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
PETROLEUM ENGINEERING

INTRODUCTION

The Department of Petroleum Engineering (College of Engineering and Petroleum) offers a Master of Science degree in **Petroleum Engineering.** Part-time and full-time students are admitted to this program. Research requirements include either thesis or non-thesis options.

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(9) CORE COURSES (3 credits each)

0650-503 Advanced Reservoir Engineering
0650-504 Advanced Drilling Engineering
0650-556 Advanced Production Engineering

3(3) CORE ELECTIVE COURSES (3 credits each)

0600-504 Numerical Analysis and Computation
0650-505 Transport Phenomena in Petroleum Engineering
0650-506 Mathematical Methods in Petroleum Engineering

9(12) SUBDISCIPLINE COURSES (3 credits each)

I) ENGINEERING

Maximum one course can be taken from this category

0600-507 Mathematical Optimization OR 0630-517 Optimal Design
0600-511 Computational Fluid Dynamics
0640-562 Multi-Phase Flow

II) RESERVOIR ENGINEERING

0650-501 Advanced Petrophysics
0650-509 Advanced Enhanced Oil Recovery
0650-521 Advanced Reservoir Simulation
0650-525 Advanced Fluid Flow in Porous Media
0650-539 Advanced Well Testing
0650-547 Characterization of Naturally Fractured Reservoirs

0650-560 Thermal Recovery Methods
0650-562 Advanced Well Logging

III) DRILLING ENGINEERING

0600-510 Advanced Fluid Mechanics
0630-543 Fracture Mechanics
0650-515 Drilling Fluid Hydraulics
0650-527 Directional and Horizontal Drilling
0650-529 Well Completions and Workovers
0650-565 Advanced Drilling Fluids

IV) PRODUCTION ENGINEERING

0650-531 Advanced Natural Gas Engineering
0650-550 Advanced Well Stimulation
0650-551 Advanced Phase Behavior of Reservoir Fluids OR 0640-575 Fluid Phase Equilibrium
0650-555 Two-phase Flow Modeling in Pipes
0650-558 Advanced Artificial Lift Methods

3(6) FREE ELECTIVE COURSES* (3 credits each)

0600-512 Advanced Engineering Mathematics I
0650-543 Gas Condensate
0650-545 Economic Evaluation of Petroleum Reservoirs
0650-549 Geostatistics OR 2090-511 Geostatistics
0650-591 Special Topics in Petroleum Engineering

*A maximum of 3 credit hours (thesis students) and 6 credits hours (project students) can be taken from **core engineering**, any other engineering, science, computing 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

0650-592	Seminar	(0)
0650-593	Project	(3) (non-thesis only)
0650-597	Thesis	(0)
0650-598	Thesis	(0)
2000-599	Thesis	(9)

COURSE DESCRIPTION

0650-501: ADVANCED PETROPHYSICS
CR: 3

Correlation of Physical Properties of Rocks in Terms of Parameters Obtained from Drilling, Log Interpretation, Reservoir Engineering.

Fundamental concepts of petrophsics, Flow through Porous Media, Mechanical, Electrical and Thermal Properties, and Methods of Petorphysical Measurements.

0650-503: ADVANCED RESERVOIR ENGINEERING
CR: 3

This course is intended to explore advanced concepts in reservoir engineering. It will start with a brief review of the fundamentals of reservoir engineering. Topics to be covered include: estimation of reservoir reserve using different methods with comparison with a simulation run, solution of the fluid flow under unsteady-state, steady-state and Pseudo-steady state flow. It also includes immiscible displacement; the fractional flow equation, Buckley-Leverett, oil recovery calculation, displacement under segregated flow condition and stratified reservoirs. Reservoir simulation case studies for water flooded reservoir and gas injection, and an introduction to EOR.

0650-504: ADVANCED DRILLING ENGINEERING
CR: 3

Design of drilling operation, bit selection and evaluation, mathematical modeling of bit wear and penetration rate, drilling hydraulics, determination of formation pore pressure and fracture pressure, rock mechanics, selection of drill string and casing, directional drilling, special design consideration in horizontal wells, and introduction to underbalanced drilling operation.

0650-505: TRANSPORT PHENOMENA IN PETROLEUM ENGINEERING
CR: 3

Shell Momentum Balance, Equations of Change for Isothermal Systems and their Applications, Macroscopic Balance and it Applications, Shell Energy Balance, Multivariate and Unsteady Conduction, Analysis of Heat-Transfer Problems, Macroscopic Balance for Non-Isothermal Systems, Diffusion and Shell Mass Balance, Unsteady Diffusion, Mass Transfer Coefficients, Dispersion in Flow Through Porous Media, Equations of Change for Multi-Component Systems, Macroscopic Balance for Multi-Component Systems.

0650-506: MATHEMATICAL METHODS IN PETROLEUM ENGINEERING
CR: 3

Solving Petroleum Engineering models with an emphasis on advanced solution methods including Green's function, series solution, Bessel function method of characteristics and separation of variable. Petroleum Engineering application of scalar, vector and tensor variables and matrices.

0650-509: ADVANCED ENHANCED OIL RECOVERY
CR: 3

Theory and applications of enhanced oil recovery processes: Chemical Flooding; Polymer Flooding, Surfactant Flooding, Micellar-Polymer Flooding (MP), Foam Flooding, Alkaline Flooding, Miscible Flooding,

0650-515: DRILLING FLUID HYDRAULICS
CR: 3

Fluid Flow Principles, Fluid Models, Measurement of Fluid Flow Properties Drilling Muds, Mud Circulation System, The Drill-String, Motor, Turbine and Bit, The Annulus, Swab and Surge Pressures, Cutting Transport, Optimization of the Hydraulics Program.

0650-521: ADVANCED RESERVOIR SIMULATION
CR: 3 PR: 0600-504

Steps involved in the development and application of numerical reservoir simulator models to primary and secondary recovery processes in reservoir engineering. Model formulation, General Material Balances, Single Phase flow, Overall Program Structure, Finite difference Approximations, finite Element Approximations, Boundary and Initial Conditions, Well Model, Anisotropy, Error, Grid Selection, Stability Analysis, Non-linear Problems, Multiphase Flow Models, IMPES Solution, Simultaneous Solution, Stability of Multiphase Flow FDEs, Reservoir Framework, Relative Permeability, Transmissibility in Multiphase Flow Effective Relative Permeability, Capillary-gravity Equilibrium, Model Initialization, Reservoir Characterization.

0650-525: ADVANCED FLUID FLOW IN POROUS MEDIA
CR: 3 PR: 0650-505

Traditional ways to describe flow through porous media, Classical view of two-phase flow, Introduction to Network Models, Effective Medium Theory, Monte-Carlo Simulations, Recent advances in using Percolation Theory.

0650-527: DIRECTIONAL AND HORIZONTAL DRILLING
CR: 3

Planning Directional Well Trajectory, Calculating the Trajectory of a Well, Planning the Kickoff and Trajectory Change, Directional Drilling

Measurements, Deflection Tools, Principles of BHA, Deviation Control.

0650-529: WELL COMPLETIONS AND WORKOVERS
CR: 3

Data Requirements for Completion or Workover Planning, Selection of the Best Completion, Formation Damage: Identification, Prevention, and Treatment Methods, Selection of well completion and Workover Fluids, Perforation: Selection and Design, Well System Behavior: Principles and Testing, Well Inflow System Applications, Well Outflow System: Tubing Performance, Well Inflow at outflow Performance, Tubing and Packer Systems: Types, Selection considerations, Movement and Forces in Tubing Packer Systems, Wireline Completions, Squeeze Cementing, Well Stimulation, Sand Control, workover Planning and Evaluation.

0650-531: ADVANCED NATURAL GAS ENGINEERING
CR: 3

Types of Reservoir Fluids, Composition and physical Properties, Phase Behavior, Equations of State, Lash & differential Calculation, Gas Reserve Estimate, Gas, Flow in Porous Media, Gas Well Testing, Hydrate, Types, Formation, Prediction and Preventions, Gas Flow in Pipes, Estimation of Bottom Hole Pressure, Unloading Gas Wells, Gas Composition, Analyzing Performance of Gas Wells, Underground Storage of Natural Gas.

0650-539: ADVANCED WELL TESTING
CR: 3

Well Test Analysis, Naturally Fractured Reservoirs, Use of transient Tests to Determine Fractured Systems, Transient Rate Analysis & Constant Pressure Production, Computer - Aided Interpretation.

0650-543: GAS CONDENSATE
CR: 3

This course in designed to help Petroleum Engineers involved in evaluation, reservoir management and production planning to understand behavior, recovery mechanisms, and well productivity of gas condensate reservoir.

0650-545: ECONOMIC EVALUATION OF PETROLEUM RESERVOIRS
CR: 3

Review of Principles of Economics, Cash Flow analysis, Oil and Gas Reserve Estimates, Decline Curve Analysis, profitability Criteria for Investment in Petroleum Industry, Project Analysis, in Terms of the Interrelation of Technical And Economic Factors, Investment Analysis in The Presence of Uncertainty and Project Planning, Reservoir Unitizantion.

0650-547: CHARACTERIZATION OF NATURALLY FRACTURED RESERVOIRS
CR: 3

Origin of Fracture, Classification of Fractures, Petrophysical Properties of fractured Reservoirs, Well Testing in fractured Reservoirs, Well Testing in Fractured Reservoirs, Well Test Equations, Detection and Identification of Fractured Reservoirs, Reservoir, Processes. Modeling Fractured Reservoirs.

0650-549: GEOSTATISTICS
CR: 3

The course is designed to provide students with a firm foundation in Geostatistics. The participants will be familiar with traditional and novel geostatistical tools for mapping petrographic properties. The first part of the course will focus on Data Analysis, Development and Modeling of Variograms. The second part of the course will emphasize on various techniques for modeling geological media such as Kriging, Sequential Indicator Simulation, and Simulated Annealing.

0650-550: ADVANCED WELL STIMULATION
CR: 3 PR: 0650-501

Diagnosis of Formation Damage, Rate Decline Analysis, Types of Formation Damage, Water Injection Problems, Stimulation Methods, Decision and Planning of Stimulation Operations, Sand Control, Gravel Packing.

0650-551: ADVANCED PHASE BEHAVIOR OF RESERVOIR FLUIDS
CR: 3

Phase behavior of petroleum reservoir fluids plays an important role in most oil recovery calculations. Thus defining each type of reservoir fluids and understanding their behavior is a vital step towards description and modeling of reservoir performance and future recovery processes. The use of laboratory data and empirical corelations to obtain PVT will be discussed. Characterization of the reservoir fluids as well as predicting their physical properties with EOS's will be performed. Exercise of tuning and danger of tuning of the

EOS's parameters are covered. Methods of lumping and splitting of the reservoir fluids for EOS simulation will be presented.

0650-555: TWO-PHASE FLOW MODELING IN PIPES
CR: 3

Theoretical treatment of two-phase flow. Introduction to two-phase flow phenomenon. Recent modeling approaches and a review of the early models. Flow pattern transition prediction and flow pattern modeling for vertical, horizontal and inclined pipes. Unified models.

0650-556: ADVANCED PRODUCTION ENGINEERING
CR: 3

Advanced study of the total system associated with production and transportation of oil and gas. NODAL TM system analysis. Steady state multiphase flow through pipes and restrictions. Comprehensive mechanistic models for multiphase flow in wellbores and pipelines. Two phase flow design.

0650-558: ADVANCED ARTIFICIAL LIFT METHODS
CR: 3

This course provides a thorough overview of the artificial lift methods. Theory, application, and design of the most important artificial lift methods, including gas lift, beam pumping, and electrical submersible pumping.

0650-560: THERMAL RECOVERY METHODS
CR: 3

This course provides students with the thermal recovery concepts. It teaches students the Heavy oil recovery by thermal techniques. The course delivers advanced and detailed information on the subject.

0650-562: ADVANCED WELL LOGGING
CR: 3

Introduction to well logging methods for determining nature and fluid content of formations penetrated by drilling. The application of well-log interpretation methods will be practiced for the cases as follows: Quantitative interpretation of well logs to estimate rock and fluid properties, including porosity, net pay thickness, fluid saturations, and fluid type/density, volumetric/weight concentrations of minerals, and dynamic petrophysical properties such as permeability. Well-log interpretation in clay-free, shaly-sand, and organic-shale formations. Theory and physics of well-log measurements: well-log interpretation techniques to estimate petrophysical and compositional properties of different formations.

0650-565: ADVANCED DRILLING FLUIDS
CR: 3

This course is designed to provide a fundamental background of drilling fluids design and functions. The student will be familiar with the different kinds of drilling fluids used in drilling operations. The proper selection of drilling fluid will be explained. The advantaged and disadvantages each drilling fluid type will be discussed. The student will be exposed to drilling fluid hysical and chemical properties and how they affect the drilled rock.

0650-591: SPECIAL TOPICS IN PETROLEUM 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.

0650-592: SEMINAR
CR: -

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

0650-593: PROJECT
CR: 3

0650-597: THESIS
CR: 0

0650-598: THESIS
CR: 0

2000-599: THESIS
CR: 9