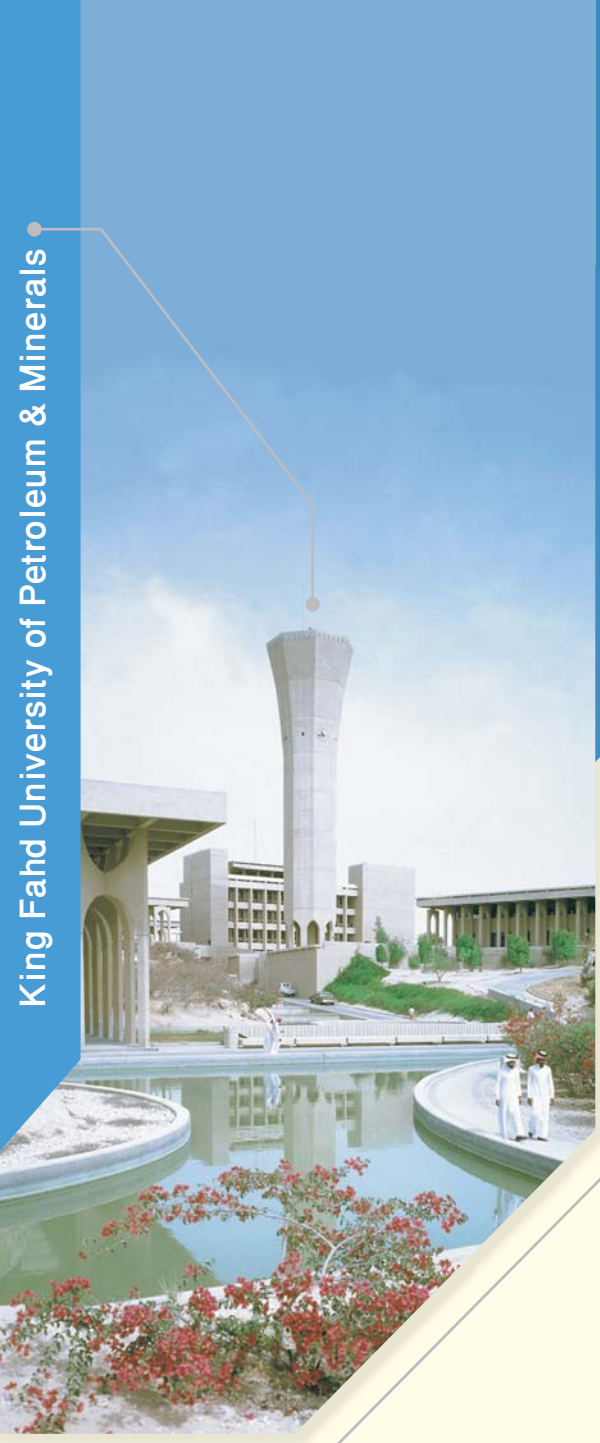
King Fahd University of Petroleum & Minerals



Graduate Bulletin

2009 - 2011

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King Fahd University of Petroleum & Minerals

GRADUATE BULLETIN

2009 -2011

Dhahran 31261, Saudi Arabia

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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 current document was prepared during the 2007/2008 academic year and printed in the spring of 2009. The contents were compiled from inputs received from the various academic departments and administrative offices throughout the University. All changes from the previous Bulletin were verified against the Graduate Council's decisions.

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 helpful 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's 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. Abdul Muttaleb Jaber
Professor
Chemistry Department
Editor, Graduate Bulletin
2009-2011

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The production of this Bulletin in its final elegant form is the work of KFUPM Press, in particular, the Director, Mr. Abdullah K. Al-Ghamdi, the Production Manager, Mr. Jamal Abu-Dhief, the designer, Mr. Abdul-Aziz M. Abdul-Latif and the typesetter, Mr. Shakeel Ahmed Abdus Shukoor. The excellent photographs that appear in the bulletin are the work of Mr. Khalil Nasr of the KFUPM Public Relations Department.

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 the 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 activity. Also, the primary purpose of the graduate programs is to train the creative type of scientist or engineer 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 of Science, Master of Engineering, Master of Business Administration, Master of City and Regional Planning, Master of Environmental Science, and Doctor of Philosophy in various disciplines.

Since it has been established in 1972, the Deanship of Graduate Studies (previously known as College of Graduate Studies) at KFUPM, has witnessed a phenomenal expansion. Currently 33 programs are being offered at the Master and 9 at the Ph.D. levels. These programs span the fields of Engineering, Science, Management, 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, it has to accommodate more students, many of whom will 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, to implement graduate studies of high quality within the unified regulations issued by the Ministry of Higher Education. Fifth, the Deanship of Graduate Studies has to develop effective ways and means to disseminate knowledge into the University and its surrounding community and to contribute and enhance the undergraduate education. In order to meet these challenges, the Deanship is continuously enhancing the flexibility and variety of its course offerings, forged stronger links with the international academic community through such innovative programs as scholarship and research assistantship programs and established 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 Accreditation Board of Engineering Technology (ABET), and the Association to Advance Collegiate School of Business (AACSB).

Currently, about 1000 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 very 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.

Dr. Salam Adel Zummo
Dean of Graduate Studies

PHYSICS

Chairman

Abdul-Aziz Mohammad Al-Jalal

Professors

Al-Adel	Al-Jarallah	Nasser
Ayub	Khattak	Tabet
Bahlouli	Naqvi	Ziq
Gondal		

Associate Professors

Abdelmonem	Faiz	Mekki, A
Aksoy	Garwan	Nagadi
Al-Kuhaili	Khiari	Yamani
Al-Ohali	Maalej	

Assistant Professors

Al-Aithan	Al-Quraishi	Al-Sulami
Al-Amoudi	Al-Ramadhan	Al-Sumaidi
Al-Jalal	Al-Sadah	Musazay
Al-Karmi	Al-Shukri	

Lecturers

Al-Zahrani	Ghannam	Mekki, M
Azad-U-Islam	Kariapper	Salem
Enaya	Khateeb-Ur-Rahman	

M.S. PROGRAM IN PHYSICS

The Graduate Program in Physics is designed to prepare the students for professional careers and further research in physics. Candidates are expected to pursue a course of study and research that will give them a greater comprehension of basic theoretical and experimental physics. Students of this program will be either theoretically or experimentally oriented, depending on the type of research they are interested in.

The program encompasses the following major branches of physics:

1. Atomic, Molecular, and Laser Physics
2. Condensed Matter Physics
3. Medical Physics (see page 407 for details)
4. Nuclear Physics
5. Theoretical Physics
6. Radiation Physics.

TEACHING AND RESEARCH FACILITIES

Radiation Protection

The Radiation Protection laboratory houses a variety of radiation detection instruments and radiation sources that include:

Liquid scintillation counter; Ion chamber survey meters; Gamma scintillation/Geiger Müller survey meters; Neutron survey meter; Nuclear track detection system (chemical etching and optical microscope with image analyzing system); Am-Be neutron sources; Co-60 gamma sources; Cs-137 gamma sources; Ra-226 alpha/gamma sources.

Superconductivity

The superconductivity Laboratory houses a 9-Tesla vibrating sample magnetometer (VSM). Transport measurements and AC-susceptibilities set-up. Magnetic properties of superconductors, nanoparticles, alloys and glasses are routinely studied in this lab.

Surface Science

The Surface Science laboratory houses a VG ESCA-LAB MKII electron spectrometer. This is a multi-technique instrument allowing complete surface analysis of samples using X-ray photoelectron spectroscopy (XPS), Auger electron spectroscopy (AES) and scanning AES, Ultraviolet photoelectron spectroscopy (UPS) and Low-energy electron diffraction (LEED). An ion gun (type EXO5) enables measuring depth profiles of elements over surface areas of various dimensions. In-situ heat treatment under controlled atmosphere is possible up to 600 degrees Celsius in a heating cell attached to the instrument.

The laboratory also possesses a home-made magnetron dc-sputtering system that is used to synthesize thin films. The Hall effect measurements can be carried out on thin films at room temperature and liquid nitrogen using the Van Der Pauw method.

The laboratory houses also a Shimadzu X-ray Diffraction (XRD) instruments and a Veeco INOVA Atomic Force Microscope (AFM) instrument.

Thin Films and Materials

Energy Research Centers (ERC)

The department has access to the following research facilities at the Energy Research Center (ERC), a separate department of the College of Sciences at KFUPM.

Nuclear Physics Facility: This consists mainly of a 350 KV, high current accelerator.

The main area of research at the 350 KV ion accelerator are fast neutron activation studies and nuclear reaction studies suing polarized and non-polarized beams of neutrons, protons and deuterons.

Laser Research Laboratory (LRL): The laser research laboratory houses a variety of molecular and atomic activities supported by advanced equipment that include several dye lasers pumped by excimer/yag/Argon ion lasers suitable for frequency-resolved (500kHz) or time-resolved studies (femtosecs).

Other Facilities

A major asset of the department that deserves separate mention is the cryogenic facility for liquefying helium and nitrogen.

In addition to the research facilities mentioned, the department also has a well-equipped workshop, and an electronic shop. The department also has a computer room containing several personal computers with major scientific software, scanners, CD Rom and CD writer, as well as all other peripherals connected with the Information Technology Center (ITC) network.

DEPARTMENTAL ADMISSION REQUIREMENTS

The Master of Science program in Physics is available to students who meet the requirements for admission to the University with a B.S. in Physics or equivalent.

The subject GRE is usually required, unless the applicant comes from a University whose grading system and standards are well known, and his undergraduate Physics record is superior.

Normally a minimum of 24 (500 level) credit hours of course work and a maximum of 6 (400 level) credit hours can be counted (approval of the advisor and the chairman) provided it is not a complete repetition of graduate courses and not core courses for undergraduate and graduate, plus six credit hours of research towards the preparation of an M.S. thesis will be required.

ACADEMIC PROGRAM

The M.S. program in Physics consists of two main groups of courses ("core courses", and "specialty courses"), seminar, and thesis. The five core courses (15 credits) must be taken by all candidates. The candidates must take three* specialty courses (9 credits). Details of the program are given below in the following degree plan.

Degree Plan for the M.S. Program in Physics

Course #	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
PHYS 5xx/4xx		3	0	3
		12	**0**	**12**
SECOND SEMESTER				
PHYS 503	Graduate Laboratory	0	6	3
PHYS 505	Classical Electrodynamics I	3	0	3
PHYS 5xx/4xx		3	0	3
PHYS 5xx/4xx		3	0	3
PHYS 599		1	0	0
		10	**6**	**12**
SUMMER SESSION AND FOLLOWING SEMESTER				
PHYS 610	Thesis	0	0	6
		0	**0**	**6**
Total Credit hours				**30**

* Normally the Department recommends that PHYS 530 (Statistical Mechanics) be taken as one of the elective courses.

** MATH 515 (Methods of Linear Operators in Science and Engineering) may be used to satisfy the PHYS 571 requirement.

The courses PHYS 5xx are to be selected from the physics specialized course offerings.

COURSE DESCRIPTION

PHYS 501 Quantum Mechanics I (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 momentum, 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 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.

Corequisites: 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/vibrational

spectra), Electromagnetic transitions: multipole expansion, decay rates, selection rules; Simple theory of Beta decay.

Prerequisites: 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 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

PHYS 610 Thesis **(0-0-6)**