

Doctor of Philosophy in Petroleum Engineering
Program code: 065070

INTRODUCTION

The PE Ph.D. program is designed to graduate Ph.D. holders that are proficient and independent researchers who can synthesize, critique, apply, and extend major theories and methods related to various innovative areas of the oil and gas industry. Possess good written and oral communication skills to effectively participate in the growth of academic, and research and development (R&D) institutions. Demonstrate high standards of ethical, environmental, and societal awareness.

PROGRAM REQUIREMENTS

42 TOTAL COURSE CREDITS

9 SPECIAL COURSES (3 credits each)

- 0650-612 Applied Petroleum Geomechanics
- 0650-613 Water Shutoff and Conformance Improvement
- 0650-622 Unconventional Reservoirs
- 0650-627 Flow Assurance in Oil and Gas Production
- 0650-630 Complex Well Planning and Construction
- 0650-632 Oil-water Dispersion and Emulsion
- 0650-633 Reservoir Characterization
- 0650-634 Chemical EOR Processes

15 GENERAL COURSES (3 credits each)

- 0650-611 Engineering Research Methods
- 0650-614 Simulation of EOR Processes
- 0650-615 Heat and Mass Transfer
- 0650-621 Multilateral Well Completion
- 0650-624 Production Logging
- 0650-625 CO₂ Capture and Sequestration for Enhanced Oil Recovery
- 0650-626 Transient Multiphase Production.
- 0650-628 Underbalanced and Managed Pressure Drilling
- 0650-629 Offshore Drilling Engineering
- 0650-631 Application of Nanotechnology in Petroleum Industry

A maximum of 6 credit hours may be taken from the PE 500 level subdiscipline courses upon the approval of program director before registration. A maximum of 6 credits may be taken from relevant Non-Petroleum engineering or sciences graduate programs upon the approval of the program director.

18 COMPULSORY COURSES

0650-692	Seminar	(0)
0650-697	Dissertation	(9)
0650-698	Dissertation	(9)

COURSE DESCRIPTION

0650-611: ENGINEERING RESEARCH METHODS
CR: 3

Research methods, type of modeling, design, theoretical, computational and interpretive issues in applied and fundamental research studies. Research components, sequence and methodology. Typical research designs, rationale for use, computational and/or computing procedures, interpretation, verification and validation of results. Scientific writing and publication.

0650-612: APPLIED PETROLEUM GEOMECHANICS
CR: 3

The course provides fundamental rock mechanics concepts and aims to emphasize their role in exploration, drilling, completion and production engineering operations. Basic stress and strain concepts, pore pressure, fracture gradient and in situ stress magnitude and orientation determination and how these properties are obtained from the field measurements. Mechanisms of deformation in rock, integrated wellbore stability analysis, depletion induced compaction and associated changes in rock properties and formation strength. Hydraulic fracturing and fracture stability are among the topics to be covered in this rock course.

0650-613: WATER SHUT-OFF AND CONFORMANCE IMPROVEMENT
CR: 3

This course aims at teaching students how to diagnose water-shutoff problems and to design water shutoff treatment and conformance improvement jobs. Factors that lead to an increase in water production, such as the presence of thief zones or high permeability zones, fractures and water coning. Water shut off and conformance-control treatments that can be used to generate relatively large volumes of incremental oil production with low costs. Selectively, targeted

small volume treatments, which extends the economic lives of marginal and mature wells.

0650-614: SIMULATION OF EOR PROCESSES
CR: 3

Recent advances in concepts of reservoir simulation within the context of reservoir management will be covered. The course will focus on the capabilities and operational features of well-known simulators for simulating thermal recovery methods and chemical flooding.

0650-615: HEAT AND MASS TRANSFER
CR: 3

Steady and unsteady mass and heat diffusion in solids and stagnant liquids. Laminar, forced and natural convection. Equations of change for non-isothermal systems and multi-component systems. Analytical and approximate solutions to equations of change with applications to problems in research and design. Heat and Mass Transport in Turbulent Flows. Diffusion under various driving forces and with chemical reaction. Energy and mass transport in boundary layers with relevant analogies. Simultaneous heat and mass transfer. Multi-component mass transport for dilute solutions.

0650-621: MULTILATERAL WELLS COMPLETION
CR: 3

The utility of multilateral wells. Drilling and well control of multilateral wells. Designing a multilateral well completions. Multilateral wells production and well performance. Discussion of case studies and economics of multilateral wells.

0650-622: UNCONVENTIONAL RESERVOIRS
CR: 3

This course is designed to expose students to the latest techniques of reserve evaluations, well test analysis, decline curve analysis, and field economics applied to unconventional reservoirs like tight gas, shale gas, shale oil, coalbed methane, gas hydrate reservoirs, and heavy oil reservoirs.

**0650-624: PRODUCTION LOGGING
CR: 3**

Mapping of fluid movement down-hole in both injection and producing wells, assessing the integrity of cement and casing, and formation evaluation using cased-hole logs.

**0650-625: CO2 CAPTURE AND SEQUESTRATION FOR ENHANCED OIL RECOVERY
CR: 3**

This course is designed to cover the mechanisms of CO2-EOR projects, CO2 Capturing options, miscible and immiscible CO2 displacement processes, phase behavior of CO2-Crude oil systems, measurements and predictions of minimum miscibility pressure, and design considerations in CO2-EOR projects.

**0650-626: TRANSIENT MULTIPHASE PRODUCTION
CR: 3**

A combination of transient multiphase flow theoretical modeling and design applications. Detailed derivation of the two transient two-phase flow models: Two-fluid model and Drift flux model. As study of the numerical aspects in transient two-phase flow: method of characteristics, explicit vs. implicit, numerical diffusion, wellposedness, and stability. Application to multiphase transient flow assurance phenomena: severe slugging and terrain slugging. A study and application of transient multiphase flow simulators.

**0650-627: FLOW ASSURANCE IN OIL AND GAS PRODUCTION
CR: 3**

Multi-disciplinary subject addressing hydrocarbon flow assurance from reservoir to sales. Topics include prediction, mitigation, and preventions of: organic and inorganic deposition; pipe erosion/corrosion; severe/terrain slugging, liquid loading, heavy oil, and others. Production system design and operational issues. Application of commercial simulators.

**0650-628: UNDERBALANCED AND MANAGED PRESSURE DRILLING
CR: 3**

Advanced analysis of underbalanced and managed pressure drilling techniques, applications, candidate selection, equipment and fluid types. Underbalanced drilling hydraulic models, risk

identification and uncertainty in underbalanced and managed pressure drilling.

**0650-629: OFFSHORE DRILLING ENGINEERING
CR: 3**

Advanced study of the unique aspects of offshore drilling operations. Introduction to Floating Drilling Vessels. Types of Motion and Waves. Drilling with a Riser, Fracture Gradients in Deep Water. Directional Well Planning and Design.

**0650-630: COMPLEX WELL PLANNING AND CONSTRUCTION
CR: 3**

Planning and calculating trajectories for complex wells such as directional, horizontal, extended reach, and multi-lateral wells. Screening analysis for selecting the optimum complex well design. Extensive survey calculation methods. Deflection tools, different bottom-hole assemblies used in complex well drilling operations, and geo-steering. Torque and drag problems, and buckling in complex wells. Wellbore stability for complex wells.

**0650-631: APPLICATION OF NANOTECHNOLOGY IN PETROLEUM INDUSTRY
CR: 3**

A comprehensive review of the different applications of nanotechnology in the oil and gas industry. A summary of all nanoparticles used along with a detailed analysis of their performance in improving the targeted parameters is comprehensively presented. Comprehensive summary of the different successful applications of nanotechnology in reservoir, production and drilling engineering and its associated challenges.

**0650-632: OIL-WATER DISPERSION AND EMULSION
CR: 3**

Advances of oil-water emulsion. Emulsion types and interfacial phenomena. Oil-water flow patterns. Emulsion stability and the use of surfactants. Emulsion processing and transportation. Comprehensive modeling and applications.

**0650-633: RESERVOIR CHARACTERIZATION
CR: 3**

Build static models by integrating geological, seismic, core and well log data to predict alteration

of reservoir characteristics. Study the impact of altered reservoir characteristics on reservoir performance.

0650-634: CHEMICAL EOR PROCESSES
CR: 3

This course provides an integrated workflow for various chemical EOR processes (CEOR). Mechanisms involved in the main CEOR processes (polymer, surfactant, and alkaline), are discussed in detail. The course addresses the properties of chemicals, base behavior, fluid geochemical reactions encountered in CEOR processes, flow in porous media, challenges in CEOR, performance of CEOR, and the design of CEOR processes.

0650-692: SEMINAR
CR: 0

The student must conduct two presentations. The first one presents the research proposal and work plan of the Dissertation. The second presentation is made prior to the final Dissertation defense.

0650-697: DISSERTATION
CR: 9

0650-698: DISSERTATION
CR: 9