic processes. Spectral analysis and frequency response methods. Auto correlation, Cross correlation, Power-spectral density. Random load transmission. Vibration data processing. Digital and fast Fourier transform. Response of continuous systems to random excitation. Wavelet analysis.

Prerequisite: ME 482 or Equivalent

ME 560 Smart Materials and Structures (3-0-3)

Analysis, design, and implementation of smart structures and systems: modeling of beams and plates with induced strain actuation, piezoelectric ceramics and polymers, shape memory alloys, electro-rheological fluids. Piezoelectric and magnetostrictive sensors and actuators, and fiber optic sensors. Integration mechanics. Damage detection and repair. Applications.

Prerequisite: Graduate Standing

ME 562 Vibration Measurement and Analysis (3-0-3)

Analysis of lumped and distributed parameter systems. Concepts of torsional vibration. Resonances. Frequency response and transfer function methods. Modal analysis. Mathematical modeling using experimental data. Digital Fourier analysis and Fast Fourier Transform. Signal processing. Data acquisition. Data formats. Transducer measurement considerations. Vibration data processing and instrumentation. Typical vibration problems. Fault diagnosis techniques of rotating machinery. Basic balancing of rotors. Resonance and critical speed testing. Machine analysis case studies.

Prerequisite: ME 413 or Equivalent

ME 563 Ultrasonic Testing Techniques (3-0-3)

Theory and principles of elastic wave propagation. Reflection, refraction, and transmission of plane waves. Dispersion and scattering. Guided wave modes. Signal processing. Ultrasonic transducers. Inspection principles of ultrasonic testing. Ultrasonic testing equipment. Material characterization. Ultrasonic flaw detection. Testing of metals. Inspection of non-metals and adhesive bonds. Case studies.

Prerequisite: Graduate Standing

ME 564 Noise and Vibration Control (3-0-3)

Analysis and measurement of sound and vibration as applied to noise control. Review of fundamentals and principles, noise generators. Measurement and analysis of noise and vibration. Noise control; noise criteria, sound absorption and insulation, noise barriers, acoustic enclosures, silencers. Vibration isolation criteria, damping materials, vibration isolating mounts. Studies of machine element noise, fan and flow induced noise, combustion and furnace noise. Fluid piping noise, compressor and pump noise, internal factory noise.

Prerequisite: Graduate Standing

ME 565 Dynamics of Multibody Systems I (3-0-3)

Definition of a multibody system; Mechanical joints and their kinematic constraints; Equations of motion for a multibody system, the constrained form of Lagrange's equation, Lagrange multipliers, joint reaction forces; Coordinate partitioning, the Lagrangian form with embedded constraints; Dynamics of spatial multibody systems, coordinate transformations using Euler parameters, formulation of the joint constraints, Dynamic equations of motion; Introduction to computational methods in dynamics.

Prerequisite: ME 552

ME 570 Experimental Methods in Materials and Processes (3-0-3)

Laboratory investigations of the mechanical, physical, and surface properties of materials. Experimental investigations of materials' behavior during processing and in various operating environments. Experimental design and evaluation of results.

Prerequisite: Graduate Standing

ME 572 Analysis of Manufacturing Processes (3-0-3)

Analytical treatment of the machining and metal-working processes. Metallurgical and economic considerations. Machine tools dynamics and vibration. Trends of current research.

Prerequisite: ME 206 or Equivalent

ME 573 Probabilistic Concepts in Design and Production (3-0-3)

Review of probabilistic concepts and distributions used in design and manufacturing engineering. Linear and nonlinear combination of random variables in probabilistic design. Error propagation and tolerance analysis. Stress-strength interference theory and reliability computations. Monte Carlo simulation. Products and systems failure rates and reliability models. Reliability testing and failure data analysis from complete and censored data using maximum likelihood estimation, method of moments, and graphical techniques using probability papers and computer software. Accelerated life testing, Reliability growth models and analysis. Preventive and corrective maintenance. Some applications in manufacturing.

Prerequisites: STAT 319 or Consent of Instructor.

ME 574 Advanced Materials Science (3-0-3)

Review on crystal structures of materials. Mechanical properties of materials. Solid solutions and phase diagrams. Influence of alloying on transformation and critical cooling rates of steels. Surface treatment of metals and alloys. Structure and mechanical properties of polymers. Structure and mechanical properties of ceramics. Special materials for biomedical and aerospace

applications.

Prerequisite: Graduate Standing

ME 575 Advanced Corrosion Engineering (3-0-3)

Corrosion thermodynamics and kinetics. Effect of environmental factors on major forms of corrosion. Environmental conditioning. Mass transfer and corrosion. Anodic and cathodic protection of metals. Organic and nonmetallic coating. Design for corrosion prevention. Testing, monitoring and inspection. Materials selection for corrosion resistance.

Prerequisite: Graduate Standing

ME 576 Tribology (3-0-3)

Classification of wear modes. Adhesion. Abrasion. Rolling-sliding wear, Erosion, Corrosion, Combined wear modes. Friction and heat transfer calculations. Wear models and testing. Design of wear resistant systems. Selection of wear resistant materials.

Prerequisite: ME 307 or Equivalent

ME 578 Mechanical Properties of Engineering Polymers (3-0-3)

General introduction to polymers and their applications. Types of mechanical behavior. Hookean and rubber elasticity. Plastic deformation. Fracture. Linear viscoelasticity. Dynamic mechanical behavior and testing. Experimental methods. Mechanical properties of polymeric composites.

Prerequisite: ME 574

ME 579 Advanced Mechanical Behavior of Materials (3-0-3)

Description of stress, strain, strain rate and elastic properties of materials. Fundamental aspects of crystal plasticity. Theory and characteristics of dislocations. Strengthening mechanisms at low temperature. Deformation at elevated temperatures and deformation maps. Emphasizing the relationships between microscopic mechanisms and macroscopic behavior of materials.

Prerequisite: ME 574

ME 580 Principles of Metal Forming (3-0-3)

Stress-strain behavior of metals. Introduction to plasticity. Homogeneous and redundant works. Plastic anisotropy. Slab methods. Upper-bound analysis. Slip line field theory. Open and closed die forging. Extrusion of metals. Mechanics of wire drawing, hot and cold rolling, stretch forming, sheet bending. Analysis of deep drawing, tube drawing and tube making.

Prerequisite: ME 572

ME 581 Computer Integrated Manufacturing (3-0-3)

A study of the impact of computers and automation on discrete parts manufacturing. Flexible manufacturing and assembly equipment. CAD/CAM concepts and applications. Process planning and manufacturing scheduling. Materials handling. Robotics. Quality assurance. Tooling and fixtures for CNC systems.

Prerequisite: ME 572

ME 583 Fatigue and Fracture of Engineering Materials (3-0-3)

Stress/Strain controlled Fatigue-Life prediction laws. Continuum fracture mechanics. Fracture modes. Fracture mechanics and microscopic plastic deformation/fracture mechanics combined approach. Cleavage, ductile fracture, fatigue, creep-fatigue and environmental cracking phenomena.

Prerequisite: ME 307 or Equivalent

ME 584 Quality Engineering (3-0-3)

Statistical process control techniques for quality and productivity improvement in production

processes. Quality control charts for variable data and attribute data. Process capability analysis. Acceptance procedures based on the quality of the product. Taguchi's ideas of quality. Experience with statistical quality control software. Case studies. The course will also address documentation using ISO 9000 and other quality standards.

Prerequisite: STAT 319 or Equivalent (not to be taken for credit with SE 534)

ME 585 Advanced Physical Metallurgy (3-0-3)

Review of structure of metals, analytical methods, dislocation and plastic deformations, diffusion, solidification of metals, nucleation and growth kinetics, phase diagrams, thermally activated plastic deformations, fracture and fracture mechanics.

Prerequisite: ME 574

ME 586 Finite Element Analysis in Metal Forming (3-0-3)

General introduction to FEM and metal forming processes. Basic formulation for elastic deformation. Introduction to plasticity and viscoplasticity. Introduction to finite element nonlinear analysis. Small-deformation elastic-plastic analysis. Finite-strain formulation for metal forming analysis. Implementation of the finite-strain formulation. Practical applications; plain strain problems of rolling and bending, axisymmetric isothermal forging, steady-state processes of extrusion and drawing. Sheet metal forming. Thermo-viscoplastic analysis. Future developments.

Prerequisite: ME 206 or Equivalent

ME 591 Special Topics in Thermofluid Sciences I (3-0-3)

Advanced topics are selected from thermofluid area of mechanical engineering. Contents of the course will be provided in detail one semester before its offering. Approval of the Departmental Graduate Committee and the Graduate Council must be secured before offering this course.

Prerequisite: Graduate Standing

ME 595 Special Topics in Engineering Mechanics I (3-0-3)

Advanced topics are selected from engineering mechanics area of mechanical engineering. Contents of the course will be provided in detail one semester before its offering. Approval of the Departmental Graduate Committee and the Graduate Council must be secured before offering this course.

Prerequisite: Graduate Standing

ME 597 Special Topics in Materials & Manufacturing I (3-0-3)

Advanced topics are selected from materials and manufacturing area of mechanical engineering. Contents of the course will be provided in detail one semester before its offering. Approval of the Departmental Graduate Committee and the Graduate Council must be secured before offering this course.

Prerequisite: Graduate Standing

ME 599 Seminar (1-0-0)

Graduate students working towards M.S. degree are required to attend the seminars given by faculty, visiting scholars, and fellow graduate students. Additionally each student must present at least one seminar on a timely research topic. Among other things, this course is designed to give the student an overview of research in the department, and a familiarity with the research methodology, journals and professional societies in his discipline. Graded on a Pass or Fail basis.

Prerequisite: Graduate Standing

ME 606 Independent Research (3-0-3)

This course is intended to allow the student to conduct research in advanced problems in his M.S. research area. The faculty offering the course should submit a research plan to be approved by the Graduate Program Committee at the academic department. The student is expected to deliver a

public seminar and a report on his research outcomes at the end of the course. Graded on a Pass or Fail basis.

Prerequisite: Prior arrangement with an instructor

ME 610 M.S. Thesis (0-0-6)

Prerequisite: ME 599

ME 611 M.S. Statistical Thermodynamics (3-0-3)

Quantum mechanics and statistics. Kinetic description of dilute gases. Classical Quantum mechanics and statistics. Kinetic description of dilute gases. Classical statistics of independent particles. Elementary kinetic theory of transport processes. Thermostatics, properties of ideal gases, kinetic theory of dilute gases. Statistical mechanical ensembles. Thermostatic properties of real substances. Applications.

Prerequisite: Graduate Standing

ME 612 Phase Change Heat Transfer and Two Phase Flow (3-0-3)

Fundamental mechanisms of evaporation and condensation. Bubble equilibrium, nucleation criteria. Pool and flow boiling models and correlations. Two-phase flow models and governing equations. Flow regime transitions. Pressure drop calculations. Measurement techniques. Drop-wise and film-wise condensation, flow and non-flow systems. Enhanced surface boiling and condensation.

Prerequisite: ME 536

ME 632 Advanced Fluid Mechanics II (3-0-3)

Stability of laminar flow and causes of transition to turbulence. Conservation equations and Reynolds stresses. Turbulent boundary layer equations, integral and other methods of solution. Free turbulence, wakes and jets. Statistical analysis; scales of turbulence, correlation functions, spectra. Measuring techniques.

Prerequisite: ME 532

ME 658 Fracture Mechanics (3-0-3)

Fracture modes and stress fields at the crack tip. Stress intensity factors. Griffith and Irwin theories. Crack initiation and propagation. Fracture tests, fracture toughness. Fatigue crack growth. Elastic-plastic fracture mechanics. Numerical methods in fracture mechanics. Mechanisms and mechanics of fracture in engineering components.

Prerequisite: ME 551

ME 661 Nonlinear Systems Dynamic Analysis (3-0-3)

Fundamentals of quantitative and qualitative analysis techniques of nonlinear dynamic systems. Elements of nonlinear systems. Phase plane diagrams, stability and bifurcation of equilibrium and limit cycles, attractors, Lyapunov stability, Poincare’ map. Harmonic balance, K-B averaging, Linstedt-Poincare’ and multiple-time scales methods. Sub-harmonic, super-harmonic, combination and internal resonances. Parametrically excited systems, Mathieu’s equation, and Floquet theory. One and two dimensional maps, structural stability and chaotic attractors, correlation dimensions, Lyapunov exponents and Melnikov’s function. Trends in current research.

Prerequisite: MATH 301 or Equivalent

ME 665 Dynamics of Multibody Systems II (3-0-3)

Review of rigid multibody dynamics, kinematics joints, constraints, and transformation of generalized coordinates. Constrained and unconstrained equations of motion. The mechanics and deformable bodies; rods, beams, and blades. Formulation of the rigid-elastic multibody equations of motion and constrained equations. Computational techniques for deformable mechanisms and

multibody flexible systems. Applications.

Prerequisite: ME 565

ME 666 Dynamics and Control of Mechanical Systems (3-0-3)

Dynamics of mechanical systems. Mechanics of ground and flight vehicles. Introduction to inertia guidance and navigation. Nonlinear control systems; fundamentals of Lyapunov theory, Describing function analysis, feedback linearization, Sliding control. Improving system response via control techniques. Optimal control design. Case studies by computer.

Prerequisite: ME 557

ME 671 Electrode Kinetics (3-0-3)

Application of principles of thermodynamics. Reversible and irreversible electrode processes. Interfacial phenomena. Principles of kinetics. Absorption. Field effects and gas-metal interface. Principles and applications of anodic and cathodic processes to electroplating and extraction of metals. Fuel cells. Case studies.

Prerequisite: ME 575

ME 672 Control of Manufacturing Processes (3-0-3)

Application of computer-based control system techniques to batch manufacturing processes. A brief review of control concepts and servomechanisms with an in-depth study of modeling and control problems associated with several manufacturing processes. These include, but not restricted to, metal cutting, metal forming and welding processes as well as the control problem associated with manipulated robotic arms in a manufacturing context.

Prerequisite: ME 572

ME 673 Metallurgical Processes and Thermodynamics (3-0-3)

Thermodynamic principles. Solutions. Heterogeneous reactions in metallurgy. Kinetics and catalysis. Physico-chemical principles as applied to extraction. Conversion and refining of metals. Applications of metallurgical processes.

Prerequisite: ME 574

ME 675 Phase Transformation in Metals (3-0-3)

Examines the thermodynamics and fundamentals of rate processes in metals. Phenomenological and atomistic points of view are considered. Kinetics of liquid-solid, solid-solid transformations and transport of matter in solids are discussed.

Prerequisite: ME 574

ME 691 Special Topics in Thermofluid Sciences II (3-0-3)

Advanced topics are selected from thermofluid area of mechanical engineering. Contents of the course will be provided in detail one semester before its offering. Approval of the Departmental Graduate Committee and the Graduate Council must be secured before offering this course.

Prerequisite: Graduate Standing

ME 695 Special Topics in Engineering Mechanics II (3-0-3)

Advanced topics are selected from the broad area of mechanical engineering. Contents of the course will be provided in detail one semester before its offering. Approval of the Departmental Graduate Committee and the Graduate Council must be secured before offering this course.

Prerequisite: Graduate Standing

ME 697 Special Topics in Materials & Manufacturing II (3-0-3)

Advanced topics are selected from the broad area of mechanical engineering. Contents of the course will be provided in detail one semester before its offering. Approval of the Departmental Graduate Committee and the Graduate Council must be secured before offering this course.

Prerequisite: Graduate Standing

ME 699: Ph.D. Seminar (1-0-0)

Ph.D. students are required to attend departmental seminars delivered by faculty, visiting scholars and graduate students. Additionally, each Ph.D. student should present at least one seminar on a timely research topic. Ph.D. students should pass the Comprehensive Examination as part of this course. This course is a pre-requisite to registering the Ph.D. Pre-dissertation ME 711. The course is graded as pass or fail. IC grade is awarded if the Ph.D. Comprehensive exam is not yet passed.

Prerequisite: Graduate Standing.

ME 701 Directed Research I (3-0-3)

This course is intended to allow students conduct research in advanced problems in their Ph.D. area of specialization. Among other things, this course is designed to give the students an overview of research in ME, and a familiarity with research methodology, journals and professional societies in his discipline. At the end of the course, the student must deliver a public seminar to present his work and findings. The course is graded on a Pass or Fail basis. To select adequate subject, prior arrangement with the instructor is required.

Prerequisite: Prior arrangement with an instructor; (3 credits – P/F)

ME 702 Directed Research II (3-0-3)

This course is intended to allow the student to conduct research in advanced problems in his Ph.D. research area. The faculty offering the course should submit a research plan to be approved by the Graduate Program Committee at the academic department. The student is expected to deliver a public seminar and a report on his research outcomes at the end of the course. This course is graded on a Pass or Fail basis.

Prerequisite: Prior arrangement with an instructor; (3 credits – P/F)

ME 711 Ph.D. Pre-Dissertation (0-0-3)

This course enables the student to submit his Ph.D. Dissertation Proposal and defend it in public. The student passes the course if the Ph.D. Dissertation committee accepts the submitted dissertation proposal report and upon successfully passing the Dissertation proposal public defense. The course grade can be NP, NF or IC.

Prerequisite: Ph.D. Candidacy, C**o-requisite**: ME 699

ME 712 Ph.D. Dissertation (0-0-9)

This course enables the student work on his Ph.D. Dissertation as per the submitted dissertation proposal, submit its final report and defend it in public. The student passes this course if the Ph.D. Dissertation committee accepts the submitted final dissertation report and upon successfully passing the Dissertation public defense. The course grade can be NP, NF or IP.

Prerequisite: ME 711

MSE COURSES

MSE 501 Material Structure and Defects (3-0-3)

Provides fundamental understanding of the structure and properties or perfect and defective materials. Topics include: Crystallography and crystal structures, Point defects in crystals, Dislocation theory, Grain boundaries.

Prerequisite: Graduate Standing

MSE 502 Thermodynamics of Materials (3-0-3)

This course is a thorough introduction to the basic principles and practical application of

thermodynamics and kinetics appropriate for first year graduate students in materials science and engineering program. The topics covered include: classical and irreversible thermodynamics, phase equilibria, theory of solutions, surface phenomena, thermodynamics and kinetics of chemical reactions, electrochemistry, gas-solid reactions, and brief introduction to diffusion.

Prerequisite: Graduate Standing

MSE 503 Materials Characterization (3-0-3)

Characterization techniques for crystal structure and composition, Characterization methods for phase changes. Nano-indentation. Error analysis and statistical measurements, Crystal structure and grain size, Phase analysis and composition, Microstructure and crystal orientation. The course will include several visits to the materials lab and an experimental term project.

Prerequisite: Graduate Standing

MSE 511 Corrosion in Oil and Petrochemical Industries (3-0-3)

Principles of corrosion; forms of corrosion in oil and gas industries; corrosion in petroleum production and operations; corrosion in petrochemical industry. Corrosion detection and monitoring techniques. Corrosion inhibition fundamentals, quality control, selection and application of oil field water chemistry. Emulsion theory and selection. Control by coating offshore and onshore installations. Economics of corrosion control in oil and gas industry.

Prerequisite: Graduate Standing

MSE 512 Fundamentals of Cathodic Protection Design (3-0-3)

A basic understanding of principle of corrosion, failures by corrosion, principles and methods of corrosion protection. Basic theory and cathodic protection basics. Types of cathodic protection systems. Cathodic protection criteria. Cathodic protection survey and monitoring. Cathodic protection design. Stray current electrolysis.

Prerequisite: Graduate Standing

MSE 521 Deformation and Fracture Mechanics of Structural Materials (3-0-3)

Material microstructure and properties; dislocations and their role in controlling mechanical properties; integration of materials microstructure and solid mechanics principles; mechanical behavior of metallic alloys, engineering polymers and composites. Fracture based on continuum fracture mechanics and microstructural damage mechanisms and relationships between material toughness, design stress, and flaw size. Additional topics include fatigue loading, elevated temperature behavior, material embrittlement, time-dependency, experimental design, and damage-tolerant life prediction.

Prerequisite: Graduate Standing

MSE 522 Failure Analysis (3-0-3)

A review of deformation, ductile and brittle fracture, fracture toughness, failure modes, stress corrosion, hydrogen damage, wear, stress concentration, fracture mechanics, fatigue, techniques and procedures for failure analysis, case studies.

Prerequisite: Graduate Standing

MSE 531 Engineering Nanomaterials (3-0-3)

Synthesis of nano-powders and nanostructured precursors (metals, ceramics, intermetallics, CNT), Manufacturing of bulk nanostructured materials and nanocoatings, Reactivity and handling of nanoparticles, Characterization of nanomaterials, Physical and mechanical properties of nanomaterials.

Prerequisite: Graduate Standing

MSE 532 Engineering Ceramics (3-0-3)

Topics covered include: Bonding in Ceramics, Structure of Ceramics, Processing Technologies,

Properties of Ceramics, and Applications of Ceramics.

Prerequisite: MSE 501

MSE 533 Coatings and Surface Engineering (3-0-3)

Surface science. Surface characterization. Surface modification. Coatings and thin films. Tribology. Surface engineering and control of surface properties.

Prerequisite: MSE 502

MSE 534 Engineering Composite Materials (3-0-3)

Properties, manufacture, forms of composites; micromechanics; orthotropic lamina properties; laminate analysis; theories; failure analysis; thermal, environmental effects.

Prerequisite: Graduate Standing

MSE 535 Biomaterials (3-0-3)

This course introduces engineering students to materials as they interact with biological systems, primarily in medicine. Topics will include an overview of the theory, practice of biomaterial science and introduce them to new materials used for medical applications. The course will include biology and biochemistry background, properties of materials used in medical applications, classes of materials used in medicine, host reactions involved in biomaterials. It will cover also biological testing of biomaterials, degradation of materials in the biological environment, applications of materials in medicine and artificial organs, tissue engineering. Practical aspects of biomaterials including new products and standards will also be covered.

Prerequisite: Graduate Standing

MSE 536 Nanotechnology: Synthesis, Structure and Properties (3-0-3)

Nanotechnology are now in the global spotlightas a new dream material in the 21st century and are broadening their applications to almost all the scientific areas, such as aerospace science, bioengineering, environmental energy, materials industry, medical and medicine science, electronic computer, security and safety, and science education. Now they are known to be superior to any other existing material in mechanical, electrical, and hydrogen storage characteristics.

Prerequisite: Graduate Standing

MSE 541 Electronic, Optical and Magnetic Properties of materials (3-0-3)

Quantitative description of electronic, optical, and magnetic structure-property relationships of materials. Strategies for the development of new materials and introduction to applications of these materials.

Prerequisite: Graduate Standing

MSE 542 Advanced Metal Casting (3-0-3)

Melt treatment, solidification aspects; nucleation and growth, working mechanism of chemical refiners, solid solutions and eutectic solidification, thermal analysis of solidification, micro and macro segregation, unconventional refinement mechanism, conventional and advanced casting processes, mold design, heat-treatment of casting, types of defects, quality control.

Prerequisite: Graduate Standing

MSE 543 Welding Processing and Metallurgy (3-0-3)

This course introduces the basic concepts used in welding and joining. It examines the significance of joining, the process options, and process fundamentals, welding metallurgy and weld ability of materials, design, economics, and inspection and quality control of joining. Specific topics covered in the course will be the physical principles of fusion welding; heat flow; thermal cycles; HAZ and physical metallurgy and mechanical properties of welded joints; applications of welding to large structures; testing of welds; nondestructive testing; design,

economics and weld specifications. Welding Metallurgy: weldability of mild steel, stainless steel, aluminum alloys, and cast iron. Weld Defects: weld cracking, weld defects, welding codes, contractions and residual stresses. Nondestructive testing; radiographic and ultrasonic testing methods, quality control and assurance.

Prerequisite: Graduate standing

MSE 544 Fundamentals of Heat Treatment

Steel Phases, phase transformation diagrams, microstructure-mechanical properties relations, steel heat treatment processes, tool steel heat treatments, processes equipment, nonferrous alloys treatments

Prerequisite: Graduate standing

MSE 545 Non-Ferrous Extractive Metallurgy (3-0-3)

Physical and chemical principles involved in the extraction of non-ferrous metals. Principles of hydro-metallurgical processes; extraction of aluminum, copper, nickel, silver and gold. Refining processes of non-ferrous metals.

Prerequisite: MSE 502

MSE 546 Materials Selection and Design (3-0-3)

Stage of product development, materials performance in service, economic of materials, material selection process, selection of materials for mechanical strength and other properties, design and selection of materials, failure prevention, case studies in design and selection of materials.

Prerequisite: Graduate standing

MSE 547 Finite Element Analysis in Material Science & Engineering (3-0-3)

Introduction to Finite Element Analysis; Finite Element Formulation; Linear and Non-linear FEA; Modeling of Materials (Metal and Non-Metals) for Structural, Thermal including phase change, Fluids, and Electromagnetic analysis; Practical applications in component design and materials processing; Future developments.

Prerequisite: Graduate standing

MSE 590 Special Topics in Materials Science and Engineering I (3-0-3)

Advanced topics are selected from the broad area of Materials Science and Engineering. Contents of the course will be provided in detail one semester before its offering. Approval of the Departmental Graduate Committee and the Graduate Council must be secured before offering this course.

Prerequisite: Graduate standing

MSE 591 Special Topics in Materials Science and Engineering II (3-0-3)

See the description of MSE 590

MSE 599 Seminar (1-0-0)

Graduate students working towards M.S. degree are required to attend the seminars given by faculty, visiting scholars, and fellow graduate students. Additionally, each student must present at least one seminar on a timely research topic. Among other things, this course is designed to give student an overview of research in the department, and a familiarity with the research methodology, journals and professional societies in his discipline. Graded on a Pass or Fail basis.

Prerequisite: Graduate Standing

MSE 606 Independent Research (3-0-3)

This course is intended to allow the student to conduct research in advanced problems in his M.S. research area. The faculty offering the course should submit a research plan to be approved by the Graduate Program Committee at the academic department. The student is expected to deliver a

public seminar and a report on his research outcomes at the end of the course. Graded on a Pass or Fail basis.

Prerequisite: Prior arrangement with an instructor

MSE 610 M.S. Thesis (0-0-6)

Prerequisite: MSE 599

DEPARTMENT OF PETROLEUM ENGINEERING

Chairman

Dr. Abdullah Sultan

Faculty

Abu-Khamsin	Gajbhiye	Mahmoud
Al-Hashim	Al-Dhafeer	Muhammadain
Al-Yousef	Awotunde	
Abdulraheem	Hossain	

The Department of Petroleum Engineering offers graduate studies leading to the degrees of Master of Science and Doctor of Philosophy. The M.S. program was started in 1982 and the Ph.D. program in 1985, and both programs feature multinational student enrollment. The Programs are designed to broaden the student's knowledge in all areas of Petroleum Engineering and to strengthen and deepen the student's understanding in one or more areas of specialty. Particular emphasis is placed on developing the student's research skills and on achieving professional competence in the areas of specialization. The current areas of research and study include Drilling Engineering, Formation Evaluation, Production Engineering, and Reservoir Engineering.

Teaching & Research Facilities

The Department has the following modern, well-equipped laboratories for teaching and advanced research:

- Drilling Fluid Flow Loop Lab
- Drilling Fluid Lab
- Quantitative Analysis Lab
- Stimulation and Formation Damage Lab.
- Core Preparation Lab.
- Rock Mechanics Lab.
- Enhanced Oil Recovery Lab.
- Fluid Properties Lab.
- Rock Properties Lab.
- Oil Well Cementing Lab.
- Production Lab.
- Thin Section Lab.
- Drilling Simulation Lab.
- Well Logging Lab.

The Department's research is directed towards achieving excellence in the areas of Production Engineering and Reservoir Engineering, which are vital for the development of petroleum resources in the Kingdom of Saudi Arabia.

M.S. PROGRAM IN PETROLEUM ENGINEERING

The objectives of the program are: (1) to promote independent thinking and creative petroleum engineering methodology by developing original research, and (2) to prepare highly qualified personnel in the field of petroleum engineering such as researchers, senior engineers, and university faculty.

Admission Requirements

In addition to the Deanship of Graduate Studies' requirements outlined in this bulletin, the following requirements should also be fulfilled.

- A Bachelor of Science degree in Petroleum Engineering equivalent to the KFUPM current undergraduate program in length, content and quality, or a Bachelor of Science degree in other engineering or closely related engineering sciences. In the latter case, applicants will be required to take deficiency courses, with no graduate credit.
- A cumulative GPA of 3.00 or above on a 4.00 scale.
- Acceptable scores in TOEFL and General GRE Tests.

Degree Requirements

- The program requires a minimum of 30 credit hours: core courses of 12 credit hours, elective courses of 12 credit hours, and thesis work equivalent to 6 credit hours. The satisfactory presentation of a seminar is also required. A maximum of 6 credit hours in the elective courses may be taken from other engineering and science graduate courses.
- The elective courses should be chosen in order to provide a coherent study of certain well-defined areas and also serve as a basis for personal interest, future graduate studies, or practice in the oil industry.

The core and major elective courses are listed below:

(a)

PETE 532	Well Performance
PETE 544	Natural Gas Engineering
PETE 545	Advanced Reservoir Simulation
PETE 560	Mathematical Methods in Petroleum Engineering
PETE 599	Seminar

(b) Major Elective Courses

PETE 5xx	PETE Elective I
PETE 5xx	PETE Elective II

(c) Free Electives

XXX 5xx	Technical Elective I*
XXX 5xx	Technical Elective II*

*. From relevant courses offered university-wide including the Petroleum Engineering Department.

Degree Plan for M.S. in Petroleum Engineering

Course No.	Title	LT	LB	CR
First Semester				
PETE 532	Well Performance	3	0	3
PETE 544	Natural Gas Engineering	3	0	3
PETE 560	Mathematical Methods in Petroleum Engineering	3	0	3
		9	**0**	**9**
Second Semester				
PETE 545	Advanced Reservoir Simulation	3	0	3
PETE 5xx	PETE Elective I	3	0	3
XXX 5xx	Technical Elective I*	3	0	3
PETE 599	Seminar	1	0	0
		10	**0**	**9**
Third Semester				
PETE 5xx	PETE Elective II	3	0	3
XXX 5xx	Technical Elective II*	3	0	3
PETE 610	M.S. Thesis	0	0	IP
		6	**0**	**6**
Fourth Semester				
PETE 610	M.S. Thesis	0	0	6
		0	**0**	**6**
Total Credits				**30**

Notes:

- Each student is expected to submit his detailed degree plan according to the above generic degree plan for approval by the Department and the Deanship of Graduate Studies within the 8th week of the second semester of enrollment.
- Students are required to adhere to the regulations of degree plan. No relaxations will be given to any student and the courses taken in conflict of the above will not be counted towards the degree.
- The order of taking the courses can be different from above but students must take the core courses before electives.

*From relevant courses offered university-wide including Petroleum Engineering Department.

PH.D. PROGRAM IN PETROLEUM ENGINEERING

The objectives of the program are to promote independent thinking and creative petroleum engineering methodology by developing original research, and to prepare highly qualified personnel in the field of petroleum engineering such as researchers, senior engineers, and university faculty.

Admission Requirements

Admission requirements, in addition to the Deanship of Graduate Studies requirements given in this bulletin, are:

- An M.S. degree in Petroleum Engineering equivalent to the current KFUPM Petroleum Engineering Master's degree or an M.S. degree in other engineering or closely related sciences. In the latter case, applicants may be required to take deficiency courses, with no graduate credit.
- A cumulative GPA of 3.2 or above on a 4.00 scale.
- Acceptable scores in TOEFL and GRE (Aptitude and Subject) tests.

Degree Requirements

- Completion of a minimum of 30 credit hours distributed as follows:
    - A minimum of 21 credit hours in 500-level, or higher, petroleum engineering courses.
    - A minimum of 9 credit hours in 500-level, or higher, courses in other engineering disciplines or sciences.
- Presentation of two satisfactory seminars.
- Maintaining a cumulative GPA of 3.00 or above in all graduate courses.
- Maintaining a cumulative GPA of 3.00 or above in all undergraduate deficiency courses.
- Passing the Comprehensive Examinations in the major and minor fields given upon completion of the course work, i.e. 30 credit hours.
- Successful completion of a dissertation and its public defense.

Degree Plan for Ph.D. in Petroleum Engineering

Course No.	Title	LT	LB	CR
First Semester				
PETE 5xx	Elective I	3	0	3
PETE 5xx	Elective II	3	0	3
PETE 5xx	Elective III	3	0	3
		9	**0**	**9**
Second Semester				
PETE 5xx	Elective IV	3	0	3
PETE 6xx	Elective V	3	0	3
PETE 6xx	Elective VI	3	0	3
		9	**0**	**9**
Third Semester				
XXX 5xx	Technical Elective VII	3	0	3
PETE 6xx	Elective VIII	3	0	3
XXX 5xx	Technical Elective IX	3	0	3
PETE 699	Seminar	1	0	0
		10	**0**	**9**
Fourth Semester				
XXX 5xx	Technical Elective X	3	0	3
PETE 711	Ph.D. Pre-Dissertation	0	0	3
		0	**0**	**6**
Fifth Semester				
PETE 712	Ph.D. Dissertation	0	0	IP
		0	**0**	**0**
Sixth Semester				
PETE 712	Ph.D. Dissertation	0	0	9
		0	**0**	**9**
Total Credits				**42**

Notes:

- Each student is expected to submit his detailed degree plan according to the above generic degree plan for approval by the Department and the Deanship of Graduate Studies within the 8th week of the second semester of enrollment.
- Students are required to adhere to the regulations of degree plan. No relaxations will be given to any student and the courses taken in conflict of the above will not be counted towards the degree.
- The order of taking the courses can be different from above but students must take the core courses before electives.

COURSE DESCRIPTIONS

PETE 512 Advanced Drilling Engineering I (3-0-3)

This course provides the student with a thorough understanding of the drilling operations and the various factors affecting them. Topics covered include drilling fluid hydraulics, hole stability, penetration rate, buckling and bending of drilling strings, well trajectory control, and optimization of drilling operations.

Prerequisite: Graduate Standing

PETE 513 Advanced Drilling Fluids (3-0-3)

The course provides an in-depth coverage of drilling fluids chemistry and rheology. Coverage includes both classical and evolving drilling fluid systems, clay chemistry, shale stabilization, drilling fluid additives and contaminants, and addresses the various problems and solutions related to drilling fluids.

Prerequisite: Graduate Standing

PETE 523 Well Test Analysis (3-0-3)

The course provides students with the theoretical background and skills needed for well test design and analysis. Solutions of the fundamental flow equation including wellbore storage and skin for slightly compressible fluids are presented and discussed. The general buildup theory and its application to infinite and bounded reservoirs is addressed and discussed. Analysis of common well tests using recently developed methods and techniques to determine reservoir parameters of homogeneous and heterogeneous systems.

Prerequisite: Graduate Standing

PETE 524 Advanced Well Logging (3-0-3)

The course provides the students with the basic and advanced skills and techniques needed to interpret modern well logs. These skills and techniques are then used for identification and evaluation of potential hydrocarbon zones from a standard suite of logs. Clean and shaly formation interpretations are covered. Computer Applications are emphasized.

Prerequisite: Graduate standing and consent of instructor

PETE 532 Well Performance (3-0-3)

The course provides detailed study of the inflow performance relationships and the horizontal, vertical and inclined multiphase flow correlations and mechanistic models. These are then used to determine the current and future performance of the well and the optimum size of the tubing and flow line as well as the optimum production strategy for the whole life of the well. The course emphasizes computer applications through the utilization of student-developed and commercially available software.

Prerequisite: Graduate Standing

PETE 533 Surface Production Facilities (3-0-3)

The course provides a detailed description, performance analysis, and design of oil, water and gas handling facilities. Design of individual components of the production system using hand calculations is first emphasized to provide complete understanding of the physics of the various processes; then, computer programs are utilized. The course concludes with a term project. The project integrates learned material for the design of a complete surface production system.

Prerequisite: Graduate standing and consent of instructor

PETE 543 Advanced Waterflooding (3-0-3)

Detailed analysis of the theory, design, and performance prediction of waterflooding of oil reservoirs. Fundamentals of rock and fluid interactions. The fractional flow equation. Linear

immiscible displacement. Prediction of areal sweep efficiency using the CGM method and stream-tube models. Water injectivity in various flood patterns. Heterogeneous reservoirs.

Prerequisite: Graduate Standing

PETE 544 Natural Gas Engineering (3-0-3)

The course is intended to provide students with the techniques needed to estimate gas reserves for normally and abnormally pressured gas reservoirs, water drive gas reservoirs, and gas condensate reservoirs. Production forecasting and decline curve analysis. Productivity enhancement through gas cycling. Fundamental gas flow equation and its solutions in terms of pressure, pressure squared and pseudo function. Gas well test design and analysis. Analysis of hydraulically fractured gas well tests. Gas field development including reservoir deliverability, total system analysis (inflow/outflow performance of gas wells), and optimum development patterns.

Prerequisite: Graduate Standing

PETE 545 Advanced Reservoir Simulation (3-0-3)

The theory of petroleum reservoir simulation with modern modeling and prediction techniques. Finite difference representation of flow equations. Construction of grid systems and time step selection. Modeling of multi-phase flow. Solution methods of a system of equations.

Prerequisite: Graduate Standing

PETE 551 Petroleum Economic Analysis (3-0-3)

The course covers the principles of economics as applied to the petroleum industry. Economic concepts such as time value of money, profitability measures, cash flow, depreciation, cost estimation, risk and uncertainty analysis are studied in detail. Applications for screening and evaluation of small and major projects are emphasized.

Prerequisite: Graduate Standing

PETE 560 Mathematical Methods in Petroleum Engineering (3-0-3)

The course covers selected topics on advanced mathematical and numerical methods and modeling in petroleum engineering. This includes numerical differentiation, integration, non-linear regression, and numerical inversion of Laplace transforms. Applications include analysis of rock properties, fluid properties, and reservoir engineering.

Prerequisite: Graduate Standing

PETE 580 Virtual Petroleum Engineering (3-0-3)

The course presents real problems and scenarios that simulate a petroleum engineering office environment. A multidisciplinary approach will be the dominant approach to all presented problems. Realistic office settings and simulation of field problems will be used to enhance the learning experience. The course will emphasize problem solving and learning through well-structured assignments and class discussions. Experienced industry experts may be utilized at certain stages of the course.

Prerequisite: Graduate standing and consent of instructor

PETE 590 Special Topics in Petroleum Engineering (3-0-3)

Advanced topics selected from the major areas of petroleum engineering covering recent developments.

Prerequisite: Consent of instructor

PETE 599 Seminar (1-0-0)

Graduate students working towards the M.S. degree are required to attend the seminars given by faculty, visiting scholars, and fellow graduate students. Additionally, each student must present at least one seminar on a timely research topic. Among other things, this course is designed to give the student an overview of research in the department, and a familiarity with the research

methodology, journals and professional societies in his discipline. Graded on a Pass or Fail basis.

PETE 606 Independent Research (3-0-3)

This course is intended to allow the student to conduct research in advanced problems in his M.S. research area. The faculty offering the course should submit a research plan to be approved by the Graduate Program Committee at the academic department. The student is expected to deliver a public seminar and a report on his research outcomes at the end of the course. Graded on a Pass or Fail basis.

Prerequisite: Prior arrangement with an instructor

PETE 610 M.S. Thesis (0-0-6)

Under the supervision of a graduate faculty member, the student selects a problem of interest to the petroleum profession. The student then researches the problem by analytical, numerical, and/or experimental means. The investigation should demonstrate adequate supervised-research skills and the ability to present results in a professional manner. The student should submit a thesis and defend it to a thesis committee.

Prerequisite: PETE 599

PETE 616 Offshore Drilling Engineering (3-0-3)

Offshore platforms and mobile vessels. Motion compensators and risers design. Offshore rigs and equipment. Offshore directional drilling. Wellhead and well control systems.

Prerequisite: PETE 512

PETE 617 Advanced Drilling Engineering II (3-0-3)

This course is intended to cover the recent advances and changes in drilling technology. Emphasis will be on the areas of horizontal and multilateral drilling and completion, slim holes and evolving drilling techniques. Optimization and cost-effective drilling practices are studied in detail with the utilization of available computer packages.

Prerequisite: PETE 512

PETE 627 Automated Well Test Analysis (3-0-3)

The course is intended to introduce the graduate student to the latest technology in well interpretation and design using interactive well test computer models. Common types of well tests and reservoir models, and the identification under various conditions of oil and gas wells are presented and discussed. The graduate student will demonstrate his understanding of the course material through development of a well test program to estimate reservoir parameters based on non-linear regression techniques for several reservoir models.

Prerequisite: PETE 523

PETE 628 Reservoir Characterization (3-0-3)

The course is intended to provide the student with advanced concepts in geostatistics. Spacial correlation, variograms, and covariograms of petrophysical variables. Static (cores, logs, seismic) and dynamic (flow) data are used to characterize the reservoirs. Estimation of spacial distribution of variables using kriging, cokriging, and conditional simulation. Applications of geostatistical techniques to construct reservoir simulation models.

Prerequisite: Graduate Standing

PETE 635 Well Stimulation (3-0-3)

The course starts with detailed discussions of the various types of formation damage, their causes and effect on well productivity. The various stimulation and damage removal methods are then introduced with detailed study of the theory, design and pre- and post-treatment analysis of sandstone and carbonate matrix acidizing. At the conclusion of the course, the student should be able to design a complete stimulation job starting from the selection of the candidate well and

ending with the posttreatment performance evaluation.

Prerequisite: PETE 532 or consent of instructor

PETE 637 Applied Hydraulic Fracturing (3-0-3)

The course provides the student with the knowledge and tools needed to design and analyze hydraulic and acid fracturing jobs. An overview of the fundamentals of rock mechanics and its application to hydraulic fracturing will be presented. Then, the data requirements and various elements of massive hydraulic fracturing treatment design are covered in detail. Finally, the design of fracture treatment using analytical tools and commercial simulators is discussed in detail. The course concludes with a term project to design a fracturing treatment and evaluate the post treatment performance of the well.

Prerequisite: PETE 532

PETE 638 Artificial Lift (3-0-3)

This course is designed to enable the student to first make decisions on the need for artificial lift and the best artificial lift method for any given well and field conditions; then, to design and optimize the artificial lift installation. Students taking this course are expected to be familiar with well performance evaluation and analysis. Therefore, the course concentrates on discussing the various types and applications of artificial lift methods with detailed study of the theory, design and analysis of gas lift, electric submersible pumps, sucker rod pumps, downhole separations and hydraulic pump installations. Recent advances in artificial lift technology will also be highlighted.

Prerequisite: PETE 532

PETE 645 Fluid Flow in Porous Media (3-0-3)

The scope, objectives, and applications of the theory of fluid flow in permeable-rock media. The continuum approach to the description of pathways and barriers. Fluid flow equations for homogeneous fluids. Derivation and generalization of Darcy's law and its applications. Flow and distribution of heterogeneous fluids. Principles and applications of hydrodynamics.

Prerequisite: PETE 560

PETE 648 Enhanced Oil Recovery (3-0-3)

The theoretical and design aspects of enhanced oil recovery methods as practiced in post-waterflood oil reservoirs. Miscible displacement methods including dry, rich, and liquefied petroleum gas. Hot fluid injection. In-situ combustion. Chemical processes employing polymers and/or surfactants. EOR screening criteria.

Prerequisite: PETE 543

PETE 649 Advanced Fluid Properties (3-0-3)

Theoretical and empirical aspects of the properties of petroleum fluids relevant to petroleum reservoir calculations. Phase behavior. PVT tests and correlations. Phase equilibria. Equations of state and phase behavior calculations. Petroleum fluid characterization. Interfacial tension in multi-phase systems. Applications in reservoir simulation.

Prerequisite: Graduate Standing

PETE 670 Reservoir Rock Mechanics (3-0-3)

The course provides detailed coverage of the fundamentals of rock mechanics including the theories of elasticity and failure mechanics, borehole stresses and acoustic wave propagation. Laboratory and field methods of acquiring rock mechanics data relevant to field applications are discussed in detail. The course concludes with thorough discussions of the application of rock mechanics in studying borehole stability, sand control, reservoir compaction and fracturing.

Prerequisite: Graduate Standing

PETE 685 Artificial Intelligence in Petroleum Engineering (3-0-3)

The course provides coverage of both theoretical and programming aspects of artificial intelligence techniques with applications to the various areas of petroleum engineering. The basics of Expert Systems, Artificial Neural Networks, Fuzzy Logic and Genetic Programming will be covered with their applications in reservoir characterization, reservoir engineering, drilling engineering and production operations. The course is concluded with individual projects utilizing commercial software to solve real problems.

Prerequisite: Graduate Standing

PETE 699: Ph.D. Seminar (1-0-0)

Ph.D. students are required to attend Departmental seminars delivered by faculty, visiting scholars and graduate students. Additionally, each Ph.D. student should present at least one seminar on a timely research topic. Ph.D. students should pass the Comprehensive Examination as part of this course. This course is a pre-requisite to registering the Ph.D. Pre-dissertation PETE 711. The course is graded as pass or fail. IC grade is awarded if the Ph.D. Comprehensive exam is not yet passed.

Prerequisite: Graduate Standing.

PETE 701 Directed Research I (3-0-3)

This course is intended to allow the student to conduct research in advanced problems in his Ph.D. Research Area. The faculty offering the course should submit a research plan to be approved by the Graduate Program Committee at the academic department. The student is expected to deliver a public seminar and a report to his research outcomes at the end of the course.

Prerequisite: Prior arrangement with an instructor; (3 credits – P/F)

PETE 702 Directed Research II (3-0-3)

This course is intended to allow the student to conduct research in advanced problems in his Ph.D. Research Area. The faculty offering the course should submit a research plan to be approved by the Graduate Program Committee at the academic department. The student is expected to deliver a public seminar and a report to his research outcomes at the end of the course.

Prerequisite: Prior arrangement with an instructor; (3 credits – P/F)

PETE 711 Ph.D. Pre-Dissertation (0-0-3)

This course enables the student to submit his Ph.D. Dissertation Proposal and defend it in public. The student passes the course if the Ph.D. Dissertation Committee accepts the submitted dissertation proposal report and upon successfully passing the Dissertation proposal public defense. The course grade can be NP, NF or IC.

Prerequisite: Ph.D. Candidacy, **Co-requisite:** PETE 699

PETE 712 Ph.D. Dissertation (0-0-9)

This course enables the student to work on his Ph.D. Dissertation as per the submitted dissertation proposal, submit its final report and defend it in public. The student passes this course if the Ph.D. Dissertation Committee accepts the submitted final dissertation report and upon successfully passing the Dissertation public defense. The course grade can be NP, NF or IP.

Prerequisite: PETE 699 and PETE 711

COLLEGE OF ENVIRONMENTAL DESIGN

DEPARTMENT OF ARCHITECTURAL ENGINEERING

Chairman

Dr. Salah O. Al-Dulaijan

Faculty

Abdou	Al-Hammad	Al-Homoud
Alshaiban	Asif	Budaiwi
Hassanain	Khaiyat	Khan
Kim	Sudhakumar	

Architectural Engineering is a discipline which is concerned with various engineering and economic aspects of design, construction, and maintenance and operation of buildings. The KFUPM graduate program in Architectural Engineering at the College of Environmental Design aims at meeting the needs of the building industry in the Kingdom, while maintaining quality education by incorporating academic, professional and international requirements.

The graduate program of the Architectural Engineering department is designed to prepare highly qualified professionals and researchers in the field with a specialized and in-depth knowledge related to the design, operation and management of the various buildings systems. The program offers students in-depth study in one of the two specialized areas of Facilities Engineering and Management and Building Environmental Control Systems.

The graduate program includes two options namely: Master of Science (M.S. Thesis option) and Master of Engineering (M.Eng., Non-Thesis option). The M. S. program requires 30 credit hours: core courses of 9 credit hours, elective courses of 15 credit hours in addition to 6 credit hours of Thesis Work. The M.Eng. program requires 42 credit hours: core courses of 9 credit hours, elective courses of 30 credit hours and 3 credit hours of Research Project. The structure and options of the Master Degree program are illustrated in the following figure.

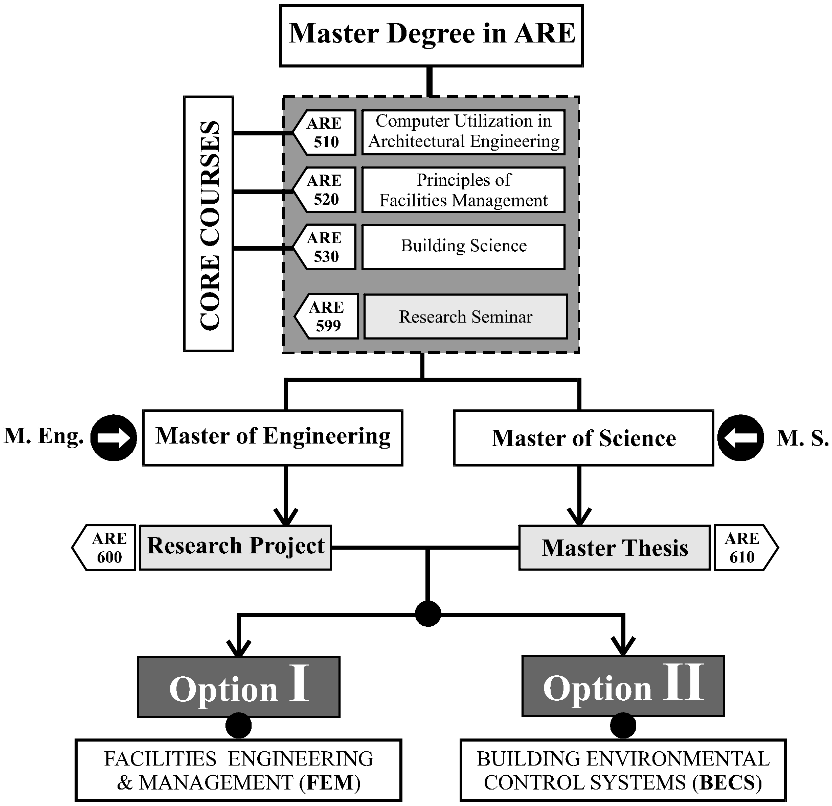

Figure: The structure and options of the Master Degree Program in ARE

Areas of Emphasis

Emphasis is given to the areas of study that are related to the post construction phase which currently characterizes the building industry and the construction sector in the Kingdom. The two main areas of emphasis in the Architectural Engineering graduate program are:

- Building Environmental Control Systems (BECS)
- Facilities Engineering and Management (FEM)

These areas which emphasize building technology and management, not only address the emerging needs of the local building industry, but also give the program a distinct identity and character.

Admission Requirements

Admission to the program requires fulfilling all KFUPM and Graduate Studies requirements. In addition, the applicant should meet the following ARE requirements:

- Bachelor degree in Architectural Engineering, Architecture, Civil and Mechanical Engineering or related Engineering fields equivalent to the KFUPM Bachelor Degree. Applicants whose majors are not Architectural Engineering, Architecture, or Civil Engineering, are required to take ARE 500 as an extra deficiency course without graduate credit.
- The Master of Engineering (M.Eng.) option is unavailable for graduate and research assistants.

M.S. PROGRAM IN ARCHITECTURAL ENGINEERING

The following lists the course requirements for the M.S. Program in Architectural Engineering:

(a). Core Courses

ARE	510	Computer Utilization in Architectural Engineering
ARE	520	Principles of Facilities Management
ARE	530	Building Science
ARE	599	Research Seminar
ARE	610	M.S. Thesis

(b). Elective Courses

1. Nine (9) credit hours: Architectural Engineering Elective courses from the chosen option BECS or FEM.
2. Six (6) credit hours: Approved Free Elective courses, one of which may be from Architectural Engineering Elective courses.

M.ENG. PROGRAM IN ARCHITECTURAL ENGINEERING

The following lists the course requirements for M.Eng. Program in Architectural Engineering

(a). Core Courses

ARE	510	Computer Utilization in Architectural Engineering
ARE	520	Principles of Facilities Management
ARE	530	Building Science

(b). Elective Courses

1. Fifteen (15) credit hours: Architectural Engineering Elective courses from the chosen option (either BECS or FEM).
2. Nine (9) credit hours: The option Free Elective courses (can be taken from Architectural Engineering Elective courses).
3. Six (6) credit hours: Approved Other Free Elective courses (can be taken from relevant KFUPM approved graduate courses outside the department).

Degree Plan for the M.S. in Architectural Engineering

Course	#	Title	LT	LB	CR
First Semester					
ARE	510	Computer Utilization in Architectural Engineering	3	0	3
ARE	520	Principles of Facilities Management	3	0	3
ARE	530	Building Science	3	0	3
			9	**0**	**9**
Second Semester					
ARE	xxx	ARE Elective	3	0	3
ARE	xxx	ARE Elective	3	0	3
ARE	xxx	ARE Elective	3	0	3
ARE	599	Seminar	1	0	0
			10	**0**	**9**
Third Semester					
XXX	xxx	Free Elective	3	0	3
XXX	xxx	Free Elective	3	0	3
ARE	610	M.S. Thesis	0	0	IP
			6	**0**	**6**
Fourth Semester					
ARE	610	M.S. Thesis	0	0	6
Total Credits					**30**

Notes:

- Each student is expected to submit his detailed degree plan according to the above generic degree plan for approval by the Department and the Deanship of Graduate Studies within the 8th week of the second semester of enrollment.
- Students are required to adhere to the regulations of degree plan. No relaxations will be given to any student and the courses taken in conflict of the above will not be counted towards the degree.
- Up to two 400-level elective courses may be allowed on recommendations of advisor.
- The order of taking the courses can be different from above but students must take the core courses before electives.

Degree Plan for M.Eng. in Architectural Engineering

Course	#	Title	LT	LB	CR
First Semester					
ARE	510	Computer Utilization in Architectural Engineering	3	0	3
ARE	520	Principles of Facilities Management	3	0	3
ARE	xxx	ARE Elective	3	0	3
ARE	xxx	ARE Elective	3	0	3
			12	**0**	**12**
Second Semester					
ARE	530	Building Science	3	0	3
ARE	xxx	ARE Elective	3	0	3
ARE	xxx	ARE Elective	3	0	3
ARE	xxx	ARE Elective	3	0	3
			12	**0**	**12**
Third Semester					
ARE	599	Research Seminar	1	0	0
XXX	xxx	Free Elective	3	0	3
XXX	xxx	Free Elective	3	0	3
XXX	xxx	Free Elective	3	0	3
XXX	xxx	Free Elective	3	0	3
			13	**0**	**12**
Fourth Semester					
XXX	xxx	Free Elective	3	0	3
ARE	600	Research Project	0	0	3
			6	**0**	**6**
Total Credits					**42**

Notes:

- Each student is expected to submit his detailed degree plan according to the above generic degree plan for approval by the Department and the Deanship of Graduate Studies within the 8th week of the second semester of enrollment.
- Students are required to adhere to the regulations of degree plan. No relaxations will be given to any student and the courses taken in conflict of the above will not be counted towards the degree.
- The option of nine (9) credit hours of Free Elective courses allows students to take Architectural Engineering Elective courses also.
- The order of taking the courses can be different from above but students must take the core courses before electives.

Course Requirements in the Two Areas of Emphasis

Option I: Building Environmental Control Systems **(BECS)**

ARE Elective Courses

ARE 513 Building Systems Evaluation & Selection
ARE 514 Post-Occupancy Evaluation
ARE 516 Safety Systems in Buildings
ARE 532 Solar Systems in Buildings
ARE 533 Energy Conservation & Management in Buildings
ARE 534 Computer-Aided Building Energy Analysis
ARE 535 HVAC Systems Design
ARE 536 Building Automation & Control
ARE 537 Modeling of Building Thermal Systems
ARE 538 Ventilation and Indoor Air Quality
ARE 543 Lighting Systems Design
ARE 544 Daylighting Design
ARE 547 Building Acoustics
ARE 548 HVAC Noise & Vibration Control
ARE 590 Special Topics in ARE

Free Elective Courses

ME 539 Solar Energy Utilization
ME 547 Thermal Environment & Energy Analysis
ME 564 Noise and Vibration Control

Option II: Facilities Engineering and Management (FEM)

ARE Elective Courses

ARE 511 Construction & Maintenance Modeling
ARE 512 Building Life Cycle Costing
ARE 513 Building Systems Evaluation & Selection
ARE 514 Post-Occupancy Evaluation
ARE 515 Facilities Operation & Maintenance
ARE 516 Safety Systems in Buildings
ARE 517 Building Defects and Maintenance
ARE 522 Facilities Planning and Relocation
ARE 524 Facilities Maintenance Management
ARE 526 Computer-Aided Facilities Management
ARE 528 Real Estate Management
ARE 529 Quality Assessment of Facilities Management
ARE 590 Special Topics in ARE

Free Elective Courses

CEM 510 Construction Planning & Scheduling

CEM 511 Construction Estimating

CEM 512 Value Engineering

CEM 516 Risk Management in Construction

CEM 520 Construction Contracting and Administration

ACCT 501 Financial Accounting

MGT 501 Principles of Management

Other Free Elective Courses

OM 502 Statistical Analysis for Business

OM 511 Management Science

OM 512 Production & Operations Management

SE 501 Introduction to Operations Research Models & theirapplication

SE 529 Advanced Maintenance Planning

SE 539 Systems Safety Engineering

CE 502 Evaluation and Testing of Concrete Structures

CRP 514 Geographic Information Systems

CRP 538 Environmental Planning and Management

MIS 502 Management Information Systems

MIS 510 Information Resource Management

Other graduate courses approved by the ARE department.

COURSE DESCRIPTIONS

ARE 500 Building Materials and Construction Systems (3-0-3)

Properties, behavior and selection of building materials including, cements, aggregate, concrete, masonry, steel, wood and finishing materials. Pre-cast and pre-stressed concrete. Applications of traditional and modern materials, and construction systems under climatic constraints. Methods of construction, excavation foundation and construction equipment.

Prerequisite: Graduate Standing (not for credit for ARE students)

ARE 510 Computer Utilization in Architectural Engineering (3-0-3)

Introductory exposure of students to the use of computers in the building engineering design process, operation and maintenance. Databases organization. The concepts of Computer-Aided Design and Drafting (CADD), Artificial Intelligence (AI), Knowledge-Based Experts Systems (KBES) and Object-Oriented Programming (OOP). Communication and connectivity, Internet and Web environment, multimedia applications. Computer modeling and simulation. Example applications.

Prerequisite: Graduate Standing

ARE 511 Construction and Maintenance Modeling (3-0-3)

Applications of analytical modeling techniques to problems in construction and maintenance management. Topics include the application of decision theory, queuing, equipment maintenance policies, strategies of maintenance, optimization techniques, and simulation applications in building construction and maintenance.

Prerequisite: Graduate Standing

ARE 512 Building Life Cycle Costing (3-0-3)

Life cycle costing approach. Types, uses, sources and output of data. Life cycle costing techniques. Managing risk and uncertainty. Depreciation, replacement and breakeven analysis. Managing project value through life cycle costing. Problems of applications of life cycle costing. Computer applications.

Prerequisite: Graduate Standing

ARE 513 Building Systems Evaluation & Selection (3-0-3)

The need for a rational approach to building systems and materials evaluation. A structured approach to building systems and materials evaluation and selection. Performance requirements criteria, system development, creativity approach, evaluating alternatives; building overall performance; case studies.

Prerequisite: ARE 500 or equivalent

ARE 514 Post-Occupancy Evaluation (3-0-3)

Introduction to post-occupancy evaluation (POE); the building performance concept, measuring performance; elements of building performance: spatial, technological, and technical criteria, total indoor environmental quality (TIEQ), the POE process model: planning, conducting and implementing POE; case studies.

Prerequisite: Graduate Standing

ARE 515 Facilities Operation & Maintenance (3-0-3)

Facilities systems functions and components. Operation, maintenance and disposition of building systems such as structural systems, envelope systems, HVAC and mechanical systems, lighting and electrical systems, security and fire safety systems and energy management systems.

Prerequisite: Graduate Standing

ARE 516 Safety Systems in Buildings (3-0-3)

Life safety concepts in building design and operation. Basic theory of fire development and propagation in confined spaces. Fire protection objectives. Fire detection and suppression systems, and methods of fire control. Fire and smoke control. Selection of construction and building materials. Smoke management and ventilation techniques. Design of architectural details' for safety (e.g. stairs, ramps, entrances exits, etc.).Computer applications.

Prerequisite: Graduate Standing

ARE 517 Building Defects and Maintenance (3-0-3)

Design and appearance: including change of appearance of concrete exposure, cracking in buildings, and protection against corrosion of reinforcing steel in concrete. Foundations and walls, including: concrete on sulfate bearing soils and ground waters, sulfate attack on brick work and rising damp in walls. Floors, roofs and joinery, including: damp-proofing solid floors, clay tile flooring, and built-up felt roofs. Painted surfaces, including: painting of iron and steel, nonferrous metals, and woodwork. Services, including: pipes and fittings for domestic water supply and durability of metals in natural waters.

Prerequisite: Graduate Standing

ARE 520 Principles of Facilities Management (3-0-3)

Principles of facilities management (FM), FM skills, FM functions. Facilities planning and administration, space utilization. Human and environmental factors, health, safety and security. Quality management. Value management, outsourcing and contracting administration. Zoning and code requirements. Building performance. Building support services. Building operation and maintenance management. Approaches and strategies for effective management and operation of facilities. Information systems in FM.

Prerequisite: Graduate Standing

ARE 522 Facilities Planning & Relocation (3-0-3)

Tools, techniques and concepts to solve problems in the planning, design, and management of large complex facilities. Analyzing and organizing facility management functions; linking business plans to strategic, tactical and project planning of facilities; developing a project management team and process; planning and programming facility changes; developing and implementing space allocation procedures and policies (including space standards); forecasting space needs; site search and selection; space planning, programming and interior design; furnishing, finishes and materials specifications; management of large scale moves and relocation.

Prerequisite: ARE 520 or Consent of the Instructor

ARE 524 Facilities Maintenance Management (3-0-3)

Maintenance Management techniques, maintenance standards, maintenance contract types, organizing and staffing of maintenance departments, estimating and budgeting, scheduling and controlling work, improving productivity, computer applications.

Prerequisite: Graduate Standing

ARE 526 Computer-Aided Facilities Management (3-0-3)

Information systems in facilities management. Computer-based FMS applications that include; real estate lease and management, space management, furniture and equipment management, telecommunications and cable management, building operations and maintenance management.

Prerequisite: ARE 520

ARE 528 Real Estate Management (3-0-3)

Overview of property management, real estate analysis and development; types of buildings,

types of tenants, tenants requirements, site evaluation and selection, market search and analysis, and feasibility studies; environmental and government regulations; real estate financing, real estate economics; marketing, financial management, management planning; leasing practices and negotiations, and lease terms and management.

Prerequisite: Graduate Standing

ARE 529 Quality Assessment of Facilities Management (3-0-3)

Facilities and services quality assessment and process management of their effectiveness, concepts of Total Quality Management (TQM), ISO standards, benchmarking, process management, audit activities management including assessment of the effectiveness of the facilities maintenance operations by means of a complete set of audit forms, key components, conducting the audit, annual review, innovation and improvement; case studies.

Prerequisite: ARE 520

ARE 530 Building Science (3-0-3)

Weather and climate; thermal radiation in the environment; water in the environment and its interaction with buildings; heat transfer in building structures, solar radiation influences on buildings. Effect of wind on buildings; air leakage and ventilation. Introduction to total indoor environmental quality including: thermal, visual, and acoustical comfort requirements and design criteria. Design considerations for buildings in hot and hot-humid climates.

Prerequisite: Graduate Standing

ARE 532 Solar Systems in Buildings (3-0-3)

Available solar radiation, radiation on opaque and transparent materials, solar collection, theory and types of solar collectors, performance of solar collectors, energy storage in solar systems, solar water heating in buildings, passive and active solar heating, design of solar heating systems, solar cooling in buildings; economics of solar systems. Computer applications.

Prerequisite: ARE 530 or Consent of the Instructor

ARE 533 Energy Conservation & Management in Buildings (3-0-3)

Energy conservation as a design determinant. Energy use and buildings in Saudi Arabia. Design techniques to minimize energy consumption of building architectural, mechanical and electrical systems. Energy conservation standards. Energy modeling and simulation, evaluation of alternative energy conservation opportunities. Energy management, energy audit. Computer applications.

Prerequisite: ARE 530 or Consent of the Instructor

ARE 534 Computer-Aided Building Energy Analysis (3-0-3)

Building energy systems analysis and evaluation; energy estimating techniques; computer models for estimating building energy consumption; applications of various building energy analysis computer programs; building energy optimization; computer evaluation of alternative building energy conservation measures (ECMs).

Prerequisite: ARE 533 or Consent of the Instructor

ARE 535 HVAC Systems Design (3-0-3)

HVAC systems characteristics. Thermal comfort, heating and cooling load calculations. Ventilation and air quality requirements. System analysis and equipment selection procedures. Air diffusion design and layout techniques. Duct design and distribution, Energy conservation considerations. Computer applications to the analysis and design of HVAC systems.

Prerequisite: ARE 530 or Consent of the Instructor

ARE 536 Building Automation and Control (3-0-3)

Concepts of automatic control systems. Logic of controls and their interaction with the building

and its systems. Control issues related to energy conservation, thermal comfort and indoor air quality in buildings; lighting systems; formulation of control models and their numerical solutions. Selected case studies of control techniques for HVAC systems.

Prerequisite: ARE 535 or Consent of the Instructor

ARE 537 Modeling of Building Thermal Systems (3-0-3)

Thermal comfort systems design performance modeling, equation fitting and mathematical modeling of thermal equipment, system simulation and optimization. Steady-state simulation of large systems, dynamic behavior of thermal systems; economics.

Prerequisite: ARE 535 or Consent of the Instructor

ARE 538 Ventilation and Indoor Air Quality (3-0-3)

Factors determining indoor air quality; measures of quality, sources of pollutants, standards, testing techniques, effects of sub-standards air quality on occupants. The influence of infiltration and ventilation on air quality. Methods of improving indoor air quality; ventilation, filtration, material selection. Current issues.

Prerequisite: Graduate Standing

ARE 543 Lighting Systems Design (3-0-3)

Lighting systems components and characteristics. Visual comfort. Color and lighting. Lighting design calculations methods. System and components selections procedures. Systems analysis, design and layout techniques. Energy conservation considerations. Computer applications.

Prerequisite: Graduate Standing

ARE 544 Daylighting Design (3-0-3)

Introduction to daylighting, daylight availability, solar illuminance, overcast sky and clear sky luminous. Design considerations, lumen methods of skylighting and sidelighting. Daylight factor. Computer applications in daylighting analysis and design, energy conservation and daylighting.

Prerequisite: Graduate Standing

ARE 547 Building Acoustics (3-0-3)

Basics of sound propagation and quantification; people perception of sound and noise; outdoor and indoor noise sources; noise criteria and rating systems; sound insulation. Techniques for controlling air-borne and structure-borne noise. Behavior of sound in enclosures; acoustical comfort requirements for speech and music; sound quality assessment. Mechanical and electrical equipment noise. Architectural detailing for acoustical performance. Computer applications in acoustical measurements, analysis and modeling.

Prerequisite: Graduate Standing

ARE 548 HVAC Noise & Vibration Control (3-0-3)

Noise and vibration, duct-borne transmission; duct-borne flow-generated noise; prediction techniques. Fan noise, calculations of duct-borne noise breakout and controlling techniques. HVAC sound reduction techniques. Noise sources and acoustic characteristics of room units. Plant room noise breakout to adjacent areas. Calculation and analysis techniques for HVAC mechanical equipment noise. Vibration isolation and control strategies. Case studies; Computer applications.

Prerequisite: ARE 535 or Consent of the Instructor

ARE 590 Special Topics in Architectural Engineering (3-0-3)

Advanced topics selected from the major areas of Architectural engineering to provide the students with recent applications and developments.

Prerequisite: Consent of the Instructor

ARE 599 Research Seminar in Architectural Engineering (1-0-0)

Identification of a research topic, literature survey, and topic development. Structured presentation on selected topic. Submission of a research paper.

Prerequisite: Graduate Standing (Equivalent to CEM 599)

ARE 600 Research Project (0-0-3)

Research study that deals with the analysis and/or design of a significant problem related to the field of Architectural Engineering and prepared under the supervision of an ARE faculty. The project report should follow formal report format including an introduction, literature review, research methodology, collection and analysis of data, conclusions and recommendations, list of references and appendices of important information. The research project will be presented and evaluated by a faculty committee.

Prerequisite: Graduate Standing

ARE 606 Independent Research (3-0-3)

This course is intended to allow the student to conduct research in advanced problems in his M.S. research area. The faculty offering the course should submit a research plan to be approved by the Graduate Program Committee at the academic department. The student is expected to deliver a public seminar and a report on his research outcomes at the end of the course. Graded on a Pass or Fail basis.

ARE 610 M.S. Thesis (0-0-6)

An original study on an approved research topic in the field of Architectural Engineering (Building Environmental Control Systems or Facilities engineering and Management) carried out under the supervision of a faculty member in Architectural Engineering.

Prerequisite: ARE 599

DEPARTMENT OF CITY AND REGIONAL PLANNING

Chairman

Dr. Adel S. Al-Dosary

Faculty

Alshuwaikhat	Al-Dosary	Nahiduzzaman
Al-Naser	Rahman	Al-Ramadan

MASTER PROGRAM IN CITY AND REGIONAL PLANNING

Planning is concerned with the forces that generate social development, locational change, economic growth, and in understanding the ways in which resources can best be used. The graduate program in City and Regional Planning at KFUPM is a multi-disciplinary problem-solving curriculum oriented towards the identification and solution of current and future city and regional problems. Nowadays the Master's degree in City and Regional Planning is considered the “standard” professional degree of the field. The program is designed to prepare students to effectively integrate social, economic, legal, political, and scientific theories with planning techniques.

The graduate program at KFUPM is distinctive among planning programs nationally in its emphasis on computer-aided planning and quantitative methods and models useful for rigorous, and systematic analysis of complex problems. The goal of the program is to educate future planners to guide the development of the social, economic, natural and built environments in order to improve the quality of life for people. Graduates in City and Regional Planning enjoy a wide variety of employment options. Their unique multidisciplinary and problem-solving education provides them with the ability to grasp the effects of new technology on all aspects of our society. They find employment with government agencies, consulting firms, as well as in academic institutions.

A Master’s degree of City and Regional Planning (MCRP) is granted after completing 42 semester credit hours with a cumulative GPA of 3.00 or better in all graduate work and satisfactorily completing one seminar (CRP 599) during the degree program.

Admission Requirements

To be eligible for admission, a student must:

- Hold a B.Sc. in City (or Urban) Planning, Architecture, Architectural Engineering, or Civil Engineering. Applicants from programs such as Systems Engineering, Economics, Geography, and other related fields will be required to take deficiency courses depending on their background.
- Meet the general KFUPM requirements.

Academic Program

The requirements of the program are spread over three semesters with a maximum of 12 credit hours per semester for a full-time regular student or a maximum of 9 credit hours for a part-time student. These requirements consist of two parts: 27 credit hours of required courses and 15 credit hours of elective courses. Of the 27 credit hours of required courses, 21 credit hours are lectures, and 6 credit hours are allocated for the Final Planning Project. In addition, each student will take an extra 15 credit hours of elective courses. Six credit hours of these must be from CRP and three must be from other relevant graduate courses offered outside the department; the remaining 6 credit hours can be taken either from CRP or non-CRP courses.

Courses for MCRP Program

(a). Core Courses (28 credit hours)

CRP 501	Planning Theory
CR 502	Planning Legislation
CRP 503	Urban & Regional Land Use
CRP 504	Urban Economics
CRP 505	Statistical Analysis in Planning
CRP 506	Urban Planning Methods
CRP 514	Geographic Information Systems (GIS)
CRP 599	Seminar

CRP 601 Final Planning Project

(b). Elective Courses

The following list of elective courses is arranged in three groups representing distinct areas of specialty in City and Regional Planning. Students can select from among these courses to satisfy the elective courses requirements regardless of the area of specialty they select from.

Area 1:

Quantitative Methods & Computer-Aided Planning

CRP 507 Computer-Aided Planning

CRP 511 Urban Models

CRP 512 Advanced Quantitative Methods

CRP 513 Cartography and Photogrammetry

CRP 515 Advanced Topics in GIS

CRP 519 Special Topics in Computer-Aided Planning

SE 501 Introduction to Operations Research Models & its Application

SE 523 Forecasting Systems

OM 552 Operations Management

MIS 502 Management Information System

CEM 514 Modeling Construction Operations

Area 2:

Socioeconomic Development and Planning

CRP 521 History of Urban Development and Planning

CRP 522 Urban and Rural Sociology

CRP 523 Regional Planning

CRP 524 Cultural & Physical Aspects of the Islamic City

CRP 525 Urban Renewal Planning

CRP 526 Planned Cities and Towns

CRP 527 Rural Development Planning

ECON 501 Principles of Economics

MGT 501 Principles of Management

MGT 552 Organizational Behavior & Leadership

MGT 562 Strategic Management

FIN 531 Real Estate Management

ARE 520 Principles of Facilities Management

ARE 528 Real Estate Management

Area 3:

Land Use and Infrastructure Planning

CRP 531 Planning Workshop

CRP 532 Theory on Urban Form and Design

CRP 533 Public Works Management

CRP 534 Housing Policies

CRP 535	Urban Infrastructure Planning
CRP 536	Urban Transportation Systems
CRP 537	City and Regional Planning in Arid Zones
CRP 538	Environmental Planning and Management
CE 571	Transportation Planning and Modeling
CE 593	Transportation System Analysis
CE 635	Water Resources Planning
CE 676	Environmental Impacts of Transportation Facilities
CEM 510	Project Planning & Scheduling

Degree plan for Master of City & Regional Planning

Course	#	Title	LT	LB	CR
First Semester					
CRP	501	Planning Theory	3	0	3
CRP	502	Planning Legislation	3	0	3
CRP	503	Urban & Regional Land Use	3	0	3
CRP	505	Statistical Analysis in Planning	3	0	3
			12	**0**	**12**
Second Semester					
CRP	504	Urban Economics	3	0	3
CRP	506	Urban Planning Methods	3	0	3
CRP	514	Geographic Information Systems (GIS)	3	0	3
CRP	xxx	CRP Elective	3	0	3
			12	**0**	**12**
Third Semester					
CRP	xxx	CRP Elective	3	0	3
XXX	xxx	Elective*	3	0	3
XXX	xxx	Elective*	3	0	3
CRP	599	Seminar	1	0	0
			10	**0**	**9**
Fourth Semester					
XXX	XXX	Elective*	3	0	3
CRP	601	Final Planning Project	1	12	6
			4	**12**	**9**
Total Credit Hours					**42**

Notes:

- Each student is expected to submit his detailed degree plan according to the above generic degree plan for approval by the Department and the Deanship of Graduate Studies within the 8th week of the second semester of enrollment.
- Students are required to adhere to the regulations of degree plan. No relaxations will be given to any student and the courses taken in conflict of the above will not be counted towards the degree.
- The order of taking the courses can be different from above but students must take the core courses before electives.

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*.At least one of these three elective courses must be from relevant graduate courses offered outside CRP.

COURSE DESCRIPTIONS

CRP 501 Planning Theory (3-0-3)

History and definition of planning, determinants, goals and objectives of spatial planning. Role, legitimacy and authority of planning. General and specific theories, such as descriptive, prescriptive and normative theories, and the context of developing countries.

Prerequisite: Graduate Standing

CRP 502 Planning Legislation (3-0-3)

An overview of planning legislation and a short history of planning process in Saudi Arabia. Methods, techniques and instruments for implementing plans through decrees and administrative acts, the basis for urban and regional planning and its relation to Shariah Law as well as the structure and organization of Saudi public planning administration. Discussion of zoning procedures, subdivision, review practices, and budget preparation and execution.

Prerequisite: Graduate Standing

CRP 503 Urban and Regional Land Use (3-0-3)

History and definition of land use planning. The concept of policy, programming and planning. Determinants and systems guiding land use development. Socioeconomic development and land use. Space requirements, spatial distribution and localization concepts. Land use planning models, and procedures for formal land use plans.

Prerequisite: Graduate Standing

CRP 504 Urban Economics (3-0-3)

Issues of population distribution and economic activities in urban areas. Microeconomic principles, and economic nature of urban systems. Economic aspects and models of urban growth and city size, land use pattern, housing, transportation, environmental problems, unemployment, and public policy.

Prerequisite: Graduate Standing

CRP 505 Statistical Analysis in Planning (3-0-3)

Probability, statistics, decision theory and their applications in city planning. Basic probability concepts, data classification and summarization. Statistical sampling, hypothesis testing, goodness of fit, regression analysis, analysis of variance, contingency tables, and elementary Bayesian decision making. Use of computer statistical packages.

Prerequisite: Graduate Standing

CRP 506 Urban Planning Methods (3-0-3)

Context and role of data and analysis in city and regional planning. Design of survey including questionnaire planning and construction, data collection and data processing. Methods and techniques used in planning such as forecasting, decision models, program evaluation and selection, program scheduling, etc.

Prerequisite: CRP 505

CRP 507 Computer-Aided Planning (3-0-3)

Information and experience inthe rapidly growing field of Computer-Aided Planning. Management Information Systems (MIS), Geographic Information Systems (GIS), Decision Support Systems (DSS), Knowledge Based Expert Systems and Automated Mapping and Graphing. Basic principles common to the design and use of software in each area.

Prerequisite: Graduate Standing

CRP 511 Urban Models (3-0-3)

Introduction to urban systems modeling in planning. Models of population projection, residential location model, urban transportation/land use models, spatial interaction models, gravitational models, employment analysis and economic base and regional income models.

Prerequisite: Graduate Standing

CRP 512 Advanced Quantitative Methods (3-0-3)

Different analytical techniques that are used by planners and policy makers in the planning process. Topics include Multivariate Analysis, Linear Programming, Non-linear Programming, and Queuing Theory. Applications of these techniques in the city and regional planning.

Prerequisite: CRP 506

CRP 513 Cartography and Photogrammetry (3-0-3)

Cartography as an instrumental tool for urban and regional planning. Topographic and thematic maps; maps for basic administrative use; systems and scales of maps; legends, keys and symbols; statistics and maps; terminology and automation of maps. Remote sensing and photogrammetry such as geometry of photographs, stereoscopic vision, terrestrial photogrammetry, etc. Interpretation of terrestrial photogrammetry and maps of all kind.

Prerequisite: CE 260 or Consent of the Instructor

CRP 514 Geographic Information Systems (GIS) (3-0-3)

GIS functional elements, attribute and spatial data structures, remote sensing and GIS, global GIS databases, and GIS Applications. Case studies of GIS adoption and application in Saudi Arabia and abroad. GIS planning and implementation, and future of GIS technology.

Prerequisite: Graduate Standing

CRP 515 Advanced Topics in GIS (3-0-3)

Technical aspects of GIS setup, GIS hardware and software, system configurations and data communications. Coordinate systems, map projections, Digital Elevation Models (DEM), data structures, and Global Positioning Systems (GPS).

Prerequisite: CRP 514

CRP 519 Special Topics in Computer-Aided Planning (3-0-3)

Advanced topics are selected from the area of Computer-Aided Planning.

Prerequisite: Graduate Standing

CRP 521 History of Urban Development and Planning (3-0-3)

History and origin of cities, their functions and structures, and theories of urban development and planning. Impact of contemporary urban development on sociocultural and economic systems and urban policies.

Prerequisite: CRP 501

CRP 522 Urban and Rural Sociology (3-0-3)

Identification of similarities and differences in patterns of family life in urban/rural settings and their influence on urban/rural spatial structures. Relationships between technological and social changes and policies, and their impact on urban/rural spatial organization as well as urban planning and design concepts. Discussion and examination of theories of urban/rural sociology in the context of Third World, Middle Eastern and Saudi Cities.

Prerequisite: Graduate Standing

CRP 523 Regional Planning (3-0-3)

Conceptual basis of regional planning; inter-regional analysis including regional input-output analysis, economic base theory, and migration; intraregional analysis including location of industry, spatial structure of regions, and models of spatial interaction.

Prerequisites: CRP 503, CRP 504

CRP 524 Cultural and Physical Aspects of the Islamic City (3-0-3)

Historical development of traditional Muslim towns. Determinants of “Islamic” urban spatial structure. The physical aspects of urban form and the role of the socio-cultural factors and legal system in the structure of Muslim towns. Urban design principles of traditional Arab and Muslim towns. Discussion of the problems of contemporary Islamic cities and the relevance of the traditional design principles to the building of future cities in the Islamic world.

Prerequisite: Graduate Standing

CRP 525 Urban Renewal Planning (3-0-3)

Changes in urban land use and the socio-economic structures of urban settings, historical districts revitalization and regeneration. Goals, plans and operations of adaptive re-use and regeneration of local traditional and modern districts.

Prerequisite: CRP 503

CRP 526 Planned Cities and Towns (3-0-3)

The origin of new town concepts as an approach to urban development in Saudi Arabia in particular and the Middle East in general. Analysis of planning and designing processes. Examination of issues and problems in new town development. Comparative evaluation of Arab, Islamic and Western new towns. Review industrial towns in Saudi Arabia.

Prerequisite: Graduate Standing

CRP 527 Rural Development Planning (3-0-3)

Ideas, concepts, policies and programs for developing rural areas on national, regional and local level. The links between national policies and rural areas, such as population growth and urbanization and their impact on rural areas. Different models of rural development with specific emphasis on hierarchy in the physical structure ranging from small towns and villages to hamlets (hijar). Specific topics of planning and design of rural areas in the region will be presented.

Prerequisite: Graduate Standing

CRP 531 Planning Workshop (1-8-3)

Physical planning elements and concepts, analysis and design of the plans of a city district (harah) or a city in small teams of students to offer experience with group dynamics. Application of the urban planning process, theories and methods are discussed to solve physical urban/rural problems.

Prerequisite: Graduate Standing

CRP 532 Theory on Urban Form and Design (3-0-3)

Review of architecture and urban design history. Theories and concepts of urban spatial design. Elements and analysis of the concept of urban space. Major theoretical and critical responses to the crises of the modern urban environment. Discussion of urban design concepts through analysis of urban settings in the Gulf region.

Prerequisite: Graduate Standing

CRP 533 Public Works Management (3-0-3)

Principles of legislation and regulations of Public Works Management together with its history. Administrative structure of agencies responsible for public works in the Kingdom. Basic budget appropriation for operation, capital projects and budget balancing, borrowing and subsidies.

Prerequisite: Graduate Standing

CRP 534 Housing Policies (3-0-3)

Overview of the housing stocks and its function as a commodity. The private versus the public housing development process. The user and housing design. Housing rehabilitation and

conservation as a community development strategy. Adaptive re-use, urban revitalization and manufactured housing. The overall evaluation of housing supply and demand versus housing need based on local demographic developments and general housing strategies at the local, regional, and national levels.

Prerequisite: Graduate Standing

CRP 535 Urban Infrastructure Planning (3-0-3)

Planning for and management of urban infrastructure projects. Identification of physical infrastructure systems such as water and sewage systems, urban transportation networks, etc. Management, finance and budgeting, and operation and maintenance of infrastructure projects. Case studies of local urban infrastructure systems.

Prerequisite: Graduate Standing

CRP 536 Urban Transportation Systems (3-0-3)

Planning and management of urban transportation systems. Functional description, planning, and analysis of transportation systems. Characteristics of major transportation modes in Saudi Arabia. Current research, ethnology, and policy issues are stressed.

Prerequisite: Graduate Standing

CRP 537 City and Regional Planning in Arid Zones (3-0-3)

Discussion of problems and planning aspects specific to arid zones. Different factors influencing the built environment in the arid regions including climate, water, vegetation, and soil. Emphasis on basic considerations of urban site's problems; economically related aspects of urbanized regions. Specific problems of construction and site selection; the design of specific urban physical cityscape and landscape in arid zones. Physical planning for sustainable resources.

Prerequisite: Graduate Standing

CRP 538 Environmental Planning and Management (3-0-3)

Major aspects of environmental analysis, planning and management. Problems and principles of site analysis, land use methods, and geologic hazard planning. Natural resource, pollution and residuals management. Economics of renewable and non-renewable resources, and the economic cost of environmental controls. Environmental impact assessment and local case studies of environmental management.

Prerequisite: Graduate Standing

CRP 590 Special Topics in City and Regional Planning (3-0-3)

Advanced topics are selected from the broad area of city and regional planning.

Prerequisite: Graduate Standing

CRP 599 Seminar (1-0-0)

A graduate student working towards his MCRP degree is required to take this course prior to the end of his degree program and contribute to the general area of his Final Planning Project research. Grades are Pass or Fail.

Prerequisite: Graduate Standing

CRP 601 Final Planning Project (1-12-6)

The student has to utilize his knowledge and skills developed during his graduate studies in dealing with a complete city and regional planning problem under the supervision of a CRP graduate faculty member. The student is expected to deal with the selected topic in his chosen area of focus. The Final Planning Project report will be presented and evaluated by a faculty committee representing the student's area of focus.

Prerequisites: All required courses; at least four elective courses.

DEPARTMENT OF CONSTRUCTION ENGINEERING AND MANAGEMENT

Chairman

DR. Khalaf Al-Ofi

Faculty

Al-Hadidi	Al-Khalil	Almohawis
Assaf	Bubshait	Siddiqui
Shash	Trigunishyah	

The graduate program in Construction Engineering & Management (CEM) has been in existence at KFUPM since 1984. The objective of the program is to provide an in-depth coverage of all the established disciplines of construction engineering and management such as construction organization and contracts, project management and control, construction methods, cost engineering, etc. It is designed to prepare fresh graduates for professional careers and to enhance the knowledge and skills of those already practicing the discipline. In the program the theoretical aspects of the discipline are interwoven with the practical ones so as to provide the synergy necessary for the student to have the option of pursuing an academic and/or professional career in the construction industry.

Teaching and Research Facilities

Students enrolled in the CEM program and EM program have access to all the teaching and research facilities in the University including laboratories, computers, educational aids, and the vast array of references available at the library or through the inter-library service. In addition, CEM students have direct access to the CED facilities which include the college library, the microcomputer lab, which is equipped with state-of-the-art personal computers and a good collection of software, the materials laboratory, and the audio-video aids necessary for lectures and special events.

Furthermore, the highly practical nature of the construction discipline provides an additional requirement which is satisfied through the CEM Department’s interface with the engineering and construction firms that provide an indispensable source of information which invigorates the program.

MASTER PROGRAMS IN CONSTRUCTION ENGINEERING AND MANAGEMENT

Admission Requirements

The CEM Department offers a Master of Science (M.S.) degree and a Master of Engineering (M.Eng.) degree both in Construction Engineering & Management degree. Admission to the program requires fulfilling all KFUPM and Deanship of Graduate Studies requirements. In addition, the applicant should meet the following CEM requirements:

- Bachelor’s degree in Engineering (preferably Civil, or Architectural Engineering for CEM) equivalent to the KFUPM Bachelor’s degree.
- Applicants from other institutions or other related fields may have to take extra courses to cover areas of deficiency without graduate credit.

Academic Programs

There are two master’s degree options in Construction Engineering & Management, the Master of Science (M.S.), and the Master of Engineering (M.Eng). The M.S. in CEM option requires the student to complete 30 credit hours; core courses of 12 credit hours, CEM elective courses of 9 credit hours, one KFUPM approved elective graduate course of 3 credit hours, and a 6 credit hours M.S. thesis. The M.E. in CEM option requires the student to complete 42 credit hours which include 24 credit hours of core courses, a 3 credit hours Master of Engineering report, 9 credit hours of CEM electives, 6 credit hours of KFUPM non-CEM graduate courses, and a research seminar. The Master of Engineering in Construction Engineering & Management program is not available to research or graduate assistants.

Degree Plan for M.S. in Construction Engineering And Management

Course	#	Title	LT	LB	CR
First Semester					
CEM	510	Project Planning and Scheduling	3	0	3
CEM	511	Construction Estimating	3	0	3
CEM	520	Construction Contracting and Administration	3	0	3
			9	**0**	**9**
Second Semester					
CEM	530	Construction Engineering	3	0	3
CEM	xxx	Approved Elective	3	0	3
CEM	xxx	Approved Elective*	3	0	3
CEM	599	Research Seminar in CEM	1	0	0
			10	**0**	**9**
Third Semester					
CEM	xxx	Approved Elective	3	0	3
XXX	xxx	Non-CEM Elective**	3	0	3
CEM	610	M.S. Thesis	0	0	IP
			6	**0**	**6**
Fourth Semester					
CEM	610	M.S. Thesis	0	0	**6**
					30

Notes:

- Each student is expected to submit his detailed degree plan according to the above generic degree plan for approval by the Department and the Deanship of Graduate Studies within the 8th week of the second semester of enrollment.
- Students are required to adhere to the regulations of degree plan. No relaxations will be given to any student and the courses taken in conflict of the above will not be counted towards the degree.
- A maximum of two 400-level elective courses may be allowed on the recommendations of the advisor.
- The order of taking the courses can be different from above but students must take the core courses before electives.

***** This elective can be selected from graduate courses within or outside the CEM Department

** This elective is to be selected from outside the CEM Department

Degree Plan for M.Eng. in Construction Engineering And Management (For Part-Time Students)

Course	#	Title	LT	LB	CR
First Semester					
CEM	510	Project Planning and Scheduling	3	0	3
CEM	520	Construction Contracting and Administration	3	0	3
			6	**0**	**6**
Second Semester					
CEM	511	Construction Estimating	3	0	3
ACCT	501	Financial Accounting	3	0	3
			6	**0**	**6**
Third Semester					
CEM	530	Construction Engineering	3	0	3
MGT	501	Principle of Management	3	0	3
			6	**0**	**6**
Fourth Semester					
CEM	xxx	Approved Elective	3	0	3
OM	502	Statistical Analysis for Business*	3	0	3
			6	**0**	**6**
Fifth Semester					
XXX	xxx	Approved Elective%	3	0	3
CEM	xxx	Approved Elective	3	0	3
			6	**0**	**6**
Sixth Semester					
CEM	599	Research Seminar	1	0	0
XXX	xxx	Approved Elective#	3	0	3
CEM	540	Const. Project Management	3	0	3
			7	**0**	**6**
Seventh Semester					
CEM	xxx	Approved Elective	3	0	3
CEM	600	Master of Engineering Report	0	0	3
			3	**0**	**6**
Total					**42**

Notes:

- Each student is expected to submit his detailed degree plan according to the above generic degree plan for approval by the Department and the Deanship of Graduate Studies within the 8th week of the second semester of enrollment.
- Students are required to adhere to the regulations of degree plan. No relaxations will be given to any student and the courses taken in conflict of the above will not be counted towards the degree.
- The order of taking the courses can be different from above but students must take the core courses before electives.

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*. Students can take CRP 505 Urban Statistics in lieu of OM 502.
%. This elective is to be selected from graduate courses from outside the CEM Department.
#. This elective can be selected from graduate courses within or outside the CEM Department

MASTER PROGRAM IN ENGINEERING MANAGEMENT

The program emphasizes academic and research excellence along with professional development of students in a particular area of interest. It also offers a wide selection of courses and research activities related to engineering and management to satisfy the local and global needs of the industry. The engineering management program is an interdisciplinary program that offers students a wide selection of courses from the Construction Engineering & Management Department, Department of Systems Engineering, College of Industrial Management as well as selected courses from other departments.

Program Objectives

- Provide engineers with career advancement opportunities as managers in the areas of engineering, design, research and development projects.
- Assist professional engineering managers to be competitive in the global marketplace.
- Teach the skills and mechanisms necessary to deal with changes associated with managing new and breakthrough technologies.
- Train engineers to plan, design, and manage complex technological projects.

Admission Requirements

To be admitted into the program students must fulfill all the requirements of KFUPM and the Deanship of Graduate Studies. In addition, applicants should have a Bachelor Degree in an Engineering discipline equivalent to a KFUPM Bachelor degree with a cumulative GPA per Deanship of Graduate Studies requirements.

Degree Requirements

Students are required to complete 42 credit hours to graduate with a Master of Engineering Management Degree. This includes 24 credit hours of core courses, 9 credit hours of designated electives from graduate courses in one of three disciplines: Systems Engineering, Industrial Management or Construction Engineering & Management, 6 credit hours of free electives from approved graduate courses, 3 credit hours of Master of Engineering Report and a Research Seminar. The list of core and other courses is given below:

Core course

MGT 501	Principles of Management
OM 502	Statistical Analysis for Business*
EM 510	Engineering Economy
EM 520	Quantitative Methods in Engineering Management
MGT 511	Organizational Theory and Design
CEM 515	Project Quality Management
EM 530	Decision Analysis
EM 550	Engineering Project Management
EM 599	Research Seminar

9 credit hours of elective courses should be selected from one of the disciplines of Systems Engineering, Industrial Management, or Construction Engineering & Management.

Designated elective courses

XXX 5xx	Designated Electives I**
XXX 5xx	Designated Electives II**
XXX 5xx	Designated Electives III**

XXX 5xx	Free Electives I
XXX 5xx	Free Electives II
EM 600	M.E. Report

*. A student can take CRP 505 Urban Statistics in lieu of OM 502
**. All three designated electives should be from one discipline (SE, CIM, or CEM)

Free Electives: 6 credit hours of free electives from graduate courses with the approval of the CEM Department.

Designated Elective Courses from Systems Engineering

SE 511	Computer Aided Design
SE 513	Modeling and System Identification I
SE 523	Forecasting Systems
SE 531	Systems Reliability/Maintainability
SE 536	Human Factors Engineering
SE 539	Systems Safety Engineering
SE 548	Sequencing and Scheduling
SE 567	Work Physiology
SE 569	Human Factors in Computing Systems
SE 570	Optimization Methods for Engineering Designs

The following are other Systems Engineering Courses approved by the CEM Department:

Designated Elective Courses from College of Industrial Management

ACCT 501	Financial Accounting
FIN501	Corporate Finance
ECON 501	Principles of Economics
MIS 502	Management Information Systems
ACCT 510	Managerial Accounting
ECON 510	Managerial Economics
OM 512	Productions and Operations Management
MKT 501	Principles of Marketing
MKT 512	Applied Marketing Research
FIN 510	Managerial Finance
MIS 510	Information Resource Management
MGT 513	Managerial Communication
MGT 521	International Business
MGT 522	Organizational Behavior and Leadership
MGT 523	Leadership, Motivation, and Power
MGT 524	International Comparative Management
MGT 525	Human Resources Management
MGT 526	Management of Organizational Change and Development

MGT 527	Entrepreneurship and Small Business Management
MGT 580	Strategic Management

Designated Elective Courses from Construction Engineering and Management

CEM 510	Project Planning and Scheduling
CEM 511	Cost Estimating
CEM 512	Value Engineering
CEM 513	Construction Productivity
CEM 517	Project Safety Management
CEM 518	Project Cost Management
CEM 520	Construction Contracting and Administration
CEM 522	Globalization and Construction Industry
CEM 525	Project Delivery Systems
CEM 527	Construction Claim and Dispute Resolution
CEM 542	Technological and Innovation in Construction & Project Management
CEM 549	Construction Management Information System

Suggested Free Electives

ICS 585	Knowledge-Based Systems
CRP 533	Public Works Management
CRP 535	Urban Infrastructure Planning
ARE 520	Principles of Facilities Management
ARE 528	Real Estate Management
PETE 551	Petroleum Economic Analysis

Degree Plan for Master in Engineering Management (Part-Time Students)

Course #	Course Title	LT	LB	CR
First Semester				
MGT 501	Principles of Management	3	0	3
EM 520	Quantitative Methods in EM	3	0	3
		6	**0**	**6**
Second Semester				
EM 510	Engineering Economy	3	0	3
OM 502	Statistical Analysis for Business	3	0	3
		6	**0**	**6**
Third Semester				
MGT 511	Organizational Theory and Design	3	0	3
CEM 515	Quality Management	3	0	3
		6	**0**	**6**
Fourth Semester				
EM530	Decision analysis	3	0	3
XXX 5xx	Designated Elective – I	3	0	3
		6	**0**	**6**
Fifth Semester				
XXX 5xx	Designated Elective – II	3	0	3
XXX 5xx	Designated Elective – III	3	0	3
		6	**0**	**6**
Sixth Semester				
EM 550	Engineering Project Management	3	0	3
XXX 5xx	Free Elective1	3	0	3
EM 599	Research Seminar	1	0	0
		7	**0**	**6**
Seventh Semester				
XXX 5xx	Free Elective - II	3	0	3
EM 600	M.E. Report	3	0	3
		6	**0**	**6**
Total Credit Hours				**42**

Notes:

- Each student is expected to submit his detailed degree plan according to the above generic degree plan for approval by the Department and the Deanship of Graduate Studies within the 8th week of the second semester of enrollment.
- Students are required to adhere to the regulations of degree plan. No relaxations will be given to any student and the courses taken in conflict of the above will not be counted towards the degree.
- The order of taking the courses can be different from above but students must take the core courses before electives.

COURSE DESCRIPTIONS

CONSTRUCTION ENGINEERING AND MANAGEMENT

CEM 510 Project Planning and Scheduling (3-0-3)

Planning, scheduling, and control of construction projects using Critical Path Method (CPM) and Project Evaluation and Review Technique (PERT); Resource leveling; scheduling with limited resources; time-cost tradeoffs, introduction to complex networks, short interval production scheduling, and related computer applications.

Prerequisite: Graduate Standing

CEM 511 Construction Estimating (3-0-3)

Introduction to cost aspects of construction, Quantity take-off methods, labor and equipment production rates, Unit Costs, Overhead, and Profits as they relate to the preparation of construction estimates. Creation and coordination of cost control systems with regard to engineering, estimating constructing, purchasing and subcontracting procedures for construction projects, conceptual, Estimating value Engineering.

Prerequisite: Graduate Standing

CEM 512 Value Engineering (3-0-3)

Value engineering concepts, function analysis system techniques (FAST), diagramming, creativity, matrix evaluation, design-to-cost, life cycle costing, human relations and strategies for organizing, performing and implementing value engineering.

Prerequisite: Graduate Standing

CEM 513 Construction Productivity (3-0-3)

Components of the construction productivity system; measurements of productivity: Work sampling, Craftsman's Questionnaire, Foreman Delay Survey, and related techniques. Construction methods improvement: Crew Balance Chart, Flow Diagram and Process Chart, Quality Circles; safety; workers' motivation and productivity improvement programs. Application of above techniques on real construction projects and computer applications.

Prerequisite: Graduate Standing

CEM 514 Modeling Construction Operations (3-0-3)

Model development for construction operations at project site level and at the contractor organization level. Probabilistic models, probability functions, Monte Carlo simulation, queuing simulation, cyclic operation network (CYCLONE), continuous simulation, modeling construction firms through system dynamic approach.

Prerequisite: Graduate Standing

CEM 515 Project Quality Assurance (3-0-3)

The objective of this course is to expose students to quality knowledge and overall strategic plans, customer satisfaction and focus, tools for Quality Project Management, Statistical Process Control, tools for continuous improvement, recent developments in quality in constructed projects, ISO standard, and use of computer application software related to quality management.

Prerequisite: Graduate Standing

CEM 516 Project Risk Management (3-0-3)

Putting risk in perspective, risk and uncertainty, risk management system, decision theory, game theory, utility and risk attitude, multi criteria decision models, simulation, risks and the construction projects - money, time and technical risks, contracts and risks, computer application

Prerequisite: CEM 510, CEM 520 and (OM 502 or CRP 505), Cannot be taken with credit with

EM 530

CEM 517 Project Safety Management (3-0-3)

Introduction to safety management, theories of accident causation, accident investigation, cost of accident, measurement of safety performance, contract provisions that address safety, the role of the different levels of management in safety, the psychological aspects of safety, and computer systems for safety management.

Prerequisite: Graduate Standing

CEM 518 Project Cost Management (3-0-3)

The course includes the application of scientific principles and techniques to the problems of cost planning and cost control. The course covers a variety of issues in cost management including evaluating investment alternatives, life cycle costing, cost analysis methods, cost control and computer applications.

Prerequisite: CEM 511, Cannot be taken with credit with EM 510

CEM 520 Construction Contracting and Administration (3-0-3)

Basic characteristics of the construction industry; interrelationship of the design and construction processes, construction contract documents, bidding and awarding procedures, construction claims and disputes, national labor and procurement regulations, leadership and computer applications.

Prerequisite: Graduate Standing

CEM 522 Globalization and Construction Industry (3-0-3)

The course will expose the students to the differences in construction systems, technology, management and culture among the advanced industrial countries, newly industrialized countries and local construction industry. Globalization movement and its effect on construction industry and local design and construction firms. Special aspects of international projects including investigation, planning, procurement, logistics, personnel and financing.

Prerequisite: Graduate Standing

CEM 525 Project Delivery System (3-0-3)

The historical evolution of project delivery, the role of procurement and contracting methods in project success, strengths and weaknesses of contemporary delivery system. Emphasis will be placed on new trends in the Project Delivery Systems such as Construction Management (CM), Design Build (DB), Build Operate And Transfer(BOT), Build Own, Operate and Transfer (BOOT), etc.: when to use, process variation, procurement, contracts and contract language, performance specification, roles of parties, organization and management, conceptual estimating, Lean construction; computer applications.

Prerequisite: CEM 520

CEM 527 Construction Claim and Dispute Resolution (3-0- 3)

Construction Claims, causes and types of construction claims, construction dispute resolution techniques, problem of traditional dispute resolution techniques, alternatives dispute, resolution techniques, alternatives dispute resolution techniques- Arbitration, mediation, conciliation, dispute, review boards, mini trials, professional ethics, computer applications.

Prerequisite CEM 520 or consent of instructor

CEM 530 Construction Engineering (3-0-3)

Construction Engineering fundamentals, equipment economics, selection and efficient application of equipment, design and simulation of construction operations, analyzing production outputs and cost.

Prerequisite: Graduate Standing

CEM 531 Heavy Industrial Construction (3-0-3)

Design interdependencies, procurement, construction and start-up of heavy industrial facilities, power plants, chemical plants, oil refineries. Design interfaces, specifications, drawings preparation. Procurement contracts, fabrications, quality control. Construction; Site, structural, piping and vessels, electrical, instrumentation. Job planning and organization. Facility start-up, case studies.

Prerequisite: Graduate Standing

CEM 532 Design & Construction of Temporary Support Structures (3-0-3)

Planning and field engineering for temporary support structures. Design and construction of concrete framework, cofferdams, scaffolding, dewatering systems, and other temporary structures required by construction operations.

Prerequisite: Graduate Standing

CEM 533 Introduction to Construction of Harbor, Coastal, and Ocean Structures (3-0-3)

Construction methods and equipment for construction of cofferdams, caissons, wharves, marine terminals, outfall sewers, power plant intakes and discharge, submarine oil and gas pipelines, dredging, offshore platforms, ocean structures, sub-sea and deep ocean facilities, case studies.

Prerequisite: CEM 530

CEM 540 Project Management (3-0-3)

A comprehensive and integrative approach to managing construction projects throughout their life cycles. Policies and procedures for the development of the project manual: Feasibility studies, contract documents, procurement, controls, and turnover.

Prerequisites: CEM 510, CEM 511, CEM 520 , course cannot be taken with credit with EM 550

CEM 542 Technological and Innovation in Construction Project Management (3-0-3)

Technology concepts; terminology and classifications. Construction advanced technologies. Emerging technologies and construction applications. Technology management in construction: R&D; technological innovation; technology deployment; support techniques. Construction technology in Saudi Arabia: innovative behavior; strategy; policy; support systems; university/industry interaction. Research projects for industry applications.

Prerequisites: Graduate Standing, Consent of the Instructor for non-CEM students.

CEM 549 Computer Applications in Construction and Maintenance Management (3-0-3)

Design of computerized Management Information System in the construction industry. Computer application in estimating, planning and scheduling, financial and cost analysis, project control. Maintenance management of bridges, pavements, residential housing, equipment, and automobile parking. Selection of software. Future directions in computerized construction and maintenance research. A term paper which covers the Design and Development of an MIS in Construction and Maintenance Management.

Prerequisite: CEM 510, CEM 511

CEM 590 Special Topics in Construction Engineering and Management (3-0-3)

Advanced topics selected from the major areas of Construction Engineering and Management to provide the student with recent developments.

Prerequisite: Graduate Standing

CEM 599 Research Seminar in CEM (1-0-0)

Introduction to the principles of scientific research: The research question, hypotheses, constructs and their operationalization, research design, internal and external validities of research findings, measurements and their reliability, data collection techniques, basic elements of the research proposal. Grades are pass or fail.

Prerequisite: Graduate Standing

CEM 600 Master of Engineering Report (0-0-3)

A report on an independent study performed under the supervision of a CEM faculty advisor. This paper should include an introduction to the topic, literature review, research methodology, analysis of data, conclusions and recommendations, appendices and references. The report will be presented and orally examined by a faculty committee.

Prerequisites: CEM 510, CEM 511, CEM 520, CEM 530, CEM 599

CEM 606 Independent Research (3-0-3)

This course is intended to allow the student to conduct research in advanced problems in his M.S. research area. The faculty offering the course should submit a research plan to be approved by the Graduate Program Committee at the academic department. The student is expected to deliver a public seminar and a report on his research outcomes at the end of the course. Graded on a Pass or Fail basis.

Prerequisite: Prior arrangement with an instructor

CEM 610 M.S. Thesis (0-0-6)

The student has to undertake and complete a research topic under the supervision of a graduate faculty member in order to probe in-depth a specific problem in Construction Engineering and Management.

Co-requisite: CEM 599

ENGINEERING MANAGEMENT

EM 510 Engineering Economy (3-0-3)

Covers the theory and application of advanced engineering economy principles and methods. Studies the effects of inflation, depreciation and taxes, cost estimation, sensitivity analysis, risk and uncertainty, capital budgeting, multi attribute decision making, advanced asset replacement analysis and real option analysis, Includes case studies and a term project related to the topic.

Prerequisite: Graduate Standing- Student cannot get credit for this course and CEM 518

EM 520 Quantitative Methods in Engineering Management (3-0-3)

Linear Programming: Concepts and Solution Techniques, Transportation and Assignment Models, Inventory Management Models, Queuing Theory, Monte Carlo Simulation, and Computer Applications. This course is equivalent to ARE 511 & CEM 514.

Prerequisite: Graduate Standing-Student cannot get credit for this course and OM 511 or ISE501

EM 530 Decision Analysis (3-0-3)

Covers the theory and practice of decision analysis and risk assessment. Covers decision theory, game theory, utility and risk attitude, probability assessment, and multi-criterion decision-making models. Describes practical applications through real world engineering /project management decision-analysis applications. Computer applications.

Prerequisite: OM 502, CRP 505 or Equivalent- Student cannot get credit for this course and CEM 516 or ISE 527

EM 550 Engineering Project Management (3-0-3)

Covers the elements of project management critical to the success of engineering projects: project management framework, strategic management and project selection, project organization, human aspects of project management, conflicts and negotiations, scope management, time management, cost management, risk management, contracts and procurement, project termination, the project

management office, and modern developments in project management. Integrates and clarifies the principles and tools through case studies from a variety of disciplines.

Prerequisite: Advanced EM Standing**-** Student cannot get credit for this course and CEM 540

EM 599 Research Seminar (1-0-0)

This course is designed to give the student an overview of research in the engineering management specialty and in the department, familiarity with the research methodology, journals and professional societies in the discipline. Graded on a Pass or Fail basis.

Prerequisite: Graduate Standing

EM 600 M.E. Report (0-0-3)

Research study that deals with the analysis and/or design of a significant problem or case study related to the field of Engineering Management prepared under the supervision of an Engineering Management faculty. The project report should follow formal report format including introduction, literature review, research methodology, collection and analysis of data, conclusions and recommendations, list of references and appendices of important information.

Prerequisite: EM 599

COLLEGE OF INDUSTRIAL MANAGEMENT

Dean

Dr. Mohammed Al-Zahrani

Assistant Dean for Graduate Programs

Dr. Aymen Kayal

Faculty

Al-Abdali	Abu-Musa	Aghdam
Al-Ahmadi	Ahmed	Albinali
Al-Algahtani	Al-Alwuhaibi	Kurdi
Amr, A	Al-Ashban	Al-Buraey
	Eid, M	Elamin
Al-Elg		Falattah,
Al-Faraj	Fathollahzadeh	Al-Ghamdi
Al-Ghamdi	Al-Hajji	Halim
Al-Harbi	Hasan	Al-Hazmi,
Al-Jabri	Jameel	Al-Kahtani
Kayal	Khaldi	Khalifa
Madani	Maghrabi	Mahdi
Makkawi	Al-Mansour	Mansour, M
Mat-zin	Al-Meer	Merdad
Miah	Mohammed	Musa, M
Nehari-Talet	Al-Ojairi	Opoku
Al-Qura'n,	Rahman	Ramady
Sadi	Al-Sahlawi	Al-Shammari
Al-Shareef	Al-Shebil	Shuridah
Sohail	Talha	El-Tayeb
Ulussever	Uthman	Walid
Yamani	Al-Zahrani	Al-Zayer

Adjunct Professors

Khumawala

The College of Industrial Management (CIM) offers three graduate degrees: Master of Business Administration (MBA), Executive Master of Business Administration (EMBA), and Master of Accountancy. All graduate programs are periodically reviewed and bench marked against leading business programs in the United States and revised to remain topical and current with evolving business trends. The graduate programs at CIM are coordinated by the Assistant Dean of the college. An outstanding faculty committed in its efforts toward continuous improvement, through the adoption of new technologies, emphasis on global perspectives and attention to ethical issues, places the CIM business curricula at par with the leading business programs around the world. All aspects of the program are designed to conform to the AACSB standards.

Teaching & Research Facilities

Building 24 is home of CIM. All teaching and computer lab facilities at CIM are smart classrooms equipped with integrated audio-visual and digital projection technologies, as well as wireless internet connection. In addition, all CIM courses utilize the latest online systems for teaching and learning offered by KFUPM.

MASTER OF BUSINESS ADMINISTRATION (MBA)

The College of Industrial Management offers a Master of Business Administration (MBA) degree which provides the necessary education and skills to prepare students to work and perform successfully at all levels of management. The program covers all the functional areas of business and allows the students to take additional elective courses that match their career aims and their personal goals and development which allows them to further integrate all functional areas and gain the essential overall view of organizational performance. The program accepts both full and part-time students and provides a list of deficiency courses for those whose educational background is not in business fields. Various teaching technologies are utilized including cases, team projects, field research, and simulations.

While the overall orientation of the program is general business management, it also puts sufficient emphasis on the international dimensions of organizational management and on the application of the theory and skills to the Saudi business environment.

Admission Requirements

An applicant for admission to the MBA program should:

- Meet the admission requirements of the Deanship of Graduate Studies at KFUPM.
- Have a four-year baccalaureate (BA or BS) degree from a recognized and reputable institution.
- Have a Grade-Point Average (GPA) of 2.5 or higher on a 4.0 scale in previous university work.
- Have at least one course in college level calculus, which covers both differentiation and integration.
- Have a working knowledge of computers as evidenced by at least one course in that area (e.g. data processing, programming, information systems, etc.).
- Have at least one-year full-time work experience. This requirement may be waived for graduate assistants, research assistants, and applicants with exceptional academic records.
- Have an acceptable score in the GMAT and TOEFL, or acceptable evidence of proficiency in the English Language.

Admission with Deficiencies

Students who have deficiencies in some or all of these areas may be provided with the opportunity to enroll in the deficiency courses offered by the College of Industrial Management. The following conditions will apply to such students:

- They are admitted as Pre-MBA students and are not allowed to enroll in the MBA core and elective courses until they complete all of their deficiency courses. A student who is left with only 3 or 6 credit hours in the Pre-MBA courses may be allowed to enroll in some core courses with the approval of the Department Chairman and Dean of Graduate Studies.
- All Pre-MBA courses must be completed with a cumulative GPA of 3.00 or more for the student to be admitted to the MBA program.
- Pre-MBA courses will not count in the MBA program GPA calculation for purposes of graduation. The MBA cumulative GPA will include grades in the core, elective and research requirement courses only.

Each applicant's academic record will be reviewed. The applicants who are deficient in the basics and fundamentals of business functional areas will be provided with the opportunity to enroll in all or some of the following three credit hour deficiency courses:

ACCT 501 Financial Accounting

ECON 501 Principles of Economics

FIN 501 Corporate Finance

MGT 501 Principles of Management

MKT 501 Principles of Marketing

MIS 502 Management Information Systems

OM 502 Statistical Analysis for Business

Deficiency Courses Waiver Guidelines

The deficiency courses will be waived according to the following guidelines:

- ACCT 501 - Financial Accounting may be waived for those whose BS or BA was in Accounting and for others through the successful completion of two courses in the principles of financial accounting (at KFUPM ACCT 201 and ACCT 202) or equivalents with a grade of 'C' or better in each of the two courses.
- ECON 501 - Principles of Economics may be waived for those whose BS or BA degree was in Economics and for others through the successful completion of two principles of economics (macro and micro) courses (at KFUPM ECON 101 and ECON 202) or equivalents with a grade of 'C' or better in both courses.
- FIN 501 - Corporate Finance may be waived for those whose BS or BA degree was in Finance and for others through the successful completion of FIN 301 at KFUPM or equivalent with a grade of 'C' or better .
- OM 502 -Statistical Analysis for Business may be waived through the successful completion of OM 201 and OM 202 at KFUPM or equivalents with a grade of 'C' or better in both courses. Student should check with the office of the Assistant Dean for other KFUPM equivalent courses that apply.
- MGT 501- Principles of Management may be waived for those whose BS or BA degree was in Management and for others through the successful completion of MGT 301 at KFUPM with a grade of 'C' or better.
- MKT 501 - Principles of Marketing may be waived for those whose BS or BA degree was in Marketing and for others through the successful completion of MKT 301 KFUPM or equivalent with a grade of 'C' or better.
- MIS 502 - Management Information Systems may be waived for those whose BS degree was in MIS and for others through the successful completion of MIS 215 at KFUPM or equivalent with a grade of 'C' or better. Student should check with the office of the Assistant Dean for other KFUPM equivalent courses that apply.

Degree Requirements

The candidates for the MBA degree are those students who have been admitted to the program and are not required to take deficiency courses or have completed their required deficiency courses with a cumulative GPA of at least 3.00 on a scale of 4.0, and fulfilled all admission provisions. The MBA degree requirements consist of 45 credit hours of which 30 credit hours are in core courses, 12 credit hours in electives and 3 credit hours in the research requirement. The MBA degree course requirements are as follows:

Core Courses

ACT 510	Managerial Accounting
ECON 510	Managerial Economics
FIN 510	Managerial Finance
MIS 510	Information Resource Management
MGT 511	Organizational Theory and Design
MGT 580	Strategic Management
MKT 513	Strategic Marketing
MKT 512	Applied Marketing Research
OM 511	Management Science
OM 512	Production and Operations Management

Elective Courses

Each student is required to take 12 credit hours from the list of elective courses. The student is given the freedom and flexibility to tailor his electives to meet his personal and career goals and interests. A student may elect to broaden his knowledge and skills by taking his electives from different functional areas or he may elect to concentrate all of his electives in one functional area to gain depth and specialization in that area.

In addition to the MBA elective courses available to the MBA students in the College of Industrial Management, a student may take one of his electives from other graduate courses offered in the University with the approval of the Department Chairman and the Dean of Graduate Studies. A list of elective courses is given below:

ACCT 512	Cost Management Systems
ACCT 515	Computerized Accounting Information Systems
ACCT 526	Fundamentals of Internal Auditing
ACCT 527	Operational Auditing
ACCT 592	Independent Research in Accounting
ECON 511	The Macroeconomic Environment of Business
ECON 512	Econometrics
ECON 520	Microeconomic Analysis
ECON 522	International Trade
ECON 525	Energy Economics
ECON 592	Independent Research in Economics
FIN 520	Financial Policy
FIN 521	International Finance
FIN 522	Financial Institution
FIN 523	Investment Analysis
FIN 525	Options, Futures, and Other Derivative Securities

FIN 529	Bank Management
FIN 531	Real Estate Management
FIN 592	Independent Research in Finance
MIS 512	Data Management
MIS 515	Systems Analysis Methodologies
MIS 525	Management Support Systems
MIS 530	Seminar in MIS
MIS 592	Independent Research in MIS
MGT 513	Managerial Communications
MGT 521	International Business
MGT 522	Organizational Behavior
MGT 523	Leadership, Motivation, and Power
MGT 524	International and Comparative Management
MGT 525	Human Resources Management
MGT 526	Management of Organizational Change and Development
MGT 527	Entrepreneurship and Small Business Management
MGT 592	Independent Research in Management
MKT 520	International Marketing
MKT 521	Buyer Behavior
MKT 523	Marketing Communications
MKT 525	Marketing Channels Management
MKT526	Services Marketing
MKT592	Independent Research in Marketing
OM515	Business Forecasting
OM516	Decision Analysis
OM519	Business Simulation
OM521	Management of Inventory Systems
OM592	Independent Research in OM

Research Requirement of three (3) Credit Hours

Each student is required to complete 3 credit hours in an independent research course (XXX 592) in any of the functional fields of business administration. Under the direction of an MBA faculty member, the student is expected to conduct a study that involves identification of business problems, literature review, data collection, systematic data analysis, and presentation (oral and written) of the problems, the methods, the results, and the conclusions.

Pre-MBA Requirements for Non-MBA Students

Course	#	Title	LT	LB	CR
First Semester					
ACCT	501	Financial Accounting	3	0	3
ECON	501	Principles of Economics	3	0	3
MGT	501	Principles of Management	3	0	3
			9	**0**	**9**
Second Semester					
MIS	502	Management Information Systems	3	0	3
FIN	501	Corporate Finance	3	0	3
OM	502	Statistical Analysis for Business	3	0	3
MKT	501	Principles of Marketing	3	0	3
			12	**0**	**12**
Total Credits Hours					**21**

Degree Plan for Master of Business Administration

Course	#	Title	LT	LB	CR
First Semester					
ACCT	510	Managerial Accounting	3	0	3
ECON	510	Managerial Economics	3	0	3
OM	511	Management Science	3	0	3
MGT	511	Organizational Theory & Design	3	0	3
			12	**0**	**12**
Second Semester					
OM	512	Production and Operations Management	3	0	3
MKT	513	Strategic Marketing	3	0	3
FIN	510	Management Finance	3	0	3
MIS	510	Information Resources Management	3	0	3
			12	**0**	**12**
Third Semester					
MKT	512	Applied Marketing Research	3	0	3
XXX	xxx	Elective 1	3	0	3
XXX	xxx	Elective 2	3	0	3
XXX	xxx	Elective 3	3	0	3
			12	**0**	**12**
Fourth Semester					
MGT	580	Strategic Management	3	0	3
XXX	592	Independent Research	0	0	3
XXX	xxx	Elective 4	3	0	3
			6	**0**	**9**
Total Credit Hours					**45**

Notes:

- Each student is expected to submit his detailed degree plan according to the above generic degree plan for approval by the Department and the Deanship of Graduate Studies within the 8^{th} week of the second semester of enrollment.
- Students are required to adhere to the regulations of degree plan. No relaxations will be given to any student, and courses taken in conflict of the above will not be counted towards the degree.
- The order of taking the courses can be different from above, but students must take the core courses before electives.

THE EXECUTIVE MASTERS OF BUSINESS ADMINISTRATION (EMBA)

The overall purpose of the Executive MBA program is to offer a unique learning opportunity for mid-career and senior executives in the Kingdom of Saudi Arabia and GCC region who wish to enhance their business knowledge and effectiveness while remaining actively involved in their business and professional careers.

The program is designed to develop the strategic thinking and leadership skills of participants, as well as enhancing their understanding of the global economy, and using information technology in order to prepare them for the challenging roles as business executives in a rapidly changing and globally competitive business environment that demands new perspectives and continuous self renewal to transform business challenges into opportunities. The program emphasizes crossfunctional business knowledge, teamwork and group study, and value creation as the prime raison deter of contemporary business enterprises.

Admission Requirements

Admission requirements for the EMBA program are:

- A baccalaureate degree from a recognized institution of higher education,
- Evidence of English proficiency,
- A minimum of 8 years work experience including 3 years at mid or upper level managerial position. Candidates with less than 8 years of work experience could be accepted as exceptional cases based on recommendation by the EMBA Committee and the Assistant Dean of CIM.

All candidates must submit a completed admission application form supported by the following:

- Three recommendation letters ,
- A current resume,
- A letter of endorsement from the applicant’s employer (if applicable) clearly demonstrating the employer’s understanding of the demands of the program and their willingness to support the applicant’s admission to the program by making a commitment to releasing the applicant from normal job responsibilities during days that classes are held.

All applications are evaluated and potential candidates are invited for personal interviews conducted by a team consisting of the CIM Assistant Dean for Graduate programs and members of the EMBA Standing Committee. The interview is usually aimed at evaluating the candidate’s personal attributes (ambition, motivation, commitment, communication and interpersonal skills) deemed necessary for success and benefit from the EMBA. It also offers the interview team an opportunity to informally assess the applicant’s English language proficiency and their capacity to meet the demands of the program.

Academic Program

Required courses are as follows:

ACCT 551	Financial Accounting and Reporting
ACCT 552	Managerial Accounting
ECON 551	Managerial Economics
ECON 561	The Macro Environment of Business
FIN 554	Managerial Finance
FIN 562	Strategic Corporate Finance
MGT 551	Behavior & Organization
MGT 554	Business Negotiations
MGT 560	Ethics & Leadership

MGT 561	International Business & Globalization
MGT 562	Strategic Management
MGT 564	Corporate Governance
MIS 564	Electronic Business Strategy
MKT 561	Strategic Marketing Management
OM 551	Quantitative Methods
OM 552	Operations Management

Degree Plan for Master of EMBA Program[7]

First Semester			
Course	**#**	**Course Title**	**Credit Hours**
ECON	551	Managerial Economics	3
OM	551	Quantitative Methods	3
MGT	551	Behavior & Organization	3
ACCT	551	Financial Accounting and Reporting	2
Second Semester			
ACCT	552	Managerial Accounting	3
OM	552	Operations Management	3
FIN	554	Managerial Finance	3
MGT	554	Business Negotiations	2
Third Semester			
MKT	561	Strategic Marketing Management	3
ECON	561	The Macro Environment of Business	2
MGT	561	International Business and Globalization	3
MGT	560	Ethics & Leadership	2
Fourth Semester			
FIN	562	Strategic Corporate Finance	3
MIS	564	Electronic Business Strategy	3
MGT	562	Strategic Management	3
MGT	564	Corporate Governance	2
Total Credit Hours			**42**

Notes:

- Students are required to adhere to the regulations of the degree plan. No relaxations will be given to any student, and courses taken in conflict of the above will not be counted towards the degree.

[7] Residency period for the program is one week.

MASTER OF ACCOUNTANCY PROGRAM

The Master of Accountancy Program (M. Acc) is designed to provide students with accounting education for careers in the accounting profession, with emphasis on both the theoretical and practical aspects of the discipline. This program will provide effective support for the accounting profession and businesses at the national, regional, and international levels.

The focus of the program is to ensure that graduates gain the accounting knowledge necessary to meet the educational standards of the accounting profession. This program prepares students to cope with the rapid changes in the theory and practice of the accounting profession which is a requisite to a successful career as a professional accountant and as an executive in industry, commerce, non-profit organizations, and the government sector.

Admission Requirements

Each student is required to have successfully completed eleven (11) courses in Accounting (33 credit hours) in the Undergraduate Accounting Program or their equivalent. These courses include Principles of Accounting I, Principles of Accounting II, Accounting Information Systems, Intermediate Accounting I, Intermediate Accounting II, Cost Accounting, Managerial Accounting, Advanced Accounting, Auditing, Accounting for Governmental and Non-Profit Entities, and Accounting Theory and Research. Any deficiency must be met before admission to candidacy for the Master of Accountancy Degree.

Degree Requirements

The program requirements are presented in the following four (4) sections:

Accounting Core (18 credit hours)

The following eighteen (18) credit hours are required in each student's Graduate Program for a Master of Accountancy Degree:

ACCT 512	Cost Management Systems
ACCT 515	Computerized Accounting Information Systems
ACCT 516	Seminar in Accounting Theory
ACCT 517	Seminar in Professional Accounting and Auditing
ACCT 518	Accounting Policy and Practice Workshop
ACCT 528	Independent research in Accounting

Business Core (9 credit hours)

Each student must take three (3) of the following courses:

FIN 510	Managerial Finance
MGT 520	Organizational Theory & Design
MGT 590	Business Policy
MIS 510	Information Resources Management
OM 510	Quantitative Business Analysis

Electives (6 credit hours)

A student can choose six (6) credit hours from the following courses:

ACCT 504	Advanced International Accounting
ACCT 514	Advanced Accounting for Governmental & Non-Profits Entities
ACCT 519	Professional Accounting Ethics and Legal Responsibility

ACCT 520	Internal and EDP Accounting
ACCT 523	Advanced Accounting Systems Analysis Design
ACCT 524	Research Methodology in Accounting
ACCT 526	Foundations of Internal Auditing
ACCT 527	Operational Auditing
FIN 520	Financial Policies
FIN 521	International Finance
MGT 521	International Business
ACCT 600	Written Comprehensive Examination

Comprehensive Examination

Each student who successfully completes all required class work must take a written comprehensive examination in Accounting. This exam is administered by the Department of Accounting and Management Information Systems. Students are allowed two chances to pass the comprehensive exam. If a student fails the exam in his first attempt, he will be given a second chance next semester. Failure to pass this exam for the second time will lead to discontinuation of the student from the program. The comprehensive exam is graded on pass or fail basis.

Degree Plan for Master of Accountancy

Course	#	Title	LT	LB	CR
First Semester					
ACCT	512	Cost Management Systems	3	0	3
ACCT	515	Computerized Accounting Information Systems	2	2	3
XXX	xxx	Business Core Course	3	0	3
			8	**2**	**9**
Second Semester					
ACCT	516	Seminar in Accounting Theory	3	0	3
ACCT	517	Seminar in Professional Accounting and Auditing	3	0	3
XXX	xxx	Business Core Course	3	0	3
			9	**0**	**9**
Third Semester					
ACCT	518	Accounting Policy and Practice Workshop	3	0	3
ACCT	528	Independent Research in Accounting	3	0	3
XXX	xxx	Business Core Course	3	0	3
XXX	xxx	Elective	3	0	3
			12	**0**	**12**
Fourth Semester					
XXX	xxx	Elective	3	0	3
ACCT	600	Written Comprehensive Exam	0	0	0
Total Credit Hours					**33**

Notes:

- Each student is expected to submit his detailed degree plan according to the above generic degree plan for approval by the Department and the Deanship of Graduate Studies within the 8th week of the second semester of enrollment.
- Students are required to adhere to the regulations of degree plan. No relaxations will be given to any student, and courses taken in conflict of the above will not be counted towards the degree.
- The order of taking the courses can be different from above, but students must take the core courses before electives.

MBA COURSE DESCRIPTIONS

ACCOUNTING

ACCT 501 Financial Accounting (3-0-3)

Financial accounting principles underlying accounting statements as they apply to financial statements of business firms, accounting system and records, income measurement and asset valuation. Emphasis on interpretation and uses of financial statements.

ACCT 510 Managerial Accounting (3-0-3)

Development and uses of accounting data for management decision-making; cost concepts, behavior, and systems; activity-based costing; pricing, process, and activity decisions; budgeting, planning and control; contemporary management accounting issues. Emphasis on real-world situations.

Prerequisite: ACCT 501 or waiver of this prerequisite according to the waiver guidelines.

ACCT 512 Cost Management Systems (3-0-3)

Problems with traditional cost allocation methods, design of operational control and performance evaluation, non-financial measurement of performance, activity-based costing systems, application of activity-based cost systems in manufacturing and service industries, cost accounting and most management system in high technology business. Readings and cases.

Prerequisite: ACCT 510 or equivalent

ACCT 515 Computerized Accounting Information Systems (2-2-3)

Role of accounting information systems within companies' operating environments, their capabilities and limitations, accounting information system data for gathering and processing, internal controls in computerized accounting systems analysis and designs, accounting decision support and expert systems, computerized accounting systems in small businesses, service industries, and not-for-profit organizations. A comprehensive project is required.

Prerequisite: ACCT 510 or equivalent

ACCT 526 Foundation of Internal Auditing (3-0-3)

Concepts and principles of internal auditing, professional standards, internal auditing process; internal control, audit evidence, EDP auditing, fraud; internal audit skills; problem solving, audit communication and behavioral skills, statistical sampling; information technology; administration of internal auditing department. Cases and a project are required.

ACCT 527 Operational Auditing (3-0-3)

Operational auditing concepts and techniques, functional audits, control and assessments of management controls, ISO and TQM, operational audits in governmental and not-for-profit organizations. Cases and project are required.

Prerequisite: ACCT510 or equivalent

ACCT 592 Independent Researches in Accounting (0-0-3)

A research proposal must be submitted in writing by the student and approved by the supervising faculty member and the MBA Chairman prior to registration. The student is required to conduct a research study in the area of accounting that is business related and adheres to all elements of sound business research. The study methods and findings must be presented orally and in writing in a manner that is consistent with acceptable standards of research communication.

Prerequisites: ACCT 510, MKT 512

ECONOMICS

ECON 501 Principles of Economics (3-0-3)

Introduction to economic systems and economic analysis. The course is an overview microeconomics covering topics such as supply and demand in individual markets, elasticities of supply and demand, theory of consumer behavior, theory of the firm, theory of production, analysis of cost elements, factors and product markets, and analysis of competitive and monopolistic markets and oligopoly. The course also includes an analysis of macroeconomics covering topics such as aggregate and aggregate supply, national output and income determination, consumption, savings, investment, government expenditures, international trade and restrictions, general price level, theory of money, monetary and fiscal policies, business cycles, unemployment, and inflation.

ECON 510 Managerial Economics (3-0-3)

This course analyzes the role of business in society as well as the role of profits in the allocation of scare resources. It develops the relevant demand and production theories, the theory of the firm, economic optimization techniques, cost/benefits analysis, and pricing policies. Economic forecasting techniques, public policy issues, public regulations, and the role of government in a market economy are introduced.

Prerequisite: ECON 501 or waiver of this prerequisite according to the waiver guidelines.

ECON 511 The Macroeconomic Environment of Business (3-0-3)

This is an advanced course in aggregate economic theory. The course analyzes the components of aggregate demand and aggregate supply, and factor shares in production functions. It also encompasses the basic structure of the classical. Keynesian, monetarist, and new classical approaches to macroeconomics and their implications for the determination of output (GDP), interest rates, general price level, unemployment, and inflation. Applications of the theory of the business cycle and the use of monetary and fiscal policy for economic stabilization are also analyzed.

Prerequisite: ECON 510

ECON 512 Econometrics (3-0-3)

This course stresses the mathematical formulation, estimation, and empirical testing of basic econometric models which can be used for forecasting economic and financial data for future planning purposes. The theory of normal linear (and nonlinear) models, generalized least squares methods, hypothesis testing, specification error, regression diagnostics, and distributed lags are analyzed in the context of economic and financial theories. Applications include simultaneous equation model, seemingly unrelated regression, pooled data estimation, and single-equation models.

Prerequisites: OM 502 or waiver of this prerequisite according to the waiver guidelines, ECON 510.

ECON 520 Microeconomic Analysis (3-0-3)

This is an advanced course covering selected topics in utility theory, analysis of demand and supply, production theory, labor market, and capital theory. It also covers price and output determination in different market structures, resource allocation, income distribution, welfare economics, the economics of uncertainty and information, as well as the analysis of partial and general equilibrium systems.

Prerequisite: ECON 510

ECON 522 International Trade (3-0-3)

This course covers advanced analysis of topics such as the gains from trade, sources of the gains from trade, sources of comparative advantage, economic integration, trade policy, the theory of commercial policy, foreign exchange rates, the balance of payments, protectionism and barriers to

trade, and the gains from specialization.

Prerequisite: ECON 510

ECON 525 Energy Economics (3-0-3)

This course deals with the analysis of energy sources (such as petroleum coal, gas and electricity), and the rates of extraction. The course also covers the analysis of demand for and supply of oil, in particular, under the assumptions of the theory of Cartels. It also includes analysis of short-and long-run costs of investments in such resources under uncertainty, the pricing of exhaustible resources such as oil, and modeling of long-run theory demand. The course includes a case study on the energy sector of the Saudi Economy.

Prerequisite: ECON 501

ECON 592 Independent Research in Economics (0-0-3)

A research proposal must be submitted in writing by the student and approved by the supervising faculty member and the MBA Chairman prior to registration. The student is required to conduct a research study in the area of economics that is business related and adheres to all elements of sound business research. The study method and findings must be presented orally and in writing in a manner that is consistent with acceptable standards of research communication.

Prerequisites: ECON 510, MKT 512

EMBA COURSE DESCRIPTIONS

ACCT 551 Financial Accounting and Reporting (2-0-2)

This course will provide an overview of the corporate external financial reporting system to enable you to understand financial accounting and reporting from the perspective of the user and manager. The course covers the rules and guidelines that governs the preparation of financial statements and the concepts of asset, equity, liability, revenue, expense, and the accounting cycles that lead to the financial statements. It will also cover the effect of management decisions on the financial statements.

ACCT 552 Managerial Accounting (3-0-3)

This course primarily deals with the understanding, generating and analysis of data used in planning, decision making and control of operations. It also examines how accounting as well as non-accounting information is used by management in decision-making. Both the theoretical and practical aspects of the subject are appropriately blended to enable the students to understand how this knowledge is used in contemporary organizations.

ECON 551 Managerial Economics (3-0-3)

Deals with the strategic application of microeconomic theory to management in markets where the firm has market/monopoly power. Covers sophisticated pricing policies, transfer pricing, dealing with competitors, corporation strategies, managing under uncertainty, asymmetric information and externalities. Examines how microeconomics may be used to enhance decision-making within the manager's organization.

ECON 561 The Macro Environment of Business (2-0-2)

Prepares students to think systematically about the state of the economy, macroeconomic policy, and the economic environment. It includes the use of economic theory in understanding financial markets, the operation and impact of government policies that determine national income, employment, investment, interest rates, money supply, and inflation.

FIN 554 Managerial Finance (3-0-3)

Applies various concepts and analytical tools pertinent to capital investments and financing decisions. The course addresses the theory and practice of financial management and the role of the financial manager in creating value. It provides the basic concepts of finance, including risk and return within modern portfolio theory, financing decisions through capital structure theory and dividends policy, and valuation of projects and securities.

FIN 562 Strategic Corporate Finance (3-0-3)

Integrative course that builds on materials covered earlier and addresses strategic corporate finance issues and decisions with emphasis on global perspectives. The course highlights analysis and the interactions of investment, financing, and dividend decisions as they affect firm value and develops student valuation skills. Other areas include mergers and acquisitions, lease analysis, options and futures, managing foreign exchange risk, and financial analysis and planning. It blends theory with practice through extensive use of case studies. The cases require student teams to draw on their personal experiences and integrate functional knowledge and diverse perspectives to address variety of issues raised.

MGT 551 Behavior and Organization (3-0-3)

The course examines the role of organization as comprised of collective individuals, and how they function as teams and interact with systems to increase organizational effectiveness. Specifically, the course will explore the complexity of organizational dynamics as influenced by structure, systems and strategy and supported by people, purpose and process. Topics include individuals and teams, motivation, performance, rewards, problem solving, decision making, communications, corporate culture, diversity, power and influence, conflict and resolution as well as organizational design and change.

MGT 554 Business Negotiations (2-0-2)

The course is designed to introduce participants to theories and processes of negotiation. Emphasis will be placed on making it relevant to a broad spectrum of negotiation problems likely to be faced by managers. A basic premise of the course is that managers need analytic as well as interpersonal skills for effective negotiation. The course will allow participants the opportunity to develop these skills experientially and to understand negotiation in useful analytical frameworks.

MGT 560 Ethics and Leadership (2-0-2)

Provides concepts of leadership and the essential skills required to become an effective leader/manager. Examines both classic and contemporary theories and models of leadership. It includes leadership styles, managing commitments, conflict resolution, emotional intelligence, and team dynamics. Explore theoretical concepts of ethics in business, as well as cases that represent the challenges they will likely face as managers. Focuses on the ways current emerging leaders can assess the values that influence their actions.

MGT 561 International Business and Globalization (3-0-3)

Addresses economic, political, legal, cultural, and managerial challenges and opportunities facing the firm in the international and global arenas.

MGT 562 Strategic Management (3-0-3)

The focus of this course is on the strategic management process which involves the overall mission and objectives of the organization, internal analysis to determine strengths and weaknesses, external analysis to determine opportunities and threats, formulating corporate, business, and functional strategies, implementation of chosen strategies and courses of action, and evaluation and control of strategies to take corrective actions. Global strategies and environments will be covered as well. Emphasis will be placed on the building blocks of competitive advantage (efficiency, quality, innovation, and customer responsiveness) that underlie most strategies. Students will learn relevant concepts and techniques and will develop skills in strategic analysis and strategy formulation through variety of methods including business cases and simulation.

Students will also learn to function as an effective member of a strategic team by working with others to analyze cases and solve business problems.

MGT 564 Corporate Governance (2-0-2)

This course describes the way corporate governance operates in today's challenging business environment. It examines the means by which investors attempt to ensure that the corporation is managed in their best interests. Governance includes setting expectations, policies, standards, and ways to verify that these are met. Topics include the structure of the corporation; the roles of the board of directors and others in monitoring management. The course also includes topics related to Saudi business laws that permit or require the board of directors to consider the interests of stakeholders like shareholders' rights. It also covers director's and officer's liability and fiduciary responsibility; and securities regulation.

MIS 564 Electronic Business Strategy (3-0-3)

Covers issues that the modern business manager must deal with in making strategic decisions concerning the choice, implementation, and execution of electronic business solutions. Strategic use of IT and its impact on business performance. Opportunities and inherent risks of IT use. Electronic business models. Electronic value chain.

MKT 561 Strategic Marketing Management (3-0-3)

Addresses the importance of organizations being market-driven and customer-focused and presents current theories and practices of marketing management. The course examines the topics of new product development, marketing resource allocation and competitive strategy. It deals with the formulation of strategic marketing as a key element of overall organization plans and policies, and focuses on balancing market opportunities and threats with resources available and alternative responses, including analysis of markets, product, promotion, distribution and pricing strategies.

OM 551 Quantitative Methods (3-0-3)

Introduces the basic quantitative methods and techniques used in analyzing business and managerial problems. This will include decision analysis and modeling using some optimization techniques such as: Linear programming 'LP', duality and sensitivity analysis of LP, integer programming, network optimization, goal programming, and basic business statistics.

OM 552 Operations Management (3-0-3)

An overview of several operations and supply chain management concepts including: process design and analysis, productivity competitiveness, operations strategy, forecasting, inventory management, quality management, scheduling, capacity planning, logistics and locations decisions, and project management. By focusing on the roles of different parties involved in operations and their interactions, the course will help develope the managerial insights for the supply chain management.

M. ACCOUNTANCY COURSE DESCRIPTIONS

ACCT 504 Advanced International Accounting (3-0-3)

This course focuses on the following issues: Similarities and differences in principles and procedures relating to the functional accounting areas of financial, cost, managerial, and auditing among different regions and countries of the world, consolidation of foreign subsidiaries, performance evaluation of foreign operations, analysis of foreign exchange transactions of financial statements of foreign operations, inflationary accounting in an international setting, Accounting and Taxation for multinational corporations, Ethics and Reporting Standards of the auditor in an international setting, and globalization of accounting standards and principles.

Prerequisites: ACCT 302, ACCT 304, ACCT 403 or equivalent at the Undergraduate level

ACCT 512 Cost Management Systems (3-0-3)

This course involves review and evaluation of recent developments in the area of Management Accounting. Emphasis on the following issues: Conceptual framework for cost systems design, new approaches and design principles for modern cost management systems. Functions of cost management systems, problems in cost allocations, assigning the expenses of capacity resources to production departments and products, design of operational control and performance measurement systems with emphasis on non-financial measures of quality performance, design principles for activity-based cost systems used for strategic profitability measurement, activity-based cost systems in manufacturing and service organizations. Cost accounting and cost management in high technology companies and in a just-in-time environment.

Prerequisites: ACCT 401, ACCT 402

ACCT 514 Advanced Accounting for Governmental & Non-Profit Entities (3-0-3)

This course focuses on fund theory, governmental accounting standards, budgeting and program evaluation. It also includes, advanced study in efficiency and effectiveness measures as prescribed by auditing standards and techniques in governmental organizations. It includes also, comprehensive accounting control techniques for non-profit entities.

Prerequisite: ACCT 305 or equivalent

ACCT 515 Computerized Accounting Information Systems (2-2-3)

An in-depth study of general ledger (G/L) software packages with emphasis on interfaces with related subsidiary ledgers; evaluation of built-in control features and audit trail of G/L software packages; in-depth study of software packages for planning and control. Special emphasis in internal control systems of computerized accounting systems.

Prerequisite: ACCT 300 or equivalent

ACCT 516 Seminar in Accounting Theory (3-0-3)

This course focuses on contemporary issues of accounting theory and practice as reflected in the accounting literature and professional accounting pronouncements. Also, it investigates thoroughly alternative models of income determination and balance sheet valuation and measurement. The course will be conducted through discussion of issues, presentations of research papers, research forum, and guest lecturers.

Prerequisites: ACCT 403, ACCT 405 or equivalent

ACCT 517 Seminar in Professional Accounting and Auditing (3-0-3)

This course is concerned with the theory and philosophy of auditing, and professional practice. Study of advanced topics in the discipline of auditing such as the development of auditing theory, generally accepted auditing standards, professional responsibility and legal ability of the auditor, cases in audit decision making, EDP auditing, internal control, and analysis of emerging issues and contemporary problems in auditing. Consideration is given to non-audit services provided by the auditor and their impact of the quality of the audit service. The course will be conducted through discussion of issues, presentations of research papers, research forum, and guest lecturers.

Prerequisites: ACCT 403, ACCT 404 or equivalent

ACCT 518 Accounting Policy and Practice Workshop (3-0-3)

This course is concerned with rigorous case studies in different areas of accounting in manufacturing and service organizations. Heavy emphasis on cases covering new areas in accounting such as measuring quality costs product casting, flexible manufacturing systems, capital budgeting under automation, product profitability analysis, and performance measurement in high technology companies. Cases in accounting policies, financial disclosure and reporting.

Prerequisites: ACCT 512, ACCT 515, ACCT 517

ACCT 519 Professional Accounting Ethics and Legal Responsibility (3-0-3)

This course is concerned with goals of Accounting Ethics Education for the development of a sense of professionalism and enhancing students' abilities to deal with ethical issues in accounting in order to maintain the public trust and confidence in the Accounting profession.

Emphasis on the following topics: Legal Environment of Business, Ethical Issues in Business, Ethical Theories, Ethical Standards and Codes adopted by professional organizations, financial fraud and illegal acts, Ethics on tax practice, computer ethics, competition in public accounting profession, moral and ethical issues related to accounting fields, and ethical problems in the multinational sector. Cases in Accounting Ethics and professionalism are used in teaching this course.

Prerequisite: ACCT 517

ACCT 520 Internal and Electronic Data Processing (EDP) Auditing (3-0-3)

This course focuses attention on the role and importance of modern internal auditing techniques used in the changing manufacturing and service environments such as statistical and computer sampling techniques, analytical reviews, flow-charting, standardization. Furthermore, it provides an in-depth exposure in developing, conducting, and reporting EDP procedures and reports. Such programs include financial and operational areas, pre-contract reviews, post-con-tract audits, special investigations, EDP audits. It also deals with the theory and techniques for measuring operational efficiency and effectiveness; informing management of operating problems and possible courses of action.

Prerequisite: ACCT 517

ACCT 523 Advanced Accounting Systems Analysis & Design (3-0-3)

An advanced study of accounting systems analysis and design methodologies, techniques, and processes with specific reference to accounting systems development life cycle; emphasis on identification of user information needs and logical system design. Special emphasis on vendors selection, system implementation, and post implementation audits.

Prerequisite: ACCT 515

ACCT 524 Research Methodology in Accounting (3-0-3)

Research technique methodologies and their application in the field of accounting for manufacturing and service organizations. Emphasis on application of research techniques on local accounting issues and problems.

Prerequisites: ACCT 516, departmental approval

ACCT 526 Foundations of Internal Auditing (3-0-3)

Concepts and principles of internal auditing, Professional Standards, internal control, operational approach and behavioral dimensions of internal auditing, administering internal auditing activities, statistical sampling and computer applications in internal auditing, relationship between the internal and the external auditor, responsibilities of board of directors' audit committee and internal auditor services. A practice-oriented research paper is required.

Prerequisite: ACCT 517 or ACCT 522

ACCT 527 Operational Auditing (3-0-3)

Operational Audit methodology, tools and techniques, functional audits, EDP audit, employees and management fraud investigation, control and assessment of management controls, government and not-for-profit audits. A practice-oriented research paper is required.

Prerequisite: ACCT 526

ACCT 528 Independent Research in Accounting (3-0-3)

Independent readings and study of selected topics in contemporary Accounting issues in

manufacturing and service organizations. Emphasis on the accounting issues which deal with the changes in technology and organization of production processes, globalization of accounting standards and practice. Subject matter to be arranged.

Prerequisites: ACCT 512; ACCT 516, departmental approval

ACCT 600 Written Comprehensive Examination (0-0-0)

Each student who successfully complete all required accounting course work must take a written comprehensive examination in Accounting. Intended to assess a student's ability to demonstrate his accounting knowledge in an integrative fashion. This exam is administered by the Department of Accounting and Management Information Systems. If a student fails to pass the exam, he will be given a second chance to retake it next semester. Failure to pass this exam for the second time will lead to discontinuation of the student from the program.

Prerequisites: ACCT 512, ACCT 515, ACCT 516, ACCT 517, ACCT 518, ACCT 528

MGT 520 Organizational Theory and Design (3-0-3)

Analysis of organizations as open systems, with emphasis on maximizing congruency among organizational structure, strategy, and environment. Impact of alternative design configurations on individual, group and inter-group behavior. Role of structure in determining organizational performance and effectiveness. Strategies of change for integrating the total organizational system.

Prerequisite: MGT 501 or equivalent

MGT 590 Business Policy (3-0-3)

General management strategy, policy determination and decision making, case analysis drawing from Saudi Arabia and international business environments. A comprehensive course integrating the various functional areas of business including computerized management game.

Prerequisite: Advanced M. Acc. standing

OM 510 Quantitative Business Analysis (3-0-3)

Linear Programming and its extensions: the Simplex algorithm, duality theory, post-optimality analysis, transportation and assignment models; network models: PERT/CPM; dynamic programming inventory control with deterministic and probabilistic models; queuing theory. The use of the Operations Research and Operations Management Computer Business Programs Library will be emphasized.

Prerequisites: OM 501, OM 502

FINANCE

FIN 501 Corporate Finance (3-0-3)

An introduction to the basic concepts and tools of corporate finance. The course covers financial planning and control techniques such as forecasting financial needs, cash budgeting, operating leverage, ratio analysis, return-on-investment, and fund statement. Other topics include working capital policies, capital budgeting, and the treatment of risk in investment decisions.

Prerequisite: ACCT 501 or waiver of this prerequisite according to the waiver guidelines.

FIN 510 Managerial Finance (3-0-3)

Managerial finance consists of two inter-related decisions of investment and financing. The former deals with capital theory and its application to capital budgeting under uncertainty. The latter deals with financial leverage, the cost of capital, dividend policy and valuation. Leasing and other instruments of long-term financing, growth through mergers and the holding company, as well as reorganization and bankruptcy.

Prerequisites: FIN 501 or waiver of this prerequisite according to the waiver guidelines, ACCT 510.

FIN 520 Financial Policy (3-0-3)

A case method analysis of corporate assets/liabilities management and related financial problems stressing financial decisions and formulation of financial policy. The subject coverage includes: working capital management, operating and financial leverage, capital budgeting, cost of capital, dividend policy, and mergers, acquisitions, and corporate restructuring. This course attempts to familiarize the students with practical aspects of financial concepts and theories. It provides the students with the tools and financial models to make decisions in real-life situations. A case-based approach is emphasized to give the students 'hands-on' managerial financial skills. It is also intended to develop communication and presentation skills and strengthen the students' confidence in their own judgment.

Prerequisite: FIN 510

FIN 521 International Finance (3-0-3)

The focus is on understanding how multinational corporations make financial decisions in an international environment. Students learn about international money and capital market operations, the determination of exchange rates, and how to analyze the balance payments accounts. Specific skills to measure and manage exposure to foreign exchange risk are developed. The course also covers corporate functions including international capital budgeting, working capital management, direct foreign investment, political risk analysis, and international banking and taxation.

Prerequisite: FIN 510

FIN 522 Financial Institutions (3-0-3)

This course has two objectives. The first focuses on understanding the flow of funds across financial markets, the nature and characteristics of these markets, and the determination of interest rates and security prices. Students are exposed to the process of financial product evolution and financial engineering techniques. The second focuses on familiarizing students with the strategic and operational issues involved in the management of financial institutions including commercial banks, Islamic financial institutions, savings banks, finance companies, pension funds and insurance companies. The course also includes a description and comparative analysis of the Islamic financial system, the Saudi financial infrastructure, and Western financial system.

Prerequisite: FIN 510

FIN 523 Investment Analysis (3-0-3)

Analysis of investments in financial securities such as bonds, common stock, preferred stock, options, commodities and Islamic financial instruments. Nature, regulation, and operations of securities markets in a western economy and an Islamic economy. Portfolio management theory and implications for capital market theory. Stock price behavior in relation to technical analysis and to capital market efficiency hypothesis.

Prerequisite: FIN 510

FIN 525 Options, Futures and Other Derivative Securities (3-0-3)

This course provides a detailed coverage of the organization, structure, and role of the derivative securities market. The course explores the properties of derivative securities (such as futures, options, options on futures, and swap markets) that are commonly encountered in practice and provides a theoretical framework within the values of these securities. Students learn skills required to use derivative securities in hedging and risk-altering investment strategies.

Prerequisite: FIN 510

FIN 529 Bank Management (3-0-3)

Examines the nature and operating strategies of banking institutions including Islamic banking institutions. Bank management issues such as liquidity management, investment strategies, capital management and asset/liability management are emphasized. Banking practices in an

international environment are also examined. Students work through cases that simulate real world decision-making.

Prerequisite: FIN 510

FIN 531 Real State Management (3-0-3)

This course deals with the analysis of residential and commercial real estate development, appraisal techniques, real estate financing, real estate market analysis, real estate management and legal environment. It also covers the theory of risk, and management of personal and business risk.

FIN 592 Independent Research in Finance (0-0-3)

A research proposal must be submitted I writing by the student and approved by the supervising faculty member and the MBA Chairman prior to registration. The student is required to conduct a research study in the area of finance that is business related and adheres to all elements of sound business research. The study methods and findings must be presented orally and in writing in a manner that is consistent with acceptable standards of research communication.

Prerequisites: FIN 510, MKT 512

MANAGEMENT INFORMATION SYSTEMS

MIS 502 Management Information Systems (3-0-3)

Introduction to the concepts of Management Information Systems. Topics include information systems support to organizational activities and functions. Fundamentals of database management and data communication concepts. Strategic applications of information systems. An overview of system development processes and the fundamentals of system analysis and design.

MIS 510 Information Resource Management (3-0-3)

Development of a framework for planning the introduction, evolution, and assimilation of information technology (computer, telecommunication, office automation) into the organization. The specific role of middle and top management in designing a long-range information architecture with emphasis on strategic and global issues. Use of case studies is emphasized.

Prerequisite: MIS 502 or waiver of this prerequisite according to the waiver guidelines.

MIS 512 Data Management (3-0-3)

Introduction of Data Base Management Systems (DBMS). Relational model and Structured Query Language. Logical database design and semantic data integrity. Physical design issues of relational databases. Transaction integrity. Database and data administration functions. Introduction to non-relational data models. Fundamentals of distributed DBMS.

Prerequisite: MIS 510

MIS 515 Systems Analysis Methodologies (3-0-3)

Business information system development covering used requirements identification, feasibility study, system analysis, design, and implementation. Systems analysis and design methodologies including SDLC, JAD, RAD, and prototyping. System analysis and project management tools.

Prerequisite: MIS 510

MIS 525 Management Support Systems (3-0-3)

Study of the decision-making processes. Comparison between Management Support Systems (MSS) and conventional information systems. Decision Support Systems (DSS), Group DSS, Executive Support Systems, Expert Systems, and Neutral Network Systems. Applications of MSS. Integration of Management Support Systems. Behavioral and technical issues in the implementation and operation of MSS.

Prerequisite: MIS 512

MIS 530 Seminar in MIS (3-0-3)

Study of contemporary issues and concepts in Management Information Systems and management of information technology. Use of presentations based on periodicals, book reviews, cases, and student term papers. Students will participate in class presentations.

Prerequisite: MIS 510

MIS 592 Independent Research in MIS (0-0-3)

A research proposal must be submitted in writing by the student and approved by the supervising faculty member and the MBA Chairman prior to registration. The student is required to conduct a research study in the area of Management Information Systems that is business related and adheres to all elements of sound business research. The study methods and findings must be presented orally and in writing in a manner that is consistent with acceptable standards of research communication.

Prerequisites: MIS 510, MKT 512

MANAGEMENT

MGT 501 Principles of Management (3-0-3)

Fundamentals of managing work and organization, managing people and managing production and operations. Topics include basic management functions of planning, organizing, leading, and controlling and related organizational processes of communication, decision-making and socialization. Other related issues such as globalization, social responsibility, ethics and application to the Saudi business environment are also covered.

MGT 511 Organizational Theory and Design (3-0-3)

Analysis of organizations as open systems, with emphasis on maximizing congruency among organizational structure, strategies, and environments; and the understanding of the impact of alternative design configurations and strategies on the individual, group, and inter-group behavior and performance. A primary focus is the influences on organizational performance and effectiveness.

Prerequisite: MGT 501 or waiver of this prerequisite according to the waiver guidelines.

MGT 513 Managerial Communications (3-0-3)

This course covers various behavioral and technical aspects of the communication processes at different levels and in various contexts in business organizations. Topics include interpersonal communication, cross-cultural communication, linguistic skills; communication aspects of interviewing, business meetings, negotiation, conflict, work relationships, and group work; and the planning, organizing, and delivery of different types of business presentations and reports.

Prerequisite: MGT 511

MGT 521 International Business (3-0-3)

The course develops the analytical capability and perspectives to manage a firm's interaction with its international and global environment. Topics include international economics and political developments, the economics and politics of trade, comparative international strategy, international strategic alliances, foreign exchange and international capital markets, risk analysis, and country culture analysis.

Prerequisites: MGT 511, ECON 510

MGT 522 Organizational Behavior (3-0-3)

Enhancing and developing students' diagnostic skills by examining individual behaviors (motives, perception, attitudes, and learning), group dynamics (communication, power conflict, productivity and morale), and organizational theory and development (culture, socialization,

structure and design). The course also provides the foundation to develop the skills required to work effectively in teams. Globalization and the international dimensions of organizational behavior are also covered.

Prerequisite: MGT 511

MGT 523 Leadership, Motivation, and Power (3-0-3)

Theoretical and practical approaches influencing and motivating people. Effectiveness of various leadership styles, different motivation theories and techniques, and power tactics from a managerial point of view. Cases, experiential exercises, and group discussions are used to enhance the learning of these concepts and managerial actions.

Prerequisite: MGT 511

MGT 524 International and Comparative Management (3-0-3)

The focus is on exploring knowledge and research findings about influences of culture and cultural diversity on management functions and processes. Topics include influences of national cultures on organizational cultures, influences of inter-organizational interactions in cross-cultural contexts, management practices in different social environments, and management perspectives in different countries.

Prerequisite: MGT 511

MGT 525 Human Resources Management (3-0-3)

Application of current behavioral science theory, research and techniques to cover how organizations plan, recruit, select, train, evaluate, compensate and develop their human resources. The coverage of these issues includes the international and global aspects of human resources management and dimensions that are specific to Saudi business environment such as the relevant laws and regulations and the Saudization efforts.

Prerequisite: MGT 511

MGT 526 Management of Organizational Change and Development (3-0-3)

Building a set of conceptual and pragmatic skills useful in understanding and managing change within organizations. Topics include theory and management of OD, planned change, business consultation, and interventions such as team interventions, third-party peacemaking interventions, training-based intervention, structural interventions, and comprehensive interventions.

Prerequisite: MGT 511

MGT 527 Entrepreneurship and Small Business Management (3-0-3)

Study and development of analytical and conceptual skills in the management of new ventures and small businesses. Coverage includes nature and importance of entrepreneurial activities and alternatives, launching and start-up issues and challenges, market and financial planning, and the processes involved in the management, marketing, finance, and control of the enterprise.

Prerequisites: MGT 511, ECON 510, FIN 510

MGT 580 Strategic Management (3-0-3)

The objectives of this course are (1) to acquaint students with the viewpoint of top managers in complex organizations; (2) to provide exposure to major strategic issues involved in planning, organizing, leading, and controlling complex organizations; and (3) to integrate a specific analytical techniques and viewpoints of functional fields into larger view of the overall organizational strategies and goals. Included is the coverage and application of certain activities such as long-range planning, environmental analysis, internal analysis, corporate creativeness and development, strategies and strategic choices and so on. Cases from the Saudi and international business environments are used.

Prerequisite: Advanced MBA Standing

MGT 592 Independent Research in Management (0-0-3)

A research proposal must be submitted in writing by the student and approved by the supervising faculty member and the MBA Chairman prior to registration. The student is required to conduct a research study in the area of management that is business related and adheres to all elements of sound business research. The study methods and findings must be presented orally and in writing in a manner that is consistent with acceptable standards of research communication.

Prerequisites: MGT 511, MKT 512

MARKETING

MKT 501 Principles of Marketing (3-0-3)

The principles of marketing to include marketing's role in society and the firm, the marketing concept, market segmentation, and target marketing. Emphasis on buyer behavior, market measurement, and elements of the marketing mix.

MKT 512 Applied Marketing Research (3-0-3)

Application of research methods for enhancing managerial decision-making in marketing. Includes use of multivariate research methodology and computer software specific to marketing problems in customer analysis, market segmentation, market forecasting, product positioning and attribute preference research.

Prerequisites: MKT 501, OM 502; or waiver of these prerequisites according to the waiver guidelines.

MKT 513 Strategic Marketing (3-0-3)

Applications of concepts, tools, and processes in marketing decision-making. Analysis of strategic marketing opportunities and problems. Planning, developing and implementation of customer driven strategies.

Prerequisite: MKT 501 or waiver of this prerequisite according to the waiver guidelines.

MKT 520 International Marketing (3-0-3)

Developing skills, knowledge, and cultural sensitivity necessary to market successfully in an international environment. Critical discussion of contemporary international marketing issues, analyzing marketing opportunities within a global context, evaluating market entry strategies, and developing and assessing international product, pricing, promotional, distribution and purchasing strategies.

Prerequisite: MKT 513 or equivalent

MKT 521 Buyer Behavior (3-0-3)

Study of decision processes and behavior of individuals and organizations as they relate to the purchase and consumption of goods and services. Consideration of concepts and theories of the behavioral sciences, research methods, and applications in marketing management.

Prerequisite: MKT 513 or equivalent

MKT 523 Marketing Communication (3-0-3)

Analysis of the marketing communications process as it relates to the design and implementation of persuasive communications with current and potential customers. Consideration of the full range of contacts between organizations and markets, message and media factors, and program performance evaluation.

Prerequisite: MKT 513

MKT 525 Marketing Channels Management (3-0-3)

Analysis of the dynamics of marketing channel relationships among firms working together to deliver goods and services to markets. Consideration of problems, opportunities, and managerial requirements of building and maintaining supply chain relationships with other firms consistent with marketing strategy.

Prerequisite: MKT 513 or equivalent

MKT 526 Services Marketing (3-0-3)

Analysis of the distinctive aspects of services as they relate to planning, organizing and implementing marketing strategies. Consideration of demand management, customer portfolios, and frameworks to understand and position services in competitive markets.

Prerequisite: MKT 513 or equivalent

MKT 592 Independent Research in Marketing (0-0-3)

A research proposal must be submitted in writing by the student and approved by the supervising faculty member and the MBA Chairman prior to registration. The student is required to conduct a research study in the area of marketing that is business related and adheres to all elements of sound business research. The study methods and findings must be presented orally and in writing in a manner that is consistent with acceptable standards of research communication.

Prerequisites: MKT 513, MKT 512

OPERATIONS MANAGEMENT

OM 502 Statistical Analysis for Business (3-0-3)

The course will employ the application of basic statistical techniques for Management. Basic concepts of probability and probability distributions, estimation theory and test of hypothesis, regression analysis, and analysis of variance.

OM 511 Management Science (3-0-3)

Linear Programming: Concepts and Solutions Techniques, Duality and Sensitivity Analysis. Transportation and Assignment Models, Goal Programming Model, Network Optimization Models including PERT/CPM project management models, Integer Programming. Additional topics may be selected from Inventory Model, Decision Analysis, Queuing Theory, Simulation, Quadratic Programming, Dynamic Programming, or Non-Linear Programming, Applications of LP and other models in Business and Industrial Management will be emphasized. Computer optimization packages will be used extensively.

Prerequisite: OM 502 or waiver of this prerequisite according to the waiver guide lines.

OM 512 Production and Operations Management (3-0-3)

Process Management; Business Process Re-Engineering; Total Quality Management; International Quality Standards such as ISO 9000, Statistical Process Control; Work Force Management and Scheduling: Capacity Planning; Aggregate Planning; Location Decisions; Layout Planning; Purchasing and Materials Management; Inventory Management Systems: Probabilistic and Deterministic Inventory Models; JIT, MRP and MRP II.

Prerequisite: OM 511

OM 515 Business Forecasting (3-0-3)

Principles and methods of forecasting. short and long-term industry forecasting. Evaluation of reliability of existing forecasting techniques. National and international business trends. The role of business forecasting in managerial planning. The use of time series models including exponential smoothing and Box-Jenkins (ARIMA) techniques for business and economics forecasting.

Prerequisite: OM 511 or equivalent

OM 516 Decision Analysis (3-0-3)

Topics may include: Decision-making under uncertainty. Decision Trees. Multi-criteria decision-making. Data Envelopment Analysis (DEA). Analytical Hierarchy Process (AHP).

Prerequisite: OM 511

OM 518 Project Management (3-0-3)

Management of development projects. Decision-making environment, economic analysis, network analysis, scheduling and control of development projects, sequential and aggregate development decisions.

Prerequisite: OM 512

OM 519 Business Simulation (3-0-3)

Application of computer simulation to the analysis and design of management decision systems. Design of simulation experiments in business research.

Prerequisite: OM 511

OM 521 Management of Inventory Systems (3-0-3)

Analysis of business organizations as integrated inventory systems. Inventory theory and model building as tools for management decision-making. General discussion of inventory models, with emphasis on characterizing the terms of optional policies and efficient computational methods.

Prerequisite: OM 512

OM 592 Independent Research in Operations Management (0-0-3)

A research proposal must be submitted in writing by the student and approved by the supervising faculty member and the MBA Chairman prior to registration. The student is required to conduct a research study in the area of operations management that is business related and adheres to all elements of sound business research. The study methods and findings must be presented orally and in writing in a manner that is consistent with acceptable standards of research communication.

Prerequisites: OM 512, MKT 512

COLLEGE OF SCIENCES

DEPARTMENT OF CHEMISTRY

Chairman

Dr. Abdulaziz Al-Saadi

Faculty

Abulkibash	Al-Ahmadi	Al-Arfaj
Al-Betar	Al-Hamdan	Al-Homouze
Al-Harbi	Al-Hooshani	Ali
Al-Muallem	Al-Suwaiyan	Al-Thagfi
Amayreh	Badawi	Barri
Chanbasha	El-Ali	Fettouhi
Förner	Imam	Isab
Kawde	Khaled	Maung
Mazumder	Morsy	Musa
Oweimreen	Peedikakkal	Qurashi
Saleh	Siddiqui	Ullah
Wazeer		

The Department of Chemistry is one of the first departments established at the University to meet the demands for chemists and industrial chemists in government, academic, and industrial organizations in the Kingdom. The wide ranging interdisciplinary environment at KFUPM is ideal for the pursuit of modern chemistry and as a result, chemists graduating from KFUPM have an impressive record of teaching and research accomplishments.

Teaching & Research Facilities

The research activities of the Department of Chemistry are exceptionally diverse and broad. Graduate courses and research projects are available in the major branches of chemistry that include analytical, industrial, inorganic, organic and physical chemistry. The ongoing research programs cover most areas of study in modern chemistry and also involve collaborative programs with other departments. Current areas of research include: organic synthesis, physical organic chemistry, coordination chemistry, X-ray structure determination, chromatography, thermodynamics of solutions, molecular dynamics by ESR, NMR, and laser techniques, polymer synthesis and characterization, electroanalytical methods, fuels chemistry research, energy production research and solid state reactions.

The Chemistry Department is well equipped for advanced research leading to higher degrees in chemistry. Research supporting facilities such as mechanical and electronic workshops are available in the Chemistry Department. The Department maintains a glass blowing shop for the repair or design of glass equipment. In addition to the University central chemical store, the departmental chemical store stocks almost all commonly used chemicals, glassware, etc. for teaching and research. General instruments aiding students and faculty in their teaching and research include various spectrophotometers, atomic absorption spectrometers, gas chromatographs and a high performance liquid chromatography unit. The major instruments available in the Department are given below:

- 500 MHz Multi Nuclear Magnetic Resonance (NMR) Spectrometer with solid state facility
- 400 MHz Multi Nuclear Magnetic Resonance (NMR) Spectrometer with Solid state facility
- Electron Paramagnetic Resonance (EPR) Spectrometer
- Single crystal X-ray diffractometer (SC-XRD)
- Inductively coupled plasma (ICP MS) spectrometer
- Inductively coupled plasma (ICP OES) spectrometer
- Atomic absorption spectrometer
- C, H, N, S-Elemental analyzer
- Fourier-transform Infrared (FTIR) spectrophotometers
- Fluorescence Spectrometer (Steady State, Lifetime, Phosphorescence)
- UV-Visible spectrometers
- Differential scanning calorimeter
- Optical rotation polarimeter
- High performance liquid chromatography
- Gas Chromatograph-Mass Spectrometers
- Gas Chromatography with FID/TCD detectors
- Electrochemical sets used for polarographic and voltammetric techniques
- Potentiostate-Galvanostate systems

Admission Requirements

All applicants must fulfill the Deanship of Graduate Studies admission requirements. In addition, the following list the departmental requirements for admission to M.S. and Ph.D:

- General and Chemistry GPA of three (3.0) or above is required for the admission.
- Applicants graduated with BS or M.S. five years ago need to submit the GRE Chemistry test score along with the application. The required GRE Chemistry test scores for the admissions into M.S. and Ph.D programs are 580 and 670 scaled scores, respectively.
- Any applicant seeking admission for the Ph.D program will be asked to take graduate core course(s) if identified by the Department Graduate Program Committee of lacking such course(s) in his previous studies.
- An applicant admitted with a deficiency in one or two subjects of chemistry will be asked to take the placement exam given by the department within two weeks from his arrival to the KFUPM. Based on the performance of the placement exam, the candidate will be asked to take the deficiency course(s).
- The student must submit a degree plan to the department by the end of his first semester.
- The student must select a thesis/dissertation advisor by the end of his second semester.
- The student must maintain a cumulative GPA of three (3.0) or above at every semester. Failing may result in a dismissal from the program.
- Towards the end of their second semester in residence, students must select their research topic and advisor.

Academic Programs

The overall objective of the graduate program at the Chemistry Department is to develop scientists with technical depth and leadership breadth for academic and industrial positions. It is aimed also to meet the requirements of the rapidly expanding petroleum and petrochemical industries, geological survey laboratories, research and development needs of Saudi Arabian industries and other institutions.

Our graduate students will be able to use the knowledge and skills they have acquired during their graduate years to pursue a wide variety of career and life goals. The M.S. and Ph.D. graduates in Chemistry possess strong fundamental and practical knowledge in all chemistry disciplines including analytical, inorganic, organic, physical, theoretical and industrial chemistry. The program prepares students for careers in research and development. Also, the program is designed to strengthen the students' background in all areas through course offerings, research projects and seminars.

M.S. PROGRAM IN CHEMISTRY

Degree Requirements

The Master of Science program in Chemistry is available to students who meet the requirements for admission to the University with a B.S. in Chemistry or equivalent.

- Towards the end of their second semester in residence, students must select their research topic and advisor.
- A total of 24 credit hours of coursework (500 or 600 level) is required. This includes 18 credit hours of chemistry courses (500 or 600 level) and 6 credit hours of free electives (500 or 600 level).
- The free electives can be taken from chemistry graduate courses or, upon the approval of the graduate advisor, from graduate courses in other departments.
- M.S. students are required to present a seminar once during the program.
- One seminar CHEM 599 and six credit hours of research work towards the preparation of an M.S. thesis are required.

The following is the list of the core and elective Courses for M.S. program in Chemistry:

CHEM 510	Advanced Physical Chemistry
CHEM 520	Physical Methods in Inorganic Chemistry
CHEM 530	Advanced Organic Chemistry
CHEM 540	Advanced Analytical Chemistry

(a) Core Courses

(b) Elective Courses

CHEM 5xx / CHEM 6xx / CHEM 606	Elective 1
CHEM 5xx / CHEM 6xx	Elective 2
CHEM 5xx / CHEM 6xx	Elective 3

(c) Free Electives

Free 5xx / Free 6xx: Free Elective 1

Degree Plan for M.S. in Chemistry

Course No.	Title	LT	LB	CR
First Semester				
CHEM 510	Advanced Physical Chemistry	3	0	3
CHEM 540	Advanced Analytical Chemistry	3	0	3
CHEM 5xx/6XX	Elective 1	3	0	3
		9	**0**	**9**
Second Semester				
CHEM 520	Physical Methods in Inorganic Chemistry	3	0	3
CHEM 530	Advanced Organic Chemistry	3	0	3
CHEM 5xx/6XX	Elective 2	3	0	3
CHEM 599	Seminar	1	0	0
		10	**0**	**9**
Third Semester				
XXX 5xx/6xx	Free Elective 1 / Chemistry Elective	3	0	3
XXX 5xx/6xx	Free Elective 2	3	0	3
CHEM 610	M.S. Thesis	0	0	IP
		6	**0**	**6**
Fourth and Subsequent Semesters				
CHEM 610	M.S. Thesis	0	0	6
		0	**0**	**6**
Total Credit Hours				**30**

Notes:

- Each student is expected to submit his detailed degree plan according to the above generic degree plan for approval by the Department and the Deanship of Graduate Studies within the 8^{th} week of the second semester of enrollment.
- Students are required to adhere to the regulations of degree plan. No relaxations will be given to any student, and courses taken in conflict of the above will not be counted towards the degree.
- The order of taking the courses can be different from above, but students must take the core courses before electives.

PH.D PROGRAM IN CHEMISTRY

Degree Requirements

- The Ph.D program in Chemistry is available to students who meet the requirements for admission to the University with an M.S.in Chemistry or equivalent.
- The student must maintain a cumulative GPA of 3.0 or above at all times. Departmental requirements for the 30 credit hours are listed below:
  - Fifteen (15) credit hours must be in the major area,
  - Six (6) credit hours must be in the minor area,
  - Ph.D students can take a maximum of nine (9) credit hours from chemistry graduate courses in areas other than the major and minor areas or, upon the approval of the degree plan,
  - The minor must be in a field within the department,
  - Ph.D. students are required to attend all departmental seminars,
  - Ph.D. students are required to present a seminar once during the program,
  - A written comprehensive examination in the major area of specialization must be passed on completion of the second year of enrolment,
  - Twelve credit hours of research work towards the preparation of a Ph.D. dissertation are required,
  - The candidate shall prepare a dissertation on an approved topic under the guidance of his supervisor and his dissertation supervising committee,
  - The Dissertation Committee examines the candidate on the dissertation,
  - The candidate, in consultation with his Dissertation Committee, and after approval from the Dean of Graduate Studies, shall arrange a time and place for a public defense of the dissertation.

Ph.D. Comprehensive Examination

- Each Ph.D. student is required to pass a comprehensive exam by the end of his 2^{nd} year.
- The comprehensive exam is a written exam.
- It shall be in the student’s area of specialization (Analytical, Inorganic, Organic, or Physical).
- The exam shall cover topics from 4 graduate level courses in the student’s major area of specialization.
- After completing the required 5 graduate level courses in his major area of specialization, a Ph.D. student will submit his comprehensive exam in the following semester.
- The passing grade in each of these four courses should be 70 % or B and above.
- The student will have only one more chance to sit again for the comprehensive exam in case he fails the first one, as per the Deanship of Graduate Studies guidelines.

Ph.D. Proposal and Defense

- Full-time students shall submit their dissertation proposal by the sixth semester of enrolment. For part-time students this deadline can be relaxed for only one more semester.
- Only students who passed their comprehensive exams are allowed to submit their dissertation proposal.
- Ph.D. students, who completed graduate course requirements and passed their comprehensive exams, should register to the course CHEM 711 (Ph.D. Pre-Dissertation).

- The students pass CHEM 711 course only if the Dissertation Committee accepts the submitted dissertation proposal and upon successfully passing the Dissertation proposal public defense.

Dissertation and Public Exit Seminar

- Students, who have successfully passed CHEM 711, can register to CHEM 712 (Ph.D. Dissertation).
- The date of the internal defense shall be decided by the student’s advisor in consultation with the committee members and approval of the department head.
- After passing the internal defense, the student should give a Public Exit Seminar, in the presence of his advisor and all of his committee members.
- The student shall be granted the Ph.D degree only if the Dissertation Committee accepts the submitted dissertation report and upon successfully passing the Dissertation publics defense.

Major, Minor and Elective Courses

(a) Major Elective Courses

CHEM 5xx / CHEM 6xx:	Major Elective 1
CHEM 5xx / CHEM 6xx	Major Elective 2
CHEM 5xx / CHEM 6xx	Major Elective 3
CHEM 5xx / CHEM 6xx	Major Elective 4
CHEM 5xx / CHEM 6xx	Major Elective 5

(b) Minor Elective Courses

CHEM 5xx / CHEM 6xx	Minor Elective 1
CHEM 5xx / CHEM 6xx	Minor Elective 2

(c) Chemistry Electives / Free Electives

CHEM 5xx / CHEM 6xx / CHEM 701	Elective 1
Free 5xx / Free 6xx / CHEM 702	Elective 2
Free 5xx / Free 6xx	Free Elective 3

Degree Plan for Ph.D. in Chemistry

Course No.	Title	LT	LB	CR
First Semester				
CHEM 5xx/6xx	Elective 1	3	0	3
CHEM 5xx/6xx	Elective 2	3	0	3
CHEM 5xx/6xx	Elective 3	3	0	3
		9	**0**	**9**
Second Semester				
CHEM 5xx / CHEM 6xx	Elective 4	3	0	3
CHEM 5xx / CHEM 6xx	Elective 5	3	0	3
CHEM 5xx / CHEM 6xx	Elective 6	3	0	3
		9	**0**	**9**
Third Semester				
CHEM xxx	Elective 7	3	0	3
CHEM xxx	Elective 8	3	0	3
XXX 5xx/6xx	Elective 9	3	0	3
CHEM 699	Seminar	1	0	0
		10	**0**	**9**
Fourth Semester				
Free 5xx	Elective 10	3	0	3
CHEM 711	Ph.D. Pre-Dissertation	0	0	3
		3	**0**	**6**
Fifth Semester				
CHEM 712	Ph.D. Dissertation	0	0	IP
Sixth Semester				
CHEM 712	Ph.D. Dissertation	0	0	9
		0	**0**	**9**
Total Credits				**42**

Notes:

- Each student is expected to submit his detailed degree plan according to the above generic degree plan for approval by the Department and the Deanship of Graduate Studies within the 8th week of the second semester of enrollment.
- Students are required to adhere to the regulations of degree plan. No relaxations will be given to any student, and courses taken in conflict of the above will not be counted towards the degree.
- The order of taking the courses can be different from above, but students must take the core courses before electives.

List of Graduate Courses by Areas

General Graduate Courses and Requirements

CHEM 500	Introduction to Research in Chemistry
CHEM 599	Graduate (M.S) Seminar
CHEM 606	Independent Research
CHEM 610	M.S. Thesis
CHEM 699	Graduate (Ph.D.) Seminar
CHEM 701	Directed Research I
CHEM 702	Directed Research II
CHEM 711	Ph.D. Pre-Dissertation
CHEM 712	Ph.D. Dissertation

Physical Chemistry Courses

CHEM 510	Advanced Physical Chemistry
CHEM 511	Chemical Kinetics
CHEM 512	Chemical Thermodynamics
CHEM 514	Electrochemical Corrosion
CHEM 515	Spectroscopy
CHEM 516	Quantum Chemistry I
CHEM 517	Computational Chemistry
CHEM 518	Colloid and Surface Chemistry
CHEM 519	Special Topics in Physical Chemistry
CHEM 614	Characterization of Materials
CHEM 615	Statistical Thermodynamics
CHEM 616	Quantum Chemistry II
CHEM 617	Chemistry and Physics of Nanomaterials
CHEM 618	Advanced Magnetic Resonance Techniques

Inorganic Chemistry Courses

CHEM 520	Physical Methods in Inorganic Chemistry
CHEM 521	Advanced Chemistry of Coordination Compounds
CHEM 522	Organometallic Chemistry
CHEM 523	Chemical Crystallography
CHEM 524	Catalysis in Industry
CHEM 525	Metal-Metal Bonds and Cluster Compounds
CHEM 528	Mechanisms of Inorganic Reactions
CHEM 529	Special Topics in Inorganic Chemistry
CHEM 620	Homogeneous Catalysis by Coordination Compounds
CHEM 621	Heterogeneous Catalysis
CHEM 622	Surface Chemistry and Catalysis
CHEM 623	Photochemistry of Coordination Compounds

CHEM 624	Solid State Chemistry
CHEM 626	Bio-Inorganic Chemistry
CHEM 627	X-ray Diffraction Analysis

Organic Chemistry Courses

CHEM 530	Advanced Organic Chemistry
CHEM 531	Physical Organic Chemistry
CHEM 532	Synthetic Organic Chemistry
CHEM 533	Nuclear Magnetic Resonance Spectroscopy
CHEM 534	Chemistry of Heterocyclic Compounds
CHEM 535	Petrochemicals
CHEM 536	Spectroscopic Identification of Organic Compounds
CHEM 537	Polymer Synthesis
CHEM 538	Natural Products Chemistry
CHEM 539	Special Topics in Organic Chemistry
CHEM 630	Physical Chemistry and Characterization of Polymers
CHEM 631	Molecular Biochemistry
CHEM 632	Bioseparations, Recombinant Techniques and Protein Sciences
CHEM 633	PolymericDrug Delivery Systems

Analytical Chemistry Courses

CHEM 540	Advanced Analytical Chemistry
CHEM 542	Electroanalytical Chemistry
CHEM 543	Separation Methods
CHEM 549	Special Topics in Analytical Chemistry
CHEM 640	Analytical Spectroscopy
CHEM 642	Chemometrics
CHEM 643	Environmental Analytical Chemistry

Environmental Chemistry Courses

CHEM 550	Advanced Environmental Chemistry
CHEM 551	Analytical Geochemistry
CHEM 552	Organic Geochemistry
CHEM 553	Environmental Pollution
CHEM 554	Environmental Geochemistry
CHEM 555	Environmental Ecology

COURSE DESCRIPTIONS

CHEM 500 Introduction to Research in Chemistry (3-0-3)

Overview of current research trends in an emerging field of chemistry. Students are expected to document new instrumentations and techniques used in different areas of research in chemistry. Based on this overview, the student will write an original research proposal and defend it in an open seminar in the department.

Prerequisite: Approval of the Graduate Advisor

CHEM 510 Advanced Physical Chemistry (3-0-3)

Classical and statistical thermodynamic concepts with emphasis on application to chemical species in solution. A consideration of theories of chemical reaction rates, kinetic studies of simple and complex systems. Basic principles and procedures of quantum chemistry with applications to atomic and molecular systems.

Prerequisite: CHEM 312 or equivalent

CHEM 511 Chemical Kinetics (3-0-3)

Empirical rate law. Order of reactions. Elementary reactions. Complex reactions. Reaction mechanisms. Steady-state approximation theory. Transition state theory. Thermodynamic formulation of the rate constant. Homogeneous reactions. heterogeneous reactions. Catalysis. Enzyme kinetics. Flash photolysis. Relaxation methods.

Prerequisite: CHEM 510

CHEM 512 Chemical Thermodynamics (3-0-3)

Principles of thermodynamics. Exact differentials and line integrals. Homogeneous functions. Equations of state of real gases; fugacity. Thermochemistry. Mixtures and solutions. Chemical and phase equilibria. Electrolytic solutions and electrochemical cells. Systematic methods of deriving thermodynamic equations. Statistical thermodynamics. Lagrange’s method of undetermined multipliers. The Boltzmann H-theorem. The Einstein crystal model and the Debye crystal model.

Prerequisite: CHEM 510

CHEM 514 Electrochemical Corrosion (3-0-3)

Fundamentals of electron transfer at the metal-solution interface, advances in electrochemical corrosion techniques, types of corrosion: galvanic, pitting, crevice, bacterial, etc. Corrosion inhibitors and coating, materials properties and selection in different corrosive environments. Advances in monitoring techniques.

Prerequisite: CHEM 510

CHEM 515 Spectroscopy (3-0-3)

An introduction to modern molecular spectroscopy with emphasis on the concepts and methods needed to understand the interaction of radiation with matter. Topics include atomic, rotational, vibrational and electronic spectra of molecules, and radio frequency spectroscopy.

Prerequisite: CHEM 510

CHEM 516 Quantum Chemistry I (3-0-3)

Postulates of quantum mechanics. Schroedinger equation, simple quantum mechanical systems, atomic wave functions, angular momentum, orbital, molecular orbital theory, variation,

perturbation theory.

Prerequisite: CHEM 510

CHEM 517 Computational Chemistry (3-0-3)

Implementation of the different theoretical models: Force field, semi-empirical, abolition, calculations to chemically related problems using latest PC-software packages. Emphasis will be placed on molecular modeling, simulations, and spectral properties of matter in its isolated or solvated form.

Prerequisite: CHEM 510

CHEM 518 Colloid and Surface Chemistry (3-0-3)

Introduction to colloid and surface chemistry, sedimentation and diffusion, rheology of dispersions, adsorption from solution, colloidal structures and surfactant solutions, electrical double layer, electrophoresis, electrostatic and polymer-induced colloid stability.

Prerequisite: CHEM 510

CHEM 519 Special Topics in Physical Chemistry (3-0-3)

Recent topics in Physical Chemistry.

Prerequisite: CHEM 510

CHEM 520 Physical Methods in Inorganic Chemistry (3-0-3)

Theory and applications of physical methods used for characterization of inorganic and organometallic compounds. Group theoretical consideration for understanding of molecular spectra and chemical bonding in coordination compounds. General concepts of molecular spectroscopy. Basic concepts of X-ray diffraction. Ionization methods (mass spectrometry and photoelectron spectroscopy).

Prerequisite: CHEM 332 or equivalent

CHEM 521 Advanced Chemistry of Coordination Compounds (3-0-3)

Review of the chemistry of transition and inner transition elements. Theories of bonding in coordination compounds. Applications of the ligand field theory to the interpretation of spectra and magnetochemistry. Structure and reactivity. Coordination compounds in biological systems and industry.

Prerequisite: CHEM 520

CHEM 522 Organometallic Chemistry (3-0-3)

General properties of organometallic compounds, metal-carbon and metal-hydrogen bonds. Ligand substitution reactions, complexes of p-bond ligands, oxidative addition and reductive elimination, insertion and elimination, nucleophilic and electrophilic addition and abstraction. Homogeneous catalysis. Characterization of organometellic compounds, carbenes, metathesis and polymerization, activation of small molecules, application to organic synthesis, oxidation and high-oxidation-state complexes. Bio-organometallic chemistry.

Prerequisite: CHEM 520

CHEM 523 Chemical Crystallography (3-0-3)

X-ray diffraction, symmetry operations and space group determination, crystals and their properties, geometric and intensity data collection, data reduction, theory of structure factors and Fourier syntheses, calculation of structure factors and Fourier syntheses; solution of structure by heavy-atom methods, refinement of structure and results. Electron microscopy and neutron diffraction.

Prerequisite: CHEM 520

CHEM 524 Catalysis in Industry (3-0-3)

Theory of homogeneous versus heterogeneous catalysis. Hydrogenation-dehydrogenation, oxidation, alkylation, addition reactions, acid reactions, and catalytic polymerization. Preparation and characterization of catalysts.

Prerequisite: CHEM 520

CHEM 525 Metal-Metal Bonds and Cluster Compounds (3-0-3)

A study of metal-metal bonds in transition metal compounds with reference to the formation of cluster compounds, the interpretation of vibrational spectra for such complexes, closed metal carbonyl cluster, general methods of preparation, structure and reactivity, application to catalysis.

Prerequisite: CHEM 520

CHEM 528 Metal-Metal Bonds and Cluster Compounds (3-0-3)

Review of fundamental concepts of chemical kinetics. Physical methods for the determination of reaction rates in inorganic systems. Application of valence bond and ligand field theories to reactions in octahedral and square planar complexes. Associative and dissociative mechanisms, the trans effect, racemization, isomerization, oxidation-reduction, and photochemical reactions.

Prerequisite: CHEM 520

CHEM 529 Special Topics in Inorganic Chemistry (3-0-3)

Recent topics in Inorganic Chemistry.

Prerequisite: CHEM 520

CHEM 530 Advanced Organic Chemistry (3-0-3)

Reaction mechanisms, conformations and structure reactivity relationships, aromaticity, carbanions, carbocations, organic reaction types including substituent effects and stereochemistry: substitution, addition, elimination, hydrolysis, electrophilic and nucleophilic aromatic substitution, and pericyclic reactions.

Prerequisite: CHEM 202 or equivalent

CHEM 531 Physical Organic Chemistry (3-0-3)

Structure and reactivity of organic molecules through the study of linear free-energy relationships, thermochemistry, kinetics, thermodynamics, rate of complex chemical reactions, isotope effects, potential energy surfaces, transition states, and general and specific acid-base theory as applied to various types of organic reactions.

Prerequisite: CHEM 530

CHEM 532 Synthetic Organic Chemistry (3-0-3)

Introduction to the concept of strategy in multi-step organic syntheses, retrosynthetic analysis, new reagents and concepts, stereospecificity, stereoselectivity, regioselectivity, chiral reagents, protecting groups, selected examples of total synthesis of natural products.

Prerequisite: CHEM 530

CHEM 533 Nuclear Magnetic Resonance Spectroscopy (3-0-3)

The study of the physical basis of the nuclear magnetic resonance spectroscopy (NMR), NMR spectra of organic molecules, experimental aspects of NMR spectroscopy, chemical shift and spin spin coupling as a function of structure, the analysis of high-resolution NMR spectra, two dimensional NMR spectroscopy, dynamic effects on NMR, selected experimental techniques of NMR, carbon-13 NMR spectroscopy and solid state NMR.

Prerequisite: CHEM 530

CHEM 534 Chemistry of Heterocyclic Compounds (3-0-3)

Nomenclature, structure and properties of heterocyclic compounds, heterocyclic analogs of cyclopropane and cyclobutane, compounds with one and two heteroatoms in a five-membered ring, heterocyclic analogs of benzene and naphthalene, compounds with two or more heteroatoms in a six –membered ring, fused ring systems, heterocyclic compounds in nature and medicine.

Prerequisite: CHEM 530

CHEM 535 Petrochemicals (3-0-3)

Raw Materials – natural and associated gas and crude oil, – their composition and processing. Thermal, catalytic cracking, catalytic reforming, Hydroprocessing, catalysts, operation variables and reaction mechanisms. Catalysis by transition metal complexes.

Prerequisite: Graduate Standing

CHEM 536 Spectroscopic Identification of Organic Compounds (3-0-3)

Identification and structural analysis of organic compounds by nuclear magnetic resonance, infrared, ultraviolet and mass spectroscopy. Discussion of instrumentation, sample handling and basic theory of each technique with emphasis on their practical applications for structure determination.

Prerequisite: CHEM 530 or equivalent

CHEM 537 Polymer Synthesis (3-0-3)

Types of polymerization reactions. Kinetic and mechanistic studies of addition and condensation polymerization by ionic, free radical and coordination initiators and catalysts. Ring opening polymerization, stereochemistry of polymerization.

Prerequisite: CHEM 530

CHEM 538 Natural Products Chemistry (3-0-3)

Classification of natural products, physico-chemical data, structural determination, syntheses, biosynthesis and physiological activity of several classes of natural products including terpenoids, steroids, carbohydrates, aromatic, aliphatic, alkaloids and non alkaloid nitrogen compounds.

Prerequisite: CHEM 530

CHEM 539 Special Topics in Organic Chemistry (3-0-3)

Recent topics in Organic Chemistry

Prerequisite: CHEM 530

CHEM 540 Advanced Analytical Chemistry (3-0-3)

Advanced instrumental analysis: electroanalytical methods including potentiometry, voltammetry and coulometry. Spectroscopic techniques: AA, FE, ICP, molecular spectroscopy: fluroscence and phosophrescence. Chromatography: principles GC, HPLC, mass spectrometry. Flow injection analysis technique (FIA).

Prerequisite: CHEM 324 or equivalent

CHEM 542 Electroanalytical Chemistry (3-0-3)

Advanced treatment of the analytical techniques and methodology with emphasis on the modern methods. Basic principles, kinetics, and mechanisms of electrode reactions and surface phenomena; potentiometry, ion-selective electrodes, electrochemical sensors, voltammetry.

Prerequisite: CHEM 540

CHEM 543 Separation Methods (3-0-3)

Theory and applications of equilibrium and non-equilibrium separation techniques. Extraction, counter current distribution, gas chromatography, liquid chromatography, column and plane chromatographic techniques, electrophoresis and other separation methods.

Prerequisite: CHEM 540

CHEM 549 Special Topics in Analytical Chemistry (3-0-3)

Recent topics in Analytical Chemistry

Prerequisite: CHEM 540

CHEM 550 Advanced Environmental Chemistry (3-0-3)

The course focuses on the study of the sources, reactions, transport, effects, and fates of chemical species in water, soil, and air environment. Specifically, the course deals with aquatic chemistry, atmospheric chemistry, soil chemistry, geospheres and hazardous substances. The nature and source of hazardous wastes, their environmental chemistry, and their treatment, minimization, and the effect of pollutants and hazardous substances on living organisms are discussed.

Equivalent to EnvS 522

Prerequisite: Graduate standing

CHEM 551 Analytical Geochemistry (3-0-3)

Analytical techniques presently available for geochemical correlation purposes have increased dramatically both in number and level of sophistication. This course focuses on the recent advancements in correlation techniques such as gas chromatography and mass-spectrometry (GC, GC/MS, GC/MS/MS, and MS/MS), principles and analytical applications of modern molecular and atomic spectroscopy. Ultraviolet, visible, infrared, luminescence and scattering techniques. Flame, plasma, arc and spark emission, atomic absorption and atomic fluorescence techniques. X-ray diffraction, nuclear magnetic resonance and isotopic ratio techniques.

Equivalent to: EnvS 515.

Prerequisite: Graduate standing

CHEM 552 Organic Geochemistry (3-0-3)

The objective of this course is to provide an up-to-date overview on the composition of the biosphere, both chemically and isotopically, thus affording a perspective on the nature and fate of organic compounds that may be preserved in the geosphere. The course focuses on the early digenesis of organic matter and its consequences for application of molecular biomarkers; kerogen and related materials; and application of organic geochemical methods for hydrocarbon exploration. Application of organic geochemistry in quaternary research and an assessment of present-day problems and future perspectives in organic geochemistry are discussed.

Equivalent to: EnvS 522.

Prerequisite: Graduate standing

CHEM 553 Environmental Pollution (3-0-3)

The course will mainly deal with problems related to marine pollution. Some of the topics are: different marine habitats, sources of marine pollution, types of pollution, effects of pollution on marine life, prevention and remedies for problems of pollution.

Equivalent to: EnvS 523.

Prerequisite: Graduate standing

CHEM 554 Environmental Geochemistry (3-0-3)

Interaction of water with minerals and organic compounds at the low temperature of many environmental settings. Emphasis on understanding groundwater compositions and capacity for transporting metals and organic solutes in the groundwater. Species classification, mass transport, surface reactions, contaminant sources, and remediation methods.

Equivalent to: EnvS 516.

Prerequisite: Graduate standing

CHEM 555 Environmental Ecology (3-0-3)

The goal of this course is better understanding of resources sharing among communities, and basic and fundamental concepts of terrestrial and aquatic environments. Global changes and nutrient cycling, nutrient availability and how resource competition among individuals within a community affects the distribution and abundance of organisms and human interactions. It also focuses on primary production, decomposition, and microbial ecology.

Equivalent to: EnvS 525.

Prerequisite: Graduate standing

CHEM 599 Graduate (M.S) Seminar (1-0-0)

Attendance of departmental seminars given by faculty, graduate students and visiting scholars. An M.S. student is expected to give a seminar on a literature topic of current interest in Chemistry.

Prerequisite: Graduate standing

CHEM 606 Independent Research (3-0-3)

This course is intended to allow the student to conduct research in advanced problems in his M.S. research area. The faculty offering the course should submit a research plan to be approved by the Graduate Program Committee at the academic department. The student is expected to deliver a public seminar and a report on his research outcomes at the end of the course. Graded on a Pass or Fail basis.

Prerequisite: Prior arrangement with an instructor

CHEM 610 M.S. Thesis (0-0-6)

Prerequisite: CHEM 599

CHEM 614 Characterization of Materials (3-0-3)

Introduction to techniques of imaging, and compositional analysis of advanced materials including nanomaterials. Principles and applications of various microscopy methods. Topics include AFM, SEM, TEM, EELS etc., and imaging processes.

Prerequisite: CHEM 510

CHEM 615 Statistical Thermodynamics (3-0-3)

The concept of ensemble and kinds of ensembles, quantum statistical mechanics, the partition function, Fermi and Bose statistics, imperfect fluids, cluster expansion, phase transitions.

Prerequisite: CHEM 512

CHEM 616 Quantum Chemistry II (3-0-3)

Application of quantum theory to molecular systems. Group theory: point groups and continuous groups. Application of group theory to atomic and molecular spectroscopy.

Prerequisite: CHEM 516

CHEM 617 Chemistry and Physics of Nanomaterials (3-0-3)

Fundamental chemical concepts and basic ideas needed to calculate the difference between the bulk properties of matter and the properties of aggregates. Tools needed to probe matter at the nanoscale level. Examples of nanoscale materials such as monolayers, fulleries, clusters, biomolecules etc., and their applications

Prerequisite: CHEM 510

CHEM 618 Advanced Magnetic Resonance Techniques (3-0-3)

Magnetic resonance theory, spin-lattice relaxation and motional narrowing of resonance lines. The density matrix of two level systems. Angular momentum and molecular rotation. Time dependent phenomena, time correlation function and memory function formalisms. Advanced concepts in pulsed magnetic resonance.

Prerequisite: CHEM 510

CHEM 620 Homogeneous Catalysis by Coordination Compounds (3-0-3)

Criteria for an effective homogeneous catalyst, survey of developed homogeneous catalytic processes, experimental methods of investigation of reaction mechanisms, supported homogeneous catalysis, metallocene catalysts, catalytic chain transfer catalysis and recent developments in coordination compounds as homogeneous catalysts.

Prerequisites: Graduate Standing

CHEM 621 Heterogeneous Catalysis (3-0-3)

Survey of developed heterogeneous catalytic processes, structures of surface, physical methods of investigation of surface phenomena, kinetics, catalysis by metal clusters, experimental considerations.

Prerequisite: Graduate Standing

CHEM 622 Surface Chemistry and Catalysis (3-0-3)

Physical and chemical properties of the surface in a reacting system, crystallite morphology, interface equilibria, adsorption and desorption kinetics, binding states and adsorbate structures, electronic properties of nonmetal catalysts, and metal-electrolyte interfaces.

Prerequisite: CHEM 520

CHEM 623 Photochemistry of Coordination Compounds (3-0-3)

Photophysical properties of excited states, photochemical reactions of excited states in coordination compounds, techniques for the study of the excited states and their reactions, photochemistry of polypyridyl complexes, photochemistry of porphyrin complexes, applications, recent developments.

Prerequisite: CHEM 520

CHEM 624 Solid State Chemistry (3-0-3)

Status solidi, shape of particles, lattice energy and Haber cycle, concepts of symmetry, crystal chemistry, structures of elements and parent structures of compounds, covalent solids, lattice defects and their thermodynamics, non-stoichiometry, alloy and intermetallic compounds, doping and semiconductors, order-disorder, phenomena, phase diagrams magnetic and electric properties, fast ionic conductivity, industrial chemicals, overview on experimental methods.

Prerequisite: CHEM 520

CHEM 626 Bio-Inorganic Chemistry (3-0-3)

Study of metalloproteins and other metal-containing biological molecules, photosynthesis, metallo and metal activated enzymes in hydrolysis and group-transfer reactions, the transition metals in biological redox reactions, nitrogen fixation, the biochemistry of iron, essential and trace elements in biological systems, metal ions and chelating agents in medicine, inorganic problems in biological systems.

Prerequisite: CHEM 520

CHEM 627 X-ray Diffraction Analysis (3-0-3)

Single crystal X-ray diffraction: data collection, structure solution and refinement. Polycrystalline X-ray diffraction: data collection and analysis including Rietveld refinement. Applications to molecular compounds, minerals and polymers.

Prerequisite: CHEM 520

CHEM 630 Physical Chemistry and Characterization of Polymers (3-0-3)

Applications of physical methods to the determination of the structure of polymers, physical chemistry of macromolecules, principles of experimental techniques and application, correlation between structure and physical macro-properties.

Prerequisite: CHEM 537

CHEM 631 Molecular Biochemistry (3-0-3)

The course focuses on the chemistry, structure, and function of biological molecules, macromolecules and systems. Topics covered include protein and nucleic acid structure, enzymology, mechanisms of catalysis, regulation, lipids and membranes, carbohydrates, bioenergetics and carbohydrate metabolism.

Prerequisite: CHEM 530

CHEM 632 Bioseparations, Recombinant Techniques and Protein Sciences (3-0-3)

General characteristics of separation processes used in the biotechnology industry - including the removal of insolubles, isolation and purification of thermally sensitive products and the preparation of products for final use by the customer. Applications of principles for biological separations, recombinant DNA techniques, protein engineering.

Prerequisite: CHEM 530

CHEM 633 Polymeric Drug Delivery Systems (3-0-3)

Biocompatible polymers and their application in drug delivery systems. Polymers of natural and synthetic origin, Special emphasis on the synthesis of biocompatible polymers. The formation of polymeric micelles, hydrogels and liposomes. The process of extravasations as uptake mechanism for polymeric delivery systems. Reading material will be based on the latest publications in the field.

Prerequisite: CHEM 530

CHEM 640 Analytical Spectroscopy (3-0-3)

Principles and analytical applications of modern molecular and atomic spectroscopy. Ultraviolet, visible, infrared, luminescence and scattering techniques. Flame, plasma, emission techniques, atomic absorption and atomic fluorescence techniques.

Prerequisite: CHEM 540

CHEM 642 Chemometrics (3-0-3)

Basic Statistics, Analysis of Variance (ANOVA), Computer Software (Mat Lab for Windows), Principles of Experimental Design, Factorial Designs and Analysis, Fractional Factorials, Response Surface Methodology, Second-order Designs, Application of the chemical Optimization by simplex.

Prerequisite: CHEM 540

CHEM 643 Environmental Analytical Chemistry (3-0-3)

Analytical aspects of several types of pollutants and the most common and recent analytical techniques used in environmental chemical analysis. This includes: atmosphere, water, oceans, land and environmental monitoring; instrumental techniques (chromatography, spectrometry, mass spectrometry, X-ray, radiochemical and electrochemical methods) used as tools for environmental analysis; sampling techniques; environmental data analysis and presentation.

Prerequisite: CHEM 540

CHEM 699: Ph.D. Seminar (1-0-0)

Ph.D. students are required to attend Departmental seminars delivered by faculty, visiting scholars and graduate students. Additionally, each Ph.D. student should present at least one seminar on a timely research topic. Ph.D. students should pass the comprehensive examination as part of this course. This course is a pre-requisite to registering the Ph.D. Pre-dissertation CHEM 711. The course is graded on pass or fail basis. IC grade is awarded if the Ph.D. Comprehensive exam is not yet passed.

Prerequisite: Graduate standing

CHEM 701 Directed Research I (0-0-3)

This course is intended to allow the student to conduct research in advanced problems in his Ph.D. research area. The faculty offering the course should submit a research plan to be approved by the Graduate Program Committee at the academic department. The student is expected to deliver a public seminar and a report on his research outcomes at the end of the course.

Prerequisite: Prior arrangement with an instructor

CHEM 702 Directed Research II (0-0-3)

This course is intended to allow the student to conduct research in advanced problems in his Ph.D. research area. The faculty offering the course should submit a research plan to be approved by the Graduate Program Committee at the academic department. The student is expected to deliver a public seminar and a report on his research outcomes at the end of the course.

Prerequisite: Prior arrangement with an instructor

CHEM 711 Ph.D. Pre-Dissertation (0-0-3)

This course enables the student to submit his Ph.D. Dissertation Proposal and defend it in public. The student passes the course if the Ph.D. Dissertation Committee accepts the submitted dissertation proposal report and upon successfully passing the Dissertation Proposal Public Defense. The course grade can be NP, NF or IC.

Prerequisite: Ph.D. Candidacy, **Co-requisite**: CHEM 699

CHEM 712 Ph.D. Dissertation (0-0-9)

This course enables the student to work on his Ph.D. Dissertation as per the submitted dissertation proposal, submits its final report and defends it in public. The student passes this course if the Ph.D. Dissertation Committee accepts the submitted dissertation report and upon successfully passing the Dissertation Public Defense. The course grade can be NP, NF, or IP.

Prerequisite: CHEM 711

DEPARTMENT OF EARTH SCIENCES

Chairman

Dr. Abdulaziz M. Al-Shaibani

Faculty

Abdulghani	Abdullah	Abdullatif
Abokhodair	Dogan	Hariri
Kaka	Kaminski	Korvin
Makkawi	Al-Ramadan	Al-Shaibani
Al-Shuhail A	Al-Shuhail A A	Tawabini
Vesnaver		

The Earth Sciences Department offers both undergraduate and graduate studies in geology and geophysics. The primary goal of the department's graduate programs is to educate geologists and geophysicists who can go directly into productive positions in the industry or government establishments. The level of instruction is also at a high standard such that it prepares the students towards the pursuance of higher studies leading to Ph.D. degree.

There are two master's degree options in Earth Sciences, namely Master of Science in Geology or Master of Science in Geophysics and Master of Geology or Master of Geophysics.

The Master of Science in Geology or Geophysics is designed for students who wish to focus on excellence in research. It requires 24 credit hours of approved course work and 6 hours of an acceptable thesis. Students are allowed to pursue their request in any area of their interest. However, the department encourages students to concentrate on current and new trends in geosciences research if supported by faculty specialties, projects, and interests.

The master of Geology or Geophysics is designed for students who wish to focus on excellence in training in Earth Sciences rather than research. It requires (39) credit hours of approved course work and (3) hours of an acceptable Master Report.

In addition to above programs, the the Department of Earth Sciences also offers Master of Science and Master of Environmental Sciences. These two programs are administed by active involvement of the Department of Chemistry in the College of Sciences.

Teaching and Research Facilities

Facilities currently available in the department include several well equipped lecture, seminar, audio-visual and resources rooms. The resource room contains a wide selection of professional journals, memories, reference textbooks and other publications. In addition, the department has a good collection of audio-visual and other instruction materials. The Earth Sciences' museum located in building 26, has a huge inventory of geological specimens (rocks, minerals, fossils, fossil fuels) collected from different areas in the Kingdom and worldwide. The department owns several 4-wheel drives and dune buggies for field trips. These vehicles are used both for local course-related field trips as well as geological itineraries during the Summer Field camp.

Laboratory facilities and equipment available in the department include thin section, reflection petroscopy, scanning electron microscopy (SEM), Xray defactometry (XRD), ground penetrating radar (GPR), paleomagnetism, remote sensing, aerial photography, resistivity, gravimeter, magnetometer, seismograph, passive seismic acquisition system and instruments for field as well as laboratory hydrologic and radiometric measurement. A modern seismic monitoring station is also located in the department. In addition, the department enjoys unrestricted access to the highly developed and equipped research facilities in the Central Analytical Laboratories, the Energy Research Laboratory and Remote Sensing units of the university Research Institute (RI). Facilities available at RI include XRF, SEM, TEM, ICP, AA, and GC-MS, X-ray emission (PIXE).

The PC laboratory of the department is equipped with the state-of-the art computing facilities. The department has several SUN workstations for training students in different geological and geophysical application software packages including IESX 2D/3D, Geo Viz, Stratlog II, GeoFrame, Petrel, and GPS-3. In addition, the department is connected to the UNIX server of the University Information Technology Center (ITC), a major data processing center in the region.

Admission Requirements

Graduates in Earth Sciences or related disciplines from the KFUPM or any other recognized institutions with a cumulative GPA of 3.00 or above (on scale of 4.00) or equivalent are eligible to apply for admission. However, candidates with a GPA between 2.5 and 3.00 are also considered for provisional admission. In addition, the applicants need to satisfy the general admission requirements of the Deanship of Graduate Studies. Students with inadequate background are expected to take the deficiency courses determined by the department.

Academic Programs

M.S. PROGRAM IN GEOLOGY

The Master of Science in Geology is designed for students who wish to focus on excellence in research.

Degree Requirements

Total credit hours required for the Master of Science in Geology program is 30 credit hours. The distribution of credit hours is as follows:

Geology Core Courses	9
Geology Elective Courses	9
Free Elective Courses	6
Thesis	6
Total Credit Hours	**30**

The Free Elective courses can be taken from any academic department (including Earth Sciences Department) provided the courses are 500-level or higher and approved by the student's academic advisor. Up to two graduate-level Geology elective courses can be substituted with 400-level undergraduate Geology courses only after advisor and department approvals. No credit will be given for any 400-level courses taken outside the department.

Students are allowed to pursue thesis research in any area of their interest. However, considering the current industry and academia needs, the department encourages students, in the Geology option, to specialize/concentrate in any of the following research areas: Sedimentology and Petroleum Geology, Economic Geology and Geochemistry, Hydrogeology, Environmental and Engineering Geology.

Core Courses

The following courses are required for all graduate students in the Geology option:

GEOL 501	Geology of the Middle East
GEOL 502	Advanced Structural Geology
GEOL 581	Geophysical Exploration
GEOL 599	Seminar
GEOL 610	M.S. Thesis

Elective Courses

Geology elective courses, their titles, and credit hours are listed in the following table:

GEOL 521	Advanced Petroleum Geology
GEOL 522	Micropaleontology
GEOL 531	Advanced Stratigraphy
GEOL 532	Advanced Sedimentology
GEOL 533	Carbonates and Evaporites
GEOL 534	Seismic and Sequence Stratigraphy
GEOL 535	Quaternary Geology of Saudi Arabia
GEOL 541	Advanced Mineralogy
GEOL 542	Advanced Petrology
GEOL 543	Ore Mineralogy

GEOL 544	Ore Deposits
GEOL 545	Advanced Economic Geology
GEOL 551	Advanced Geochemistry
GEOL 552	Geochemical Prospecting
GEOL 561	Advanced Hydrogeology
GEOL 562	Groundwater Modeling
GEOL 563	Development of Ground Water Resources
GEOL 571	Advanced Engineering Geology
GEOL 572	Geo-Environment
GEOL 573	Terrain Analysis
GEOL 582	GIS Applications in Geology
GEOL 583	Photogeology and Remote Sensing
GEOL 584	Applied Geostatistics
GEOL 585	Geological Laboratory Techniques
GEOL 590	Independent Studies
GEOL 592	Special Topics

Free Elective Courses

All students are required to complete two electives (6 credit hours) to be chosen from any academic department, including Earth Sciences Department, provided the courses are 500 level courses or above and approved by the student's academic advisor. Students are required to:

- Attend and pass the GEOL 599 seminar, which carries no credit,
- Satisfy the GEOL 610 thesis requirement (6 credit hours). He must complete the thesis on an approved topic under the supervision of his graduate thesis committee,
- Maintain a cumulative and major GPA of 3.00 or above in all graduate work.

Degree Plan for M.S. in Geology

Course No.	Title	LT	LB	CR
First Semester				
GEOL 501	Geology of the Middle East	3	0	3
GEOL xxx	Geology Elective I	3	0	3
GEOL xxx	Geology Elective II	3	0	3
		9	**0**	**9**
Second Semester				
GEOL 502	Advanced Structural Geology	3	0	3
GEOL xxx	Geology Elective III	3	0	3
XXX xxx	Free Elective I	3	0	3
GEOL 599	Seminar	1	0	0
		10	**0**	**9**
Third Semester				
GEOL 581	Geophysical Exploration	3	0	3
XXX xxx	Free Elective II	3	0	3
GEOL 610	M.S. Thesis	0	0	IP
		6	**0**	**6**
Fourth Semester				
GEOL 610	M.S. Thesis	0	0	6
		0	**0**	**6**
Total Credit Hours				**30**

Notes:

- Each student is expected to submit his detailed degree plan according to the above generic degree plan for approval by the Department and the Deanship of Graduate Studies within the 8^{th} week of the second semester of enrollment.
- Students are required to adhere to the regulations of degree plan. No relaxations will be given to any student, and courses taken in conflict of the above will not be counted towards the degree.
- Up to two 400-level elective courses may allowed on recommendations of the advisor.
- The order of taking the courses can be different from above, but students must take the core courses before electives.

MASTER OF GEOLOGY

The Master of Geology program is designed for the professional geoscientists who wish to focus on excellence in training in geosciences rather than research.

Degree Requirements

Total credit hours required for the Master in Geology program is 42. The distribution of credit hours is as follows:

Geology Core Courses	12
Geology Elective Courses	15
Free Elective Courses	12
Geology Master Report	3
Total Credit Hours	**42**

The Free Elective courses can be taken from any academic department (including Earth Sciences Department) provided the courses are 500-level or higher and approved by the student's academic advisor. Up to two graduate-level Geology elective courses can be substituted with 400-level undergraduate Geology courses only after advisor and department approvals. No credit will be given for any 400-level courses taken outside the department.

Students are allowed to pursue thesis research in any area of their interest. However, considering the current industry and academia needs, the department encourages students, in the Geology option, to specialize/concentrate in any of the following research areas: Sedimentology and Petroleum Geology, Economic Geology and Geochemistry, Hydrogeology, Environmental and Engineering Geology.

Core Courses

The following courses are required for all graduate students in the Geology option:

GEOL 501	Geology of the Middle East
GEOL 502	Advanced Structural Geology
GEOL 581	Geophysical Exploration
GEOL 585	Geological Laboratory Techniques
GEOL 599	Seminar
GEOL 600	Geology Master Report

Elective Courses

Geology elective courses, their titles, and credit hours are listed in the following table:

GEOL 521	Advanced Petroleum Geology
GEOL 522	Micropaleontology
GEOL 531	Advanced Stratigraphy
GEOL 532	Advanced Sedimentology
GEOL 533	Carbonates and Evaporites
GEOL 534	Seismic and Sequence Stratigraphy
GEOL 535	Quaternary Geology of Saudi Arabia
GEOL 541	Advanced Mineralogy
GEOL 542	Advanced Petrology
GEOL 543	Ore Mineralogy

GEOL 544	Ore deposits
GEOL 545	Advanced Economic Geology
GEOL 551	Advanced Geochemistry
GEOL 552	Geochemical Prospecting
GEOL 561	Advanced Hydrogeology
GEOL 562	Groundwater Modeling
GEOL 563	Development of Ground water Resources
GEOL 571	Advanced Engineering Geology
GEOL 572	Geo-Environment
GEOL 573	Terrain Analysis
GEOL 582	GIS Applications in Geology
GEOL 583	Photogeology and Remote Sensing
GEOL 584	Applied Geostatistics
GEOL 590	Independent Studies
GEOL 592	Special Topics

Free Elective Courses

All students are required to complete four electives (12 credit hours) to be chosen from any academic department, including Earth Sciences Department, provided the courses are 500 level courses or above and approved by the student's academic advisor. Students are required to:

- Attend and pass the GEOL 599 seminar, which carries no credit,
- Satisfy the GEOL 610 Geology Master Report requirement (3 credit hours). He must complete the report on an approved topic under the supervision of his academic advisor,
- Maintain a cumulative and major GPA of 3.00 or above in all graduate work.

Degree Plan for Master of Geology

Course No.	Title	LT	LB	CR
First Semester				
GEOL 501	Geology of the Middle East	3	0	3
GEOL xxx	Geology Elective I	3	0	3
GEOL xxx	Geology Elective II	3	0	3
XXX xxx	Free Elective I	3	0	3
		12	**0**	**12**
Second Semester				
GEOL 502	Advanced Structural Geology	3	0	3
GEOL xxx	Geology Elective III	3	0	3
GEOL 599	Seminar	1	0	0
XXX xxx	Free Elective II	3	0	3
		10	**0**	**9**
Third Semester				
GEOL 581	Geophysical Exploration	3	0	3
GEOL xxx	Geology Elective IV	3	0	3
XXX xxx	Free Elective III	3	0	3
XXX xxx	Free Elective IV	3	0	3
		12	**0**	**12**
Fourth Semester				
GEOL 585	Geological Laboratory Techniques	2	3	3
GEOL xxx	Geology Elective V	3	0	3
GEOL 600	Geology Master Report	0	0	3
		5	**3**	**9**
Total Credit Hours				**42**

Notes:

- Each student is expected to submit his detailed degree plan according to the above generic degree plan for approval by the Department and the Deanship of Graduate Studies within the 8^{th} week of the second semester of enrollment.
- Students are required to adhere to the regulations of degree plan. No relaxations will be given to any student, and courses taken in conflict of the above will not be counted towards the degree.
- Maximum of two 400-level elective courses may be allowed on recommendations of the advisor.
- The order of taking the courses can be different from above, but students must take the core courses before electives.

M.S. PROGRAM IN GEOPHYSICS

The Master of Science in Geophysics is designed for students who wish to focus on excellence in research.

Degree Requirements

Total credit hours required for the Master of Science in Geophysics program is 30 credit hours. The distribution of credit hours is as follows:

Geophysics Core Courses	9
Geophysics Elective Courses	6
Graduate Mathematics Course	3
Free Elective Courses	6
Thesis	6
Total Credit Hours	**30**

All students are required to complete one graduate level Mathematics course. The Free Elective courses can be taken from any academic department (including Earth Sciences Department) provided the courses are 500-level or higher and approved by the student's academic advisor. Up to two graduate-level Geophysics elective courses can be substituted with 400-level undergraduate Geophysics courses only after advisor and department approvals. No credit will be given for any 400-level courses taken outside the department. In addition to above an M.S. student is required to:

- Attend and pass the GEOP 599 seminar, which carries no credit.
- Satisfy the GEOP 610 (M.S. thesis) requirements and complete it on an approved topic under the supervision of his advisor, and
- Must maintain a cumulative and major GPA of 3.00 or above in all graduate course work.

Core Courses

The following courses are required for all graduate students in the Geophysics option:

GEOP 501	Reflection Seismology
GEOP 502	Potential Theory Methods
GEOP 503	Solid-Earth Geophysics
MATH 5xx	Graduate Mathematics Course
GEOP 599	Seminar
GEOP 610	M.S. Thesis

Elective Courses

Geophysics elective courses, their titles, and credit hours are listed below:

GEOP 504	Applied Environmental Geophysics
GEOP 505	Advanced Computational Geophysics
GEOP 510	Seismic Data Analysis
GEOP 515	Geophysical Inversion
GEOP 520	Geomagnetism & Paleomagnetism
GEOP 525	Electrical Methods
GEOP 530	Basin Analysis
GEOP 535	Seismic & Sequence Stratigraphy

GEOP 540	Three-Dimensional Seismic Interpretation
GEOP 545	Petroleum Data Integration & Management
GEOP 550	Reservoir Characterization
GEOP 590	Independent Studies
GEOP 592	Special Topics

Degree Plan for M.S. in Geophysics

Course No.	Title	LT	LB	CR
First Semester				
GEOP 501	Reflection Seismology	3	0	3
GEOP 502	Potential Theory Methods	3	0	3
GEOP xxx	Geophysics Elective I	3	0	3
		9	**0**	**9**
Second Semester				
GEOP 503	Solid Earth Geophysics	3	0	3
GEOP xxx	Geophysics Elective II	3	0	3
XXX xxx	Free Elective I	3	0	3
GEOP 599	Seminar	1	0	0
		10	**0**	**9**
Third Semester				
MATH 5xx	Graduate Mathematics Course	3	0	3
XXX xxx	Free Elective II	3	0	3
GEOP 610	M.S. Thesis	0	0	IP
		6	**0**	**6**
Fourth Semester				
GEOP 610	M.S. Thesis	0	0	6
		0	**0**	**6**
Total Credit Hours				**30**

Notes:

- Each student is expected to submit his detailed degree plan according to the above generic degree plan for approval by the Department and the Deanship of Graduate Studies within the 8th week of the second semester of enrollment.
- Students are required to adhere to the regulations of degree plan. No relaxations will be given to any student, and courses taken in conflict of the above will not be counted towards the degree.
- Up to two 400-level elective courses are allowed on the approval of the advisor.
- The order of taking the courses can be different from above, but students must take the core courses before electives.

MASTER OF GEOPHYSICS

The Master of Geophysics program is designed for the professional geoscientists who wish to focus on excellence in training in geosciences rather than research.

Degree Requirements

Total credit hours required for the Master of Geophysics is 42. The distribution of credit hours is as follows:

Geophysics Core Courses	9
Geophysics Elective Courses	15
Graduate Mathematics Course	3
Free Elective Courses	12
Geophysics Master Report	3
Total Credit Hours	**42**

All students are required to complete one graduate Mathematics course and four electives (12 credit hours) to be taken from any academic department, including Earth Sciences Department, provided the courses are 500 level courses or above and approved by the student's academic advisor. Students are required also to:

- Attend and pass the GEOP 599 seminar, which carries no credit.
- Satisfy the GEOP 600 Master report requirement (3 credit hours). He must complete the report on an approved topic under the supervision of his academic advisor and
- Maintain a cumulative and major GPA of 3.00 or above in all graduate work.

Core Courses

The following courses are the core courses for graduate students in the Geophysics option.

GEOP 501	Reflection Seismology
GEOP 502	Potential Theory Methods
GEOP 503	Solid-Earth Geophysics
MATH 5xx	Graduate Mathematics Course
GEOP 600	Geophysics Master Report
GEOP 599	Seminar

Elective Courses

Geophysics elective courses, their titles, and credit hours are listed in the following table:

GEOP 504	Applied Environmental Geophysics
GEOP 505	Advanced Computational Geophysics
GEOP 510	Seismic Data Analysis
GEOP 515	Geophysical Inversion
GEOP 520	Geomagnetism & Paleomagnetism
GEOP 525	Electrical Methods
GEOP 530	Basin Analysis
GEOP 535	Seismic & Sequence Stratigraphy
GEOP 540	Three-Dimensional Seismic Interpretation
GEOP 545	Petroleum Data Integration & Management

GEOP 550	Reservoir Characterization
GEOP 590	Independent Studies
GEOP 592	Special Topics

Degree Plan for Master of Geophysics

Course No.	Title	LT	LB	CR
First Semester				
GEOP 501	Reflection Seismology	3	0	3
GEOP 502	Potential Theory Methods	3	0	3
GEOP 5xx	Geophyiscs Elective I	3	0	3
XXX xxx	Free Elective I	3	0	3
		12	**0**	**12**
Second Semester				
GEOP 503	Solid Earth Geopysics	3	0	3
GEOP xxx	Geophysics Elective II	3	0	3
GEOP 599	Seminar	1	0	0
XXX xxx	Free Elective III	3	0	3
		10	**0**	**9**
Third Semester				
MATH 5xx	Graduate Mathematics Course	3	0	3
GEOP xxx	Geophysics Elective III	3	0	3
XXX xxx	Free Elective III	3	0	3
XXX xxx	Free Elective IV	3	0	3
		12	**0**	**12**
Fourth and Subsequent Semesters				
GEOP xxx	Geolphysics Elective IV	3	3	3
XXX xxx	Geophysics Elective V	3	0	3
GEOL 600	Geophysics Master Report	0	0	3
		6	**3**	**9**
Total Credit Hours				**42**

Notes:

- Each student is expected to submit his detailed degree plan according to the above generic degree plan for approval by the Department and the Deanship of Graduate Studies within the 8th week of the second semester of enrollment.
- Students are required to adhere to the regulations of degree plan. No relaxations will be given to any student, and courses taken in conflict of the above will not be counted towards the degree.
- Maximum of two 400-level elective courses may allowed on recommendations of the advisor.
- The order of taking the courses can be different from above, but students must take the core courses before electives.

MASTER PROGRAMS PROGRAM IN ENVIRONMENTAL SCIENCES

Environmental Science is an interdisciplinary field dealing with the scientific study of natural systems and human impacts on these systems. Most environmental problems are complex, demanding the problem-solving insights of multiple disciplines. A student seeking to specialize in Environmental Science is required to focus on at least three areas. First, it is important for him to understand the natural processes (both physical and biological) that operate in the world. Second, it is important to appreciate the role that technology plays in our society and its capacity to alter natural processes as well as solve problems caused by human impact. Third, the complex social processes that are characteristics of human populations must be understood and integrated with knowledge of technology and natural processes to fully appreciate the role of humans in the natural world. The department of Earth Scineces, with active collaboration of Department of Chemistry offers degrees of M.S. and Masters in Environmental Sciences.

Programs Objectives

The Environmental Sciences programs aim at providing students with a broad-based foundation in the scientific principles that govern natural and engineered environmental systems. In addition, the program focuses on the critical environmental problems which transcend national borders, which also have local relevance. The program is helpful in preparing students for careers that require the policy-and decision-making skills necessary to integrate technical knowledge into a broader, applied framework.

The program integrates the natural, chemical, and physical sciences taught in the College of Sciences with a strong emphasis on concept-based learning and empiricism. In this program, the students are trained for careers in Environmental Science research and management in a wholly problem solving setting.

Participating Departments

The program is administered by the Deptment of Earth Sciences in the College of Sciences with the active involvement of the Department of Chemistry. In addition, students also take courses from other University departments as electives.

Academic Programs

M.S. PROGRAM IN ENVIRONMENTAL SCIENCES

The M.S. program in Environmental Sciences is designed for students who wish to focus on excellence in research.

Degree Requirements

Total credit hours required for the Master of Science in Geophysics program is 30 credit hours. The distribution of credit hours is as follows:

Environmental Sciences Core Courses	12
Environmental SciencesElective Courses	6
Free Elective Courses	6
Thesis	6
Total Credit Hours	**30**

Admission Requirements

Science or engineering graduates from recognized institutions who have a GPA of 3.00 or above (on a 4.00 scale), or equivalent, are eligible to apply for admission as a regular student in the Master of Environmental Sciences Program. Applicants should also have satisfied the Graduate

School admission requirements. Students with any deficiencies in their undergraduate courses will be required to take the relevant deficiency courses.

Program Requirements

Core Courses

ENVS 510 Advanced Environmental Geology

ENVS 522 Environmental Chemistry

ENVS 532 Environmental Biology

ENVS 542 Concepts of Environmental Management

General Required Courses

ENVS 599 Seminar

ENVS 610 M.S. Thesis

Elective Courses

Students are also required to take two courses from the following elective course list for a total of 6 credit hours as Environmental Sciences electives.

Environmental Geology Discipline

ENVS 514 Desertification

ENVS 515 Environmental Hydrogeology

ENVS 516 Ground-Water Resources Management

ENVS 518 Geophysics for Environmental Applications

ENVS 519 Environmental Remote Sensing

Environmental Chemistry

ENVS 523 Advanced Analytical Geochemistry

ENVS 525 Advanced Environmental Pollution

ENVS 526 Air Pollution

ENVS 528 Environmental Toxicology

Environmental Biology Discipline

ENVS 533 Advanced Environmental Ecology

ENVS 535 Environmental Biotechnology

ENVS 536 Environmental Microbiology

ENVS 538 Marine Pollution

Environmental Management Discipline

ENVS 543 Management of Marine Environment

ENVS 545 Environmental Risk Assessment and Modeling

ENVS 546 Environmental Impact Assessment

ENVS 548 Industrial Waste Management

ENVS 549 Environmental Sustainability

Other Electives

ENVS 564	Statistical Methods in Environmental Research
ENVS 590	ENVS Special Topics I
ENVS 591	ENVS Special Topics II
ENVS 606	Independent Research

Degree Plan for M.S. in Environmental Sciences

Course No.	Title	LT	LB	CR
First Semester				
ENVS 510	Advanced Environmental Geology	3	0	3
ENVS 522	Environmental Chemistry	3	0	3
XXX xxx	Free Elective I	3	0	3
		9	**0**	**9**
Second Semester				
ENVS 532	Environmental Biology	3	0	3
ENVS 542	Concepts of Environmental Management	3	0	3
ENVS 5xx	Environmental Science Elective I	3	0	3
ENVS 599	Seminar	1	0	0
		10	**0**	**9**
Third Semester				
ENVS 5xx	Environmental Sciences Elective II	3	0	3
XXX xxx	Free Elective II	3	0	3
ENVS 610	M.S. Thesis	0	0	IP
		6	**0**	**6**
Fourth Semester				
ENVS 610	M.S. Thesis	0	0	6
		0	**0**	**6**
Total Credit Hours				**30**

Notes:

- Each student is expected to submit his detailed degree plan according to the above generic degree plan for approval by the Department and the Deanship of Graduate Studies within the 8th week of the second semester of enrollment.
- Students are required to adhere to the regulations of degree plan. No relaxations will be given to any student, and courses taken in conflict of the above will not be counted towards the degree.
- Maximum of two 400-level elective courses may be allowed on recommendations of the advisor.
- The order of taking the courses can be different from above, but students must take the core courses before electives.

MASTER PROGRAM IN ENVIRONMENTAL SCIENCES

The Master program in Environmental Sciences is designed for students who wish to focus on excellence in research.

Degree Requirements

Total credit hours required for the Master of Science in Environmental Sciences is 30 credit hours. The distribution of credit hours is as follows:

Environmental Sciences Core Courses	15
Environmental SciencesElective Courses	12
Free Elective Courses	12
Environmental Sciences Master Report	03
Total Credit Hours	**42**

Program Requirements

Core Courses

ENVS 510 Advanced Environmental Geology

ENVS 522 Environmental Chemistry

ENVS 532 Environmental Biology

ENVS 542 Concepts of Environmental Management

ENVS 546 Environmental Impact Assessment

General Requirement

ENVS 599Seminar

General Requirement

ENVS 600ENVS Master Report

Environmental Science Elective Courses

A candidate of Master Program is required to take at least 12 credits. These courses can be picked up from the courses listed as elective courses of M.S. program in Environmental sciences excluding ENVS 546 and ENVS 606.

Free Elective Courses

All master students are required to complete 12 credit hours of elective courses to be chosen from any academic department or program in the University, including the Environmental Sciences Program, provided the courses are 400/500 level courses or above, and according to the approved degree plan of the students.

Degree Plan for Master in Environmental Sciences

Course No.	Title	LT	LB	CR
First Semester				
ENVS 510	Advanced Environmental Geology	3	0	3
ENVS 522	Environmental Chemistry	3	0	3
ENVS 5xx	Environmental Sciences Elective I	3	0	3
XXX xxx	Free Elective I	3	0	3
		12	**0**	**12**
Second Semester				
ENVS 532	Environmental Biology	3	0	3
ENVS 542	Concepts of Environmental Management	3	0	3
ENVS 5xx	Environmental Science Elective II	3	0	3
ENVS 599	Seminar	1	0	0
		10	**0**	**9**
Third Semester				
ENVS 546	Environmental Impact Asssessment	3	0	3
ENVS 5xx	Environmental Sciences Elective III	3	0	3
XXX xxx	Free Elective II	3	0	3
XXX xxx	Free Elective III	3	0	3
		12	**0**	**12**
Fourth Semester				
ENVS 600	ENVS Master Report	3	0	3
ENVS 5xx	Environmental Science Elective IV	3	0	3
XXX xxx	Free Elective IV	3	0	3
		9	**0**	**9**
Total Credit Hours				**42**

Notes:

- Each student is expected to submit his detailed degree plan according to the above generic degree plan for approval by the Department and the Deanship of Graduate Studies within the 8th week of the second semester of enrollment.
- Students are required to adhere to the regulations of degree plan. No relaxations will be given to any student, and courses taken in conflict of the above will not be counted towards the degree.
- Maximum of two 400-level elective courses may be allowed on recommendations of the advisor.
- The order of taking the courses can be different from above, but students must take the core courses before electives.

PH.D. PROGRAM IN GEOLOGY

The Ph.D. program in geology is the latest of programs offered by the Earth Sciences Department. The program reflects, and builds upon the Department's long-standing vision: to continue as the leading Geosciences Department in the region through a balanced approach between education and research.

Admission Requirements

The following are eligibility requirements for admission to the Ph.D program in Geology:

- Applicants should hold an MSc degree in any field of Earth Sciences with a GPA of 3.0 or higher (or its equivalent) from reputable Institutions.
- They should meet KFUPM & Departmental standards of performance in the GRE and in the TOEFL score.
- In case of part-time students there is an altogether one full year residency requirement, with full release from work duties.

Degree Requirements

The Ph.D. program is offered in three Major Areas, each of them having several specializations ("Minor Areas"):

- Petroleum Geology (Minor Areas: Paleontology, Clay Minerology, Basin Analysis, Reservoir Characterization, Petroleum Exploration, Exploration Geophysics, etc.)
- Hydrogeology & Environmental Geology (Minor Areas: Numerical Modeling, Flow in Porous Media, Geostatistics, etc.)
- Structural & Regional Geology (Minor Areas: GIS, Remote Sensing, Economic Geology, etc.).

The Student will take courses and Comprehensive examination as follows:

- Two compulsory core courses from the GEOL6XX list (i.e.: GEOL 601 Carbonate Sedimentology & Diagenesis; GEOL 602 Global & Regional Tectonics; 3 Earth Sciences Elective Courses from their Major Area (GEOL 6XX, GEOL 5XX, GEOP 5XX or ENVS 5XX) provided such courses, or their equivalent, had not been already taken during his M.Sc. program.
- Three free elective courses from the 6XX or 5XX Courses offered by the ESD or from other Depts. of KFUPM College of Sciences, College of Comp.Sci. and Eng., or College of Eng. Sciences.
- A Ph.D. student has to successfully pass a comprehensive examination by the end of the second year from the student's enrolment in the Ph.D. program The Comprehensive Examination will normally be given during the third semester after the student enrollment in the Ph.D. program. The Ph.D. student will be allowed to take the Comprehensive Examination only twice. The examination is graded on pass or fail basis.

Degree Plan for Ph.D. in Geology

Course No.	Title	LT	LB	CR
First Semester				
GEOL 601	Carbonate Sed. and Diagenesis	2	0	3
GEOL/GEOP 5xx/6xx	Earth Sciences Elective 1	3	0	3
XXX 5xx/6xx	Free Elective I	3	0	3
		8	**0**	**9**
Second Semester				
GEOL 602	Global and Regional Tectonics	3	0	3
GEOL/GEOP 5xx/6xx	Earth Sciences Elective 2	3	0	3
XXX 5xx/6xx	Free Elective 2	3	0	3
		9	**0**	**9**
Third Semester				
GEOL/GEOP 5xx/6xx	Earth Sciences Elective 3	3	0	3
GEOL/GEOP 5xx/6xx	Earth Sciences Elective 4	3	0	3
GEOL/GEOP 5xx/6xx	Earth Sciences Elective 5	3	0	3
GEOL 699	Seminar	1	0	0
		10	**0**	**9**
Fourth Semester				
XXX 5xx/6xx	Free Elective 3	3	0	3
GEOL 711	Ph.D. Pre-Dissertation	0	0	3
		3	**0**	**6**
Fifth Semester				
GEOL 712	Ph.D. Dissertation	0	0	IP
Sixth Semester				
GEOL 712	Ph.D. Dissertation	0	0	9
		0	**0**	**9**
Total Credits				**42**

Notes:

- Each student is expected to submit his detailed degree plan according to the above generic degree plan for approval by the Department and the Deanship of Graduate Studies within the 8th week of the second semester of enrollment.
- Students are required to adhere to the regulations of the degree plan. No relaxations will be given to any student, and courses taken in conflict of the above will not be counted towards the degree.
- The order of taking the courses can be different from above, but students must take the core courses before electives.

COURSE DESCRIPTIONS

GEOLOGY

GEOL 501 Geology of the Middle East (3-0-3)

Topography, geomorphology and geologic setting of the Middle East, major tectonic elements in the region, Pre-Cambrian rocks (the Arabian-Nubian Shield); Non-Folded Phanerozoic rocks, Mesozoic Cenozoic fold belts (e.g. the Oman Mountains, the Zagros Belt, the Northern Iraq Chain, the Toros Chain); origin of the minerals in the Middle East. At least one field trip is required.

Prerequisite: GEOL 318 or consent of the instructor

GEOL 502 Advanced Structural Geology (3-0-3)

Principles and concepts of rock mechanics applied to structural features, brittle and ductile deformations, large-scale tectonics and regional tectonic provinces and associated structures; geometrical analysis of megascopic structures in terrains with multiple or complex deformations; analysis of strain from deformed primary features. At least one field trip is required.

Prerequisite: GEOL 305 or consent of the instructor.

GEOL 521 Advanced Petroleum Geology (3-0-3)

Origin, migration and accumulation of petroleum; Properties of reservoir rocks; Biomarkers and geochemical correlations; Techniques of subsurface geology – formation evaluation using well logs, different mapping techniques; geological problems of production and secondary recovery are emphasized; case histories of major oil fields are reviewed. At least one field trip is required.

Prerequisite: GEOL 415 or consent of the instructor

GEOL 522 Micropaleontology (3-0-3)

Definition and historical development of micropaleontology, techniques in micropaleontological and microstratigraphical analysis; survey of the major microfossil groups, their morphology, taxonomy, ecology, geologic distribution, evolutionary trends and stratigraphic use, with selected problems from Arabia and nearby regions.

Prerequisite: GEOL 214 or consent of the instructor.

GEOL 531 Advanced Stratigraphy (3-0-3)

Review of the basic stratigraphic concepts; Sedimentary facies and facies relations- Walther's law; International codes and procedures on classification and nomenclatures of stratigraphic units – lithostratigraphy, biostratigraphy and chronostratigraphy, methods of correlations; Seismic stratigraphy; Sequence stratigraphy- sequences, system tracts, parasequrences; other stratigraphic methods including magneto-stratigraphy, isotope stratigraphy and event stratigraphy; Basin analysis and tectonics. At least one field trip is required.

Prerequisite: GEOL 307 or consent of the instructor.

GEOL 532 Advanced Sedimentology (3-0-3)

Review of the properties of sedimentary materials- clastic and carbonates; Concept of flow regime and bed forms; Sedimentary processes and depositional environments – continental,

marginal marine and marine; Facies and facies analysis--criteria for recognition of ancient sedimentary environment; Interpretation and recognition of major depositional environments: fluvial, eolian, delta, beach and barrier bar, marine shelf-clastics and carbonates, deep marine turbidite, pelagic; Burial diagenesis clastics and carbonates.

Prerequisite: GEOL 307 or consent of the instructor.

GEOL 533 Carbonates and Evaporites (3-0-3)

Principles of carbonate and evaporite sedimentology; depositional sequences defined in modern environments and utilized to interpret ancient rock records; depositional and diagenetic microfacies; recognition and description of hydrocarbon reservoirs in carbonate rocks.

Prerequisite: GEOL 307 or consent of the instructor.

GEOL 534 Seismic and Sequence Stratigraphy (3-0-3)

Seismic velocities, Wavelets, Acoustic impedance, Reflection coefficient, Data acquisition & data processing, 2-D and 3-D seismic methodology, Seismic response to geological structures, Convergent margins, Divergent margins, Salt tectonics, Sedimentary processes, Depositional environments, Well log correlation, Seismic facies analysis, Global changes in sea level, System tracts, Chrono- and litho-stratigraphy, Clastics and carbonate sequence stratigraphy, Case histories.

Prerequisite: (GEOL 307 and GEOP 202) or consent of the instructor

GEOL 535 Quaternary Geology of Saudi Arabia (3-0-3)

Evaluation of sedimentological, hydrogeological, geomorphological and climatic processes during the Quaternary period in Saudi Arabia; characteristics, distribution, and origin of Quaternary deposits, stratigraphy and chronology; formation of associated landforms, landscapes, sea level fluctuations; comparison of the Quaternary hydrogeology, geochronology and climate of the Arabian peninsula with that of North Africa and Europe.

Prerequisite: GEOL 307 or consent of the instructor.

GEOL 541 Advanced Mineralogy (2-3-3)

Chemical and physical basis of mineralogy such as crystal chemistry, crystal structure, geochemistry, etc. Studies of some of the less common minerals. Laboratory work will cover instrumental techniques using X-ray diffraction, differential thermal analysis, heavy liquids, isodynamic separator, etc.

Prerequisite: GEOL 216 or consent of the instructor.

GEOL 542 Advanced Petrology (2-3-3)

Selected topics in igneous and metamorphic petrology such as magmatic differentiation, generation, metamorphic facies, in conformity with concepts of global tectonics. Emphasis may be varied to suit the needs of students. Laboratory studies will examine suits of rocks from igneous and metamorphic terrains. At least one field trip is required.

Prerequisite: GEOL 320 or consent of the instructor.

GEOL 543 Ore Mineralogy (2-3-3)

Ore microscopic techniques. Textures and optical properties of ore minerals. Systematic mineralogy of ore minerals. A study of fluid inclusions in ore minerals. Stable isotopes. Mineral stabilities and paragenesis. Introduction to mineral processing.

Prerequisite: GEOL 216 or consent of the instructor.

GEOL 544 Ore Deposits (3-0-3)

A study of the different metallic and non-metallic ore deposits, their characteristics, ore geneses, and geological settings. Ore formation processes, ore bearing fluids, wall rock alteration, paragenesis, isotopic and fluid inclusion studies and ore deposits distribution according to their geological environment. The metalogenic provinces in Saudi Arabia and examples of ore deposits within the Arabian Shield and cover rocks. At least one field trip to an operational mine or mineral prospect is required.

Prerequisite: GEOL 456 or consent of the instructor.

GEOL 545 Advanced Economic Geology (3-0-3)

A study of the different exploration methods of the ore deposits, and the control of structural, sedimentological, chemical and physical factors on ore deposits formation. Methods of ore deposits evaluation and the geostatistical assessments of the ore deposits. Preparation of an exploration project and steps of its implementation. At least one field trip to an operational mine is required.

Prerequisite: GEOL 456 or consent of the instructor.

GEOL 551 Advanced Geochemistry (3-0-3)

Principles, Geochemistry applied to mineral exploration, pollution characterization and low temperature diagenesis; clay mineral and cation exchange; adsorption; redox equillibria; heavy metals and metalloids; stability relationships; overview of isotope geochemistry; transport and reaction modeling; interpretation of data, case histories and research problem.

Prerequisite: GEOL 355 or consent of the instructor.

GEOL 552 Geochemical Prospecting (3-0-3)

Geochemical behavior of common ore elements, development of primary and secondary holes around ore deposits, distribution of detrital material and solutions by streams and glaciers, etc. Strategy of geochemical exploration programs in different terrains and different climates. Field and semifield methods of analysis for trace amount of metals.

Prerequisite: Consent of the instructor.

GEOL 561 Advanced Hydrogeology (3-0-3)

A general review of the principles of physical hydrogeology: Geology of porous media; Darcy's law; Groundwater flow equations; Pumping test analysis and aquifer evaluation. Concepts of mass transport in porous medium; Contaminant hydrogeology; Capture zone analysis; Methods of remediation.

Prerequisite: GEOL 423 or equivalent

GEOL 562 Groundwater Modeling (3-0-3)

Review of groundwater flow and transport equations; Development of numerical models describing groundwater flow and transport; Application of numerical modeling related to groundwater depletion and contaminant transport; Case studies.

Prerequisite: GEOL 423 or equivalent. Experience in a programming language is recommended.

GEOL 563 Development of Ground-Water Resources (3-0-3)

An introduction to geophysical and geochemical methods of exploration for planning, and design of regional water resources investigations. Case histories in the management of ground-water resources. Literature review and special field problems. in resource developments.

Prerequisite: GEOL 562 or consent of the instructor.

GEOL 571 Advanced Engineering Geology (3-0-3)

Use of different site investigation techniques for identification and evaluation environmental problems before and after construction phases, engineering geological mapping, and assessment of engineering geological hazards in the arid region, geohazards, risk assessment, sampling and monitoring methods utilized in the engineering applications. Special emphasis is also given to study the engineering geological aspects of existing engineering/environmental problem(s) at selected site(s).

Prerequisite: GEOL 341 or consent of the instructor

GEOL 572 Geo-Environment (3-0-3)

Study of interaction between human activity and geologic environment; role of geosciences in planning and management of the environmental applications, prediction and forecasting of

hazards and changes of the environment caused by natural processes, man-made and technological activities; selected case studies.

Prerequisite: GEOL 446 or consent of the instructor

GEOL 573 Terrain Analysis (3-0-3)

Study of geomorphic processes, landform development, surficial earth materials, terrain mapping and hazard evaluation, urban climate, urban hydrology, engineering geological aspects, soil types, terrain classification, ecology and vegetation, role of Geographic Information Systems. (GIS) on terrain analysis. Special emphasis will be given to evaluate of the engineering geological properties of terrain factors for site selection and design of engineering and environmental projects. Selected case studies.

Prerequisite: GEOL 312 or consent of the instructor

GEOL 581 Geophysical Exploration (3-0-3)

General survey of the most widely used Geophysical methods for natural resources exploration and environmental studies (e.g. seismic, gravity, magnetic, resistivity, telluric, magnetelluric, self-potential and GPR methods). Discussions include theoretical basis, field instruments, acquisition and reduction of raw data, various interpretation techniques and field examples. This course cannot be taken for credit by students in the Geophysics option.

Prerequisite: GEOP202 or equivalent

GEOL 582 GIS Applications in Geology (3-0-3)

Introduction to the GIS. Type of geological and remote sensing data used in GIS and data preparation for GIS studies. Uses of GIS in mineral and hydrocarbon exploration, and in geological, and structural studies. Spatial relationship and geological associations.

Prerequisite: Consent of the instructor.

GEOL 583 Photogeology and Remote Sensing (3-0-3)

Advanced application of multi spectral imagery, radar and other remote sensing data to geological environments. Emphasis will be given to different digital image processing techniques and how they can be utilized for specific geological problem.

Prerequisite: Graduate standing.

GEOL 584 Applied Geostatistics (3-0-3)

Importance of modeling and simulation in characterizing geologic parameters; Conventional estimation techniques; Principles of the regionalized variables theory; Analysis of spatial structures and there relation to geologic features; Kriging methods and their applications; Types of conditional simulation techniques; Utilization of geostatistical packages for modeling purposes.

Prerequisite: Graduate standing.

GEOL 585 Geological Laboratory Techniques (2-3-3)

The use of equipment such as the XRD, XRF, AA, SEM, M.S.-GC, HPLC, ultrasonic wave generators in geological investigations; preparation of both thin and polished sections in rocks, minerals and ores; preparation of oriented thin sections in microfossils staining techniques in mineralogical, petrological and paleontological investigations.

Prerequisite: Consent of the instructor.

GEOL 592 Special Topics (3-0-3)

Advanced course that may be offered on a geological topic of interest to a faculty member apart from the topics covered in the elective courses. The Department should secure the approval of the Graduate Council each time the course is offered.

Prerequisite: Consent of the instructor.

GEOL 599 Seminar (1-0-0)

Graduate students are required to attend all the technical seminars organized by the department. Additionally, each student must present at least one seminar on a timely research topic. This course is designed to provide students an overview of research in the Department, and a familiarity with the latest research methodologies, journals and professional societies in his discipline. This course is graded on a Pass or Fail basis.

Prerequisite: Graduate standing.

GEOL 600 Geology Master Report (0-0-3)

The student carries out a research project on an approved topic in Geology. A written report and an oral presentation are required. The project, report, and presentation should be finished in one semester. Pass-Fail basis only. This course is available only for the students enrolled in the Master of Geology program.

Prerequisite: Graduate standing.

GEOL 601 Carbonate Sedimentology & Diagenesis(2-3-3)

Processes of deposition of carbonate sediments. Recent environments as analogues for ancient carbonate sequences. Petrology and petrography of modern and ancient carbonate rocks, the reconstruction of their physical/chemical depositional and diagenetic environments in time and space. Major near-surface diagenetic environments, subaerial exposure, dolomitization, burial diagenesis. Carbonate aqueous equilibria, and carbonate geochemistry of trace elements and stable isotopes. Laboratories are devoted to thin-section analysis and hand-specimen study of carbonate sediment and rocks, carbonate classifications, studying carbonate facies, models, and carbonate diagenesis. Field trips required.

Prerequisite: GEOL 533 (or equivalent) or consent of the instructor.

GEOL 602 Global & Regional Tectonics (3-0-3)

Emphasis will be placed on crustal dynamics, plate tectonics and driving forces, evolution of collisional, transform and extensional systems, and dynamic indicators of past and current tectonic processes on global and regional level.

Prerequisite: GEOL 502 (or equivalents) or consent of the instructor.

GEOL 606 Independent Research (3-0-3)

This course is intended to allow the student to conduct research in advanced problems in his M.S. research area. The faculty offering the course should submit a research plan to be approved by the Graduate Program Committee at the academic department. The student is expected to deliver a public seminar and a report on his research outcomes at the end of the course. Graded on a Pass or Fail basis.

GEOL 610 M.S. Thesis (0-0-6)

Preparation of a thesis, oral presentation and defense.

Prerequisite:GEOL 599

GEOL 615 Advanced Basin Analysis(3-0-3)

An interdisciplinary integration of geodynamics, mathematical and physical modeling, and sedimentary geology. Emphasizes basin formation, nature and maturation of the basin fill, and timing of events. Theoretical and computational basin models. Case histories of various basins illustrate approaches. Field trips required.

Prerequisite: GEOP 530 (or equivalent) or consent of the instructor.

GEOL 620 Advanced Hydrogeochemistry (3-0-3)

Chemical principles applied to the understanding of factors controlling groundwater composition with an emphasis on water-mineral reactions. Introduction to chemical equilibrium computer modeling programs.

Prerequisite: GEOL551 (or equivalent) or consent of the instructor.

GEOL 630 Advanced Quantitative Hydrogeology(3-0-3)

Overview of groundwater modeling techniques with environmental and geologic applications. Interaction of geology and subsurface groundwater flow. Basin hydrology modeling. Practical experience in computer simulations of subsurface hydrogeologic processes. Computer models will be developed and used for simulation of the fate and transport of pollutants in streams, lakes, and estuaries.

Prerequisite: GEOL 561 or GEOL562 (or equivalent) or consent of the instructor.

GEOL 640 Clastic Sedimentology & Diagenesis (2-3-3)

Description and interpretation of sediments in ancient and modern depositional environments; Post-depositional alteration of sandstones and shales with emphasis on process-oriented controls on mineral reaction and porosity/permeability modification; Origin, distribution and evolution of clay minerals in sandstones; Importance of diagenesis for planning of recovery and production processes. Field trips are required.

Prerequisite: GEOL 532 (or equivalent) or consent of the instructor.

GEOL 650 Clay Mineralogy(2-3-3)

The origin, physical and chemical properties, mode of occurrence of clay minerals in natural systems, such as weathering, burial diagenetic & hydrothermal environments. Effects of clay minerals on reservoir properties and on environment and health.

Prerequisite: GEOL 541 or GEOL 532 (or equivalent) or consent of the instructor.

GEOL 660 Depositional Modeling & Reservoir Quality(3-0-3)

Introduction to geostatistical concepts and tools for description and modeling of spatial variability in oil/gas reservoirs and other geological formations. Topics include review of basic statistic concepts, exploratory spatial data analysis, stationarity and ergodicity, variogram and covariance, kriging, spatial sampling, stochastic realizations and simulations, conditioning, and indicator kriging.

Prerequisite: GEOL 521 or GEOP 550 (or equivalent) or consent of the instructor.

GEOL 670 Eustacy & Sequence Stratigraphy (3-0-3)

Systematic analysis of modern and ancient deposition facies and their interpretation in a sequence stratigraphic context. Integration of well-logs, seismic sections, core, and outcrop analysis will be adapted.

Prerequisite:GEOL 534 or GEOP 535 (or equivalent) or consent of the instructor.

GEOL 680 Organic & Petroleum Geochemistry (2-3-3)

Origins, and classifications of organic matter in the geosphere. Modern and ancient processes and environments of deposition of organic-rich strata, including hydrocarbon-source rocks and coals. The role of temperature and time in the maturation of hydrocarbons. The biomarker concept, pyrolysis techniques, isotopes in petroleum exploration, basin modeling and kinetic studies, organic petrography and detailed studies of case histories**.**

Prerequisite: consent of the instructor.

GEOL 690 Petrophysics and Well Log Interpretation (3-0-3)

Acoustic, electric, radioactive and hydraulic properties of reservoir rocks. Well logging tools and modern well-log interpretation. Integration of the logs with outcrop and seismic data to produce

comprehensive sedimentologic and stratigraphic models. Clean and shaly formation interpretations are both covered. Computer applications are emphasized.

Prerequisite: GEOP 550 (or equivalent) or consent of the instructor.

GEOL 699: Ph.D. Seminar (1-0-0)

Ph.D. students are required to attend Departmental seminars delivered by faculty, visiting scholars and graduate students. Additionally, each Ph.D. student should present at least one seminar on a timely research topic. Ph.D. students are required to pass the comprehensive examination as part of this course. This course is a pre-requisite to registering the Ph.D. Pre-dissertation GEOL 711. The course is graded as Pass or Fail. IC grade is awarded if the Ph.D. Comprehensive exam is not yet passed.

Prerequisite: Graduate Standing.

GEOL 701 Directed Research (3-0-3)

This course is intended to allow the student to conduct research in advanced problems in his Ph.D. research area. The faculty offering the course should submit a research plan to be approved by the Graduate Program Committee at the academic department. The student is expected to

deliver a public seminar and a report on his research outcomes at the end of the course. This course is graded on a Pass or Fail basis.

Prerequisite: Prior arrangement with an instructor**.**

GEOL 702 Directed Research (3-0-3)

This course is intended to allow the student to conduct research in advanced problems in his Ph.D. research area. The faculty offering the course should submit a research plan to be approved by the Graduate Program Committee at the academic department. The student is expected to deliver a public seminar and a report on his research outcomes at the end of the course. This course is graded on a Pass or Fail basis.

Prerequisite: Prior arrangement with an instructor**.**

GEOL 711 Ph.D. Pre-Dissertation (0-0-3)

This course enables the student to submit his Ph.D. Dissertation Proposal and defend it in public. The student passes the course if the Ph.D. Dissertation committee accepts the submitted dissertation proposal report and upon successfully passing the Dissertation proposal public defense. The course grade can be NP, NF or IC.

Prerequisite: Ph.D. Candidacy, **Co-requisite:**GEOL 699

GEOL 712 Ph.D. Dissertation (0-0-9)

This course enable the student to work on his Ph.D. Dissertation as per the submitted dissertation proposal, submit its final report and defend it public. Students are encouraged, as part of the Dissertation preparation, to submit related publications as conference presentations or to peer reviewed Journals. The course grade can be NP, NF or IP.

Prerequisite: GEOL 711

GEOPHYSICS

GEOP 501 Reflection Seismology(3-0-3)

Elasticity of anisotropic media, general wave equations and their solutions, Zoeppritz equations, direct hydrocarbon indicators, vertical seismic profiling, crosshole tomography, 3-D seismic exploration, correlation of well-log and seismic data, S-wave exploration.

Prerequisite*:* GEOP 315 or equivalent

GEOP 502 Potential Theory Methods (3-0-3)

In-depth study of potential field theory as applied to the gravity and magnetic methods of exploration, field equations and their solutions, representation of fields in spherical harmonics, instruments and field procedure in the collection and processing of gravity and magnetic data, interpretation techniques, and separation, continuation, and filtering of field anomalies, the direct and inverse problems of potential fields, computer modeling of 2-D and 3-D dimensional sources.

Prerequisite*:* GEOP 404 or equivalent

GEOP 503 Solid-Earth Geophysics (3-0-3)

Movement of the Earth, standard Earth models, heat flow in the Earth, the Earth's magnetic field, plate tectonics, physics of faulting and principles of earthquake seismology.

Prerequisite*:* GEOP 202 or equivalent

GEOP 504 Applied Environmental Geophysics (3-0-3)

Geophysical methods in environmental site assessment, emphasis on sites relevant to toxic waste disposals, contamination, detection and mapping of cavities, near-surface pipes, and hidden harmful objects, geophysical precursors for monitoring earthquakes and volcanic eruptions, case histories.

Prerequisite*:* GEOL 201 and GEOP 202 or equivalent

GEOP 505 Advanced Computational Geophysics (2-3-3)

Overview of linear algebra and potential field theory, the MATLAB, linear transforms of potential fields, 1-D and 2-D filtering, multi-channel optimal filtering, optimization, the maximum entropy and its applications, discriminant analysis and neural networks.

Prerequisite*:* GEOP 205 or equivalent

GEOP 510 Seismic Data Analysis (2-3-3)

Amplitude variation with offset, anisotropy, dip moveout processing, seismic migration algorithms, time-lapse studies, multicomponent recording, converted modes, deterministic and statistical deconvolution, wavelet shaping, wavelet extraction, multiple suppression, and automated static correction. Processing packages such as Seismic Unix, Hampson-Russell, Focus, and ProMax will be used during this course.

Prerequisite*:* GEOP 320 or equivalent

GEOP 515 Geophysical Inversion (3-0-3)

Overview of information theory & linear algebra, discrete and continuous inverse problems, Backus-Gilbert inversion, Monte Carlo inversion, case histories from exploration seismics, potential fields, geoelectric prospecting and rock physics.

Prerequisite*:* GEOP 205 or equivalent

GEOP 520 Geomagnetism & Paleomagnetism (3-0-3)

In-depth study of the nature, description, and analysis of the present magnetic field, spherical harmonics in applied geophysics, observatory weak remnants of the field, computation of its coefficients, the IGRF, measurement and analysis of the ancient geomagnetic field, theory of rock magnetism, acquisition of remnants by rocks, theories of TRM and DRM, instruments and

techniques of paleointensity and paleodirection measurement from rocks, analysis and interpretation of paleomagnetic measurements, applications of paleomagnetic methods in geology and geophysics, brief discussion of the origin of the geomagnetic field.

Prerequisite*:* GEOP 202 or equivalent

GEOP 525 Electrical Methods (3-0-3)

Physical principles of electrical and electromagnetic methods, numerical solutions for 2-D and 3-D problems, instrumentation and layout planning for land and airborne surveys, computer modeling and processing of field data, methods of interpretation, including curve matching, forward modeling, inversion, and recent advances in resistivity logging for oil and gas reservoirs.

Prerequisite*:* GEOP 450 or equivalent

GEOP 530 Basin Analysis (3-0-3)

Isostacy and subsidence, salt tectonics, basin classification, basin geometry, thermal burial history, oil generation and migration, heat flow and gradients, paleotemperature, basin modeling, and case histories.

Prerequisite*:* GEOL 201, and GEOP 202 or equivalent

GEOP 535 Seismic & Sequence Stratigraphy (2-3-3)

Review of seismic reflection principles, geodynamics, causes of changes in sea level, eustatic change of sea level, cycle chart, sedimentary supply and processes, sequence boundaries, seismic facies analysis, chronostratigraphy verus lithostratigraphy, system tracts, clastics sequence stratigraphy, carbonate sequence stratigraphy, seismic response of different structures, case histories.

Prerequisite*:* Consent of the instructor

GEOP 540 Three-Dimensional Seismic Interpretation (2-3-3)

Review of 3-D seismic data acquisition and processing, structural interpretation from 3-D slices and sections, stratigraphic interpretation, seismic attributes and wavelet analysis, seismic resolution, reservoir imaging and classification, high resolution data and integration with well-log data, 3-D visualization, and geophysical computer application in seismic interpretation.

Prerequisite*:* GEOP 415 or equivalent

GEOP 545 Petroleum Data Integration & Management (2-3-3)

Data structure and fundamental considerations, data quality, error, natural variation, data input, verification, storage and output format, geographic information system and different types of software, spatial data and attributes, data management and integration.

Prerequisite*:* Consent of the instructor

GEOP 550 Reservoir Characterization (3-0-3)

Reservoir description, scaling, core and rock description, log interpretation and calibration to 3-D seismic, geostatistics, kriging, distributions, simulation, structural and sequence stratigraphy and their use in reservoir characterization, reservoir heterogeneities, data integration and quality control.

Prerequisite*:* GEOP 415 or equivalent

GEOP 590 Independent Study (3–0-3)

Advanced work in certain areas of geophysics, adapted to the student's own field of interest. A well-written report and presentation are required. The course should not duplicate thesis work and cannot be repeated for credit. Approval of the Chairman of the Department should be secured each time the course is offered.

Prerequisite*:* Graduate Standing

GEOP 592 Special Topics (3-0-3)

Advanced course that may be offered on a geophysical topic of interest to a faculty member apart from the topics covered in the elective courses. The Department should secure the approval of the Graduate Council each time the course is offered.

Prerequisite*:* Graduate Standing

GEOP 599 Seminar (1-0-0)

Graduate students are required to attend the seminars given by faculty members, visiting scholars, and fellow graduate students. Additionally, each student must present at least one seminar on a timely research topic. This course is designed to give the student an overview of research in the Department, and a familiarity with the research methodology, journals, and professional societies in his discipline. Graded on a Pass or Fail basis.

Prerequisite*:* Graduate Standing

GEOP 600 Geophysics Master Report (0-0-3)

The student carries out a research project on an approved topic in Geophysics. A written report and an oral presentation are required. The project, report, and presentation should be finished in one semester. Pass-Fail basis only. This course is available only for students enrolled in the Master of Geophysics program.

Prerequisite*:* Graduate Standing

GEOP 606 Independent Research (3-0-3)

This course is intended to allow the student to conduct research in advanced problems in his M.S. research area. The faculty offering the course should submit a research plan to be approved by the Graduate Program Committee at the academic department. The student is expected to deliver a public seminar and a report on his research outcomes at the end of the course. Graded on a Pass or Fail basis.

GEOP 610 M.S. Thesis (0-0-6)

Preparation of a thesis, oral presentation and defense.

Prerequisite*:* GEOP 599

ENVIRONMENTAL SCIENCES

ENVS 510 Advanced Environmental Geology (3-0-3)

Study of interaction between human activities and geologic environment; role of environmental geological knowledge in understanding, evaluation and mitigation of geologic hazard, study the human impacts on the generation and dispersion of contaminants on the Earth's system, and the role of environmental geological aspects on waste disposal sitting, environmental problem-solving, and selected case studies.

Prerequisite: Graduate standing

ENVS 514 Desertification (3-0-3)

The course covers the concept and evolution of desertification, land degradation, dimension and distribution of desertification in each continent, process of desertification, prevention and remedial measures. Special emphasis is given to desertification in the Middle East.

Prerequisite: ENVS 510 or consent of instructor

ENVS 515 Environmental Hydrogeology (3-0-3)

The course will emphasize the concepts of physical and chemical hydrogeology. Characterization and evaluation of aquifers response using well hydraulics and aquifer tests. Introduction to geophysical and geochemical methods to explore, investigate, assess, and characterize

groundwater systems. Concepts of contaminant transportation and its effects on groundwater environment. Introduction to and discussions about contemporary remediation techniques.

Prerequisite: ENVS 510 or consent of instructor

ENVS 516 Ground-Water Resources Management (3-0-3)

This course introduces principles of planning and implementing groundwater investigation and modeling studies for groundwater resources in arid regions. The course discusses site reconnaissance, data acquisition and interpretation, site characterization, integration of hydrogeologic information, construction of conceptual models, applications of analytical procedures, and formulation of computer simulation models to describe groundwater flow and contaminant transport. Appropriate analytical and numerical models will be utilized to solve problem-oriented case studies.

Prerequisite: ENVS 410 or consent of instructor

ENVS 518 Geophysics for Environmental Applications (3-0-3)

Geophysical methods that are commonly applied in environmental site assessment and characterization studies; emphasis on sites relevant to solid waste disposals, contamination, mapping the location of utilities and underground storage tanks, mapping the areal extent of buried waste in landfills and at uncontrolled dump sites…etc. The course will concentrate on electrical resistivity, ground penetrating radar, magnetic, and electromagnetic methods. For each method, the sequence will proceed from basic principles through methodology and applications, to case histories. Applications will be emphasized; theory will be kept to essentials. Assigned readings and literature reviews will be an integral part of the course.

Prerequisite: ENVS 510 or consent of instructor

ENVS 519Environmental Remote Sensing (2-3-3)

A multidisciplinary course delineating the physical basis of electromagnetic remote sensing, the concepts of information extraction, and applications. This course introduces the theory and techniques of remote sensing and their application to environmental analysis. The course will cover the principles of remote sensing, including radiation theory; sensor systems; data acquisition, storage, and analysis. The course will deal with the application of remote sensing principles and data to environmental science.

Prerequisite: ENVS 510 or consent of instructor

ENVS 522 Environmental Chemistry (3-0-3)

Emphasis on the major concepts essential to the practice of environmental science, technology, and chemistry. The course covers the chemical fate and transport of inorganic and organic chemical pollutants in the air, water and soil environments. The course provides clear explanations to important concepts such as the atmosphere, hydrosphere, and geospheres. Contaminated site assessment and remediation as well as management of solid and hazardous waste are discussed in this course.

Prerequisite: Graduate standing

ENVS 523 Advanced Analytical Geochemistry (2-3-3)

The course introduces principles and applications of chemical analysis of geological materials (water, soil, sediments, and rocks). The analytical techniques covered including: Chromatography, Spectroscopy, Mass spectrometry and Atomic spectroscopy. Operating principles of analytical Instruments such as GC, HPLC, GC/MS, ICP, AA, FTIR, ICP, XRD and XRF will be covered in the course.

Prerequisite: ENVS 522or consent of the Instructor

ENVS 525 AdvancedEnvironmental Pollution (3-0-3)

The course will mainly cover the human-induced environmental pollution of air, land and water occurring on local, regional and global scales. Noise, thermal and radioactive pollution problems will be introduced. The course also covers methods used to assess the extent of pollution problems and the recent technologies used to remediate polluted sites.

Prerequisite: Graduate standing

ENVS 526 Air Pollution (3-0-3)

This course covers the following topics: elements of air pollution, air pollutants, effects of air pollution on materials, vegetations, animals and humans, meteorology of air pollution, air pollution sampling and its monitoring, dispersion of air pollutants and air pollution modeling, and control of air pollution.

Prerequisite: Graduate standing

ENVS 528 Environmental Toxicology(3-0-3)

This course will cover several areas of environmental toxicology, including general toxicological theory, effects of contaminants on various biological systems, and discussion of environmental toxicological issues (including case studies and methodologies). Topics include source and exposure routes of pollutants, basics of quantitative toxicology, effects of exposure, risk perception, and environmental regulations as they relate to toxicology.

Prerequisite: Graduate standing

ENVS 532 Environmental Biology (3-0-3)

Examines major issues in environmental biology and provide information on cell biology, updated information on inheritance and genetic. Provide students with information on species evolution and species diversity in different types of environments. It also provides information on animal structures and functions and links it with the ecology and behavior of organisms. Offers an opportunity to conduct in-depth individual research projects in environmental biology. Critical examination of recent published papers, extensive library research, data analysis, writing of reviews, and oral presentations. Students present their scientific results in a seminar.

Prerequisite: Graduate standing

ENVS 533 Advanced Environmental Ecology (3-0-3)

This course will provide comprehensive understanding to the complex interrelationships in nature and mechanisms of interaction among living organisms and their environments. It will introduce the ecosystem concept, interactions between organisms and the biotic environment; and investigates the structure and functioning of ecological systems and balance between terrestrial and marine/aquatic systems. In addition it t examines response of ecological systems to changes of environmental conditions caused by human activities.

Prerequisite: Graduate Standing

ENVS 535 Environmental Biotechnology (3-0-3)

This course will focus on how biotechnology techniques are applied to solve environmental problems. Topics to be covered will include an overview of environmental biotechnology, Agricultural Biotechnology, and Biotechnology of the marine environment will be addressed and discussed. Covered materials will goes on to explore the diverse way in which biotechnology is applied to tackle environmental problems and issues, from monitoring of the environment and treatment of waste, to the removal of pollutants and extraction of oils and minerals. This course will close by discussion of specific topics related to existing environmental problems.

Prerequisite: ENVS 532 or consent of instructor

ENVS 536 Environmental Microbiology(3-0-3)

This course is intended to serve as an introduction to microbiology and provide a basis for the application of microbiological principles in environmental systems. The course examines fundamental principles of microbiology, biochemistry, and microbial ecology in the context of environmental applications. The course will also provide a comprehensive review of currently used methods and applications of water and soil microbiology, biodeterioration and bioremediation in environmental science and engineering.

Prerequisite: ENVS 532 or consent of instructor

ENVS 538 Marine Pollution (3-0-3)

The course will mainly deal with problems related to marine pollution. Some of the topics are: different marine habitats, sources of marine pollution, types of pollution, and effects of pollution on marine life, prevention and remedies for problems of pollution. The course covers all aspects of marine pollution such as physical, chemical, and biological sources of marine pollution.

Prerequisite: ENVS 532 or consent of instructor

ENVS 542 Concepts of Environmental Management (3-0-3)

A multi-disciplinary course that covers major concepts of environmental management that incorporates business, planning and policy issues. The course addresses the spectrum of environmental affairs management subjects related to water resources, air emissions and waste management. International and national environmental standard regulations, permits and audits will be covered in the course. The course will also cover the concepts of risk analysis, impact assessment and basics of environmental management system.

Prerequisite: Graduate standing

ENVS 543 Management of Marine Environment (3-0-3)

The course will introduce students to components of the marine environment and its major habitats, and recourses. It will identify different resources and those found at the Arabian Gulf in particular. It will identify the role of human activities including various types of pollution, and how to prevent or minimize its effects. It will focus on management of various aspects of marine environment resources and best practices to conserve it. It will also cover the role of international and regional organizations to manage marine resources and diversity of marine life to carry on sustainability.

Prerequisite: ENVS 538 or consent of instructor

ENVS 545 Environmental Risk Assessment and Modeling (3-0-3)

The course covers topics related to the applications of statistics and probability to environmental problems like uncertainty analysis and stochastic modeling. Topics covered in the course include source identification & characterization, pollutants fate and transport mechanisms, evaluation of exposure pathways and identification of recipients and exposure routes. Formulation of risk equations and their indices based on toxicology & exposure data to evaluate environmental and health risks. Introduction to risk-based corrective actions and restoration technologies. Analytical models and case studies will be discussed in different parts of the course.

Prerequisite: Graduate Standing

ENVS 546 Environmental Impact Assessment (3-0-3)

The aim of the course is to introduce the components and structure of an Environmental Impact Assessment (EIA) as well as discuss how national guidelines and requirements for EIAs influence the outcome. This course provides students with a working knowledge of the environmental impact assessment process and the information, including environmental studies, needed to prepare an environmental impact assessment document or an environmental impact statement.

Prerequisite: Graduate Standing

ENVS 548 Industrial Waste Management (3-0-3)

This course covers concepts and techniques for handling hazardous and industrial wastes. Regulations governing hazardous waste are introduced to the students. The fundamentals of waste treatment and disposal processes are discussed. The course also covers the recent remediation technologies of waste-contaminated sites.

Prerequisite: Graduate standing

ENVS 549 Environmental Sustainability (3-0-3)

This course explores the concepts and practices of environmental sustainability. It presents the economic, social, and environmental dimensions of sustainable development. It focuses on the effects of changing patterns of production, consumption, resources, supplies, and energy resources on environmental sustainability. It involves critical thinking exercises to find solutions to the existing environmental problems and the locally stressing sustainability issues. The course will include field trips, interaction with conservationists, environmental scientists, and different environmental authorities.

Prerequisite: Graduate standing

ENVS 564 Statistical Methods in Environmental Researches (3-0-3)

This course covers an introduction to statistical modeling, estimation, and hypothesis testing for applied research problems in the environmental sciences. Emphasis will be on comparisons of means between two or more groups, analysis of variance, design of experiments, and regression. A statistical computing package will also be introduced.

Prerequisite: Graduate Standing

ENVS 590 ENVS Special Topics I (3-0-3)

Selected topics in the area of environmental sciences and engineering. Two special topics courses may be offered in one semester.

Prerequisite: Graduate Standing

ENVS 591 ENVS Special Topics II (3-0-3)

Selected topics in the area of environmental sciences and engineering. Two special topics courses may be offered in one semester.

Prerequisite: Graduate Standing

ENVS 599 Seminar (1-0-0)

Graduate students are required to attend all the technical seminars organized by the department. Additionally, each student must present at least one seminar on a current research topic. This course is designed to provide students with an overview of research in the Department, and a familiarity with the latest research methodologies, journals and professional societies in their discipline. This course is graded on a Pass or Fail basis.

Prerequisite: Graduate standing.

ENVS 600 Master Report (0-0-3)

The student carries out a research project on an approved topic in Environmental Sciences. Written report and an oral presentation are required. The project, report, and presentation should be finished in one semester. Pass-fail basis only. This course is available only for students enrolled in the Master of Environmental Sciences program.

ENVS 606 Independent Research (3-0-3)

This course is intended to allow the student to conduct research in advanced problems in his M.S. research area. The faculty offering the course should submit a research plan to be approved by the Graduate Program Committee at the academic department. The student is expected to deliver a public seminar and a report on his research outcomes at the end of the course. Graded on a Pass or Fail basis.

Prerequisite: Graduate standing.

ENVS 610 M.S. Thesis (0-0-6)

Presentation should be finished in one semester. Pass-fail basis only. This course is available only for students enrolled in the Master of Sciences program.

Prerequisite: Graduate standing, ENVS 599

DEPARTMENT OF MATHEMATICS AND STATISTICS

Chairman

Dr. Hussain Al-Attas

Faculty

Abuihlail	Abu-Sbeih	Ahmad
Al-Assaf	Alassar	Aldweik
Anabosi	Al-Attas	Azad
Belhaiza	Binns	Bokhari A
Bokhari M	Bonfoh	Boucherif
Chanane	Echi	Fairag
Fukharuddin	Alfuraidan	Furati
Al-Garni	El-Gebeily	Al-Homidan
Al Humaidi	Ibrahim	Iqbal
Jamal	Kabbaj	Khalfallah
Khan A R	Khan S	Laradji
Lo	Malik	Messaoudi
Mimouni	Mustafa I	Mustapha
Al-Mutawa	Omar	Al-Rasasi
Riaz	Al Sabah	Saleh, K
Saleh, M	Sarhan	Al-Sawi
Al Shahrani	Al-Shammari	Shehadeh
Smii	Tatar A	Tatar N
Tawfiq	Yousuf	Zaman

Chair Professor

Cockburn	Albeverio

Adjunct/Joint Professor

Ansari	Kara	Mordukhovich
Qadir	Hogendijk	Khamsi

The Department of Mathematics and Statistics offers graduate programs leading to the degrees of Master of Science and Doctor of Philosophy. The diversity of graduate courses offered in the Department gives the student an opportunity to specialize in one of the several fields of pure Mathematics, applied Mathematics, numerical analysis, and applied statistics.

M.S. PROGRAM IN MATHEMATICS

Admission Requirements

The applicant should have an undergraduate degree equivalent to the KFUPM BS degree in Mathematics or statistics. However, an applicant lacking an adequate undergraduate background (or preparation) may be admitted if recommended by the Graduate Committee, with the understanding that the course work taken to remove the undergraduate deficiencies is not credited towards the degree requirements.

Degree Requirements

An MS student must complete 24 credit hours of course work subject to the following conditions:

- At least 18 credits must be in the Department of Mathematics and Statistics, of which MATH 531, MATH 533 and MATH 550 must be taken as core courses,
- A maximum of 6 credits at the 400-level can be counted,
- Pass the seminar course MATH 599 under the guidelines provided in this Graduate Bulletin,
- Prepare a thesis on a subject of his choice according to the general procedures of the Deanship of Graduate Studies. The thesis work earns the student 6 credit hours, thus bringing the total to 30 credit hours to complete the M.S.degree.

Degree Plan for M.S. in Mathematics

Course	#	Title	LT	LB	CR
First Semester					
MATH	531	Real Analysis	3	0	3
MATH	550	Linear Algebra	3	0	3
MATH	xxx	Math Elective	3	0	3
			9	**0**	**9**
Second Semester					
MATH	533	Complex Variables I	3	0	3
MATH	xxx	Math Elective	3	0	3
MATH	xxx	Math Elective	3	0	3
MATH	599	Seminar	1	0	0
			10	**0**	**9**
Third Semester					
XXX	xxx	Free Elective	3	0	3
XXX	xxx	Free Elective	3	0	3
MATH	610	M.S. Thesis	0	0	IP
			6	**0**	**6**
Fourth Semester					
MATH	610	M.S. Thesis	0	0	6
Total Credit Hours					**30**

Notes:

- Each student is expected to submit his detailed degree plan according to the above generic degree plan for approval by the Department and the Deanship of Graduate Studies within the 8th week of the second semester of enrollment.
- Students are required to adhere to the regulations of degree plan. No relaxations will be given to any student, and courses taken in conflict of the above will not be counted towards the degree.
- Up to two 400-level elective courses may allowed on recommendations of the advisor.
- The order of taking the courses can be different from above, but students must take the core courses before electives.

M.S. PROGRAM IN APPLIED STATISTICS

(THESIS OPTION)

Admission Requirements

For M.S. degree in applied statistics, an undergraduate degree in Mathematics or Statistics degree is not necessary, however an applicant must have the equivalent of MATH 101, MATH 102, MATH 201 and STAT 201, moreover an applicant with a non-statistics degree has to take STAT500 to remedy the deficiency.

Degree Requirements

To complete the M.S. program, a candidate must complete a minimum of 24 semester credit hours within the following limitations:

- At least 18 credit hours must be in Statistics, of which STAT 501, STAT 502 and STAT 510 must be taken as core courses,
- A maximum of 6 credit hours of 400-levels can be counted,
- Take the seminar course STAT 599 under the guidelines provided in this graduate bulletin,
- Prepare a thesis on a subject of his choice according to the general procedures of the Deanship of Graduate Studies. The thesis work count as 6 semester-credit hours, thus bringing the total number of required credit hours to 30.

Degree Plan for M.S. in Applied Statistics (Thesis option)

Course	#	Title	LT	LB	CR
First Semester					
STAT	501	Probability and Mathematical Statistics	3	0	3
STAT	xxx	Statistics Elective I	3	0	3
STAT	xxx	Statistics Elective II	3	0	3
			9	**0**	**9**
Second Semester					
STAT	502	Statistical Inference	3	0	3
STAT	xxx	Statistics Elective III	3	0	3
XXXX	xxx	Free Elective I	3	0	3
STATS	599	Seminar	1	0	0
			10	**0**	**9**
Third Semester					
STAT	510	Regression Analysis	3	0	3
XXXX	xxx	Free Elective II	3	0	3
STAT	610	M.S. Thesis	0	0	IP
			6	**0**	**6**
Fourth Semester					
STAT	610	M.S. Thesis	6	0	6
			6	**0**	**6**
Total Credit Hours					**30**

Notes:

- Each student is expected to submit his detailed degree plan according to the above generic degree plan for approval by the Department and the Deanship of Graduate Studies within the 8th week of the second semester of enrollment.
- Students are required to adhere to the regulations of degree plan. No relaxations will be given to any student, and courses taken in conflict of the above will not be counted towards the degree.
- Up to two 400-level elective courses may allowed on recommendations of the advisor.
- The order of taking the courses can be different from above, but students must take the core courses before electives.

MASTER PROGRAM IN APPLIED STATISTICS

(NON-THESIS OPTION)

Degree Requirements

The non-thesis option focuses on more applied work, and statistical methods as evidenced by the requirement of such courses as STAT530, the design and analysis of experiments, and STAT565 sampling methods, as well as two courses from outside the department in an area of application.

To complete the M.S. program, a candidate must complete a minimum of 42 semester credit hours subject to the following:

- At least 30 credits must be in Statistics, of which STAT 501, STAT 502, STAT 510, STAT 530, STAT 565 and STAT 600 must be taken as core courses,
- At least three elective statistics courses must be at the 500 level,
- Two courses must be taken from outside the Department with the approval of the academic advisor. It is highly recommended to take these courses in an area of application, e. g. Economics, Management, Engineering,etc.,
- A seminar course STAT 599 is also needed to complete M.S. requirements.

Degree Plan for Master in Applied Statistics (Non-Thesis option)

Course	#	Title	LT	LB	CR
First Semester					
STAT	501	Probability & Mathematical Statistics	3	0	3
STAT	xxx	Statistics Elective I	3	0	3
STAT	xxx	Statistics Elective II	3	0	3
			9	**0**	**9**
Second Semester					
STAT	502	Statistical Inference	3	0	3
STAT	565	Sampling Methods	3	0	3
XXXX	xxx	Free Elective I	3	0	3
			9	**0**	**9**
Third Semester					
STAT	510	Regression Analysis	3	0	3
STAT	530	Design and Analysis of Experiments	3	0	3
STAT/ MATH	xxx	Statistics/Mathematics Elective I	3	0	3
			9	**0**	**9**
Fourth Semester					
STAT	xxx	Statistics Elective III	3	0	3
STAT/ MATH	xxx	Statistics/Mathematics Elective II	3	0	3
XXXX	xxx	Free Elective II	3	0	3
			9	**0**	**9**
Fifth Semester					
STAT	xxx	Statistics Elective IV	3	0	3
STAT	600	Project	2	3	3
STAT	599	Seminar	1	0	0
			6	**3**	**6**
Total Credit Hours					**42**

Notes:

- Each student is expected to submit his detailed degree plan according to the above generic degree plan for approval by the Department and the Deanship of Graduate Studies within the 8th week of the second semester of enrollment.
- Students are required to adhere to the regulations of degree plan. No relaxations will be given to any student, and courses taken in conflict of the above will not be counted towards the degree.
- Maximum of two 400-level elective courses may be taken upon approval of the academic advisor.
- The order of taking the courses can be different from above, but students must take the core courses before the electives.

PH.D. PROGRAM IN MATHEMATICS

The Department offers Ph.D. programs in the areas of Applied Mathematics & Numerical Analysis and in Pure Mathematics. Each of these two areas consists of a number of fields of specialization.

Admission Requirements

Applicants should have a Masters' degree in Mathematics or a related field with a minimum GPA of 3.2 from an institution of acceptable standing. They should also meet the standards of performance in the GRE advanced test in Mathematics and in the TOEFL as laid down by the College of Graduate Studies. Any deficiency in the mathematical background of a student must be removed within two semesters of admission into the graduate program.

Degree Requirements

To complete the Ph.D. degree requirements, a candidate must complete a minimum of 30 credit hours of graduate level courses, in addition to deficiency courses at the M.S. level, if any. These courses are to be chosen such that:

- A minimum of 15 credit hours must be in one of the two major areas cited above. Of these, 12 must be in the student's field of specialization,
- A minimum of 6 credit hours must be taken in a minor field from outside the student's chosen area,
- A minimum of 4 600-level courses in Mathematics must be taken for credit.

After completion of most of his course work, a Ph.D. student will take a written Comprehensive Examination, covering certain basic areas of Mathematics as well as areas related to his specialization. [8]After successful completion of the course work and passing the comprehensive examination, the student will proceed as follows:

- Register Ph.D. Pre-Dissertation course (MATH 711),
- Publically defend his Ph.D. proposal and,
- Register Ph.D. dissertation (MATH 712).

After successful completion of his Ph.D. research, the student will publically defend his dissertation based on original and scholarly research conducted by him and judged to be a significant contribution to his area of specialization.

[8]To pass the comprehensive examination, a student is entitled to two attempts. A student who fails the comprehensive examination in his first attempt, will be given a second chance to take the examination. The comprehensive examination is graded on pass or fail basis.

Degree Plan for Ph.D. in Mathematics

Course	#	Title	LT	LB	CR
First Semester					
MATH	xxx	Course from Major Area	3	0	3
MATH	xxx	Course from Major Area	3	0	3
XXX	xxx	Free Elective	3	0	3
			9	**0**	**9**
Second Semester					
MATH	xxx	Course from Major Area	3	0	3
XXX	xxx	Free Elective	3	0	3
XXX	xxx	Free Elective	3	0	3
			9	**0**	**9**
Third Semester					
MATH	xxx	Course from Major Area	3	0	3
MATH	xxx	Course from Major Area	3	0	3
MATH	695	Reading and Research I	3	0	3
MATH	699	Seminar	1	0	0
			10	**0**	**9**
Written Comprehensive Examination					
Fourth Semester					
MATH	696	Reading and Research II	3	0	3
MATH	711	Ph.D. Pre-Dissertation	0	0	3
			3	**0**	**6**
Fifth Semester					
MATH	712	Ph.D. Dissertation			IP
Sixth Semester					
MATH	712	Ph.D. Dissertation	0	0	**9**
Total Credit Hours					**42**

Notes:

- Each student is expected to submit his detailed degree plan according to the above generic degree plan for approval by the Department and the Deanship of Graduate Studies within the 8th week of the second semester of enrollment.
- Students are required to adhere to the regulations of degree plan. No relaxations will be given to any student, and courses taken in conflict of the above will not be counted towards the degree.
- The order of taking the courses can be different from above, but students must take the core courses before electives.

COURSE DESCRIPTIONS

MATHEMATICS

MATH 502 General Relativity (3-0-3)

Minkowski space. Tensor analysis on differentiable manifolds. The Einstein field equations. Exact solutions; the Schwarzschild and Reissner-Nordstrom solutions. The three classical tests of general relativity. Energy momentum tensor for perfect fluids and the electromagnetic field. The interior Schwarzschild solution. Black holes and analytic extensions. Robertson-Walker and other cosmological models of the universe. Distance measurements in cosmology.

Prerequisite: MATH 301. (Credit may not be obtained for both MATH 502 and PHYS 575)

MATH 505 Mathematical Theory of Elastodynamics (3-0-3)

An introduction to Cartesian tensors. Stress and strain tensors. Conservation of mass, energy and momentum. Hooke's law and constitutive equations. Isotropic solids and some exact solutions of elasticity. Elastodynamic equations. Elastic waves in an unbounded medium. Plane waves in a half space. Reflection and refraction at an interface. Surface waves.

Prerequisite: MATH 301 or equivalent

MATH 513 Mathematical Methods for Engineers (3-0-3)

Laplace transforms including the convolution theorem, error and gamma functions. The method of Frobenius for series solutions to differential equations. Fourier series, Fourier-Bessel series and boundary value problems, Sturm-Liouville theory. Partial differential equations: separation of variables and Laplace transforms and Fourier integrals methods. The heat equation. Laplace equation, and wave equation. Eigenvalue problems for matrices, diagonalization.

Prerequisite: MATH 202. (Not open to mathematics majors. Students cannot receive credit for both MATH 301 and MATH 513)

MATH 514 Advanced Mathematical Methods (3-0-3)

Integral transforms: Fourier, Laplace, Hankel and Mellin transforms and their applications. Singular integral equations. Wiener-Hopf techniques. Applications of conformal mapping. Introduction to asymptotic expansion

Prerequisite: MATH 301or MATH 430 or MATH 513

MATH 521 General Topology I (3-0-3)

Basic set theory (countable and uncountable sets, Cartesian products). Topological spaces (basis for a topology, product topology, functions, homeomorphisms, standard examples). Connected spaces, path connectedness. Compact spaces, compactness in metrizable spaces. Countability axioms, first countable and second countable spaces. Separation axioms, Urysohn's Lemma, Urysohn's metrization theory. Complete metric spaces.

Prerequisite: MATH 421

MATH 523 Algebraic Topology (3-0-3)

Concept of categories and functors. Simplicial complexes, subdivision and simplicial approximations. Homotopy, fundamental group and covering spaces. Fundamental group of polyhedron. Chain complexes, homology groups and their topological invariance.

Prerequisite: MATH 421. (MATH 521 is recommended)

MATH 525 Graph Theory (3-0-3)

Review of basic concepts of graph theory. Connectivity, matching, factorization and covering of graphs, embeddings, edge and vertex coloring. Line graphs. Reconstruction of graphs. Networks and algorithms.

Prerequisite: MATH 425

MATH 527 Differential Geometry (3-0-3)

Curves in Euclidean spaces: arclength, tangent, normal and binormal vectors, curvature and torsion. Frenet formulas. Isoperimetric inequality. Differential geometry and local theory of surfaces, the first and second fundamental forms. Local isometries. Geodesics. Gaussian and mean curvature of surfaces. The Gauss- Bonnet theorem. Manifolds and differential forms. Introduction to Riemannian geometry.

Prerequisite: MATH 421

MATH 531 Real Analysis (3-0-3)

Lebesgue measure and outer measure. Measurable functions. The Lebesgue integral. Lebesgue convergence theorem. Differentiation and integration. Lp spaces. Riesz representation theorem. Introduction to Banach and Hilbert spaces.

Prerequisite: MATH 411

MATH 533 Complex Variables I (3-0-3)

Analytic functions. Cauchy's theorem and consequences. Singularities and expansion theorems. Maximum modulus principle. Residue theorem and its application. Compactness and convergence in space of analytic and meromorphic functions. Elementary conformal mappings.

Prerequisites: MATH 411; MATH 430 or consent of the instructor

MATH 535 Functional Analysis I (3-0-3)

Normed linear spaces, Banach spaces, Hilbert spaces, Banach Algebras (definitions, examples, geometric properties), bounded linear operators, convex sets, linear functionals, duality, reflexive spaces, weak topology and weak convergence, Banach fixed point theorem, Hahn-Banach theorem, uniform boundedness principle, open mapping theorem, closed graph theorem, representation of functionals on Hilbert spaces (Riesz Representation Theorem).

Prerequisite: MATH 411

MATH 536 Functional Analysis II (3-0-3)

Algebra of bounded operators, self-adjoint operators in Hilbert Spaces, Normal operators, compact operators, projections, spectral theory of linear operators in normed spaces and Hilbert spaces, spectral mapping theorem, Banach-Alaoglu theorem.

Prerequisite: MATH 535

MATH 537 Topological Vector Spaces (3-0-3)

Topological vector spaces, locally convex spaces, Krein-Milman theorem, duality in locally convex spaces, separation theorem for compact convex sets, topological tensor products, nuclear mappings and spaces.

Prerequisite: MATH 535

MATH 538 Applied Functional Analysis (3-0-3)

A quick review of basic properties of topological, metric, Banach and Hilbert spaces. Introduction of Hausdorff metric and iterated function system. Fixed point theorems and their applications.

Introduction to infinite dimension calculus – Frechet and Gateaux derivatives, Bochner integral. Introduction to weak and w*-topologies. Algorithmic optimization including complementarity problems and variational inequalities.

Prerequisite: MATH 411

MATH 540 Harmonic Analysis (3-0-3)

Fourier series on the circle group (Fourier coefficients, Fourier series of square summable functions, absolutely convergent Fourier series, Fourier coefficients of linear functionals), The convergence of Fourier series, Fourier transforms on L1(R), Fourier transforms on Lp(R), The Payley-Wienner theorems. Fourier analysis on locally compact groups (locally compact groups, the Haar measure, characteristic and the dual group, Fourier transforms, almost periodic functions and the Bohr compactification).

Prerequisite: MATH 411

MATH 545 Algorithms and Complexity (3-0-3)

Polynomial time algorithms and intractable problems; relationship between the classes P, NP, and NP-complete; Cook's theorem and the basic NP-complete problems. Techniques for proving NP-completeness; NP-hardness. Hierarchy of complexity classes.

Prerequisite: Consent of the Instructor

MATH 550 Linear Algebra (3-0-3)

Basic properties of vector spaces and linear transformations, algebra of polynomials, characteristic values and diagonalizable operators, invariant subspaces and triangulable operators. The primary decomposition theorem, cyclic decompositions and the generalized Cayley-Hamilton theorem. Rational and Jordan forms, inner product spaces, The spectral theorem, bilinear forms, symmetric and skew symmetric bilinear forms.

Prerequisite: MATH 280

MATH 551 Abstract Algebra (3-0-3)

Basic definitions of rings and modules, homomorphisms, sums and products, exactness, Hom and tensor, adjoint isomorphism, free, projective and injective modules. Chain conditions, primary decomposition, Noetherian rings and modules, Artinian rings, structure theorem.

Prerequisite: MATH 345. (MATH 450 is recommended)

MATH 552 Fields and Galois Theory (3-0-3)

Field extensions, the fundamental theorem. Splitting fields and algebraic closure, finite fields, separability, cyclic, cyclotomic, and radical extensions. Structure of fields: transcendence bases.

Prerequisite: MATH 345. (MATH 450 is recommended)

MATH553 Homological Algebra (3-0-3)

Review of free, projective, and injective modules, direct limits. Watt's theorems. Flat modules. Localization. Noetherian, semisimple, Von Neumann regular, hereditary, and semi-hereditary rings. Homology, homology functors, derived functors. Ext. and Tor. homological dimensions, Hilbert Syzygy theorem.

Prerequisite: MATH 551

MATH 554 Rings and Categories of Modules (3-0-3)

Classical ring structure theorems, functors between module categories, equivalence and duality for module categories. Decomposition properties of injective and projective modules. Specific Artinian rings.

Prerequisite: MATH 551

MATH 555 Commutative Algebra (3-0-3)

Basics of rings and ideals. Rings of fractions, integral dependence, valuation rings, discrete valuation rings, Dedekind domains, fractional ideals. Topologies and completions, filtrations, graded rings and modules. Dimension theory.

Prerequisite: MATH 551

MATH 560 Applied Regression and Experimental Design (3-0-3)

Simple linear regression. Testing of intercept and slope. Multiple linear regression. Estimation parameters and testing of regression coefficients. Prediction and correlation analysis. Analysis of variance technique. Completely randomized and randomized block designs. Latin square design. Incomplete block design. Factorial design, 2k factorial design and blocking and confounding in 2k factorial design.

Prerequisite: STAT 201, STAT 319, or Instructor's Consent. (Students cannot receive credit for both MATH 560 and STAT 430 or SE 535)

MATH 561 Mathematical Statistics (3-0-3)

Axioms and foundations of probability. Conditional probability and Bayes' theorem. Independence. Random variables and distribution functions and moments. Characteristic functions, Laplace transforms and moment generating functions. Function of random variables. Random vectors and their distributions. Convergence of sequences of random variables. Laws of large numbers and the central limit theorem. Random samples, sample moments and their distributions. Order statistics and their distributions.

Prerequisite: STAT 302 or Consent of the Instructor

MATH 563 Probability Theory (3-0-3)

Foundations of probability theory. Measure-theoretic approach to definitions of probability space, random variables and distribution functions. Modes of convergence and relations between the various modes. Independence, Kolmogorov type inequalities. Tail events and the Kolomogorov 0-1 law. Borel-Cantelli lemma. Convergence of random series and laws of large numbers. Convergence in distribution. Characteristic functions. The central limit theorem. Weak convergence of probability measures. Conditional expectations and martingales.

Prerequisite: STAT 301

MATH 565 Advanced Ordinary Differential Equations I (3-0-3)

Existence, uniqueness and continuity of solutions. Linear systems, solution space, linear systems with constant and periodic coefficients. Phase space, classification of critical points, Poincare'-Bendixson theory. Stability theory of linear and almost linear systems. Stability of periodic solutions. Laypunov's direct method and applications.

Prerequisite: MATH 465

MATH 568 Advanced Partial Differential Equations I (3-0-3)

First order linear and nonlinear equations. Classification of Second order equations. The wave equation, heat equation and Laplace's equation. Green's functions, conformal mapping. Separation of variables, Sturm-Liouville theory. Maximum principles and regularity theorems.

Prerequisite: MATH 470

MATH 569 Linear Elliptic Partial Differential Equations (3-0-3)

Sobolev spaces, Mollifiers, Dual spaces, Poincare's inequality, Lax-Milgram Theorem, linear elliptic problems, Weak formulation, weak derivatives, Weak solutions, Existence uniqueness and regularity, maximum principle.

Prerequisite: MATH 531

MATH 571 Numerical Analysis of Ordinary Differential Equations (3-0-3)

Theory and implementation of numerical methods for initial and boundary value problems in ordinary differential equations. One-step, linear multi-step, Runge-Kutta, and extrapolation methods; convergence, stability, error estimates, and practical implementation, Study and analysis of shooting, finite difference and projection methods for boundary value problems for ordinary differential equations.

Prerequisite: MATH 471 or Consent of the Instructor

MATH 572 Numerical Analysis of Partial Differential Equations (3-0-3)

Theory and implementation of numerical methods for boundary value problems in partial differential equations (elliptic, parabolic, and hyperbolic). Finite difference and finite element methods: convergence, stability, and error estimates. Projection methods and fundamentals of variational methods. Ritz-Galerkin and weighted residual methods.

Prerequisite: MATH 471 or Consent of the Instructor

MATH 573 Matrix Computations and Optimization Algorithms (3-0-3)

Survey of practical techniques of numerical analysis for engineering and graduate students. Topics include computational and theoretical aspects of direct and iterative methods for linear systems, iterative solutions of nonlinear systems (successive approximations, relaxation, conjugate gradient, and quasi-Newton methods), sparse materials, least-squares problems (both linear and nonlinear), eigenvalue problems, and optimization problems. Problems include case studies in various disciplines.

Prerequisites: MATH 280; MATH 321 or SE 301. (Not Open to Mathematics Majors)

MATH 574 Numerical Methods of Partial Differential Equations (3-0-3)

Concepts of consistency, stability, and convergence of numerical schemes. Initial and boundary value problems for ordinary differential equations. Various finite difference and finite element methods and their applications to fundamental partial differential equations in engineering and applied sciences. Case studies selected from computational fluid mechanics, solid mechanics, structural analysis, and plasma dynamics.

Prerequisite: MATH 321, SE 301, or Consent of the Instructor. (Not Open to mathematics Majors)

MATH 575 Introduction to Approximation Theory (3-0-3)

Best approximation in normed linear spaces: basic concepts. Lagrange and Hermite interpolation. Approximate solution of over-determined system of linear equations. Linear approximation of

continuous functions in Chebyshev and least squares norms. Rational approximation. Piecewise polynomial approximation. Cubic and B-splines.

Prerequisite: Consent of the Instructor.

MATH 577 Introduction to Industrial Mathematics (3-0-3)

Why and how industrial Mathematics? The description of air bag sensor. How to judge the quality of a non-woven fabric? Damage estimation in a machine (fatigue life time). Mathematics to solve the above mentioned problems.

Prerequisite: MATH 202, MATH 280, or Consent of the Instructor

MATH 579 Wavelets and Fractals (3-0-3)

The continuous wavelet transform, the discrete wavelet transform, advantages of using wavelet transforms over the classical Fourier transform. Applications of wavelets in solution of differential and partial differential equations. Iterated function system and deterministic fractals.

Prerequisite: MATH 202

MATH 580 Convex Analysis (3-0-3)

Convex sets and convex functions; epigraphs, level sets. Inf-convolution; continuity and semi-continuity. Separation theorems and the Hahn-Banach theorem. Representation theorems, Caratheodory theorem. Polyhedra. Farkas lemma. Fenchel's theorem. Applications to linear systems. The weak duality theorem. Convex systems. Differentiability. Subdifferentials and subgradients, generalized gradients. Inf-compactness. Applications to Math programming and control theory. Cones of tangent. Constraint qualifications and optimality conditions for non-smooth minimization problems.

Prerequisite: MATH 411, or Consent of the Instructor

MATH 581 Advanced Linear Programming (3-0-3)

A rigorous and self-contained development of the theory and main algorithms of linear programming. Formulation of linear programs. Theory of linear programming (linear inequalities, convex polyhedral duality). Main LP algorithms (simplex, revised simplex, dual, and ellipsoidal algorithms). Geometry and theory of the simplex, dual, and ellipsoidal algorithms. Geometry and theory of the simplex method. Sensitivity analysis. Related topics (games, integer programming, parametric programming, stochastic programming). Representative applications in Economics, Engineering, Operations Research, and Mathematics. Familiarity with computer implementation of LP methods will be acquired by working on individual (or small group) projects of applying LP to student's chosen areas.

Prerequisite: MATH 321, MATH 573, or Consent of the Instructor. (Credit cannot be given to both MATH 581 and SE 503)

MATH 582 Nonlinear Programming (3-0-3)

An advanced introduction to theory of nonlinear programming, with emphasis on convex programs. First and second order optimality conditions, constraint qualifications, Lagrangian convexity and duality. Penalty function methods. Theory and algorithms of main computational methods of nonlinear programming. Representative applications of nonlinear programming in Economics, Operations Research and Mathematics.

Prerequisite: MATH 412

MATH 586 Design and Analysis of Experiment (3-0-3)

Concepts of statistical designs and linear models. Basic designs: Completely randomized design. Randomized block design. Latin square designs (computer aided selection) models: Fixed, random and mixed models, estimation of parameter using Gauss-Markov theorem. Expectation of mean squares with and without use of matrix theory. Incomplete block designs. Factorial experiment, 2^p confounding, fractional replicate and orthogonal designs. 3^p confounding, fractional replicate and orthogonal designs. P q N confounding; fractional replicate and orthogonal designs. Tagouchi method as applied to design of experiments for engineering, industrial and agricultural data analysis. Extensive use of computer packages and computer aided designs.

Prerequisites: Graduate Standing, Consent of the Instructor

MATH 587 Advanced Applied Regression (3-0-3)

Least square method and properties. Simple and multiple linear regression with matrix approach. Development of liner models. Residual analysis. Polynomial models. Use of dummy variables in multiple linear regression. Analysis of variance approach. Selection of 'best' regression equation. Concepts of mathematical model building. Non-linear regression and estimation. Extensive use of computer packages.

Prerequisites: Graduate Standing, Consent of the Instructor

MATH 590 Special Topics in Mathematics (Variable Credit 1-3) Variable Contents.

Prerequisite: Graduate Standing

MATH 591 Introduction to the Mathematical Literature (0-1-0)

Research and expository survey journals in mathematical sciences, review journals, citation journals, journal abbreviations and literature citations. Classification of mathematical subjects. Library search: books, bound journals, current periodicals, microfilms. Searching for publications on a specific subject or by a certain author. Structure and organization of a research paper in Mathematics. Methods of dissemination of mathematical results: abstracts, conferences, research papers, books and monographs. Major mathematical societies and publishers and their publication programs. The course will consist of one lecture a week and «workshop» sessions at the KFUPM Library supervised by the instructor.

MATH 595 Reading and Research I (Variable Credit 1-3) Variable Contents

Advanced topics are selected in an area of Mathematics. Contents of the course will be provided in detail one semester before its offering. Approval of the Departmental Graduate Committee must be secured before offering this course.

Prerequisite: Graduate Standing

MATH 596 Reading and Research II (Variable Credit 1-3) Variable Contents

Prerequisite: Graduate Standing

MATH 599 Seminar (1-0-0)

Prerequisite: Graduate Standing

MATH 602 Topics in Fluid Dynamics (3-0-3)

Kinematics and dynamics. Potential flow. Navier-Stokes equations. Some exact solutions. Laminar boundary layers. Stokes and Oseen flows. Sound waves. Topics in gas dynamics. Surface waves. Flow in porous media. Darcy's law and equation of diffusivity.

Prerequisite: MATH 505 or equivalent

MATH 605 Asymptotic Expansions and Perturbation Methods (3-0-3)

Asymptotic sequences and series. Asymptotic expansions of integrals. Solutions of differential equations at regular and irregular singular points. Nonlinear differential equations. Perturbation methods. Regular and singular perturbations. Matched asymptotic expansions and boundary layer theory. Multiple scales. WKB theory.

Prerequisites: MATH 430; MATH 301 or MATH 513

MATH 607 Inverse and Ill-Posed Problems (3-0-3)

Mathematical and numerical analysis of linear inverse and/or ill-posed problems for partial differential, integral and operator equations. Tikhonov regularization. Constraints and a priori bounds. Methodologies for achieving «optimal» compromise between accuracy and stability. Applications to practical problems in remote sensing, profile inversion, geophysics, inverse scattering and tomography.

Prerequisite: MATH 513, MATH 573, or Consent of the Instructor.

MATH 610 M.S. Thesis (0-0-6)

Prerequisite: MATH 599

MATH 611 Hilbert Space Methods in Applied Mathematics I (3-0-3)

Review of normed and product spaces. Theory of distributions, weak solution.

Complete orthonormal sets and generalized Fourier expansions. Green's functions and boundary value problems, modified Green's functions. Operator theory, invertibility, adjoint operators, solvability conditions. Fredholm alternative. Spectrum of an operator. Extremal principles for eigenvalues and perturbation of eigenvalue problems. Applications.

Prerequisite: MATH 535

MATH 612 Hilbert Space Methods in Applied Mathematics II (3-0-3)

Integral equations; Fredholm integral equation, spectrum of a self-adjoint compact operator, inhomogeneous equation. Variational principles and related approximation methods. Spectral theory of second-order differential operator, Weyl's classification of singular problems. Continuous spectrum. Applications. Introduction to nonlinear problems. Perturbation theory. Techniques for nonlinear problems.

Prerequisite: MATH 611

MATH 621 General Topology II (3-0-3)

The Tychonoff theorem, one-point compactification, the Stone-Cech compactification. Paracompactness, Lindelof spaces, Stone's theorem. Metrizability, the Nagata-Smirnov metrization theorem. Homotopy paths, fundamental group, simply-connected spaces, retracts and deformation retracts; the fundamental groups of the circle, the punctured plane and the n-sphere; Van Kampen's theorem.

Prerequisite: MATH 521

MATH 627 Differentiable Manifolds and Global Analysis (3-0-3)

Calculus on manifolds. Differentiable manifolds, mappings, and embeddings. Implicit functions theorem, exterior differential forms, and affine connections. Tangent bundles. Stoke's theorem. Critical points. Sard's theorem. Whitney's embedding theorem. Introduction to Lie groups and Lie algebras. Applications.

Prerequisite: MATH 527

MATH 631 Advanced Topics in Real and Abstract Analysis (3-0-3)

Topics to be chosen from Measure and Integration, Measurable Selections, Locally Convex Spaces, Topological Groups, Harmonic Analysis, Banach Algebras.

Prerequisite: MATH 531

MATH 633 Complex Variables II (3-0-3)

Harmonic functions. The Riemann mapping theorem. Conformal mappings for multi-connected domains. Elliptic functions and Picard’s theorem. Analytic continuation. Entire functions. Range of an analytic function. Topics in univalent functions and geometric function theory.

Prerequisite: MATH 533

MATH 637 Non-linear Functional Analysis and Applications (3-0-3)

Fixed points methods. Nonexpansive mappings. Differential and integral calculus in Banach spaces. Implicit and inverse function theorems. Potential operators and variational methods for linear and nonlinear operator equations. Extrema of functionals. Monotone operators and monotonicity methods for nonlinear operator equations. Applications to differential and integral equations and physical problems.

Prerequisite: MATH 535

MATH 640 Calculus of Variations (3-0-3)

Gateaux and Fréchet differentials. Classical calculus of variations. Necessary conditions. Sufficient conditions for extrema. Jacobi and Legendre conditions. Natural boundary conditions. Broken extrema, Erdmann-Weierstrass condition. Multiple integral problems. Constrained extrema. Hamilton principle with applications to mechanics and theory of small oscillations. Problems of optimal control. Direct methods including the Galerkin and the Ritz-Kantorovich methods. Variational methods for eigenvalue problems.

Prerequisite: MATH 411, or Consent of the Instructor

MATH 641 Topics in Calculus of Variations (3-0-3)

Selected topics from the following: Variational inequalities, weak lower semicontinuity and extremal problems in abstract spaces, theory of optimal control, stochastic control, distributed parameter systems, optimization problems over infinite horizons, algorithmic and penalty methods in optimization.

Prerequisite: MATH 640

MATH 642 Control and Stability of Linear Systems (3-0-3)

Review of systems of linear differential equations to include existence and uniqueness, contraction mappings, fixed points, transition matrix, matrix exponentials, the Laplace transform and stability. Linear control systems. Controllability, observability and duality. Weighting patterns and minimal realizations. Feedback. Linear regulator problem and matrix Riccati equations. Fixed-end point problems. Minimum cost and final-value problems in control theory. Stability of linear systems. Uniform stability. Exponential stability.

Prerequisites: MATH 465; MATH 460 or MATH 550

MATH 645 Combinatorics and Graph Theory (3-0-3)

Enumerative analysis, generating functions. Sorting and searching. Theory of codes. Block design. Computational combinatorics. Methods of transforming combinatorial ideas into efficient algorithms. Algorithms on graphs, network flow.

Prerequisite: MATH 425

MATH 651 Universal Algebra (3-0-3)

Lattices: basic properties, distributive and modular lattices, complete lattices, equivalence relations and algebraic lattices; Algebras: definition and examples, isomorphisms, subalgebras congruences and quotient algebras, homomorphism theorems, direct products, subdirect products, simple algebras, class operators and varieties, terms and term algebras, free algebras, Birkhoff's theorem, equational logic, Boolean algebras: Boolean algebras and Boolean rings, filters and ideals, Stone duality, connections with model theory: First-order languages and structures, reduced products and ultraproducts.

Prerequisite: MATH 551

MATH 652 Advanced Topics in Group Theory (3-0-3)

Advanced theory of solvable and nilpotent groups. General free groups. Krull- Schmidt theorem. Extensions. The general linear group. Group rings and group algebras. Representation theory of groups.

Prerequisite: MATH 450. (MATH 551 is recommended)

MATH 653 Advanced Topics in Commutative Algebra (3-0-3)

Selected topics from: prime spectra and dimension theory; class groups; ideal systems and star operations; multiplicative ideal theory; generator Property; homological aspects of commutative rings; pullbacks of commutative rings.

Prerequisite: MATH 555. (MATH 552 and MATH 553 are recommended)

MATH 654 Advanced Topics in Algebra (3-0-3)

Selected topics from: groups, rings, modules, and general algebraic systems.

Prerequisites: Graduate Standing, Consent of the Instructor

MATH 655 Applied & Computational Algebra (3-0-3)

Contents vary. Concepts and methods in algebra which have wide applications in mathematics as well as in computer science, systems theory, information theory, physical sciences, and other areas. Topics may be chosen from fields of advanced matrix theory; algebraic coding theory; group theory; Gr◌bner bases; or other topics of computational and applied algebra.

Prerequisites: Graduate Standing, Consent of the Instructor

MATH 661 Mathematical Statistics (3-0-3)

Theory of point estimation, Properties of estimators. Unbiased estimation and lower bounds for the variance of an estimator. Methods of moments and maximum likelihood. Bayes' and minimax estimation. Minimal sufficient statistics. Neymann-Pearson theory of testing of hypotheses. Unbiased and invariant tests. Confidence estimation. Confidence intervals (shortest length, unbiased and Bayes'). The general linear hypothesis and regression. Analysis of variance. Nonparametric statistical inference.

Prerequisite: MATH 561

MATH 663 Advanced Probability (3-0-3)

Measurable functions and integration. Radon-Nikodym theorem. Probability space. Random vectors and their distributions. Independent and conditional probabilities. Expectation. Strong laws of large numbers. The weak compactness theorem. Basic concepts of martingales. Invariance principles. The Law of the Iterated Logarithm. Stable distributions and infinitely divisible distributions.

Prerequisites: MATH 531, MATH 563

MATH 665 Advanced Ordinary Differential Equations II (3-0-3)

Self-adjoint boundary-value problems, Sturm-Liouville theory. Oscillation and comparison theorems. Asymptotic behavior of solutions. Singular Sturm-Liouville problems and non self adjoint problems. Hypergeometric functions and related special functions. Bifurcation phenomena.

Prerequisite: MATH 565

MATH 667 Advanced Partial Differential Equations II (3-0-3)

Classification of first order systems. Hyperbolic systems, method of characteristics. Applications to gas dynamics. Dispersive waves; application to water waves. Potential theory, single and double layers, existence theory for Dirichlet and Neumann problems.

Prerequisite: MATH 568

MATH 668 Evolution Equations (3-0-3)

Maximum Monotone Operators, Bounded and unbounded operators, Pseudo monotone operators, Self-adjoint, Evolution Equations in Hilbert and Banach spaces, Hille-Yosida Theorem, application to linear heat and wave Equations, Nonlinear Evolution equations, The Galerkin Method

Prerequisite: MATH 569

MATH 669 Integral Equations (3-0-3)

Review of the Fredholm and Hilbert-Schmidt theories for Fredholm integral equations of the second kind. Kernels with weak and logarithmic singularities. Singular integral equations of the first and second kind (Abel, Carleman, and Wiener-Hopf equations). Nonlinear integral equations (Volterra and Hammerstein equations). Application of the Schauder fixed point theorem. Nonlinear eigenvalue problems and integral equation methods for nonlinear boundary-value problems. Nonlinear singular integral equations. Applications to engineering and physics (the nonlinear oscillator, the airfoil equation, nonlinear integral equations arising the radiation transfer, hydrodynamics, water waves, heat conduction, elasticity, and communication theory).

Prerequisite: MATH 535

MATH 673 Numerical Solution of Integral Equations (3-0-3)

Numerical methods and approximate solutions of Fredholm integral equations of the second kind (both linear and nonlinear). Approximation of integral operators and quadrature methods. Nystrom method. Method of degenerate kernels. Collectively compact operator approximations. Numerical methods for Volterra integral equations. Methods of collocation, Galerkin, moments, and spline approximations for integral equations. Iterative methods for linear and nonlinear integral equations. Eigenvalue problems.

Prerequisite: MATH 471 or Consent of the Instructor

MATH 674 Numerical Functional Analysis (3-0-3)

Theoretical topics in numerical analysis based on functional analysis methods. Operator approximation theory. Iterative and projection methods for linear and nonlinear operator equations. Methods of steepest descent, conjugate gradient, averaged successive approximations, and splittings. Stability and convergence. Abstract variational methods and theoretical aspects of spline and finite element analysis. Minimization of functionals. Vector space methods of optimization. Newton and quasi-Newton methods for operator equations and minimization.

Prerequisite: MATH 535 or MATH 611

MATH 680 Dynamic Programming (3-0-3)

Development of the dynamic programming algorithm. Optimality principle and characterizations of optimal policies based on dynamic programming. Shortest route problems and maximum flow problems. Adaptive process. One-dimensional allocation processes. Reduction of dimensionality. Additional topics include imperfect state information models, the relation of dynamic programming to the calculus of variations, and network programming. Computational experience will be acquired by working on individual projects of applying dynamic programming to case study problems.

Prerequisite: MATH 640

MATH 681 Topics in Mathematical Programming (3-0-3)

Contents vary. Topics selected from: Nonconvex optimization, geometric programming, Lagrangian algorithms, sensitivity analysis, large-scale programming, nonsmooth optimization problems and optimality conditions in infinite-dimensional spaces, combinatorial optimization, computation of fixed points, complementarity problems, multiple-criteria optimization, and semi-infinite programming.

Prerequisite: MATH 582 or Consent of the Instructor

MATH 690 Special Topics in Mathematics (Variable Credit 1-3) Variable Contents

Prerequisite: Admission to Ph.D. Program

MATH 695 Reading and Research I (Variable Credit 1-3) Variable Contents

Advanced topics are selected in an area of Mathematics. Contents of the course will be provided in detail one semester before its offering. Approval of the Departmental Graduate Committee must be secured before offering this course.

Prerequisite: Admission to Ph.D. Program

MATH 696 Reading and Research II (Variable Credit 1-3) Variable Contents

Prerequisite: Admission to Ph.D. Program

MATH 699 Ph.D. Seminar (1-0-0)

Ph.D. students are required to attend Departmental seminars delivered by faculty, visiting scholars and graduate students. Additionally, each Ph.D. student should present at least one seminar on a timely research topic. Ph.D. students should pass the comprehensive examination as part of this course. This course is a pre-requisite to registering the Ph.D. Pre-dissertation MATH 711. The course is graded on Pass or Fail basis. IC grade is awarded if the Ph.D. Comprehensive exam is not yet passed.

Prerequisite: Graduate Standing.

MATH 711 Ph.D. Pre-Dissertation (0-0-3)

This course enables the student to submit his Ph.D. Dissertation Proposal and defend it in public. The student passes the course if the Ph.D. Dissertation Committee accepts the submitted dissertation proposal report and upon successfully passing the Dissertation Proposal Public Defense. The course grade can be NP, NF or IC.

Prerequisite: Ph.D. Candidacy, **Co-requisite**: ME 699

MATH 712 Ph.D. Dissertation (0-0-9)

This course enables the student to work on his Ph.D. Dissertation as per the submitted dissertation proposal, submits its final report and defend it in public. The student passes the course if the Ph.D. Dissertation Committee accepts the submitted final dissertation report and upon successfully passing the Dissertation Public Defense. The course grade can be NP, NF or IP.

Prerequisite: Math 711.

APPLIED STATISTICS

STAT500 Statistics for Experimenters (3-3-4)

Probability. Probability distributions. Fundamentals of statistical inference. Estimation. Hypothesis testing. Correlation and regression. Multiple regression. One-way Classification. Analysis of variance. Introduction to categorical data analysis. Nonparametric methods.

Prerequisites: Graduate Standing. This is a deficiency course and cannot be taken for credit by Statistics major students.

STAT 501 Probability and Mathematical Statistics (3-0-3)

Axioms and foundations of probability. Conditional probability and Bayes' theorem. Independence. Random variables and distribution functions and moments. Characteristic functions. Laplace transforms and moment generating functions. Function of random variables. Random vectors and their distributions. Convergence of sequences of random variables. Laws of large numbers and the central limit theorem. Random samples, sample moments and their distributions. Order statistics and their distributions

Prerequisites: Graduate Standing. Cannot be taken for credit with MATH 561 and MATH 563

STAT 502 Statistical Inference (3-0-3)

Methods of estimation. Properties of estimators: consistency, sufficiency, completeness and uniqueness. Unbiased estimation. The method of moments. Maximum likelihood estimation. Techniques for constructing unbiased estimators and minimum variance unbiased estimators. Bayes estimators. Asymptotic property of estimators. Introduction to confidence intervals. Confidence intervals for parameters of normal distribution. Methods of finding confidence intervals. Fundamental notions of hypotheses testing. The Neyman-Pearson lemma. Most powerful test. Likelihood ratio test. Uniformly most powerful tests. Tests of hypotheses for parameters of normal distribution. Chi-square tests, t-tests, and F-tests.

Prerequisites: STAT 501. Cannot be taken for credit with MATH 561 and MATH 563.

STAT 510 Regression Analysis (3-0-3)

Simple linear regression and multiple regressions with matrix approach. Development of linear models. Inference about model parameters. Residuals Analysis. Analysis of variance approach. Selection of the best regression equation. Using statistical packages to analyze real data sets.

Prerequisites: STAT 501. Cannot be taken for credit with MATH 560 or SE 535.

STAT 511 Applied Regression and Experimental Design (3-0-3)

Simple linear regression. Estimating and testing of intercept and slope. Multiple linear regressions. Estimation parameters and testing of regression coefficients. Prediction and correlation analysis. Analysis of variance technique. Completely randomized and randomized block designs. Latin Square designs. Incomplete block design. Factorial design, 2^k factorial

designs and blocking and confounding in 2^k factorial designs. Using statistical packages to analyze real data sets.

Prerequisites: Graduate Standing. Cannot be taken for credit with MATH 560 or ISE 530. Cannot be taken by Statistics major students.

STAT 512 Demographic Methods (3-0-3)

Demographic fundamentals, Measurement of mortality, Life table, Multiple decrement life table, Analysis of Marriage, Measurement of fertility, Parity progression, Determinants of fertility, Population growth, Models of population structure, Survival analysis, Cox proportional hazards (single and multiple events), Competing events, Parametric demographic models.

Prerequisites: Graduate Standing.

STAT 515 Stochastic Processes (3-0-3)

Basic classes of stochastic processes. Poisson processes. Renewal processes. Regenerative processes. Markov chains. Stochastic population models and branching processes. Queuing processes. Applications of Stochastic process models.

Prerequisites: STAT 501. Cannot be taken for credit with EE 570. Cross-listed with ISE 543.

STAT 525 Nonparametric Methods (3-0-3)

The binomial test. The quantile test. Tolerance limits. The sign test. The Wlicoxon signed ranked test. The Mann-Whitney tests. Contingency tables. The median test. Measures of dependence. The chi squared goodness-of-fit test. Cochran’s test. Tests for equal variances. Measures of rank correlation. Linear regression methods. One and two ways analysis of variance. Using statistical packages to analyze real data sets.

Prerequisites:STAT501.

STAT 530 Design and Analysis of Experiments (3-0-3)

Completely randomized design. Randomized block design. Latin square designs. Models: Fixed, random, and mixed models. Incomplete block design. Factorial experiments 2^k designs. Confounding in 2^k designs. Nested and Split-plot designs. Fractional and orthogonal designs. Fractional replicate and orthogonal designs. Using statistical packages (e.g. Statistica, Minitab, SAS, SPSS, etc.) to analyze real data sets.

Prerequisites: STAT 502. Cannot be taken for credit with MATH 560 or ISE 535.

STAT 540 Multivariate Analysis (3-0-3)

Aspects of multivariate analysis. Matrix algebra and random vectors. The multivariate normal distribution. The Wishart distribution. Distribution of a correlation matrix. Inference about a mean vector. Comparing several multivariate means. Multivariate linear regression models. Principal components. Factor analysis. Canonical correlation analysis. Discrimination and classification. Using statistical packages to analyze real data sets.

Prerequisites: STAT 502.

STAT 560 Time Series Analysis (3-0-3)

General approach to time series. Stationary models and autocorrelation. Linear processes and ARMA Models. Forecasting stationary time series. ARMA (p, q) models. Preliminary estimation and Yule-Walker approach. Method of moments and maximum likelihood estimations. ARIMA models for non-stationary time series. Forecasting non-stationary time series. Forecasting ARIMA models. Seasonal ARIMA models. Using statistical packages to analyze real data sets.

Prerequisites: STAT 502.

STAT 565 Sampling Methods (3-0-3)

Simple random sample. Sampling proportion. Sample size estimation. Stratified random sampling. Ratio, regression, and difference estimators. Systematic sampling. Single stage cluster sampling. Multi-stage cluster sampling. Unequal probability sampling.

Prerequisites: Graduate Standing.

STAT 575 Categorical Data Analysis (3-0-3)

Two-way and three-way contingency tables. Log linear model and logistic regression model. Building and applying logit and loglinear models. Multicategory logit models. Models for matched pairs. Using statistical packages to analyze real data sets.

Prerequisites: STAT 502.

STAT 590 Special Topics in Statistics (3-0-3)

Advanced topics are selected from the broad area of Statistics. The contents of the course are given in detail one semester in advance of that in which it is to be offered. The approval of the Graduate Council will be necessary for offering this course.

Prerequisite: Graduate Standing.

STAT 591 Special Topics in Statistics (3-0-3)

Advanced topics are selected from the broad area of Statistics. The contents of the course are given in detail one semester in advance of that in which it is to be offered. The approval of the Graduate Council will be necessary for offering this course.

Prerequisite: Graduate Standing.

STAT 599 Seminar (1-0-0)

Graduate students are required to attend the seminars by faculty members, visiting scholars, and fellow graduate students. Additionally, each student must present at least one seminar on a timely research topic. Among other things, this course is designed to give the students an overview of research in Statistics, and a familiarity with research methodology, journals and professional societies in his discipline. Graded on a Pass or Fail basis.

Prerequisite: Graduate Standing.

STAT 600 Project (2-3-3)

The project course is arranged between a student and faculty member to train students in research methodology and undertaking a real data set to analyze this set and make recommendations to the client. Students may study specific problems in the era of Applied Statistics. In this course students are asked to prepare a report and possibly publish a paper in reflecting advanced knowledge in the Statistics field. The work will be evaluated based on a report, a seminar and oral examination.

Prerequisite: Graduate Standing.

STAT 606 Independent Research (3-0-3)

This course is intended to allow the student to conduct research in advanced problems in his M.S. research area. The faculty offering the course should submit a research plan to be approved by the Graduate Program Committee at the academic department. The student is expected to deliver a public seminar and a report on his research outcomes at the end of the course. Graded on a Pass or Fail basis.

Prerequisite: Consent of Instructor.

STAT 610 M.S. Thesis(0-0-6)

Prerequisite: STAT 599

DEPARTMENT OF PHYSICS

Chairman

Dr. Abdullah A. Al-Sunaidi

Faculty

Al-Adel	Al-Aithan	
Al-Amoudi	Ayub	Bahlouli
Al-Basheer	Dastageer	Dwaikat
Faiz	Gasmi	Ghannam
Gondal	Haider	Harrabi
Hrahsheh	Islam	Al-Jalal
Al-Karmi	Khateeb	Khattak
Khiari	Al- Kuhaili	Kunwar
Maalej	Al-Marzoug	Al-Matoug
Mekki, A	Mekki, M	Nagadi
Naqvi	Nasser	Al-Ohali
Rashid	Rao	Al-Sadah
El-Said	Salem	Al-Shukri
Al-Sunaidi	Yamani	Al-Zahrani
Ziq		

The Physics Department offers three graduate degrees:

- Master of Science in Physics,
- Doctor of Philosophy in Physics, and
- Master in Medical Physics.

The Department started offering M.S. in Physics in 1980, Master in Medical Physics in 2000, and Ph.D. in Physics in 2012.

Many factors make the Physics Department at KFUPM a great choice for pursing graduate studies. It has a highly qualified and large faculty body with diverse background. It offers a caring and friendly learning environment with students coming from different countries having their distinct cultural backgrounds. Also, the Department has well-equipped research facilities in many areas of physics. In addition, as a leading technical institute in the area with well-established academic departments and research centers, KFUPM offers many opportunities to conduct advanced interdisciplinary research.

Teaching and Research Facilities

The Department of Physics has modern laboratories supporting the teaching and research activities of its graduate programs. These include the following:

Laser Research Laboratory

Laser Research Laboratory is housed in five spacious rooms and was established more than 25 years ago. It is equipped with different modern lasers, spectroscopic and analytical tools which enable its researchers to carry out advanced applied and basic research in the field of laser. The tools that are available include supersonic jet spectroscopy, laser breakdown spectroscopy, photo-acoustic spectroscopy, fluorescence spectroscopy, time resolved spectroscopy, Raman spectroscopy, cavity ring down spectroscopy, and pulsed laser deposition.

Nuclear Physics Laboratory

Nuclear Physics Laboratory is built around a 350 keV ion accelerator and a portable D-D neutron generator. Present research focuses on prompt gamma neutron activation analysis of industrial and environmental samples using a variety of gamma detectors.

Radiation Protection Laboratory

A variety of radiation detection instruments and radiation sources are available in the Radiation Protection Laboratory. The radiation detection instruments include liquid scintillation counter; ion chamber survey meters; gamma scintillation/Geiger Muller survey meters; neutron survey meter; and nuclear track detection system. The nuclear sources include Am-Be neutron sources; Co-60 gamma sources; Cs-137 gamma sources; and Ra-226 alpha/gamma sources.

Superconductivity Laboratory

The superconductivity Laboratory houses a 9-Tesla vibrating sample magnetometer (VSM), magneto-transport and AC-susceptibilities set-up as well as a facility to grow single crystals. Magnetic properties of superconductors, nanoparticles, oxides, alloys and glasses are routinely studied in this lab. Phase slip and vortex states in superconductors are also investigated.

Surface Science Laboratory

The researchers in the Surface Science Laboratory investigate surface properties of materials with the help of a variety of instruments including X-ray photoelectron spectroscopy, x-ray diffractometer, atomic force microscope, and Hall-effect set-up working at room and liquid nitrogen temperatures. Furthermore, the laboratory possesses home made magnetron dc-

sputtering systems for thin film synthesis and a computer controlled gas sensing set up.

Thin Film Laboratory

The Thin Film Laboratory has a variety of thin film deposition and characterization instruments. The deposition instruments include a thermal evaporation unit, pulsed laser deposition unit, DC/RF magnetron sputtering unit, and Dip coating unit. The characterization instruments include spectrophotometer, spectrofluorometer, photoluminescence unit, a Hall-effect system, atomic force microscopy, a stylus profilometer. In addition, the Laboratory has an automated thin-film gas sensing system and a number of furnaces for annealing.

Supporting Facilities

The research laboratories are supported by a cryogenic facility for liquefying helium and nitrogen as well as by mechanical and electronic workshops. Laboratory investigate surface properties of materials with the help of a variety of instruments including X-ray photoelectron spectroscopy, x-ray diffractometer, atomic force microscope, and Hall-effect set-up working at room and liquid nitrogen temperatures. Furthermore, the laboratory possesses home-made magnetron dc-sputtering systems for thin film synthesis and a computer controlled gas sensing set up.

M.S. PROGRAM IN PHYSICS

Admission Requirements

The Master of Science (M.S.) program in Physics is available to students who meet the requirements for admission to the University with a B.S. in Physics or equivalent from an institution of acceptable standing. The Department might ask the applicant to submit his score in GRE subject test in Physics.

Degree Requirements

The M.S. program in physics requires the successful completion of 24 credit hours of course work, seminar, and a research thesis with 6 credit hours. The course work consists of core and elective courses. Five courses or 15 credit hours of core courses must be taken by all candidates. The remaining three courses or 9 credit hours are elective.

It is strongly recommended that PHYS 530 (Statistical Mechanics) be taken as one of the elective courses. With the approval of the academic advisor and the chairman, the student might take at most 6 credit hours of elective courses from 400-level courses provided that they are not core courses for the undergraduate program. The student might take MATH 513 (Mathematical Methods for Engineers) instead of the core course PHYS 571 (Advanced Methods of Theoretical Physics).

Degree Plan for M.S. in Physics

Course	No	Title	LT	LB	CR
First Semester					
PHYS	501	Quantum Mechanics I	3	0	3
PHYS	507	Classical Mechanics	3	0	3
PHYS	571	Advanced Methods of Theoretical Physics	3	0	3
			9	**0**	**9**
Second Semester					
PHYS	503	Graduate Laboratory	0	6	3
PHYS	505	Classical Electrodynamics I	3	0	3
PHYS	5xx/4xx	Elective	3	0	3
PHYS	599	Seminar	1	0	0
			7	**6**	**9**
Third Semester					
PHYS	5xx/4xx	Elective	3	0	3
PHYS	5xx/4xx	Elective	3	0	3
PHYS	610	M.S. Thesis	0	0	IP
			6	**0**	**6**
Fourth Semester					
PHYS	610	M.S. Thesis	0	0	6
Total Credit Hours					**30**

Notes:

- Each student is expected to submit his detailed degree plan according to the above generic degree plan for approval by the Department and the Deanship of Graduate Studies within the 8^{th} week of the second semester of enrollment.
- Students are required to adhere to the regulations of degree plan. No relaxations will be given to any student, and courses taken in conflict of the above will not be counted towards the degree.
- Maximum of two 400-level elective courses may be allowed on recommendations of the advisor.
- The order of taking the courses can be different from above, but students must take the core courses before electives.

MASTER PROGRAM IN MEDICAL PHYSICS

Medical physics is an applied branch of physics concerned with the application of the concepts and methods of physics for the diagnosis and treatment of human diseases. The main areas of medical physics are the treatment of cancer by ionizing radiation (radiation therapy), diagnostic imaging with X-rays, ultrasound, and nuclear magnetic resonance (diagnostic radiology), diagnostic imaging with radioisotopes (nuclear medicine) and the study of radiation hazards and radiation protection (health physics). The objective of the Master's program in Medical Physics is to satisfy the need of the Kingdom for qualified clinical medical physicists.

KFUPM has established an active collaboration with local and national medical centers to facilitate teaching, training, and research in the field of medical physics. King Fahad Specialist Hospital in Dammam and King Faisal Specialist Hospital & Research Center in Riyadh are examples of top medical centers where students have the opportunity for excellent clinical training and quality research.

Admission Requirements

Applicants holding a Bachelor's degree in science or engineering from a university of recognized standing are invited to apply for admission to the Master's degree in medical physics, provided they satisfy the general admission requirements of the Graduate School. Applicants must have a suitable scientific background to enter the medical physics program demonstrated by the completion of the following KFUPM courses or their equivalent: Methods of Applied Mathematics (MATH 301), Modern Physics (PHYS 212), Experimental Physics I (PHYS 303). Applicants must make up for any deficiencies in their prior program within two semesters of enrollment. Once accepted in the program, graduate students are required to take a full time course load.

Degree Requirements

In addition to the KFUPM requirements, all students enrolled in the Master's program in Medical Physics must pass a minimum of 42 credit hours of graduate courses and a comprehensive exam. The breakup of the required 42 credit hours of course work is as follows:

Core courses **22 credit hours**

- Elective courses 11 credit hours
- Clinical training 6 credit hours
- Medical physics project 3 credit hours

The following lists the **core** course requirements for the Master program in Medical Physics:

MEPH 500	Human Anatomy Physiology
MEPH 510	Radiobiology
MEPH 561	Radiological Physics and Dosimetry
MEPH 563	Radioisotopes in Medicine and Biology
MEPH 566	Radiotherapy Physics
MEPH 567	Diagnostic Radiology Physics
MEPH 569	Health Physics

A list of **elective courses**, from which a minimum of 3 credit hours of courses is selected, is given below:

MEPH 581	Laboratory in Radiological Physics – Radiotherapy
MEPH 582	Laboratory in Radiological Physics – Diagnostic Radiology
MEPH 583	Laboratory in Radiological Physics – Nuclear Medicine
MEPH 584	Laboratory in Radiological Physics – Health Physics
MEPH 585	Laboratory in Radiological Physics – CT, MRI, and DSA
MEPH 586	Laboratory in Radiological Physics – Medical Ultrasound

Below is a list of **courses** of which a minimum of 8 credit hours of courses are to be selected:

MEPH 501	Physics for Medicine and Biology
MEPH 511	Instrumentation for Medical Physics
MEPH 568	Magnetic Resonance Imaging (MRI)
MEPH 570	Advanced Brachytherapy Physics
MEPH 571	Advanced External Radiation Oncology
MEPH 573	Imaging in Medicine
MEPH 574	Applications of Digital Imaging: DSA, CT, MRI
MEPH 575	Diagnostic Ultrasound Physics
MEPH 591	Selected Topics in Medical Physics
MEPH 592	Independent Reading
EE 562	Digital Signal Processing I
EE 663	Image Processing
MATH 513	Mathematical Methods for Engineers

Clinical Training

Clinical training in medical physics is acquired in the series of Laboratory in Radiological Physics courses (MEPH 581-586). Each laboratory involves performing particular experiments and procedures in hospitals. Additional clinical medical physics training is obtained in the clinical training course (MEPH 590). The course consists of a 16-week hospital-based clinical rotation in: diagnostic imaging, nuclear medicine, radiation therapy, and health physics. A student in this course observes and practices clinical procedures under the direct supervision of a senior clinical medical physicist. The student will write a monthly progress report about the clinical procedures he learned and performed. The evaluation and the follow-up of each student will be done in cooperation between the supervising clinical medical physicist from the hospital and a medical physics faculty member from KFUPM.

Medical Physics Project

The project is an independent study that offers an opportunity for students to carry out experimental or theoretical research projects, based on their special interests and ideas in the field of medical physics. A student performs the proposed projects under the supervision of a medical physics faculty advisor.

Comprehensive Examination

All students in the Medical Physics program are required to pass a written comprehensive examination as a requirement for the Master's degree. The examination consists of questions on the core courses. Candidates are advised to take this exam as soon as they complete the core courses. A candidate who fails the examination the first time is allowed only one more chance to retake the exam next time it is offered.

Degree Plan for Master of Medical Physics

Course	#	Title	LT	LB	CR
First Semester					
MEPH	510	Radiobiology	2	0	2
MEPH	561	Radiological Physics and Dosimetry	3	0	3
MEPH	567	Diagnostic Radiology Physics	3	3	4
			8	**3**	**9**
Second Semester					
MEPH	500	Human Anatomy and Physiology	3	0	3
MEPH	563	Radioisotopes in Medicines and Biology	2	3	3
MEPH	566	Radiotherapy Physics	2	3	3
			7	**6**	**9**
Third Semester					
MEPH	569	Health Physics	3	3	4
MEPH	571	Advanced External Radiation Oncology	3	0	3
MEPH	581	Laboratory in Radiological Physics – Radiotherapy	0	3	1
MEPH	583	Laboratory in Radiological Physics – Nuclear Medicine	0	3	1
			6	**9**	**9**
Fourth Semester					
MEPH	568	MRI	2	0	2
MEPH	575	Diagnostic Ultrasound Physics	2	3	3
MEPH	582	Laboratory in Radiological Physics – Diagnostic Radiology	0	3	1
MEPH	599	Seminar	1	0	0
MEPH	600	Medical Physics Project	0	0	3
			5	**6**	**9**
Fifth Semester					
MEPH	590	Clinical Training	0	0	**6**
Total Credit Hours					**42**

Notes:

- Each student is expected to submit his detailed degree plan according to the above generic degree plan for approval by the Department and the Deanship of Graduate Studies within the 8th week of the second semester of enrollment.
- Students are required to adhere to the regulations of degree plan. No relaxations will be given to any student, and courses taken in conflict of the above will not be counted towards the degree.
- The order of taking the courses can be different from above, but students must take the core courses before electives.

PH.D. PROGRAM IN PHYSICS

The Department offers Ph.D. program in the following major areas of physics:

- Atomic, Molecular and Optical Physics
- Condensed Matter Physics
- Nuclear Physics

Experimental or theoretical research can be pursued in any of the above areas.

Admission Requirements

The applicant must fulfill KFUPM admission requirements set by the Deanship of Graduate Studies. The applicant should have a Masters' degree in physics or related field from an institution of acceptable standing. The Department might ask the applicant to submit his score in GRE Subject Test in Physics. Each new student will take an entrance examination and any deficiency in his physics background must be removed within two semesters of admission into the graduate program.

Degree Requirements

The Ph.D. program in physics requires the successful completion of 30 credit hours of course work, seminar, written and oral comprehensive exams, and a research dissertation of which 3 credit hours are allocated to Ph.D. Pre-Proposal and 9 credit hours to Ph.D. dissertation).

The course work consists of core and elective courses. Core courses consist of five courses or 15 credit hours. Each of the three major areas has its own core courses that must be taken by all students specialized in the area. The core courses are as follows:

Atomic, Molecular and Optical Physics

PHYS 511	Quantum Optics
PHYS 551	Atomic and Molecular Physics
PHYS 608	Laser Spectroscopy
PHYS 611	Nonlinear Optics
PHYS 612	Laser Physics

Condensed Matter Physics

PHYS 532	Solid State Physics I
PHYS 536	Low Temperature Physics
PHYS 630	Phase Transitions and Critical Phenomena
PHYS 632	Quantum Theory of Solids
PHYS 636	Semiconductor Device Physics I

Nuclear Physics

PHYS 520	Introduction to Strong Interaction
PHYS 521	Advanced Nuclear Physics I
PHYS 522	Advanced Nuclear Physics II
PHYS 523	Nuclear Instrumentation
PHYS 621	Advanced Methods of Theoretical Nuclear Physics with Applications to Nuclear Models

The remaining five courses or 15 credit hours are elective. Two of the elective courses or six credit hours must be selected from one of the other two major areas. The remaining nine credit hours should comprise other graduate physics, mathematics, science or engineering courses. These courses must be approved in advance by the Graduate Program Committee of the Department of Physics. The student will be required to take as elective courses PHYS 571: Advanced Methods of Theoretical Physics (or equivalently MATH 513: Mathematical Methods for Engineers) and PHYS 530: Statistical Mechanics if he did not take these or equivalent courses during his M.Sc. degree.

The written comprehensive exam will be based on four selected graduate level courses in the major or minor areas of the student. The selection of these courses and the preparation of the exam are administered by the Department Graduate Committee. The exam must be taken before the beginning of the fourth semester from the date of the enrolment into the Ph.D. program. A student has two chances to pass the written comprehensive exam. The second attempt mustn't be later than two semesters after the first attempt.

After successful completion of the written comprehensive examination, the student should formally select a dissertation advisor and should write his dissertation proposal. Following this, the student will be tested orally in his field of specialty to insure his readiness for scholarly research. The oral comprehensive exam must be taken within two semesters after the student has passed the written part of the comprehensive exam.

The student must submit and successfully defend a dissertation based on original and scholarly research conducted by him and judged to be a significant contribution to his area of specialization.

Since most of the Ph.D. graduates will be working at universities where teaching is an integral part of employment, therefore, every Ph.D. student is encouraged to participate in some form of teaching activity for at least one semester.

Degree Plan for Ph.D. in Physics

Course	No	Title	LT	LB	CR
First Semester					
PHYS	xxx	Course from Major Area	3	0	3
PHYS	xxx	Course from Major Area	3	0	3
PHYS	xxx	Course from Minor Area	3	0	3
			9	**0**	**9**
Second Semester					
PHYS	xxx	Course from Major Area	3	0	3
PHYS	xxx	Course from Minor Area	3	0	3
PHYS	xxx	Course from Minor Area	3	0	3
			9	**0**	**9**
Third Semester					
PHYS	xxx	Course from Major Area	3	0	3
PHYS	xxx	Course from Major Area	3	0	3
PHYS	xxx	Reading and Research I	3	0	3
PHYS	699	Seminar	1	0	0
			10	**0**	**9**
Fourth Semester					
PHYS	xxx	Free Elective	3	0	3
PHYS	711	Ph.D. Pre-Dissertation	0	0	3
			3	**0**	**6**
Fifth Semester					
PHYS	712	Ph.D. Dissertation	0	0	IP
Sixth Semester					
PHYS	712	Ph.D. Dissertation	0	0	**9**
Total Credit Hours					**42**

Notes:

- Each student is expected to submit his detailed degree plan according to the above generic degree plan for approval by the Department and the Deanship of Graduate Studies within the 8th week of the second semester of enrollment.
- Students are required to adhere to the regulations of degree plan. No relaxations will be given to any student and the courses taken in conflict of the above will not be counted towards the degree.
- The order of taking the courses can be different from above but students must take the core courses before electives.

COURSE DESCRIPTIONS

PHYSICS

PHYS 501 Quantum Mechanics (3-0-3)

Brief review of quantum mechanics including operators, linear vector spaces and Dirac notation; General theory of angular momentum and rotation group, addition of angular momento, Clebsh-Gordan technique, scattering of spin ½ particles with spinless particles, tensor operators; a brief review of time dependent perturbation theory, interaction of radiation with matter, absorption of light, induced and spontaneous emission, electric and magnetic dipole transitions, selections rules and scattering of light.

Prerequisite: PHYS 402

PHYS 502 Quantum Mechanics II (3-0-3)

Quantization of radiation field; Emission and absorption of photons by atoms, Lamb shift; Relativistic spin zero particles, Klein–Gordon equation, Quantization of spin 0 field; Relativistic spin 1/2 particles; details of Dirac equation and its applications; Quantization of Dirac field; 2-component neutrino theory; Covariant perturbation theory; S-matrix; electron and photon propagators; Application to 2-photon annihilation, Compton scattering and Moller scattering; Introduction to mass and charge renormalization.

Prerequisite: PHYS 501

PHYS 503 Graduate Laboratory (0-6-3)

Four experiments from the different areas of current research interest in the Physics Department, each is supervised by a faculty member from the respective research specialty. Emphasis will be on some of the techniques and instrumentation currently used in research; computer-assisted and advanced techniques of analysis of data.

Prerequisite: PHYS 403 or Consent of the Instructor

PHYS 505 Classical Electrodynamics I (3-0-3)

Boundary value problems in electrostatics and magnetostatics; dielectrics and magnetic media; Maxwell's equations and conservation laws; wave guides and resonators; simple radiating systems.

Prerequisite: PHYS 306

PHYS 506 Classical Electrodynamics II (3-0-3)

The electromagnetic potentials and the Hertz vectors; cylindrical waves, spherical waves, the Debye potentials; multipole radiation; classical relativistic electrodynamics; radiation from moving charges.

Prerequisite: PHYS 505

PHYS 507 Classical Mechanics (3-0-3)

Topics discussed include variational principles; Lagrange's equations; the rigid body equations of motion; Hamilton's equations; canonical transformations; Hamilton–Jacobi theory; small oscillations and normal coordinates; continuous systems and fields.

Prerequisite: PHYS 301

PHYS 511 Quantum Optics (3-0-3)

Partial coherence; photon statistics; stochastic processes; Markoffian processes; statistical states

in quantum theory; equation of motion of the electromagnetic field; coherent state representation of the electromagnetic field; quantum theory of optical correlation; theoretical laser models; nonlinear optical phenomena.

Prerequisites: PHYS 411, PHYS 501

PHYS 515 Astrophysics (3-0-3)

Radiative transfer and internal structure of normal stars; red giants; white dwarfs; neutron stars; pulsars; nova and super-nova explosions; nuclear theories of stellar evolution; binary systems and galactic x-ray sources; galaxies; quasars and cosmology.

PHYS 520 Introduction to Strong Interactions (3-0-3)

Topics of borderline between Nuclear and Particle Physics will be emphasized e.g., Isospin and charge dependent effects in nuclear forces; Meson exchange effects in nuclear physics; Structure of nucleon and nuclei by electron scattering; Quarks in nuclei.

Prerequisite: PHYS 501

PHYS 521 Advanced Nuclear Physics I (Nuclear Structure) (3-0-3)

Generalities; Nuclear sizes, forces, binding energies, moments; Nuclear models: Fermi-gas model, liquid drop model (fission), collective models (rotational/vi-brational spectra), Electromagnetic transitions: multipole expansion, decay rates, selection rules; Simple theory of Beta decay.

Prerequisite: PHYS 422, PHYS 501

PHYS 522 Advanced Nuclear Physics II (Nuclear Reactions) (3-0-3)

Two body system and nuclear forces; nuclear reactions; scattering matrix, resonance optical model; compound nucleus; direct reactions; fission, heavy ion nuclear reactions; photo-nuclear reactions.

Prerequisites: PHYS 422, PHYS 501

PHYS 523 Nuclear Instrumentation (3-0-3)

Nuclear radiation detectors; basic pulse circuits, pulse shaping methods for nuclear spectroscopy, resolution in nuclear spectroscopy systems, amplifiers; pulse height and shape discriminators; timing circuits; multi-channel pulse height analyzers; multi-parameter and computer analysis.

Prerequisites: PHYS 403, PHYS 422

PHYS 524 Neutron Physics (3-0-3)

Production and detection of neutrons; introduction to polarization; production of polarized neutrons; polarized targets; neutron-induced reactions; applications in other fields.

Prerequisites: PHYS 422, PHYS 501

PHYS 530 Statistical Mechanics (3-0-3)

The statistical basis of thermodynamics; elements of ensemble theory, the canonical and grand canonical ensembles; quantum statistics; application to simple gases; Bose and Fermi systems; Imperfect gas; Phase transitions and Ising model.

PHYS 532 Solid State Physics I (3-0-3)

Review of free electron gas. Bravais lattice and crystal structure, reciprocal lattice and Brillouin zones, crystal binding, electron states in periodic potential, energy band structure and application to metals, semiconductors and insulators, Fermi surface, surface effects, lattice dynamics and lattice specific heat, electron-photon and effective electron-electron interactions, and dielectric properties and applications.

Prerequisites: PHYS 306, PHYS 432

PHYS 533 Solid State Physics II (3-0-3)

Transport phenomena, impurity effects and impurity structure, various spectroscopies using photons and charged particles as excitation source and application to bulk and surface properties, many-body effects, magnetism and related topics, superconductivity and related theories, and resonance phenomena and applications.

Prerequisite: PHYS 532

PHYS 536 Low Temperature Physics (3-0-3)

Production of low temperatures; the cryogenic fluids; superfluidity; helium I and II; He 3; type I and II super-conductivity; BCS theory; applications of superconductivity.

Prerequisite: PHYS 401

PHYS 541 Elementary Particle Physics I (3-0-3)

Characterization of particle: Mass, spin and magnetic moment; classification of particles; internal quantum numbers; baryon and lepton charges and hypercharge; Isospin and SU(2) group; Discrete space-time transformations; Determination of parity and spin of particles; K^0-K^0 complex; CP violation; CPT theorem; Quark model of hadrons; 3 quark flavors and SU(3) classification of particles; Mass spectrum of hadrons and their magnetic moments in quark model; Discovery of additional quark flavors; Color charge and gluon; Non-relativistic treatment of one gluon exchange potential and its application to mass spectrum of hadrons.

Prerequisite: PHYS 501

PHYS 542 Elementary Particle Physics II (3-0-3)

Introduction to weak interactions, V-A theory; Vector and axial vector currents; Intermediate vector bosons, Non-abelian gauge transformations; Spontaneous symmetry breaking; Unification of weak and electromagnetic interactions; Introduction to quantum chromodynamics; Introduction to grand unification.

Prerequisites: PHYS 502, PHYS 541

PHYS 551 Atomic and Molecular Physics (3-0-3)

Energy levels and wave functions of atoms and molecules; microwave, infrared, visible and UV spectroscopies; lasers and masers; LS and j j coupling; Thomas-Fermi and Hartree-Fock approximations; relativistic effects; group theoretical considerations; collisions.

Prerequisite: PHYS 501

PHYS 561 Plasma Physics I (3-0-3)

Review introduction to the basics of plasma physics; thermodynamics and statistical mechanics of equilibrium plasma; macroscopic properties and waves in the fluid plasma; stability of the fluid plasma; transport phenomena.

Prerequisites: PHYS 461, PHYS 530

PHYS 562 Plasma Physics II (3-0-3)

Kinetic equations; Vlasov theory of plasma waves; Vlasov theory of plasma stability; the nonlinear Vlasov theory of plasma waves and instabilities; fluctuation correlation and radiation; particle motion; selected advanced topics.

Prerequisite: PHYS 561

PHYS 571 Advanced Methods of Theoretical Physics (3-0-3)

Partial differential equations, Separation of variables; Eigenfunctions and Eigenvalues; Linear vector spaces and linear operators; Green functions; Integral equations; Integral transforms.

Prerequisite: PHYS 371 or Consent of the Instructor

PHYS 573 Group Theory and Quantum Mechanics (3-0-3)

An introductory course into the physical application of group theory. Topics discussed are abstract group theory; group representations; symmetries; the rotation group; application of group theory to atoms, molecules, and solids.

Prerequisite: PHYS 501

PHYS 575 General Relativity (3-0-3)

The Equivalence principle; Field equations and the gravitational potential; solutions of Einstein's equations; the classical tests for general relativity; cosmology; star phenomenology including stellar equilibrium; Neutron star and gravitational collapse.

Prerequisite: Consent of the Instructor

PHYS 590 Special Topics in Physics (3-0-3)

Advanced topics selected for their current interest.

Prerequisite: Consent of the Instructor

PHYS 599 Seminar (1-0-0)

Graduate students are required to attend the seminars given by faculty, visiting scholars, and fellow graduate students. Additionally, each student must present at least one seminar on a timely research topic. Among other matters, this course is designed to give the student an overview of research in the Department, and a familiarity with the research methodology, journals, and professional societies in his discipline. Graded on a Pass or Fail basis.

Prerequisite: Graduate Standing

PHYS 606 Independent Research (3-0-3)

This course is intended to allow the student to conduct research in advanced problems in his M.S. research area. The faculty offering the course should submit a research plan to be approved by the Graduate Program Committee at the academic department. The student is expected to deliver a public seminar and a report on his research outcomes at the end of the course. Graded on a Pass or Fail basis.

PHYS 607 Symmetry and Molecular Spectroscopy (3-0-3)

A graduate course dealing with molecular symmetry and its importance in Molecular Spectroscopy: It will involve symmetry operation, molecular spectra and assignments, etc.

Prerequisites: Consent of the instructor

PHYS 608 Laser Spectroscopy (3-0-3)

Conventional spectroscopic techniques; resonant and multiphoton laser absorption processes; fluorescence and phosphorescence; ionization, dissociation, ejected electron spectroscopy, mass spectroscopy; time-of-flight spectroscopy; photo-acoustic spectroscopy ; analysis and interpretation of spectra from gases, liquids, and solids; collisions and other perturbations; configuration interaction; multichannel quantum defect theory and analysis; supersonic jet molecular spectroscopy; polarization spectroscopy; stimulated Raman scattering, coherent effects, laser cooling and Bose-Einstein condensation.

Prerequisite: Consent of the instructor

PHYS 610 M.S. Thesis (0-0-6)

Prerequisites: PHYS 599

PHYS 611 Nonlinear Optics (3-0-3)

Nonlinear optical susceptibility; wave equation description of nonlinear optical interactions; quantum mechanical description; harmonic generation; intensity-dependent refractive index; optical Bloch equations; nonlinear wave mixing; optical phase conjugation, self focusing, optical bistability; pulse propagation and optical solutions; acoustic-optic and electro-optic effects; simulated scattering processes; photorefractive effect.

Prerequisite: Graduate Standing

PHYS 612 Laser Physics (3-0-3)

Radiative and non-radiative transitions; line broadening; optical wave-guides and resonators; resonator modes; oscillation and amplification; gain coefficient; rate equation analysis; semi-classical laser theory; density matrix formalism; lasing without population inversion; Q-switching, mode locking and pulse compression; spectral narrowing.

Prerequisite: PHYS 501

PHYS 613 Advanced Laser Theory (3-0-3)

Quantum mechanical equations of the light field and the atom; quantum mechanical Langevin equations; generalized Fokker-Planck equations; quantum coherence; single-mode operation on homogeneously and in homogeneously broadened transitions; phase-locking; multi-mode action; duke super-radiance; photon counting; fluctuations; quantum chaos; squeezed light.

Prerequisites: PHYS 612 or Consent of the instructor

PHYS 614 Laser Systems (3-0-3)

Design considerations; specific laser systems; gas lasers, atomic vapor lasers, solid state lasers, dye lasers, semiconductors lasers, color center lasers, spin-flip Raman lasers, free-electron lasers, optical parametric oscillators; super-radiance and amplified spontaneous emission; wave-guides; tunability; laser optics; laser parameter measurements; pulse width and line width controls; nonlinear processes including harmonic generation and frequency mixing; laser applications; recent developments.

Prerequisite: PHYS 612

PHYS 620 Relativistic Quantum Field Theory (3-0-3)

Functional integral formulation of gauge theories. Divergences, regularization, and renormalization. Higher order processes in electrodynamics. Non-abalian gauge theories. Renormalization group

Prerequisite: PHYS 502

PHYS 621 Advanced Methods of Theoretical Nuclear Physics with Applications to Nuclear Models (3-0-3)

The topics covered: Racah algebra, 6-j, 9-j symbols, second quantization, graphology, evaluation of two-and many-body nuclear matrix elements, Moshinsky transformation, collective models, microscopic models, Nilssen levels, interplay of collective and microscopic models, large-amplitude collective motion, super-heavy elements, high-spin states.

Prerequisite: PHYS 521

PHYS 622 Many Body Techniques in Nuclear Physics (3-0-3)

The topics covered: second quantization, systems of identical particles, occupation nuclear representation, many-body operators coherent states for bosons and fermions, mean-field approximations, variational principles, HF approximation for boson and fermion systems, time-

dependent mean-field approximation, time-dependent Hartree-Fock, perturbation theory, functional integral formulation, Feynman path-integral formulation, Partition function for Many-particle systems; Perturbation theory, Wick's theorem, Feynman diagrams and diagrammatic expansions, Green's functions: Analytic properties, equations of motion, approximations.

Prerequisite: PHYS 502

PHYS 623 Methods of Experimental Nuclear Physics (3-0-3)

Graduate course in methods and techniques of experimental nuclear physics providing a general background in advanced techniques of experimental nuclear physics. Topics to be covered are: Nuclear particle accelerators and important components of beam transportation system, duoplasmatron and polarized ion sources, polarized beams and targets, techniques of single and double scattering polarization experiments involving spin 0, 1/2 and spin 1 particles, techniques of spin-spin correlation experiments.

Prerequisite: Consent of the instructor

PHYS 630 Phase Transitions and Critical Phenomena (3-0-3)

Theoretical study of phase transitions and critical phenomena: Topics covered include: Introduction to the main characteristics of phase transition phenomena; Simple models (Ising, Gaussian and spherical models); real space renormalization; mean field theory, Landau-Ginzburg model; diagrammatic perturbation theory and Feynman rules in wave vector space; renormalization group theory; applications.

Prerequisites: PHYS 530

PHYS 632 Quantum Theory of Solids (3-0-3)

Second quantization; elementary excitations, phonons, magnons, plasmons; Fermion fields and the Hartree-Fock approximation; dielectric response; many-body techniques, electron-phonon interaction, superconductivity.

Prerequisite: PHYS 532

PHYS 636 Semiconductor Device Physics I (3-0-3)

Quantum mechanical foundation for modern semiconductor devices: band structure, carrier concentration at thermal equilibrium and non-equilibrium, optical, thermal and high electric field properties, band-gap engineering, metal-semiconductor contacts, semiconductor hetrojunction; Schottky and ohmic contacts; MESFET, MOSFET and MOS capacitors; photovoltaic.

Prerequisite: Graduate Standing

PHYS 637 Semiconductor Device Physics II (3-0-3)

Band structure; statistical mechanics of electrons and holes; transport properties; optical properties; principle of homojunctions and heterojunctions; electron confinement; nanostructures; quantum well structures.

Prerequisite: PHYS 537

PHYS 638 Physics of Thin Films (3-0-3)

Growth thermodynamics and nucleation; surfaces and interfaces; growth modes, structural properties and defects, textured films, amorphous films; chemical properties, mechanical properties, stresses in thin films; electrical properties; optical properties; deposition techniques; characterization techniques; special topics and applications : Photovoltaic, gas sensing, smart coatings, information storage.

Prerequisite: Graduate Standing

PHYS 654 Laser Physics (3-0-3)

Radiative and non-radiative transitions; line broadening; optical wave-guides and resonators; resonator modes; oscillations and amplifications; gain coefficients; rate equation analysis; semi classical laser theory; density matrix formalism; lasing without population inversion; Q-switching, mode locking and pulse compression; spectral narrowing.

Prerequisite: PHYS 501

PHYS 690 Special Topics in Physics I (3-0-3)

Advanced topics selected for their current research interest.

Prerequisite: Consent of the Instructor

PHYS 691 Special Topics in Physics II (3-0-3)

Advanced topics selected for their current research interest.

Prerequisite: Consent of the Instructor

PHYS 692 Special Topics in Physics III (3-0-3)

Advanced topics selected for their current research interest.

Prerequisite: Consent of the Instructor

PHYS 693 Special Topics in Physics IV (3-0-3)

Advanced topics selected for their current research interest.

Prerequisite: Consent of the Instructor

PHYS 699: Ph.D. Seminar (1-0-0)

Ph.D. students are required to attend Departmental seminars delivered by faculty, visiting scholars and graduate students. Additionally, each Ph.D. student should present at least one seminar on a timely research topic. Ph.D students should pass the comprehensive examination as part of this course. This course is a pre-requisite to registering the Ph.D. Pre-dissertation PHYS 711. The course is graded as pass or fail. IC grade is awarded if the Ph.D. Comprehensive exam is not yet passed.

Prerequisite: Graduate Standing.

PHYS 701 Directed Research I (3-0-3)

This course is intended to allow the student to conduct research in advanced problems in his Ph.D. research area. The faculty offering the course should submit a research plan to be approved by the graduate program committee of the department. The student is expected to deliver a public seminar and report on his research outcomes at the end of the course.

Prerequisite: Prior arrangement with the course instructor

PHYS 702 Directed Research II (3-0-3)

This course is intended to allow the student to conduct research in advanced problems in his Ph.D. research area. The faculty offering the course should submit a research plan to be approved by the graduate program committee of the department. The student is expected to deliver a public seminar and report on his research outcomes at the end of the course.

Prerequisite: Prior arrangement with the course instructor

PHYS 711 Ph.D. Pre-Dissertation (0-0-3)

This course enables the student to submit his Ph.D. Dissertation Proposal and defend it in public. The student passes the course if the Ph.D. Dissertation committee accepts the submitted dissertation proposal report and upon successfully passing the Dissertation proposal public defense. The course grade can be NP, NF or IC.

Prerequisite: Ph.D. Candidacy, **Co-requisite:** PHYS 699

PHYS 712 Ph.D. Dissertation (0-0-9)

This course enables the student to work on his Ph.D. Dissertation as per the submitted dissertation proposal, submits its final report and defend it in public. The student passes the course if the Ph.D. Dissertation committee accepts the submitted final dissertation report and upon successfully passing the Dissertation public defense. The course grade can be NP, NF or IP.

Prerequisite: PHYS 711

MEDICAL PHYSICS

MEPH 500 Human Anatomy and Physiology (3-0-3)

The course will cover subjects including cell physiology, organs and systems physiology and anatomy. The student will learn to identify gross anatomical structures, define the major organ systems, and describe the physiological mechanisms for repair, maintenance, and growth. Anatomical structures and physiological function should be correlated with imaging modalities to view them.

Prerequisite: Graduate Standing

MEPH 501 Physics for Medicine and Biology (3-0-3)

Forces on bones and muscles; body fluid flow; electrodynamics of nerve impulses; electrocardiograms; magnetocardiograms and magnetoencephalograms; diffusion processes, membrane transport, kidney function; biological effects in magnetic resonance and ultra-low frequency electromagnetic radiation; laser applications.

Prerequisite: PHYS 212 or equivalent

MEPH 510 Radiobiology (2-0-2)

Effects of ionizing radiations on living cells and organisms, including physical, chemical, and physiological bases of radiation cytotoxicity, mutagenicity, and carcinogenesis.

Prerequisite: Graduate Standing

MEPH 511 Instrumentation for Medical Physics (2-3-3)

Concepts of medical instrumentation, transducers, and medical electronics design. Various types of sensors and measurement apparatus used for the calibration of medical imaging and therapy systems will receive particular attention.

Prerequisite: Graduate Standing

MEPH 561 Radiological Physics and Dosimetry (3-0-3)

Interactions and energy deposition by ionizing radiation in matter; concepts, quantities and units in radiological physics; principles and methods of radiation dosimetry.

Prerequisite: PHYS 212; MATH 202 or equivalent

MEPH 563 Radioisotopes in Medicine and Biology (2-3-3)

Physical principles of radioisotopes used in medicine and biology and operation of related equipment; lecture and lab.

Prerequisite: PHYS 212 or equivalent

MEPH 566 Radiotherapy Physics (2-3-3)

Ionizing radiation use in radiation therapy to cause controlled biological effects in cancer patients. Physics of the interaction of the various radiation modalities with body-equivalent materials, and physical aspects of clinical applications; lecture and lab.

Prerequisite: MEPH 561

MEPH 567 Diagnostic Radiology Physics (3-3-4)

Physics of x-ray diagnostic procedures and equipment, radiation safety, general imaging considerations; lecture and lab.

Prerequisites: PHYS 212; MATH 202 or equivalent

MEPH 568 Magnetic Resonance Imaging (MRI) (2-0-2)

Physics and technology of magnetic resonance imaging (MRI), emphasizing techniques employed in medical diagnostic imaging. Major topics: physics of MR, pulse sequences, hardware, imaging techniques, artifacts, and spectroscopic localization.

Prerequisite: MEPH 567

MEPH 569 Health Physics (3-3-4)

Physical and biological aspects of the use of ionizing radiation in industrial and academic institutions; physical principles underlying shielding instrumentation, waste disposal; biological effects of low levels of ionizing radiation; lecture and lab.

Prerequisite: MEPH 561

MEPH 570 Advanced Brachytherapy Physics (2-0-2)

The use of radioactive sources for radiotherapy including: materials used, source construction dosimetry theory and practical application, dosimetric systems, localization and reconstruction. The course covers low dose rate, high dose rate and permanently placed applications.

Prerequisite: MEPH 566

MEPH 571 Advanced External Radiation Oncology (3-0-3)

Physics of ionizing radiation therapy with emphasis on external beam dosimetry and treatment planning.

Prerequisite: MEPH 566

MEPH 573 Imaging in Medicine (3-0-3)

The conceptual, mathematical and statistical aspects of imaging science, and a survey from this formal viewpoint of various medical imaging modalities, including film-screen radiography, positron and x-ray computed tomography, and magnetic resonance imaging.

Prerequisites: PHYS 212; MATH 301 or equivalent

MEPH 574 Applications of Digital Imaging: DSA, CT, MRI (2-0-2)

This course will focus on practical aspects of digital diagnostic imaging. The course will cover digital subtraction angiography (DSA), x-ray transmission computed tomography (CT), and nuclear magnetic resonance imaging (MRI).

Prerequisites: MEPH 567, MEPH 567

MEPH 575 Diagnostic Ultrasound Physics (2-3-3)

Propagation of ultrasonic waves in biological tissues; principles of ultrasonic measuring and imaging instrumentation; design and use of currently available tools for performance evaluation of diagnostic instrumentation; biological effects of ultrasound; lecture and lab.

Prerequisites: PHYS 212; MATH 202 or equivalent

MEPH 581 Laboratory in Radiological Physics – Radiotherapy (0-3-1)

Practicing the protocol for the determination of absorbed dose from high-energy photon and electron beams. Performing dosimetry and quality assurance for radiation therapy machines. Participating in treatment plans of cancer patients.

Prerequisite: MEPH 566

MEPH 582 Laboratory in Radiological Physics – Diagnostic Radiology (0-3-1)

Measuring the performance of clinical x-ray, mammography, fluoroscopy and angiography machines. Performing dosimetry tests and quality assurance.

Prerequisite: MEPH 567

MEPH 583 Laboratory in Radiological Physics – Nuclear Medicine (0-3-1)

Practicing the acceptance and quality assurance procedures for Nuclear Medicine imaging and non-imaging hardware. Practicing regulations and record keeping associated with the acquisition and dispensing of radio-pharmaceuticals. Radiation safety of patients, personnel, and area monitoring.

Prerequisite: MEPH 563

MEPH 584 Laboratory in Radiological Physics – Health Physics (0-3-1)

Performing dosimetry procedure to monitor ionizing radiation in hospital and radiation areas. Performing shielding tests and shielding design. Practicing regulations and record keeping associated with radiation monitoring and radiation safety.

Prerequisite: MEPH 569

MEPH 585 Laboratory in Radiological Physics – CT, MRI, and DSA (0-3-1)

Performing acceptance and quality assurance tests on CT, DSA and MR scanners and machines. Performing dosimetry measurements to insure radiation safety.

Prerequisite: MEPH 567

MEPH 586 Laboratory in Radiological Physics – Medical Ultrasound (0-3-1)

Performing acceptance and quality assurance tests for clinical diagnostic ultrasound scanners. Operating clinical ultrasound equipment independently.

Co-requisite: PHYS 212; MATH 202 or equivalent

MEPH 590 Clinical Training (0-0-6)

The course consists of a 16-week hospital-based clinical rotation in: diagnostic imaging (x-rays, CT, DSA, fluoroscopy, mammography, MRI, diagnostic ultrasound), nuclear medicine, radiation therapy, and health physics. The student will write a monthly progress report about the clinical procedures he learned and performed.

Prerequisite: Department Approval

MEPH 591 Selected Topics in Medical Physics (3-0-3)

Various subjects of interest to medical physics faculty and students.

Prerequisite: Consent of the Instructor

MEPH 592 Independent Reading (3-0-3)

The course can be taken under the supervision of a faculty member to conduct an in-depth study of a subject.

Prerequisite: Consent of the Instructor

MEPH 599 Seminar (1-0-0)

Graduate students are required to attend the seminars given by faculty, visiting scholars, and

fellow graduate students. Additionally, each student must present at least one seminar on a timely research topic. Among other things, this course is designed to give the student an overview of research in the Department, and a familiarity with the research methodology, journals, and professional societies in his discipline. This course carries no credit and is graded on a Pass or Fail basis.

Prerequisite: Graduate Standing

MEPH 600 Medical Physics Project (0-0-3)

The project is an independent study performed under the supervision of a medical physics faculty advisor. A graduate student conducts a theoretical or experimental investigation and writes a report. The report should include an introduction to the topic, literature review, research methodology, analysis of data, conclusions and recommendations, appendices and references. The report will be presented by the student and evaluated by medical physics faculty.

Prerequisite: Graduate Standing

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