Syllabus for the

**M.E (Petroleum Engineering)**

(W.e.f 2008-2009)
THE SYLLABUS IS PREPARED BY:

BOS- Petroleum and Petrochemical Engineering
       University of Pune

PEER REVIEW BY:

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- Mr. Madhav Tilgulkar, Consultant, Petroleum Engineering, Pune

Note: - This syllabus is subject to change without prior notice by the concerned BOS
## UNIVERSITY OF PUNE
### STRUCTURE OF M.E. (PETROLEUM ENGINEERING)
#### REVISED TWO-YEAR COURSE (2008)

### SEMESTER I

<table>
<thead>
<tr>
<th>Code</th>
<th>Subject</th>
<th>Teaching Scheme</th>
<th>Examination Scheme</th>
<th>Credits</th>
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<td>Horizontal, Multilateral and Intelligent wells</td>
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<td>512104</td>
<td>Elective I</td>
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### Elective I

512104

- a) Advanced Geological Methods in Petroleum Exploration and Development
- b) Reservoir Petrophysics
- c) Oil and Gas Field Development Strategies and Risk Analysis
- d) Petroleum Business Strategies and Risk Analysis

### Elective II

512105

- a) Modern Completion Technology
- b) Well Design and Engineering
- c) Well Testing and Analysis
- d) Well Control
## SEMESTER II

<table>
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<td>512110</td>
<td>Advanced Natural Gas Engineering</td>
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### 512111 Elective III
- a) Artificial Lift Techniques
- b) Advanced Stimulation Techniques
- c) Piping Design and Engineering
- d) Advanced Offshore Technology

### 512112 Elective IV (Open)
- a) Technology of Coal Bed Methane
- b) Unconventional Hydrocarbon Resources and Development Strategies
- c) Open elective, can be taken from any branch of elective

## SEMESTER III

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## SEMESTER IV

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**Note** - The Contact Hours for the calculation of load of teacher
Seminar- 1 Hr / week / student, Project - 2 Hr / week / student

* The Term Work of Project stage II of semester IV should be assessed jointly by the pair of internal and external examiners along with the oral examination of the same.
512101 Numerical Methods and Simulation in Petroleum Engineering

Teaching Scheme: Examination
Scheme: Paper: 100 Marks
Lectures: 4 Hours/Week Duration: 3 Hours.

Overview of Reservoir Geology and Engineering:

Numerical Reservoir Simulation: Introduction and overview:


Reservoir simulation and management.

Selecting a numerical method to solve the problem.

Reference Books:


512102 Petroleum Reservoir Management

Teaching Scheme: Examination
Lectures: 4 Hours/Week Paper: 100 Marks
Duration: 3 Hours.


Reservoir Management Concepts and Processes, Fundamentals, Data acquisition, interpretation and integration.

Static and Dynamic Reservoir Modeling, Integration of exploration and development technology

Reservoir Performance Analysis and Prediction, Conservation of reservoir energy. Influence of reservoir structure on water control

Reservoir Economics: risk and uncertainties, economic evaluation and optimization

Applications of Improved Recovery Processes, new drilling, completion and production technology. Use of artificial intelligence.

Case studies from petroleum literature

Reference Books:


Carlson, M., “Practical Reservoir Simulation”, Pennwell, 2003


512103 Horizontal, Multilateral and Intelligent wells

Teaching Scheme: Examination
Lectures: 4 Hours/Week Paper: 100 Marks
Duration: 3 Hours.

Review of conventional drilling techniques. Review of drill string and casing design, conventional well control techniques.


Comparison with vertical drilling techniques, reservoir engineering concepts and well completions.

Applications of above drilling techniques in field development. Development of tight reservoirs. Recent Trends.

MWD, LWD, drilling economics, drilling optimization methods, associated problems. Economics of complex wells.

Case Studies from Petroleum literature.

Reference Books:


Advanced Exploitation Technology Manual, MAURER ENGINEERING INC, 2000

Supplemental papers from the literature
Elective I

a. Advanced Geological Methods in Petroleum Exploration and Development

Teaching Scheme:
Scheme:
Lectures: 4 Hours/Week
Paper: 100 Marks
Duration: 3 Hours.


Petrography of reservoir rocks, application of core data, structural and stratigraphic applications of log and dipmeter data, reservoir geology models for development planning particularly water flooding and Enhanced Oil Recovery (EOR) operations.

Geological considerations in reservoir heterogeneity and reservoir characterization, application of seismic techniques to reservoir delineation, shale geology, subsurface pressure systems, origin, measurement and detection of abnormal pressures.

Spatial and temporal distribution of hydrocarbons, Model approach to exploration stratigraphy with reference to petroliferous basins. Seismic stratigraphy and seismic modeling for hydrocarbon detection.

Tectonics, sedimentation and exploration history of important world occurrences.

Geological Risk analysis

Reference Books:


b. Reservoir Petrophysics

Teaching Scheme:  
Exam Scheme:  
Lectures: 4 Hours/Week  
Paper: 100 Marks
Duration: 3 Hours.

Conventional methods of interpretation of well logs and recent developments in petrophysics. Qualitative and quantitative estimation of different parameters.

Porosity-Permeability relationship, empirical equations, correlation  
Formation Resistivity and Water Saturation, Capillary Pressure and Wettability, Borehole Environment.

Darcy’s Law: Flow of fluids in porous media, flow of gas in porous media, flow in multiple permeability rocks with or without cross flow. Relative permeability.

Classification and properties of reservoir fluids

Effect of Stress on Rock Properties

Fluid Rock Interactions: Importance of near wellbore permeability, types of fines, effect of fines migration, critical velocity concept, identification of permeability damage.

Reference Books:

Asquith George & Krygowski Daniel: Basic Well Log Analysis. USA. AAPG, 2004

Supplemental papers from the literature
c.) Oil and Gas Field Development

Teaching Scheme:
Scheme:
Lectures: 4 Hours/Week
Examination
Paper: 100 Marks
Duration: 3 Hours.

Review of various geological, reservoir engineering and petroleum production principles and methods with reference to oil and gas field development. Drainage of oil and gas reservoirs by wells.


Need of additional energy for pressure maintenance of a reservoir. Techniques for various artificial lift methods. Field evaluation for EOR. Field development with application of secondary and tertiary recovery.

Field development with reservoir management. Application of mathematical modeling and computer simulation for optimum field development. Economics of field development. Consideration of down stream utilization and consumption.

Special consideration for gas field developments.

Development of marginal fields. Indian Scenario.

Planning of various surface installations, Group Gathering Stations. Pipe line transportation of oil and gas. Pumping stations. Use of SCADA / DCS. Future field expansion. The ecological and environmental aspects. hazard and remedies.
**Reference Books**

Santkumar, Oil and Gas Field Development. 2000 India

Laxman Singh, Oil and Gas Fields of India. Indian Petroleum Publishers. 2000

Supplemental papers from the literature
d) Petroleum Business Strategies and Risk Analysis

Teaching Scheme: Examination
Scheme:
Lectures: 4 Hours/Week Paper: 100 Marks
Duration: 3 Hours.

Introduction to upstream economic analysis, energy overview of India.

Time Value of Money, cash flow analysis, capital budgeting techniques, general probability, elements of oil and gas project cash flows.

Reserves classification methods, quantification, assessment of geoscience and reservoir engineering uncertainties. Assessment of reserves, production and demand in international market.

Inflation and cost escalation, oil market and OPEC, share of non OPEC countries in oil production,

International oil and gas pricing mechanism. Geopolitics.


Accounting systems for oil and gas

Project Economic Evaluation and Petroleum economic models. Decision analysis, Valuation of petroleum properties

Reference Books:


Cronquist, C., Estimation and Classification of Reserves of Crude Oil, Natural Gas, and Condensate, SPE (2001)


512105 Elective II

a.) Modern Completion Technology

Teaching Scheme: Examination
Scheme:
Lectures: 4 Hours/Week Paper: 100 Marks
Duration: 3 Hours

Well completion: types of wells, completion functions, types of completion Well completion design

Mechanical aspects of well testing, Subsurface completion equipment and accessories, Well Head Equipment, Interval selection consideration and optimization of tubing dimensions for maximum Production, Special consideration for horizontal and multilateral completions, Perforation of oil and gas wells, Sand Control, Reservoir stimulation

Data acquisition, SCADA systems,

Completion technology for unconsolidated formations, Intelligent completion equipment, Tubing string design (dimension, materials, connections,) based on pressure-temp. Operating conditions, safety requirements,

HPHT and horizontal well completions, Work over equipment: Wire Line, Snubbing Unit, Coil Tubing, Completion and Work over design and execution,

Deepwater completions. Recent trends.

Reference Books

Reservoir Stimulation, Dowell-Schlumberger


Williams, et.al.: Acidizing Fundamentals, SPE Monograph No. 6, SPE

Supplemental papers from the literature
b) Well Planning and Design

Teaching Scheme: Examination
Scheme:
Lectures: 4 Hours/Week Paper: 100 Marks
Duration: 3 Hours

Collection and preparation of data for well planning, Prediction of pore pressure and fracture gradient, Selection of well location, well trajectory, hole geometry and casing seats, Bit, mud, casing and cement plan, Completion effects on well planning, Rig sizing and selection, Well cost estimation and AFE preparation

Well selection, reservoir evaluation, costing

AFE selection, geological input, testing and completion requirement, drilling consideration,

Well plan organization and data gathering, Well Dynamics, Rig design consideration

Reference Books


Economides M et al. Editor by Petroleum Well Construction John Wiley and Sons, 1998

Craft B.C et al "Well Design - Drilling and Production”. Prentice-Hall, 1962,

Schechter R.S., “Oil Well Stimulation” Prentice Hall, 1992

Supplemental papers from the literature
512105 Elective II

c) Well Testing and Analysis

Teaching Scheme: Examination
Scheme: Paper: 100 Marks
Lectures: 4 Hours/Week Duration: 3 Hours.


Pressure Build-up Tests: Procedure, analysis, multirate analysis, effects of fault, partial penetration, deviated wells.


Type Curve Analysis: Need, procedure, types of well that can be analyzed, typical examples using at least three different type curves.

Drill Stem Test: Detailed procedure, analysis, equipment used.

Other Well Tests: Gas well tests, interference tests, fractured well test, horizontal well tests.

Production testing equipment and well head equipment.

Software used to analyze above tests.

Reference Books:

Beggs D S. Gas Production Operations. OGCI Publications. 2002


512105  Elective II

d) Well Control

Teaching Scheme:  
Lectures: 4 Hours/Week

Examination

Exam Scheme:
Paper: 100 Marks
Duration: 3 Hours.

Review of drilling operations, fluids and functions, associated problems, causes of kicks, geology of normally / overpressured zones.

Review of rig hydraulics, pressure control procedures, kick indications, fluid dynamics in well control, problems and procedures in well control, underbalanced well control techniques.

Surface and subsurface equipment, valves, Blowout Preventors (BOP), BOP control system, operations, design considerations, blowout contingency planning, relief well design and operations.

Well control during testing, cementation operations, Well completion operations in abnormally pressured zones.

Offshore well control operations: Methodology, equipments, procedures, special considerations, multiwell hydraulic control system for sub sea completions.

Safety Procedures.

Case Studies.

Reference Books:


Laboratory Practices I

Teaching Scheme: Examination
Scheme:
Practicals: 6 Hours/Week Term Work: 50 Marks

Each candidate should perform at least six experiments from the list of experiments given below and submit the journal, which will form the term work for the subject.

1) Experiments based on log interpretation, preparation and evaluation of log cross-section
2) Use of any standard log interpretation software.
3) Core flooding studies
4) Geological description well cuttings/cores.
5) Study of radioactive and electrical properties of rocks
6) Data analysis of Pressure transient tests a) Pressure buildup b) Pressure draw down
7) Gas well testing data analysis a) Flow after flow test b) Modified isochronal test.
9) Design of sand control system.
10) Design of a typical well completion job.
11) Study of any one of the standard software in petroleum engineering with respect to data input, data analysis and interpretation.
12) Study and design of gas lift string.
13) Study of multiphase flow regimes with their characteristics
15) Directional Drilling and deviation control.
Each student is required to deliver a seminar in the first semester.

Topic of the seminar should be based on current trends in advanced research emphasizing literature review. A seminar report of about 30 typed pages should be submitted under the supervision of teacher. Available case studies may also be incorporated.
Teaching Scheme: 
Lectures: 4 Hours/Week
Examination Scheme: Paper: 100 Marks
Duration: 3 Hours.

Overview of operations of upstream oil industry.

Introduction to GIS, Spatial Data Models, Spatial Data Structures, Spatial Data Inputs, Visualization and Query of Spatial Data, Spatial Data Transformations, Tools for Map Analysis: single and multiple maps,

Geostatistics in data handling.

Environmental assessment. Petroleum industry case studies

Applications of different software used in Petroleum Industry.

Reference Books:


Supplemental papers from the literature
512109 Environmental Management Technology and Safety Measures

Teaching Scheme:
Scheme:
Lectures: 4 Hours/Week

Examination
Paper: 100 Marks
Duration: 3 Hours.

Quality Environment Management: Planning and resource allocation, performance and review, compensation, quality practices

Components of Environment and Current Environmental Issues, Air Pollution and Control Methods, Meteorological Aspects of Air Pollutant Dispersion, Sources and Classification of Water Pollutants, HAZOP analysis,

Environmental control in Petroleum Industry, Drilling and production operations and environmental impact of discharge in the onshore and offshore areas, produced water and treatment. Planning for environmental protection.

Wastewater Treatment Technologies, solid waste disposal, hazardous waste, oilfield waste management. Operational practices and procedures

Accidents in oil industry and environmental degradation, contingency plans, disaster management

Integrated Environmental Biotechnology in Petroleum Industry,

Environmental Regulations, sensitive habitants, Health and Safety laws, quality assurance.

Decommissioning of oil and gas installations

Reference Books:


Supplemental papers from the literature
512110  Advanced Natural Gas Engineering

Teaching Scheme:
Lectures: 3 Hours/week

Properties and Measurement of Natural Gas:
Phase behavior fundamentals, qualitative and quantitative phase behavior, vapor liquid equilibrium.
Equation of state, critical pressure and temperature determination. Gas compressibility, viscosity and thermal conductivity, formation volume factor.
Gas flow measurement, and fundamentals,

Gas Reservoir Performance
Steady State Flow of Gas in Production Tubing
Temperatures profiling in flowing gas systems.
Natural gas processing Gas Compression
Gas Gathering and Transport
Installation, operation and trouble shooting of natural gas pipelines

Books
512111 Elective III

a. Artificial Lift Techniques

Teaching Scheme: Examination
Scheme:
Lectures: 4 Hours/Week Paper: 100 Marks
Duration: 3 Hours.


Well Inflow and outflow performance and multiphase flow in pipes. Flow assurance

Gas Lift: Types, design of continuous and intermittent lift, gas lift valve design, performance prediction and optimization.

Pump Assisted Lift: Sucker Rod Pumps. Electrical Submersible pumps. Plunger Lift

Hydraulic Fracturing, Acidizing. Acid Fracturing: Design of an acid fracturing job, predicting depth of penetration in carbonate and sandstone reservoirs.

Production Optimization,

Reference Books:


512111 Elective III

b) Advanced Stimulation Techniques

Teaching Scheme:  
Schedule:  
Lectures: 4 Hours/Week  
Examination  
Paper: 100 Marks  
Duration: 3 Hours.

Reservoir Stimulation in Petroleum Production,


Basics of Hydraulic Fracturing, Mechanics, Fracturing Fluid Chemistry and Proppants, Performance of Fracturing Materials, Fracture Evaluation Using Pressure Diagnostics,

Fracture Treatment Design, Fracturing Operations, Post-Treatment Evaluation and Fractured Well Performance

Introduction to Matrix Treatments, Formation Damage: Origin, Diagnosis and Treatment Strategy, Additives in Acidizing Fluids,


Books

Reservoir Stimulation, Dowell-Schlumberger, 2004.


Williams, B.B., Gidley, J.L. and Schechter, R.S.: Acidizing Fundamentals, Monograph Series, Richardson, Texas, USA, Society of Petroleum Engineers (1979) 6.

Economides, Hill and Economides: Petroleum Production Systems
512111 Elective III

c) Enhanced Oil Recovery

Teaching Scheme: Examination
Scheme:
Lectures: 4 Hours/Week Paper: 100 Marks
Duration: 3 Hours.

Reservoir Engineering concept of Enhanced Oil Recovery (EOR) classification, comparative performance of different methods. Screening process and technical constraints.

Basic equations for fluid flow in permeable media, mass conservation, energy equations, and momentum equations.

Phase behavior, fluid properties, displacement efficiencies, volumetric sweep efficiency.

Chemical EOR Methods: Polymer, surfactant polymer, alkaline.

Gas Processes: Miscible, immiscible, carbon dioxide, nitrogen, LPG.

Thermal Processes: Hot water, steam flooding, insitu combustion.

Other EOR Processes: Microbial, huff and puff, Water Alternating Gas (WAG), Steam Assisted Gravity Drainage (SAGD).

Case histories from Petroleum Literature.

Reference Books:


Supplemental papers from the literature
d) Advanced Offshore Technology

Teaching Scheme: Examination
Duration: 3 Hours.

Lectures: 4 Hours/Week

Paper: 100 Marks

Introduction: sea and sub sea environment, water depths, waves, wind and ocean currents. introduction to offshore oil and gas system.


Overview of subsea systems.

Methods of Station Keeping: Mooring systems, dynamic positioning, tensioning systems, surface motion compensation.

Testing: Downhole testing equipment, methods and types of test analysis. Production testing, completion and abandonment.

Transportation: Offshore pipelines, tankers, offshore separation facilities and storage.

Environmental Assessment.

Diving System: History, commercial diving, physiological constraints, diving capabilities and equipment, safety procedures.

Reference Books:


Stewart H. R. : Drilling and Producing Offshore, PennWell Pubs.


512112  Elective IV (Open)

a) Piping Engineering and Technology

Teaching Scheme:
Lectures: 3 Hrs/Week

Examination Scheme:
Paper: 100 Marks.
Duration: 3 Hrs.

Pipeline systems definition and applications, codes and standard related to pipelines. Pipeline hydraulics: single phase gas and liquids, multiphase fluids and heavy /waxy crude. Design considerations for strength, stability and installation. Pipeline materials and components. design aspects, covering such issues as risers, slug catchers, pigging facilities, etc. Basic design considerations for pipeline facilities. Pipeline construction for cross country and offshore systems focusing on welding. Pressure testing, pre-commissioning and commissioning Pipeline integrity aspects including inline inspection. Leak detection and emergency planning considerations


Piping systems for petroleum products, yard piping; fire fighting, distillation and heat exchangers. Long distance pipelines.


Environmental Assessment.

Reference books:


Supplemental papers from the literature
512112  Elective IV (Open)

b) Technology of Coal Bed Methane

Teaching Scheme: Examination
Scheme:
Lectures: 4 Hours/Week Paper: 100 Marks
Duration: 3 Hours.

CBM: Fundamentals of coal geology, sedimentology of coal, coal measures, diageneiss of coal/kerogen, coal gas generation and composition, measuring gas content, gas composition and capacity, reservoir characteristics like porosity, permeability system, diffusion and fractures.

CBM well planning, drilling, formation evaluation, completion and production.

Well Testing: Completion design and technique and open hole completions, fractures and cavity completions, artificial lift design.

Production Fundamentals: Equipment planning and design, gathering, processing and transportation, efficiency dewatering technique, reducing producing bottomhole pressure matrix shrinkage impact, infill drilling.

CBM reservoir engineering aspects like simulation, development and prediction, gas in place, effects of ash and moisture, use of well logs, estimating of porosity and permeability.

Environmental and Safety aspects of CBM production.

Reference Books:


Gayer, R. Harris, I : Coal Bed Methane and Coal Geology.


512112  Elective IV (Open)

c) Unconventional Hydrocarbon Resources and Development Strategies

Teaching Scheme: Examination
Scheme: Paper: 100 Marks
Lectures: 4 Hours/Week Duration: 3 Hours.

Resources of oil and gas as conventional hydrocarbon sources, scenario in a crude oil depleted world, alternatives available.

Non-conventional petroleum resources, Economic and environmental considerations of the above fuels.

Synthetic fuels: Nonconventional raw materials other than crude oil as feedstock. Strategic needs for synthetic fuels. Options such as methanol, ethanol, medium calorific value gas, Hydrogen.

Criteria for consideration as a nonconventional raw material for synfuel. description of raw materials. Description and characteristics of liquids and gaseous synfuel options.

Mass Energy Transformations. Energy, Economics and Environment. Introduction to conversion technologies:

Reference Books


Supplemental papers from the literature
Lab Practice II

Teaching Scheme: Examination
Scheme: Practical: 6 Hours/Week
Marks: Term Work: 50

Each candidate should perform at least two experiments from each group from the following list given below and submit the journal which will form the term work for the subject.

Group I: Study of Production Engineering design problems
Group II: Study of Geographical Information Systems.
Group III: Study of numerical solutions related to problems in Petroleum engineering using MATLAB or equivalent mathematical software package.
Group IV: Computer programming assignments for Reservoir Simulation.
Group V: (a) Conceptual and mechanical design of a simple experiment to illustrate a reservoir rock/fluid property.
(b) Study of corrosion of metals.
(c) Study of Gas Chromotography to analyse hydrocarbons.
(d) Study of properties of LPG.
(e) ASTM Distillation
(f) Chemical analysis of water.

Seminar II

Teaching Scheme: Examination
Scheme: Practical: 1 Hour/Week
Marks: Term Work: 50

Each student is required to deliver a seminar in the second semester and submit a report of about 30 typed pages. Topic of the seminar should be based on the chosen discipline of research suggesting current trends in advanced research. It should be based on literature survey related to identified problem for research.
512115  Seminar III

Teaching Scheme: Examination
 Scheme:
Practicals: 4 Hour/Week  Term Work: 50
Marks

Each student is required to deliver a seminar in the third semester based on the chosen discipline of research for dissertation work.

512114  Dissertation Stage I

Teaching Scheme: Examination
 Scheme:
Practicals: 18 Hours/Week  Term Work: 50
Marks

Students, under the supervision of an internal teacher and/or an external teacher/guide, should, undertake a project in a specialized area of Petroleum Engineering. They should first undertake an extensive library search for articles/books/web sites on the required topic.

512114  Dissertation Stage II

Teaching Scheme: Examination
 Scheme:
Practicals: 18 Hours/Week  Term Work: 200
Marks
  Oral: 50 Marks

Students should, under the supervision of an internal teacher and/or an external teacher/guide undertake to do a project in a specialized area of Petroleum Engineering. They should first undertake an extensive library search for articles/books/web sites on the required topic. This work should be a solution to an original practical problem or original research work related to Petroleum Engineering. The final typed dissertation should clearly state the problem, work accomplished and conclusions. The typed dissertation work should be ready before the oral defense.