

Skill Enhancement Courses (SEC)

Course Code	Course Name	Level	L	T	P	C	CIE	SEE	Total	Pre-requisite
241PT019	MATLAB For Petroleum Engineers Lab	IC			2	2	50	50	100	-
241PT051	Well Control & Pressure Control Lab	IC			1	1	100	-	100	-
241PT020	Petroleum Equipment Design & Simulation Lab	IC			2	2	50	50	100	SPO
241PT018	Drilling Simulation Lab	AC			2	2	50	50	100	-
241PT021	Unit Operations Using SCI Lab	AC			2	2	50	50	100	FMPE & HTPO
Total					9	9				

MATLAB for Petroleum Engineers Lab

Course Code: 241PT019

L	T	P	C
0	0	2	2

Course Outcomes: At the end of the Course, Student will be able to:

- CO1:** Develop a program to create geological model using simple matlab code.
- CO2:** Make use of different homogeneous models for geological layers.
- CO3:** Apply the concepts of flow models in porous media.
- CO4:** Build grids of structured, unstructured and complex grids.
- CO5:** Develop GUI for the Grids Generated using the MRST

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	2	-	-	3	-	-	-	1	-	-
CO2	2	2	-	-	3	-	-	-	1	-	-
CO3	2	2	-	-	3	-	-	-	1	-	-
CO4	2	2	-	-	3	-	-	-	1	-	-
CO5	2	2	-	-	3	-	-	-	1	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	3	-
CO2	-	3
CO3	3	-
CO4	-	-
CO5	-	-

List of Practices

1. Data representation, error analysis, introduction to MATLAB; Applied MATLAB programming
2. Structured programming and looping
3. Numerical solution of algebraic and transcendental equations.
4. Create a geological model is a grid describing the geometry of the reservoir rock, here chosen as a regular $1 \times 1 \times 30$ Cartesian grid.
5. Curve fitting: Straight line fit, polynomial curve fit and exponential curve Fit.
6. Numerical integration: Trapezoidal rule, Simpson's one-third rule, Simpson's three-eighth rule,
7. Solution of simultaneous algebraic equations: Gauss elimination method.

8. Numerical solution of ordinary differential equation: Taylor's method, Euler's method, Runge- Kutta method, modified Euler's method; Predictor corrector method: Adam's method and Milne's method.
9. consider a reservoir consisting of a homogeneous $500 \times 500 \times 25$ m³ sand box with an isotropic permeability of 100 mD, represented on a regular $20 \times 20 \times 5$ Cartesian grid.
10. Optimization algorithms and introduction to Simulink.

Additional Practices:

1. Consider a homogeneous reservoir in the form of a 2D rectangle $[0,4] \times [0,1]$. Flow is driven from the north to the south side of the reservoir by a fluid source with unit rate located at $(2,0.975)$
2. Construct a Radial symmetric grids graded towards the origin are commonly used to increase resolution near wells.
3. Construct an areal Voronoi grid from a set of generating points obtained by perturbing the vertices of a regular Cartesian grid and then use the function `makeLayeredGrid` to extrude this Voronoi grid to 3D along vertical pillars in the z-direction.

Textbooks:

- 1 Knut-Andreas Lie ,An introduction to reservoir simulation using matlabgnu and Octave, User Guide for the MATLAB Reservoir Simulation Toolbox (MRST),Cambridge press, 2019 eISBN: 9781108492430
- 2 Chapra, S., "Applied Numerical Methods with MATLAB for Engineers and Scientists", Edition: 4, McGraw-Hill Education (2017). eISBN: 9780077144883

Reference Books:

- 1 Pratap, R. "Getting Started with MATLAB: A Quick Introduction for Scientists & Engineers", Ox- ford University Press, (2010). eISBN: 9780199731244
- 2 Ahuja, P. "Introduction to Numerical Methods in Chemical Engineering", PHI Learning Pvt., Edi- tion: 2 (2019). eISBN: 9789389347173

Web Links:

- 1 <https://www.mathworks.com/academia/books/an-introduction-to-reservoir-simulation-using-matlab-gnu-octave-lie.html>
- 2 <https://www.sintef.no/contentassets/8af8db2e42614f7fb94fb0c68f5bc256/mrst-book-2016.pdf>
- 3 <https://www.cambridge.org/core/books/an-introduction-to-reservoir-simulation-using-matlabgnu-octave/modeling-reservoir-rocks/D54C1FD08E64FDD810436E0651E40650>

Well Control & Pressure Control Lab

Course Code: 241PT051

L	T	P	C
0	0	1	1

Course Outcomes:

At the end of the Course, Student will be able to:

- CO 1: Make use of excel to solve the area and volume calculations.
- CO 2: Calculate the examples related to volume, capacities and displacements
- CO 3: Explain the well control risk and borehole geometry
- CO 4: Study and solve the gas laws and its characteristics
- CO 5: Study the concept of circulating system.

Mapping of course outcomes with program outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	-	2	2	-	2	-	-	-	2	-	-
CO2	-	2	2	-	2	-	-	-	2	-	-
CO3	-	3	3	-	3	-	-	-	2	-	-
CO4	-	3	3	-	3	-	-	-	2	-	-
CO5	-	3	3	-	3	-	-	-	2	-	-

Mapping of course outcomes with program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	2	-
CO2	2	-
CO3	2	-
CO4	2	-
CO5	2	-

List of Experiments:

1. **Introductory Concepts: Areas and Volumes**
 - I. Perimeter and area
 - II. Units of area
 - III. Angles
 - IV. Areas of regular shapes
 - V. Conservation of area
2. **Volumes, Capacities and Displacements**
 - I. Calculating mud pit volumes and capacity
 - II. Calculating the volume of a cylinder
 - III. Calculating the capacity of a cylinder in bbl/ft
 - IV. Calculating annular volumes
 - V. Calculating annular capacities
 - VI. Calculating drill pipe, casing and tubing capacities
 - VII. Calculating metal displacement
 - VIII. Calculating closed end displacements

3. **Well Control Risks When Tripping**
 - I. Tripping 'dry' and tripping 'wet'
 - II. Tripping into the well
 - III. Tripping out of the well
 - IV. Trip tanks
 - V. Trip sheets
4. **Borehole Geometry**
 - I. Drill string capacity and annular volumes
 - II. Surface and subsea well geometry
 - III. Calculating drill string capacity and annular volumes for a surface well
 - IV. Calculating drill string capacity and annular volumes for a subsea well
5. **Gas and its characteristics**
 - I. Gas and gas characteristics
 - II. Gas mass
 - III. Gas density
 - IV. Pressure gradient
6. **Gas Laws**
 - I. How gas changes with pressure
 - II. Gas density changes with pressure
 - III. High pressure gases
 - IV. Ideal gas law
7. **Accumulator bottles**
 - I. Accumulator capacity calculations
 - II. Accumulator pre-charge
 - III. Accumulator minimum operating pressure
 - IV. Accumulator maximum operating pressure
 - V. Useable hydraulic fluid volume
8. **The Circulating System**
 - I. Understanding pump pressure
 - II. Combining several pipe sections into a system
 - III. The drilling circulating system
 - IV. Mud pump pressure in a circulating system
 - V. Changes in pump rate
 - VI. Changes in drilling fluid density
9. **Effect of Circulation on Bottomhole Pressure**
 - I. The effect of circulating pressures on bottomhole pressure (BHP)
 - II. The effect of annular pressure loss on BHP
 - III. Equivalent circulating density (ECD)
10. **Pump outputs, Strokes and Circulating time**
 - I. Pump output and pump strokes
 - II. Calculating the required number of strokes
 - III. Calculating the time required to pump a volume of fluid
 - IV. Using both formulas with given well data

Reference Books:

1. "Drilling Engineering" by J.J. Azar and G. Robello Samuel ISBN: 978-0750678613
2. "Applied Drilling Engineering" by Adam T. Bourgoyne Jr., et al. ISBN: 978-0884152585

Web Links:

- I. <https://iwcf.org/well-control-pressure-calculations/#/>

Petroleum Equipment Design & Simulation Lab

Course Code: 241PT020	L	T	P	C
	0	0	2	2

Course Outcomes:

At the end of the Course, Student will be able to:

- CO1: Design and simulation of the two-phase, three phase separators and compressors
- CO2: Design and simulation of absorber-stripper unit for removal of CO₂ and H₂S from natural gas
- CO3: Size /rate the pipeline & pumping systems for liquid pumping & simulate water hammer conditions
- CO4: Design and simulation of flash vaporization units
- CO5: Generating sized equipment data sheets as per the industry standards with required information fordetailed design / manufacture

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	-	-	-	-	2	-	-	-	2	2	1
CO2	-	-	-	-	2	-	-	-	2	2	1
CO3	-	-	-	-	2	-	-	-	2	2	1
CO4	-	-	-	-	2	-	-	-	2	2	1
CO5	-	-	-	-	2	-	-	-	2	2	1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	-	2
CO2	-	2
CO3	-	2
CO4	-	2
CO5	-	2

List of Practices:

1. Study Oil- Water separator
2. Study Gas- Oil-Water separator
3. Study Lean / rich amine heat exchanger
4. Study Air-cooled heat exchanger.
5. Study CO₂ and H₂S absorber unit using, MEA/DEA amine solution.
6. Study Stripping unit
7. Study Single stage flash vaporization unit

8. Study three stage flash vaporization unit.
9. Study Liquid pumping system & simulation of water-hammer phenomena
10. Study Gas Compressor unit

List of Additional Practices:

1. Study Expander
2. Study Conversion Reaction
3. Study Equilibrium Reaction

Reference Books:

1. Process Modeling, Simulation and Control for Chemical Engineering, Luyben, McGraw Hill Education; 2 editions, 2013. eISBN: 9780070391598
2. Optimization of Chemical Processes, Thomas F. Edgar, David M. Himmelblau, Thomas E. Casson, 2nd Edition, 2001. eISBN: 9780071189774
3. Elements of Chemical Reaction Engineering, Fogler H.S, Prentice Hall India Learning Private Limited; 4 edition, 2008. eISBN: 9780131278394

Web Links:

1. https://petrowiki.org/Oil_and_gas_separators
2. <http://www.thermopedia.com/content/551/>
3. https://en.wikipedia.org/wiki/Amine_gas_treating
4. www.chemprosys.com/products/evaporators/multi-stage-flash/
5. <https://worldwidescience.org/topicpages/w/water+hammer+phenomena.html>

Drilling Simulation Lab

Course Code: 241PT018

L T P C
0 0 2 2

Course Outcomes: At the end of the Course, Student will be able to:

- CO1:** Evaluate the suitability of drilling Simulator by performing different laboratory tests
- CO2:** Analyse the effect of adding different drilling parameters with simulation
- CO3:** Analyse the effect of adding different kick parameters with simulation
- CO4:** Estimate the kick by using methods.
- CO5:** Function effectively as an individual, and as a member or leader while performing lab experiments.

Mapping of Course Outcomes with Program Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	-	-	-	-	-	-	2	-	-	-
CO2	2	-	-	-	-	-	-	2	-	-	-
CO3	2	-	-	-	-	-	-	2	-	-	-
CO4	2	-	-	-	-	-	-	2	-	-	-
CO5	2	-	-	-	-	-	-	3	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1	-	2
CO2	2	-
CO3	-	2
CO4	2	-
CO5	-	-

List of Practices:

1. Drilling a vertical well up to a certain depth using the various drilling systems such as the hoisting system and the rotary system.
2. Calculation and monitoring of all the drilling parameters such as the drilling rate (rate of penetration, ROP), rotary speed, drill pipe pressure, casing pressure, mud weight etc.
3. Setting up of a situation where a kick is induced into a well and fixing it using the driller's method (two circulation method). Preparation of a kill sheet.
4. Resolving a kick using the wait of weight method (Engineer's method, one circulation method). Preparation of a kill sheet.
5. Resolving a kick using the volumetric method. Preparation of a kill sheet.
6. Resolving a kick using the concurrent method. Preparation of a kill sheet.
7. Resolving the drilling problem when a choke is plugged.
8. Resolving a drilling problem when a choke is washed out.

9. Resolving a drilling problem when a bit nozzle is plugged.
10. Evaluate the effect of differential sticking on drilling.

Additional Practices:

1. Resolving a drilling problem when the well is packed-off.
2. Evaluate the effect of surge and swabbing on drilling.

Text Books:

- 1 Lab Manual For Drilling Simulator

Reference Books:

- 1 Well Control Problems Solutions : Neal A J.dams 1983 eISBN: 9780878141241

Unit Operations Using SCI Lab

Course Code: 241PT021

L T P C
0 0 2 2

Course Outcomes: At the end of the Course, Student will be able to:

- CO1:** Develop simulation to optimize column performance with Distillation Column.
- CO2:** Make use of various methods to determine heat transfer coefficients.
- CO3:** Apply hydrodynamics and reaction kinetics within fluidized bed systems
- CO4:** Develop empirical models to predict pump performance under varying conditions
- CO5:** Simulate the evaporation of a liquid in a single-effect or multi-effect evaporator

Mapping of Course Outcomes with Program Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	2	-	-	3	-	-	-	1	-	-
CO2	2	2	-	-	3	-	-	-	1	-	-
CO3	2	2	-	-	3	-	-	-	1	-	-
CO4	2	2	-	-	3	-	-	-	1	-	-
CO5	2	2	-	-	3	-	-	-	1	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1	3	-
CO2	-	3
CO3	3	-
CO4	-	3
CO5	2	-

List of Practices:

1. **Distillation Column Simulation:**
Simulate the operation of a distillation column to separate a binary mixture using the McCabe-Thiele method or other equilibrium-based approaches.
2. **Heat Exchanger Performance Analysis:**
Analyze the heat transfer characteristics of a shell-and-tube heat exchanger under various operating conditions.
3. **Fluidized Bed Reactor Simulation:**
Simulate the behavior of a fluidized bed reactor for gas-solid reactions and investigate the effects of different parameters on reactor performance.
4. **Pump Performance Curve Estimation:**
Estimate the performance curve of a centrifugal pump by analyzing its head-flow characteristics using experimental data.
5. **Mixer-Settler Design and Optimization:**
Design and optimize a mixer-settler unit for liquid-liquid extraction processes, considering factors such as residence time and phase distribution.

6. Fluid Flow in Pipes:
Analyze the pressure drop and flow characteristics of fluids in pipes of different diameters and lengths using SCILAB's fluid dynamics simulation capabilities.
7. Solid-Liquid Filtration Experiment:
Simulate the filtration process in a filter press or filter medium to determine the filtration rate, cake formation, and pressure drop.
8. Crystallization Process Modelling:
Model the crystallization process in a batch or continuous crystallizer to predict crystal size distribution and yield under varying conditions.
9. Evaporation Process Simulation:
Simulate the evaporation of a liquid in a single-effect or multi-effect evaporator to determine heat transfer coefficients and evaporation rates.
10. Absorption Tower Design:
Design and analyze the performance of a packed or tray absorption tower for gas-liquid mass transfer processes, such as CO₂ removal from flue gases.

Additional Practices:

1. Centrifugation Experiment:
Analyze the separation efficiency of a centrifuge for solid-liquid or liquid-liquid separation processes and optimize operating parameters.
2. Fluid Mixing Analysis:
Investigate the mixing efficiency and time required to achieve homogeneity in a stirred tank reactor or mixing vessel under different agitation speeds.
3. Gas-Liquid Mass Transfer Experiment:
Study the mass transfer characteristics of a gas-liquid contactor, such as a bubble column or stirred tank, for absorption or stripping processes.

Text Books:

- 1 Scilab Code for Unit Operations of Chemical Engineering, Warren L. McCabe, Julian C. Smith, Peter Harriott, McGraw Hill, 2010. eISBN: 0-07-112738-0
- 2 Introduction to Scilab: For Engineers and Scientists, Sandeep Nagar, APress; 1st ed. Edition, 2017. eISBN: 978-1484231959

Reference Books:

- 1 Introduction to Scilab, Rachna Verma, Arvind Verma, independently published, 2018. eISBN: 9789353008390
- 2 Scilab: from Theory to Practice - I. Fundamentals, Philippe Roux, Éditions D-BookeR, 2016 eISBN: 9782822702928

Web Links:

- 1 <https://www.opensourceforu.com/2015/05/using-scilab-with-the-mccabe-thiele-method/>
- 2 <https://www.colan.org/process-modeling-component/scilab-unit-operation/>
- 3 <https://kpriet.ac.in/stories/898/dynamic-simulation-of-a-distillation-column-in-dwsim>
- 4 <http://surl.li/tvqos>
- 5 <http://surl.li/tvqok>