College of Engineering

- **Engineering (Core Courses)**
- **Master Degree Program in Electrical Engineering**
- **Master Degree Program in Computer Engineering**
- **Master Degree Program in Civil Engineering**
- **Master Degree Program in Mechanical Engineering**
- **Master Degree Program in Chemical Engineering**
- **Master Degree Program in Petroleum Engineering**
- **Master Degree Program in Industrial and Systems Engineering**
- **Master Degree Program in Systems and Process Control Engineering**

ENGINEERING (CORE COURSES)

INTRODUCTION

Engineering graduate programs require the study of some of the following general (core) graduate engineering courses.

0600-503	Statistical Concepts in Engineering	(3)
0600-504	Numerical Analysis and Computation	(3)
0600-505	Finite Element Methods	(3)
0600-506	Continuum Mechanics	(3)
0600-507	Mathematical Optimization	(3)
0600-508	Random Variables and Stochastic Processes	(3)
0600-510	Advanced Fluid Mechanics	(3)
0600-511	Computational Fluid Dynamics	(3)
0600-512	Advanced Engineering Mathematics I	(3)
0600-513	Advanced Engineering Mathematics II	(3)

COURSE DESCRIPTION

0600-503: STATISTICAL CONCEPTS IN ENGINEERING
CR: 3

Elements of probability theory, random variables, analytical models of random phenomena, reliability, factor of safety, safety margin, extreme value statistics, Monte-Carlo simulation, empirical determination of distribution models, confidence intervals, regression and correlation analysis, general applications to engineering design problems, stochastic processes.

0600-504: NUMERICAL ANALYSIS AND COMPUTATION
CR: 3

Norms, limits and condition numbers. Inverses of perturbed matrices. Integrative techniques for solving systems of equations. The LU, QR and singular value decompositions. Algorithms for the linear least squares and linear minimax problems. Computation of the eigenvalues of a matrix. the interpolation and polynomial approximation. Approximate methods for initial value problems and for boundary value problems.

0600-505: FINITE ELEMENT METHODS
CR: 3

Origin and basis of finite-element methods in continuum mechanics, stiffness method, assumed displacement field, potential energy and Rayleigh-Ritz method, types of elements, modeling, accuracy and convergence, solution techniques and computer application to structural and fluid mechanics.

0600-506: CONTINUUM MECHANICS
CR: 3

Cartesian tensors. Basic principles of continuum mechanics: deformation, displacement, strain, stress, conservation of mass, continuum thermodynamics and constitutive equations. Illustrative applications in elasticity, fluid dynamics, viscoelasticity ad plasticity.

0600-507: MATHEMATICAL OPTIMIZATION
CR: 3

Basic Concepts: The gradient vector and the Hessian Matrix, multidimensional Taylor's theorem, linear and quadratic approximation of a function. Unconstrained optimization, necessary

and sufficient conditions for optimality. Algorithms for single variable minimization, the Fibonacci search and the Golden section search, algorithms that use repeated polynomial interpolation. Algorithms for multi-dimensional minimization; The steepest descent, the Newton method and its variations, conjugate gradient algorithms such as the Flecter-Reeves, Polak and Ribieve, Quasi-Newton Methods such as the DEP-BFGS, Huang's family of algorithms. Constrained optimization: Necessary and sufficient conditions for constrained minima. Algorithms for constrained optimization: interior and exterior penalty function methods, augmented Lagrangian methods, Resen's gradient projection.

0600-508: RANDOM VARIABLES AND STOCHASTIC PROCESSES
CR: 3

Introduction to probability theory and engineering applications of probability. random variables and expected values. distribution of functions of random variables and applications of R.V. to system problems. Stochastic processes, correlation and power spectra, systems and random signals. Engineering decisions and estimation theories.

0600-510: ADVANCE FLUID MECHANICS
CR: 3

Motion of ideal, Newtonian, and non-Newtonian single-phase fluids. Continuity and Navier-Stokes equations for one and two dimensional flows. Turbulence and boundary layer theories. Flow through conduits, and porous medium. Homogenous and non-homogenous multiphase flow systems.

600-511: COMPUTATIONAL FLUID DYNAMICS
CR: 3

This course introduces students to the numerical and computational fluid dynamics. It will provide graduate students (Science and Engineering students) with techniques and approaches to solve numerical fluid mechanics problems encountered in real fluid flows. Methods for boundary layers, incompressible viscous flows, and inviscid compressible flows are studied. Finite differences and finite volume techniques are emphasized. The course utilizes using commercial CFD packages and MATLAB to solve fluid flow problems.

0600-512: ADVANCED ENGINEERING MATHEMATICS I
CR:3

Analytic function, residues, contour integration. Power series solutions of ordinary differential equations: Bessel's, Legendre's, Chebysheve's and Laguerre's functions. Matrix algebra eigenvalues, eigen-functions, and solutions of systems of differential equations. Software applications.

0600-513: ADVANCED ENGINEERING MATHEMATICS II
CR:3

Sturm-Liouville problem. Partial differential equations: Characteristic curves, separation of variables and integral transforms (Laplace and Fourier), method of characteristics. Wave, heat and diffusion-equations. Software applications.

MASTER OF SCIENCE
INDUSTRIAL AND SYSTEMS ENGINEERING (ISE)
Program code: 0660

INTRODUCTION

Industrial and Management Systems Engineering Department (College of Engineering and Petroleum) offers a Master Degree in **Industrial and Systems Engineering** (ISE). The program features a thesis and non-thesis option. The aim of this program is to equip graduates with quality industrial and systems engineering education and research experience necessary to pursue further graduate work at leading international institutions, and fulfill national aspirations and market needs.

According to the University Council decision dated 4/2/2007, Thesis students admitted with effect from September 2007 are exempted from the comprehensive examination.

PROGRAM REQUIREMENTS

33(33) TOTAL COURSE CREDITS (non-thesis option in parenthesis)

6(6) CORE COURSES (3 credits each)

0600-503 Statistical Concepts in Engineering
0660-553 Simulation Analysis and Applications

12(18) SUBDISCIPLINE COMPULSORY (3 credits each)

Students must take at least one course from each of the following subdisciplines

A. Quality and Organizational Excellence

0660-535 Quality Engineering and Management
0660-536 Total Quality and Organizational Excellence
0630-516 Reliability and Maintainability (Mech. Eng.)

B. Safety and Human Factors

0660-521 Occupational Safety Engineering and Management
0660-523 System Safety and Risk Assessment
0660-525 Human Factors Systems

C. Operations Research

0600-507 Mathematical Optimization
0660-561 Linear Programming and Network Flows
0660-563 Data Analytics

D. Production and Operations Planning

0660-551 Production and Inventory Management
0660-552 Decision Analysis
0660-557 Supply Chain Management

6(6) FREE ELECTIVE COURSES

* A maximum of 3 credits hours (thesis students) and 6 credits hours (project students) of graduate courses can be taken from:

· Area of Engineering (Core and elective)
· Area of Science
· Area of Joint Graduate Programs (Engineering/Science Specialization)

with the approval of the graduate program director before registering for the course.

9(3) COMPULSORY COURSES

0660-592	Seminar	(0)
0660-593	Project	(3) (non-thesis only)
0660-597	Thesis	(0)
0660-598	Thesis	(0)
2000-599	Thesis	(9)

COURSE DESCRIPTION

0660-521: OCCUPATIONAL SAFETY ENGINEERING AND MANAGEMENT
CR: 3

Survey of common safety hazards and abatement methods; safety engineering control and systems (ventilation, fire suppression, noise, climate conditions, fall protection); safety management systems; application of financial and statistical analyses in safety; safety application in oil and gas, logistics, healthcare, and construction.

0660-523: SYSTEM SAFETY AND RISK ASSESSMENT
CR: 3

System safety concepts; risk assessment matrix; system safety program components; system safety analysis techniques and methods; MIL-STD-882, preliminary hazard analysis, failure mode and effect analysis, fault tree analysis, fault hazard analysis, Management Oversight Risk Tree, what-if analysis, Hazard and Operability Study. Applications in oil and gas, logistics, healthcare, and construction.

0660-525: HUMAN FACTORS SYSTEMS
CR: 3

Fundamentals of human factors; the human error; the human-machine systems; applications of perceptual factors (visual, auditory, tactual) and cognitive factors in the design of products, machines, and systems; anthropometric-based workspace design; applications of human factors in oil and gas, construction, and other local environments.

0660-535: QUALITY ENGINEERING AND MANAGEMENT
CR: 3

Quality fundamentals; methods for quality control and quality improvement; statistical process control and capability analysis; statistical software application; quality management systems concepts, principles, and requirements; applications in oil

and gas, manufacturing, health care, education, banking and finance, and government.

0660-536: TOTAL QUALITY AND ORGANIZATIONAL EXCELLENCE
CR: 3

The total quality approach; organizational excellence programs; six sigma performance. Applications of excellence programs and operations in oil and gas, manufacturing, health care, education, banking and finance, and government.

0660-551: PRODUCTION AND INVENTORY MANAGEMENT
CR: 3

Introduction to production and service systems. Production planning and control in decision making. Forecasting. Aggregate production planning. Capacity planning. Materials requirement planning. Scheduling. Inventory Planning, Integrated Production Planning and Control Advanced topics in the operation of production systems (e.g., performance measures, self-regulating production control systems and scheduling) are introduced as well as advanced methods and tools for analyzing and solving planning, scheduling and control of production systems.

0660-552: DECISION ANALYSIS
CR: 3

This course provides a coherent approach to modern decision making, it provides an overview of the tools, techniques, and skills needed to analyze decision-making problems characterized by risk, uncertainty and conflicting objectives. The emphasis is tailored to the models representing decision situations by the use of probability and utility theory to represent uncertainties and preferences. Particularly, the course focuses on the application of a wide variety of quantitative methods to aid in decision-making, including statistical inference, Bayesian theory, populations and samples, decision tree analysis, expected monetary and cost values, value of perfect and sample information, conflicting alternatives, Analytical Hierarchy Process, and efficiency analysis of decision making units (Data Envelopment Analysis). Techniques learned throughout the course are implemented in real world decision problems using different software packages to realize how decision-making principles can be applied to vast areas such as business, engineering, technology, supply chains, healthcare, etc.

0660-553: SIMULATION ANALYSIS AND APPLICATIONS
CR: 3

Simulation concepts and methodologies for modeling complex real systems. Fundamental concepts of a system simulation and its applications will be demonstrated using a simulation language. Topics include, terminating and steady state systems, input data analysis, determination of simulation input parameters and distribution fitting, analysis of output, model verification and validation, variance reduction techniques and model animation. Application in oil and gas, prominent manufacturing and service sectors, logistics, healthcare government sector and others.

0660-557: SUPPLY CHAIN MANAGEMENT
CR: 3

This course focuses on suppliers, manufacturers, warehouses, distributors, retailers and customers to create an efficient supply chain. Topics include basic elements of the supply chain. Supply chain metrics. Decisions pertaining to logistics including: transportation, distribution, warehouse managements and information flow in the supply chain.

0660-561: LINEAR PROGRAMMING AND NETWORK FLOWS
CR: 3

The conventional linear programming model, the Simplex method: foundation and computation, special Simplex implementation, duality and sensitivity analysis, network flows.

0660-563: DATA ANALYTICS
CR: 3

This course presents a broad overview of the various aspects in data analytics such as data reduction, advanced data mining, exploring methodologies, scrubbing, modeling and interpretation. In addition to formulating and solving real world problems of massive data sets using the appropriate analytical modeling techniques and statistical principles. Particular attention will be paid to practical, efficient and

statistically sound techniques of selected topics such as: data structures, visual analytics, data mining, clustering algorithms, classification and prediction models, rule-based classifiers and decision trees, Bayesian classifiers, basic machine learning models (K-nearest neighbors, support vector machines), data reduction and principal component analysis. In addition, the course will address recent and emerging topics such as big data and massive data sets and mobile data analytics.

0660- 592: SEMINAR
CR: 0 CO-Requisites: 0660-593 Or 0660-597

With the guidance of the graduate program committee, the seminar topics include:
- Research writing methods.
- Presentation skills
- Surveying literature.
- Bibliography style.
- New tools (LaTeX, Data analysis etc...)

0660- 593: PROJECT
CR: 3 CO-Requisites: 0660-592

The student undertakes an independent project on a research topic of theoretical and/or experimental focus under the supervision of a faculty member listed in the supervisory list of the College of Graduate Studies. The objective is to provide the student with an opportunity to integrate and apply the knowledge gained throughout the course of study in a practical problem. The student must document the project in a scientific report following standard research writing guidelines and give a public presentation to the project examination committee.

0660- 597: THESIS
CR: 0 CO-Requisites: 0660-592

0660- 598: THESIS
CR: 0

2000- 599: THESIS
CR: 9