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 PR:0600-512

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
CHEMICAL ENGINEERING

INTRODUCTION

The Department of Chemical Engineering (College of Engineering and Petroleum) offers a Master of Science program in **Chemical Engineering**. Part-time and full-time students are admitted to this program. Research requirements include either thesis or non-thesis options. The program prepares qualified Engineers for an advanced professional career in three main areas: Water & Environmental Engineering, Petroleum Refining and Petrochemicals and Process Engineering & Economics. Research interests in the department lie in these four main areas: Environmental Process Engineering; Water technology, including Desalination and Waste Water Treatment; Petroleum and Petrochemical and Process System Engineering & Economics.

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

The program requirements are (non-thesis option in parenthesis):

33(33) TOTAL COURSE CREDITS

9 CORE ELECTIVE COURSES (3 credits each)

0640-511 Advanced Mathematics in Chemical Engineering
0640-521 Advanced Chemical Engineering Thermodynamics
0640-522 Advanced Reactor Design
0640-541 Advanced Momentum Transfer OR 0600-510 Advanced Fluid Mechanics
0640-543 Advanced Heat Transfer
0640-544 Advanced Mass Transfer
0640-545 Advanced Transport Phenomena
0640-555 Chemical Process Dynamics and Control

9 SUB DISCIPLINE ELECTIVE COURSES (3 credits each)

I. WATER & ENVIRONMENTAL ENGINEERING

0640-513 Food Processing
0640-551 Air Pollution Control
0640-552 Waste Minimization
0640-557 Industrial Water Treatment
0640-561 Advanced Desalination

0640-562 Multi-phase Flow
0640-565 Advanced Corrosion Engineering
0640-567 Membrane Technology
0640-569 Special Topics in Water Technology
0640-595 Special Topics in Pollution Engineering

II. PETROLEUM REFINING AND PETROCHEMICALS:

0640-512 Fluidization Engineering
0640-563 Advanced Natural Gas Processing
0640-565 Advanced Corrosion Engineering
0640-566 Catalytic Process in Petroleum Refining
0640-570 Polymer Engineering
0640-571 Energy Conservation
0640-572 Advanced Petroleum Refining
0640-574 Estimation of Fluid Properties
0640-575 Fluid Phase Equilibrium
0640-577 Special Topics in Petrochemical Engineering
0640-579 Advanced Petrochemical Engineering

III. PROCESS ECONOMICS AND SYSTEMS ENGINEERING

0640-540 Artificial Intelligence in Chemical Engineering
0640-553 Computer Aided Process Design
0640-555 Chemical Process Dynamics and Control
0640-571 Energy Conservation
0640-581 Advanced Economic Analysis
0640-582 Process Optimization
0640-583 Innovation and Technology Management
0640-584 Analytical Tools for Investment Management
0640-590 Special Topics in Process System Engineering
0640-591 Special Topics in Techno-Economics

6(12) FREE ELECTIVE COURSES

A maximum of 3 credit hours (thesis students) and 6 credits hours (project students) can be taken from **core engineering**, any other engineering, science, computer science, and engineering or joint graduate programs with the approval of the Graduate Program Director and Area Committee Chairman before registering the course. **Also, courses can be taken from the same graduate program courses.**

COMPULSORY

0640-592	Seminar	(0)
0640-593	Project	(3) (non-thesis only)
0640-597	Thesis	(0)
0640-598	Thesis	(0)
2000-599	Thesis	(9)

COURSE DESCRIPTION

0640-511: ADVANCED MATHEMATICS IN CHEMICAL ENGINEERING
CR: 3

First order differential equation. Partial differential equations. Laplace transforms. Fourier transform. Separation of variables. Similarity solution. Pertubation analysis. Polynomial approximation. Non-linear regression. Multiple regression. Introduction to neural networks.

0640-512: FLUIDIZATION ENGINEERING
CR: 3

This objective of this course is to give students a good grounding in fluidization technology, which is widely employed in the petrochemical and other industry sectors. Topics to be covered include: basics of fluidization; types of fluidized bed (e.g. dense-phase, fast-fluidized beds, three-phase beds, etc.); industrial applications; gas distributors - their importance and design; gas cleaning equipment, e.g. cyclones, bag filters, etc., bubble mechanics; heat and mass transfer; modelling and design.

0640-513: FOOD PROCESSING
CR: 3

Background to the food industry, food-processing operations; brief descriptions of relevant food chemistry and microbiology; heat-treatment operations; sterilization and pasteurization (retorting); UHT processing; refrigeration; and a description of food processing sectors relevant to Kuwait (e.g. milling and baking).

0640-521: ADVANCED CHEMICAL ENGINEERING THERMODYNAMICS
CR: 3

Review of first second and third laws of thermodynamics. Applications of the first and second laws. Fundamental equations and thermodynamic relations. Gibbs-Duhem equation. Partial molar quantities. Equations of state and fugacity calculations. Thermodynamic departure quantities. Intermolecular forces and property estimations. Phase equilibrium calculations. Chemical reaction equilibrium and effects of temperature and pressure on reaction conversions. Statistical thermodynamics and partition functions. Use of statistical thermodynamics in estimating thermodynamic properties.

0640-522: ADVANCED REACTOR DESIGN
CR: 3

Effect of temperature, pressure and mixing patterns on conversion and product distribution in complex homogeneous reactions. Theoretical models for non-ideal flow and fluid mixing.

0640-540: ARTIFICIAL ENTELLIGENCE IN CHEMICAL ENGINEERING
CR: 3

History of artificial intelligence. Expert system knowledge, computing and manipulation of knowledge. Proces applications of expert systems such as the co-operate intelligence network, production management and supervision including setpoint optimization, process sequencing and production recipes. Process control applications in intelligent operator interface, predictive control and fuzzy control. Applications in safety systems and alarm management.

0640-541: ADVANCED MOMENTUM TRANSFER
CR: 3

Different patterns of flow: in an annulus, two immescible fluids, creeping. Equation of continuity, of motion and of change. Velocity distribution in turbulent flow. Time smoothed equations, eddy viscosity and friction factors for different flows. Fluidized bed hydrodynamics. Turbulance theory and applications to mixing.

0640-543: ADVANCED HEAT TRANSFER
CR: 3

Correlations of heat transfer coefficient. Unsteady and two dimensional conduction: analytical solution compared to numerical techniques and where each method fits. Thermal boundary-layers flow and temperature distribution in turbulent flows. Application of different numerical techniques in fluid flow-heat transfer problems. Introduction to some topics in radiation. Two phase heat transfer case study for design.

0640-544: ADVANCED MASS TRANSFER
CR: 3

Models for diffusion and dispersion. Mass transfer with chemical reactions. Simultaneous heat and mass transfer. Modelling of absorption, extraction and adsorption systems. Energy requirements for operations. Synthesis of separation sequences.

0640-545: ADVANCED TRANSPORT PHENOMENA
CR: 3

Principles of molecular diffusion and measurement and characteristics of diffusion coefficient. Flow field induced by mass transfer. Heat and mass transfer in absence of a flow field. Flow field

induced by body forces or external forces, finite difference solution of transport problems. Moving boundary problems.

0640-551: AIR POLLUTION CONTROL
CR: 3

Dispersion models of pollutants in the atmosphere. Particulate matter and design of control equipment. Gaseous pollutants and design of control equipment. Atmospheric photochemical reactions. Instrumentation, measurement and emission testing equipment. Air pollution packages. Application.

0640-552: WASTE MINIMIZATION
CR: 3

Concept of clean technologies with minimal emissions. Concept of waste minimization and its applications in process design. Waste reduction technologies such as in-plant modifications, recycle, recovery and re-use and waste exchange. Case studies will include examples from petroleum refining, petrochemical and chemical industries.

0640-553: COMPUTER AIDED PROCESS DESIGN
CR: 3

Introduction to Computer Aided Design (CAD). Chemical Engineering Simulation Systems (CHESS). Flow sheet synthesis. Distillation column simulators (Distill). Absorption, extraction and distillation simulators (ABDIS). Workshop problems.

0640-555: CHEMICAL PROCESS DYNAMICS AND CONTROL
CR: 3

Mathematical principles of process dynamics and control. Derivation and solution of differential equations describing the behaviour of typical chemical engineering process units. Mathematical analysis and design of control systems. Digital and sampled data control systems.

0640-557: INDUSTRIAL WATER TREATMENT
CR: 3

Application of chemical engineering principles to selected operations encountered in industrial waste water treatment. The course highlights the removal of suspended solids biological treatment, and chemical treatment methods.

0640-561: ADVANCED DESALINATION
CR: 3

Development of desalination technology. Basic principles of desalination. Theory and practice of the following desalination plants: Multistage flash distillation, multiple effect boiling, Reverse osmosis, electrodialysis, solar distillation, freezing. Dual-purpose desalination plants. Main problems in desalination (e.g. scale formations and corrosion). Cost considerations, comparative studies of some desalination plants.

0640-562: MULTI-PHASE FLOW
CR: 3

Gas-liquid systems, solid-liquid systems, homogeneous slurries, heterogeneous slurries, long distance transportation in pipelines, gas-solid pneumatic transportation. Complex flow systems. Modelling and computational aid in multiphase flow.

0640-563: ADVANCED NATURAL GAS PROCESSING
CR: 3

Layout of local petroleum industry, phase equilibria concepts, water-hydrocarbon systems, hydrate formation, amine treatment, carbonate treatment, liquifaction, liquids recovery.

0640-565: ADVANCED CORROSION ENGINEERING
CR: 3

Advanced treatment of corrosion engineering with emphasis on industrial local problems. Atmospheric and seawater corrosion. Cathodic and anodic protection. Corrosion: Protection and inhibition.

0640-566: CATALYTIC PROCESSES IN PETROLEUM REFINING
CR: 3

This course focuses on the design and modeling of various types of catalytic reactors used in Petroleum Refining Industry. Emphasis will be focused on the following refining operations: Catalytic cracking, catalytic hydrocracking, catalytic hydrotreating, catalytic reforming, catalytic isomerization, catalytic alkylation, and catalytic polymerization.

0640-567: MEMBRANE TECHNOLOGY
CR: 3

Types of membrane separation processes. Gas permeation in a membrane. Dialysis. Reverse osmosis. Ultrafiltration membrane process. Gel permeation chromatography. Membrane manufacture. Membrane physical and chemical properties.

0640-569: SPECIAL TOPICS IN WATER TECHNOLOGY
CR: 3

An upper division of graduate technical elective treating topics in Engineering mostly not covered in other courses, chosen at the discretion of the Graduate Program Committee.

0640-570: POLYMER ENGINEERING
CR: 3

Introduction to statistical mechanical theories. Borownian motion. Dynamics of flexible polymers in ideal solutions. Multichain systems. Visoelasticity theories. Dynamic of a Polymer in a fixed network. Ridged rodlike polymers in ideal solutions. Ridged rodlike polymers in semidilute solutions. Ridged rodlike polymers in concentrated solutions.

0640-571: ENERGY CONSERVATION
CR: 3

Thermodynamics and energy conservation, energy and separation processes, optimization of heat exchanger systems, thermally coupled distillation systems, heat pumps, hybrid desalination systems, economic analysis of technical solution to energy conservation problems, term paper.

0640-572: ADVANCED PETROLEUM REFINING
CR: 3

Refinery configurations. Characterizations of crude oils and products. Coking. Catalytic cracking. Catalytic hydrocracking. Hydroprocessing and Hydrotreating. Reforming. Product blending. Computer simulation of refinery processes.

0640-574: ESTIMATION OF FLUID PROPERTIES
CR: 3

Estimation procedures for properties of gases and liquids. Critical properties PVT, heat capacities. Thermodynamic properties, vapor pressure, surface tension, viscosities, thermal conductivities and diffusion coefficients. Application to industrial problems.

0640-575: FLUID PHASE EQUILIBRIUM
CR: 3

Essence of the problem. Thermodynamics of phase equilibrium. Fugacity calculation of thermodynamic properties of fluids using equation of state. Intermolecular forces and theory of corresponding states. Property changes on mixing phase rule. Gibbs Duhem equation. Fundamental equations of, calculation of vapor liquid, liquid-liquid-solubility stability. Application and impact of data precision on design.

0640-577: SPECIAL TOPICS IN PETROCHEMICAL ENGINEERING
CR: 3

An upper division of graduate technical elective treating topics in mostly not covered in other courses, chosen at the discretion of the Graduate Program Committee.

0640-579: ADVANCED PETROCHEMICAL ENGINEERING
CR: 3

Selected topics in Petrochemical Engineering. Production of alcohols, ethers, aromatics, ethylene, propylene and glycols. Computer simulation of one of the above topics.

0640-581: ADVANCED ECONOMIC ANALYSIS
CR: 3

The project cycle. Financial statements and ration analysis. Discounted cash flow analysis. Decision rules for single and multiple alternatives. Inflation and currency issues. Rate of return and leverage. Cost/benefit analysis. Cost estimation. Sensitivity analysis and risk management. Monte Carlo simulation and decision tree analysis. Market assessment and forecasting. Supply and demand analysis. Project and case studies.

0640-582: PROCESS OPTIMIZATION
CR: 3

This course surveys basic computational tools and theory for solving linear and nonlinear optimization problems. The value of these tools will be illustrated on applications including chemical plant design, process operations and scheduling, and parameter estimation. A main goal of the course is to introduce students to the philosophy underlying optimization and the tools necessary to implement this philosophy. A large variety of examples show the wide applicability of optimization methodology.

0640-583: INNOVATION AND TECHNOLOGY MANAGEMENT
CR: 3

R&D environment. R&D communication and virtual teams. Integration of R&D into corporate

strategy. Developing corporate competence area. Managing competence. Technology acquisition and transfer. Approaches to developing new business areas and management of change. Internal development, licensing, joint ventures, alliances, venture capital and acquisitions.

0640-584: ANALYTICAL TOOLS FOR INVESTMENT MANAGEMENT
CR: 3

The concept of technical analysis. Dow theory and behavioral finance. Cycle theory and applications. The long wave and technological issues. Business and market cycles. Elliot wave theory. Fibonacci numbers and applications. Pattern recognition and time series identification. Input/output models and multivariable modelling. Neural networks and applications. Detrending techniques. Oscillators and market timing. Statistical analysis applied to investment management.

0640-590: SPECIAL TOPICS IN PROCESS SYSTEM ENGINEERING
CR: 3

An upper division of graduate technical elective treating topics in Engineering mostly not covered in other courses, chosen at the discretion of the Graduate Program Committee.

0640-591: SPECIAL TOPICS IN TECHNO-ECONOMICS
CR: 3

An upper division of graduate technical elective treating topics in Engineering mostly not covered in other courses, chosen at the discretion of the Graduate Program Committee.

0640-592: SEMINAR
CR: -

Following the directions of the graduate program committee related to thesis or project.

0640-593: PROJECT
CR: 3

0640-595: SPECIAL TOPICS IN POLLUTION ENGINEERING
CR: 3

An upper division of graduate technical elective treating topics in Engineering mostly not covered in other courses, chosen at the discretion of the Graduate Program Committee.

0640-597: THESIS
CR: 0

0640-598: THESIS
CR: 0

2000-599: THESIS
CR: 9