DEPARTMENT OF ARCHITECTURAL ENGINEERING

Chairman

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Faculty

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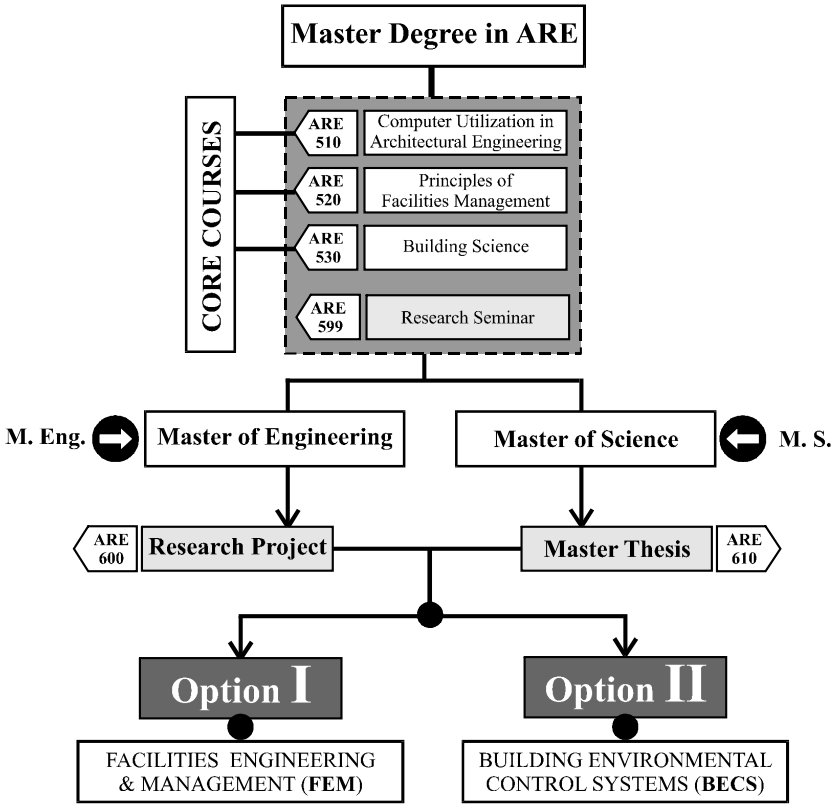
Architectural Engineering is a discipline which is concerned with various engineering and economic aspects of design, construction, and maintenance and operation of buildings. The KFUPM graduate program in Architectural Engineering at the College of Environmental Design aims at meeting the needs of the 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.



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.

MASTER OF SCIENCE IN ARICHITECTURAL ENGINEERING

Degree Requirements

(a) Core Courses (15 credit hours)		Credit Hours
Computer Utilization in Architectural Engineering	ARE 510	3
Principles of Facilities Management	ARE 520	3
Building Science	ARE 530	3
Research Seminar	ARE 599	0
MS Thesis	ARE 610	6

(b) Elective Courses (15 credit hours)		
Three ARE Courses from chosen option	ARE xxx	9
Two Approved Elective Courses, one of which can be ARE	XXX xxx	6

Elective courses:

Option I (BECS): ARE 513, 514, 516, 532, 533, 534, 535, 536, 537, 538, 543, 544, 547, 548, 590
ME 539, 547, 564
Option II (FEM): ARE 511, 512, 513, 514, 515, 516, 517, 522, 524, 526, 528, 529, 590
CEM 510, 511, 512, 516, 520, ACCT 501, MGT 501
Other Electives: OM 502, 511, 512, SE 501, 529, 539, CE 502, CRP 514, 538, MIS 502, 510

Degree Plan

COURSE	TITLE	LT	LB	CR	COURSE	TITLE	LT	LB	CR
First Year									
ARE 510	Computer Utilization in Architectural Eng.	3	0	3	ARE xxx	ARE Elective I	3	0	3
ARE 520	Principles of Facilities Management	3	0	3	ARE xxx	ARE Elective II	3	0	3
ARE 530	Building Science	3	0	3	ARE xxx	ARE Elective III	3	0	3
					ARE 599	Research Seminar	1	0	0
		9	**0**	**9**			**10**	**0**	**9**
Second Year									
XXX xxx	Elective I	3	0	3	ARE 610	Thesis	0	0	6
XXX xxx	Elective II	3	0	3					
ARE 610	Thesis	0	0	IP					
		6	**0**	**6**			**0**	**0**	**6**
Total credit hours required in Degree Program : 30									

- The order of taking the courses can be different from above but students must take the core courses before electives.

MASTER OF ENGINEERING IN ARICHITECTURAL ENGINEERING

Degree Requirements

(a) Core Courses (12 credit hours)		Credit Hours
Computer Utilization in Architectural Engineering	ARE 510	3
Principles of Facilities Management	ARE 520	3
Building Science	ARE 530	3
Research Seminar	ARE 599	0
Research Project	ARE 600	3

(b) Elective Courses (30 credit hours)		
Five ARE Courses from chosen option	ARE xxx	15
Three Option Elective Courses (can be ARE)	XXX xxx	9
Two Other Elective Courses (can be non-ARE)	XXX xxx	6

Elective courses:

Option I (BECS): ARE 513, 514, 516, 532, 533, 534, 535, 536, 537, 538, 543, 544, 547, 548, 590
ME 539, 547, 564
Option II (FEM): ARE 511, 512, 513, 514, 515, 516, 517, 522, 524, 526, 528, 529, 590
CEM 510, 511, 512, 516, 520, ACCT 501, MGT 501
Other Electives: OM 502, 511, 512, SE 501, 529, 539, CE 502, CRP 514, 538, MIS 502, 510

Degree Plan

COURSE	TITLE	LT	LB	CR	COURSE	TITLE	LT	LB	CR
First Year									
ARE 510	Computer Utilization in Architectural Eng.	3	0	3	ARE 530	Building Science	3	0	3
ARE 520	Principles of Facilities Management	3	0	3	ARE xxx	ARE Elective III	3	0	3
ARE xxx	ARE Elective I	3	0	3	ARE xxx	ARE Elective IV	3	0	3
ARE xxx	ARE Elective II	3	0	3	ARE xxx	ARE Elective V	3	0	3
		12	**0**	**12**			**12**	**0**	**12**
Second Year									
ARE 599	Research Seminar	1	0	0	XXX xxx	Elective V	3	0	3
XXX xxx	Elective I	3	0	3	ARE 600	Research project	0	0	3
XXX xxx	Elective II	3	0	3					
XXX xxx	Elective III	3	0	3					
XXX xxx	Elective IV	3	0	3					
		13	**0**	**12**			**3**	**0**	**6**
Total credit hours required in Degree Program : 42									

- The order of taking the courses can be different from above but students must take the core courses before electives.

ARCHITECTURAL ENGINEERING

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.
Note: Can not to be taken for credit by ARE students.
Prerequisite: Graduating Standing

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: Graduating 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: Graduating 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: Graduating Standing

ARE 513 Building Systems Evaluation and 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: Graduating Standing

ARE 515 Facilities Operation and 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: Graduating 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: Graduating 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: Graduating 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: Graduating Standing

ARE 522 Facilities Planning and 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 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: Graduating 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 Instructor

ARE 533 Energy Conservation and 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 Consbet of 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 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 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 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 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 and 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 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 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.
Note: Equivalent to CEM 599.
Prerequisite: Graduate Standing

ARE 600 Research Project (3-0-3)
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.
Prerequisite:

ARE 610 M.S. Thesis (3-0-3)
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