VISVESVARAYA TECHNOLOGICAL UNIVERSITY
BELAGAVI

BE/B.TECH Scheme of Teaching and Examinations
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
(Effective from the Academic Year 2018-2019)
### III - SEMESTER

**B. E. PETROCHEM ENGINEERING**

Choice Based Credit System (CBCS) and Outcome Based Education (OBE)

**SEMESTER - III**

**TRANSFORM CALCULUS, FOURIER SERIES AND NUMERICAL TECHNIQUES**

(Common to all Programmes)

<table>
<thead>
<tr>
<th>Course Code</th>
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<th>CIE Marks</th>
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<tr>
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<td>03</td>
<td>Exam Hours</td>
<td>03</td>
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</tbody>
</table>

**Course Learning Objectives:**

- To have an insight into Fourier series, Fourier transforms, Laplace transforms, Difference equations and Z-transforms.
- To develop the proficiency in variational calculus and solving ODE’s arising in engineering applications, using numerical methods.

**Module-1**

**Laplace Transforms:** Definition and Laplace transform of elementary functions. Laplace transforms of Periodic functions and unit-step function – problems.

**Inverse Laplace Transforms:** Inverse Laplace transform - problems, Convolution theorem to find the inverse Laplace transform (without proof) and problems, solution of linear differential equations using Laplace transform.

**Module-2**

**Fourier Series:** Periodic functions, Dirichlet’s condition. Fourier series of periodic functions period $2\pi$ and arbitrary period. Half range Fourier series. Practical harmonic analysis, examples from engineering field.

**Module-3**

**Fourier Transforms:** Infinite Fourier transforms, Fourier sine and cosine transforms. Inverse Fourier transforms. Simple problems.

**Difference Equations and Z-Transforms:** Difference equations, basic definition, z-transform-definition, Standard z-transforms, Damping and shifting rules, initial value and final value theorems (without proof) and problems, Inverse z-transform. Simple problems.

**Module-4**

**Numerical Solutions of Ordinary Differential Equations (ODE’s):** Numerical solution of ODE’s of first order and first degree- Taylor’s series method, Modified Euler’s method. Range - Kutta method of fourth order, Milne’s and Adam-Bashforth predictor and corrector method (No derivations of formulae), Problems.

**Module-5**

**Numerical Solution of Second Order ODE’s:** Runge -Kutta method and Milne’s predictor and corrector method. (No derivations of formulae).

**Calculus of Variations:** Variation of function and functional, variational problems, Euler’s equation, Geodesics, hanging chain, problems.

**Course Outcomes:** At the end of the course the student will be able to:

- **CO1:** Use Laplace transform and inverse Laplace transform in solving differential/ integral equation arising in network analysis, control systems and other fields of engineering.
- **CO2:** Demonstrate Fourier series to study the behaviour of periodic functions and their applications in system communications, digital signal processing and field theory.
- **CO3:** Make use of Fourier transform and Z-transform to illustrate discrete/continuous function arising in wave and heat propagation, signals and systems.
- **CO4:** Solve first and second order ordinary differential equations arising in engineering problems using single step and multistep numerical methods.
- **CO5:** Determine the extremals of functionals using calculus of variations and solve problems arising in dynamics of rigid bodies and vibrational analysis.

**Question paper pattern:**
• The question paper will have ten full questions carrying equal marks.
• Each full question will be for 20 marks.
• There will be two full questions (with a maximum of four sub-questions) from each module.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Name of the Publisher</th>
<th>Edition and Year</th>
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</table>

Reference Books

<table>
<thead>
<tr>
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<th>Publisher</th>
<th>Edition and Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Advanced Engineering Mathematics</td>
<td>Chandrika Prasad and Reena Garg</td>
<td>Khanna Publishing,</td>
<td>2018</td>
</tr>
</tbody>
</table>

Web links and Video Lectures:
2. http://www.class-central.com/subject/math(MOOCs)
4. VTU EDUSAT PROGRAMME - 20
Course Learning Objectives: The students will
1. Learn basic laws about the behavior of gases, liquids and solids and some basic mathematical tools.
2. Understand systematic problem solving skills, enhance confidence, and generate careful work habits.
3. Learn what material balances are, how to formulate and apply them, how to solve them.
4. Learn what energy balances are, and how to apply them and finally, to learn how to deal with the complexity of big problems.

Module-1

UNITS AND DIMENSIONS:
Fundamental and derived units, Conversion, Dimensional consistency of equations, Dimensionless groups and constants, conversions of equations.

BASIC CHEMICAL CALCULATIONS:
Concept of mole, mole fraction, Compositions of mixtures of solids, liquids and gases, Concept of Normality, Molarity, Molality, ppm, Ideal gas law calculations.

Module-2

MATERIAL BALANCE WITHOUT REACTION:
General material balance equation for steady and unsteady state, Typical steady state material balances in distillation, absorption, extraction.

Module-3

MATERIAL BALANCE WITHOUT REACTION:
Drying, mixing and evaporation, Elementary treatment of material balances involving bypass, recycle and purging.

Module-4

STEADY STATE MATERIAL BALANCE WITH REACTION:
Principles of Stoichiometry, Concept of limiting, excess reactants and inerts, fractional and percentage conversion, fractional yield and percentage yield, selectivity, related problems, Ultimate and proximate analysis of fuels, Calculations involving burning of solid, liquid and gaseous fuels, excess air, air-fuel ratio calculations. 08 Hr

Module-5

ENERGY BALANCE:

Course Outcomes: On completion of this course the student will have
1. Clear idea of various types of unit systems and they will be able to convert units from one form of the unit to other.
2. Sound strategy for solving material and energy balance problems.
3. Adopt the tools learned from the course from the numerical problems which contain more than two unit operations.
4. Develop mathematical relations for mass balance and energy balances for any processes.

QUESTION PAPER PATTERN:
- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

TEXT BOOKS:

REFERENCE BOOKS:

**Course Learning Objectives:** The students will

1. Understand concepts on nature of fluids, pressure concepts and measurement of pressure by various experimental methods and by mathematical relations and enhancement of problem solving skills.
2. Learn detailed explanation on types of fluids, stress and velocity relations, type of fluid flow and boundary layer relations.
3. Understand relationship between kinetic energy, potential energy, internal energy and work complex flow systems using Bernoulli’s equation with application to industrial problems.
4. Understand clear concepts on Flow of incompressible fluids in conduits and thin layers and friction factor variations with velocity and friction losses using Bernoulli’s Equations and they will be demonstrated experimentally.
5. Study Flow of compressible fluids, Dimensional analysis, Dimensional homogeneity and various dimensionless numbers and their applications.
6. Understand principles and working of various types of pumps, transportation and metering of fluids using various experimental techniques and applications to industry.

### Module-1
**FLUID STATICS AND ITS APPLICATIONS:**
Concept of unit operations, Concept of momentum transfer, Nature of fluids and pressure concept, variation of pressure with height – hydrostatic equilibrium, Barometric equation, Measurement of fluid pressure – manometers, Continuous gravity decanter, Centrifugal decanter.

**FLUID FLOW PHENOMENA:**

### Module-2
**BASIC EQUATIONS OF FLUID FLOW:**
Average velocity, Mass velocity, Continuity equation, Euler and Bernoulli equations Modified equations for real fluids with correction factors, Pump work in Bernoulli equation, Angular momentum equation.

**FLOW OF INCOMPRESSIBLE FLUIDS IN CONDUITS AND THIN LAYERS:**
Laminar flow through circular and non-circular conduits, Hagen Poiseuille equation, Laminar flow of Non-Newtonian liquids, Turbulent flow in pipes and closed channels.

### Module-3
**FLOW OF INCOMPRESSIBLE FLUIDS IN CONDUITS AND THIN LAYERS:** (Contd..)
Friction factor chart, friction from changes in velocity or direction, Form friction losses in Bernoulli equation, Flow of fluids in thin layers.

**FLOW OF COMPRESSIBLE FLUIDS:**
Continuity equation, Concept of Mach number, Total energy balance, Velocity of sound, Ideal gas equations, Flow through variable-area conduits, Adiabatic frictional flow, Isothermal frictional flow (elementary treatment only).

### Module-4
**TRANSPORTATION AND METERING OF FLUIDS:**
Pipes, Fittings and valves, Measurement of fluid and gas flow rates by orifice meter, rotameter and pitot tube, Elementary concept of target meter, vortex-shedding meters, turbine meters, positive displacement meters, magnetic meters, coriolis meters and thermal meters, Flow through open channel-weirs and notches.

### Module-5
**PUMPS:**
Performance and Characteristics of pumps-positive displacement and centrifugal pumps, Fans, compressors, and blowers.
## INTRODUCTION TO UNSTEADY STATE FLOW:
Time to empty the liquid from the tank.

## DIMENSIONAL ANALYSIS:
Dimensional homogeneity, Rayleigh’s and Buckingham II- methods, Significance of different dimensionless numbers, Elementary treatment of similitude between model and prototype.

### Course Outcomes:
On completion of this course the students will be able to
- Analyze different types of fluids and able to measure pressure difference for flow of fluids.
- Understand and analyze the relationship between kinetic and potential energy, internal energy, work, and heat in complex flow systems using Bernoulli’s equation, perform macroscopic energy balances.
- Analyze and calculate friction factor for different types of flow in various types of constructions.
- Develop mathematical relations using Dimensional analysis by Rayleigh’s and Buckingham –\(\pi\) method.

### QUESTION PAPER PATTERN:
- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

### TEXT BOOKS:

### REFERENCE BOOKS:
B. E. PETROCHEM ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - III

PHYSICAL, ORGANIC AND INORGANIC CHEMISTRY

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<tr>
<td>Credits</td>
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<td>Exam Hours</td>
<td>03</td>
</tr>
</tbody>
</table>

Course Learning Objectives: The students will
1. To study the concept of atoms and molecules
2. To study the periodic properties of elements
3. To have a basic understanding about the classification and nomenclature of organic compounds.

Module-1

Physical Chemistry: General Topics - Concept of atoms and molecules; Dalton’s atomic theory; Mole concept; Chemical formulae; Balanced chemical equations; Calculations (based on mole concept) involving common oxidation-reduction, neutralisation, and displacement reactions; Concentration in terms of mole fraction, morality and normality.

Surface chemistry - Elementary concepts of adsorption (excluding adsorption isotherms); Colloids: types, methods of preparation and general properties; Elementary ideas of emulsions, surfactants and micelles.

Module-2

Organic Chemistry: General introduction, Hybridisation of carbon; Sigma and pi-bonds; Shapes of simple organic molecules; Structural and geometrical isomerism; Optical isomerism of compounds containing up to two asymmetric centres, (R,S and E,Z nomenclature excluded); IUPAC nomenclature of simple organic compounds (only hydrocarbons, mono-functional and bi-functional compounds); Conformations of ethane and butane (Newman projections); Resonance and hyper conjugation; Keto-enol tautomerism; Determination of empirical and molecular formulae of simple compounds (only combustion method).

Module-3

Organic Chemistry: Hydrogen bonds: definition and their effects on physical properties of alcohols and carboxylic acids; Inductive and resonance effects on acidity and basicity of organic acids and bases; Polarity and inductive effects in alkyl halides; Reactive intermediates produced during homolytic and heterolytic bond cleavage; Formation, structure and stability of carbocations, carbanions and free radicals.

Module-4

Inorganic Chemistry: Atomic Structure - Bohr model of hydrogen atom, Bohr’s equation for the energy of electron in hydrogen atom, the hydrogen spectrum, limitations of Bohr theory, photoelectric effect, idea of de Broglie matter waves, Heisenberg’s uncertainty principle and its significance, Schrodinger wave equation (derivation not expected), wave functions, significance of ψ (psi) and ψ^2, atomic orbitals, Nodal planes in atomic orbitals, quantum numbers (n, l, m), Zeeman effect, Stern-Gerlac experiment, spin quantum number (s), shapes of s, p and d orbitals. Aufbau and Pauli’s exclusion principles, Hund’s rule, energy level diagram of a multielectron atom, concept of effective nuclear charge, Slater’s rules and applications, Electronic configuration of atoms.

Module-5

Inorganic Chemistry: Periodic properties - Periodic trends in atomic volume, atomic and ionic radii, ionisation enthalpy, electron affinity(electron gain enthalpy), electronegativity and metallic character, Pauling’s electronegativity scale, Classification of elements as s, p, d & f block.

Course Outcomes:
- After studying this course, students will be able to: understand basic concept of physical, organic and inorganic chemistry.

QUESTION PAPER PATTERN:
- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

TEXT BOOKS:
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<tr>
<th>Reference Books</th>
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**REFERENCE BOOKS:**
B. E. PETROCHEM ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)

SEMESTER - III

INTRODUCTION TO PETROCHEMICAL ENGINEERING

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<tr>
<td>Exam Hours</td>
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Course Learning Objectives: This course will enable students to
1. Fundamental and methodologies in the petroleum refining processes

Module-1


Module-2


Module-3

Petroleum Products and Test Methods: Crude oil Analysis, Different types of fuels & their test methods (Domestic fuels, Automotive fuels, Aviation fuel, Furnace fuels, Lubricating Oil and Miscellaneous Products)

Module-4


Module-5


Course Outcomes:
- At the end of the course students are able understand the unit process involved in the petroleum refining process

QUESTION PAPER PATTERN:
- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

TEXT BOOKS:

REFERENCE BOOKS:
2. F. Abdulin, “Production of oil gas” Mir publishers, Moscow.
**B. E. PETROCHEM ENGINEERING**  
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)  
**SEMESTER - III**

### INSTRUMENTAL METHODS OF CHEMICAL ANALYSIS

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<tr>
<td>SEE Marks</td>
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</table>

**Course Learning Objectives:** This course enables students to:

The various modern analytical techniques like IR spectroscopy, AAS, Flame photometry, Radiochemical, Electrophoretic, Polarography, different chromatographic methods and other important topics are taught to enable the students to understand and apply the principles involved in the determination of different bulk drugs and their formulation. In addition to the theoretical aspects, the basic practical knowledge relevant to the analysis is also imparted.

#### Module-1


**Introduction, basic principles and instrumentation** - Infrared Spectroscopy, Flame Photometry, Atomic Absorption Spectroscopy and Mass Spectrometry.

#### Module-2

**Radiochemical Techniques** – Define radioactivity, half life of radioactive element, radioactive isotopes, Induced radioactivity, GM Counter, Gas ionization detector, Scintillation counter, Quenching, Radiodating, Radioactive tracer, Autoradiography, Radioimmuno assay.

**Electrophoretic Methods** – Principle, Types – free solution method and zone electrophoresis, Electrophoretic mobility, Factors affecting electrophoretic mobility.

#### Module-3


#### Module-4

**Introduction to Chromatography:** Classification - Theory - distribution coefficient, rate of travel, retention time, retention volume, adjusted retention volume, specific retention volume, column capacity, separation number, peak capacity, shapes of chromatic peak, column efficiency, resolution, optimization of column performance, Chromatogram, Void volume.

**Thin Layer Chromatography:** Stationary phase, mobile phase, sample application, development techniques – evaluation and documentation, advantages and disadvantages of TLC.

#### Module-5

**Gas Chromatography:** Principle, carrier gas, stationery phase, instrumentation, sample injection, column detectors (TCD, FID, ECD), effect of temperature on retention, qualitative and quantitative analysis.

**High Performance Liquid Chromatography:** Principle, instrumentation, column, sample injection, detectors (absorbance, refractive index, electrochemical), mobile phase selection, ion pair chromatography.

**Course Outcomes:** At the end of the course students are able

- To apply their knowledge in developing the new methods for the determination and validate the procedures.
- The appreciable knowledge will be gained by the students in the Modern Analytical Techniques and can apply the theories involved in the Analysis of various bulk drugs and their formulations.

**QUESTION PAPER PATTERN:**

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
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B. E. PETROCHEM ENGINEERING  
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)  
SEMESTER - III

**MOMENTUM TRANSFER LABORATORY**

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**Course Learning Objectives:** To enable the students to learn experimentally to calibrate flow meters, find pressure loss for fluid flows and determine pump characteristics.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Experiments</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>Calibration of Orifices meters</td>
</tr>
<tr>
<td>2</td>
<td>Calibration of Venturi meters</td>
</tr>
<tr>
<td>3</td>
<td>Flow through V-Notch</td>
</tr>
<tr>
<td>4</td>
<td>Centrifugal Pump</td>
</tr>
<tr>
<td>5</td>
<td>Pipe friction major loss Apparatus</td>
</tr>
<tr>
<td>6</td>
<td>Open orifice meter</td>
</tr>
<tr>
<td>7</td>
<td>C_n, C_o, &amp; C_d of an Orifice</td>
</tr>
<tr>
<td>8</td>
<td>Calibration of triangular notch</td>
</tr>
<tr>
<td>9</td>
<td>Viscosity measurement of Non-Newtonian fluids.</td>
</tr>
<tr>
<td>10</td>
<td>Characteristic curves of pumps</td>
</tr>
<tr>
<td>11</td>
<td>Pressure drop studies in packed column</td>
</tr>
<tr>
<td>12</td>
<td>Determination of drag coefficient</td>
</tr>
</tbody>
</table>

**Note:** Minimum 10 experiments are to be conducted

**Course Outcomes:**
The student would have practical knowledge on the measurement of fluid flow and their characteristics at different operating conditions.

**Conduct of Practical Examination:**
1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

**Reference Books:**
**B. E. PETROCHEM ENGINEERING**  
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)  
SEMESTER - III  

### MOMENTUM TRANSFER LABORATORY

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**Course Learning Objectives:** To enable the students to learn experimentally to calibrate flow meters, find pressure loss for fluid flows and determine pump characteristics.

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<tbody>
<tr>
<td>1</td>
<td>Estimation of ASTM Distillation</td>
</tr>
<tr>
<td>2</td>
<td>Estimation of TDP Distillation</td>
</tr>
<tr>
<td>3</td>
<td>Estimation of Red Vapour Pressure</td>
</tr>
<tr>
<td>4</td>
<td>Determination of Calorific Value of the fuel</td>
</tr>
<tr>
<td>5</td>
<td>Determination of Copper strip corrosion</td>
</tr>
<tr>
<td>6</td>
<td>Determination of Moisture Content</td>
</tr>
<tr>
<td>7</td>
<td>Determination of Sulphur Content</td>
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<td>8</td>
<td>Determination of Demulsibility number</td>
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<tr>
<td>9</td>
<td>Analysis of fertilizer</td>
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<tr>
<td>10</td>
<td>Determination of Aromatic Content Determination</td>
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<tr>
<td>11</td>
<td>Determination of foaming Characteristics</td>
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<td>12</td>
<td>Determination of Aniline Point</td>
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<tr>
<td>13</td>
<td>Analysis of coal- Moisture Volatile matter &amp; Ash content</td>
</tr>
<tr>
<td>14</td>
<td>Acid – Base Titration</td>
</tr>
</tbody>
</table>

**Note:** Minimum 10 experiments are to be conducted

**Course Outcomes:** Students would be able to understand basic principles involved in testing of Petroleum products by different techniques.

**Conduct of Practical Examination:**
- Minimum of 10 experiments are to be conducted and all 10 experiments are to be included for practical examination.
- Students are allowed to pick one experiment from the lot.
- Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.
- Change of experiment is allowed only once and 15% marks allotted to the procedure part to be made zero.

**Reference Books:**
### Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

#### Aadaliitha Kannada

<table>
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**Course Outline:**

- **Module 1:** Aadalitha Kannada
  - **Objective:**
    - Focus on the teaching hours and credits for the course.
  - **Teaching Hours/Week:** (0:2:0)
  - **Credits:** 01

**Course Details:**

- **Course Code:** 18KAK28/39/49
- **Teaching Hours/Week (L:T:P):** (0:2:0)
- **CIE Marks:** 100
- **Credits:** 01

**Aadalitha Kannada:**

- **Module 1:**
  - **Course Outline:**
    - Focus on the teaching hours and credits for the course.
  - **Teaching Hours/Week:** (0:2:0)
  - **Credits:** 01

**Course Details:**

- **Course Code:** 18KAK28/39/49
- **Teaching Hours/Week (L:T:P):** (0:2:0)
- **CIE Marks:** 100
- **Credits:** 01

**Aadalitha Kannada:**

- **Module 1:**
  - **Course Outline:**
    - Focus on the teaching hours and credits for the course.
  - **Teaching Hours/Week:** (0:2:0)
  - **Credits:** 01

**Course Details:**

- **Course Code:** 18KAK28/39/49
- **Teaching Hours/Week (L:T:P):** (0:2:0)
- **CIE Marks:** 100
- **Credits:** 01
### Course Learning Objectives:
The course will enable the students to understand Kannada and communicate in Kannada language.

### Table of Contents:
- Chapter - 1: Vyavaharika kannada – Parichaya (Introduction to Vyavaharika Kannada).
- Chapter - 2: Kannada Aksharamale haagu uchcharane (Kannada Alphabets and Pronunciation).
- Chapter - 3: Sambhashanegaagi Kannada Padagalu (Kannada Vocabulary for Communication).
- Chapter - 4: Kannada Grammar in Conversations (Sambhashaneyalli Kannada Vyakarana).
- Chapter - 5: Activities in Kannada.

### Course Outcomes:
At the end of the course, the student will be able to understand Kannada and communicate in Kannada language.

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<th>Course Code</th>
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<td>Credits</td>
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**B. E. PETROCHEM ENGINEERING**
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)

**SEMESTER - III**

**CONSTITUTION OF INDIA, PROFESSIONAL ETHICS AND CYBER LAW (CPC)**
(COMMON TO ALL PROGRAMMES)

<table>
<thead>
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<th>Course Code</th>
<th>18CPC39/49</th>
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</table>

**Course Learning Objectives:**

- To know the fundamental political codes, structure, procedures, powers, and duties of Indian government institutions, fundamental rights, directive principles, and the duties of citizens.
- Understand engineering ethics and their responsibilities; identify their individual roles and ethical responsibilities towards society.
- Know about the cybercrimes and cyber laws for cyber safety measures.

**Module-1**

**Introduction to Indian Constitution:**

**Module-2**

**Union Executive and State Executive:**

**Module-3**

**Elections, Amendments and Emergency Provisions:**

**Constitutional special provisions:**
Special Provisions for SC and ST, OBC, Women, Children and Backward Classes.

**Module-4**

**Professional / Engineering Ethics:**

**Module-5**

**Internet Laws, Cyber Crimes and Cyber Laws:**
Internet and Need for Cyber Laws, Modes of Regulation of Internet, Types of cyber terror capability, Net neutrality, Types of Cyber Crimes, India and cyber law, Cyber Crimes and the information Technology Act 2000, Internet Censorship. Cybercrimes and enforcement agencies.

**Course Outcomes:**
On completion of this course, students will be able to,

- CO 1: Have constitutional knowledge and legal literacy.
- CO 2: Understand Engineering and Professional ethics and responsibilities of Engineers.
- CO 3: Understand the cybercrimes and cyber laws for cyber safety measures.

**Question paper pattern for SEE and CIE:**
- The SEE question paper will be set for 100 marks and the marks scored by the students will proportionately be reduced to 60. The pattern of the question paper will be objective type (MCQ).
- For the award of 40 CIE marks, refer the University regulations 2018.
<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Name of the Publisher</th>
<th>Edition and Year</th>
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<tr>
<td>1</td>
<td>Constitution of India, Professional Ethics and Human Rights</td>
<td>Shubham Singles, Charles E. Haries, and et al</td>
<td>Cengage Learning India</td>
<td>2018</td>
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<td>2</td>
<td>Cyber Security and Cyber Laws</td>
<td>Alfred Basta and et al</td>
<td>Cengage Learning India</td>
<td>2018</td>
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**Reference Books**

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<th>Edition and Year</th>
</tr>
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<tr>
<td>3</td>
<td>Introduction to the Constitution of India</td>
<td>Durga Das Basu</td>
<td>Prentice –Hall,</td>
<td>2008</td>
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<tr>
<td>4</td>
<td>Engineering Ethics</td>
<td>M. Govindarajan, S. Natarajan, V. S. Senthilkumar</td>
<td>Prentice –Hall,</td>
<td>2004</td>
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</table>
B. E. CHEMICAL ENGINEERING
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - III

ADDITIONAL MATHEMATICS – I
(Mandatory Learning Course: Common to All Programmes)
(A Bridge course for Lateral Entry students under Diploma quota to BE/B. Tech. programmes)

Course Code: 18MATDIP31
CIE Marks: 40
Teaching Hours/Week (L:T:P): (2:1:0)
SEE Marks: 60
Credits: 0
Exam Hours: 03

Course Learning Objectives:
• To provide basic concepts of complex trigonometry, vector algebra, differential and integral calculus.
• To provide an insight into vector differentiation and first order ODE’s.

Module-1
Complex Trigonometry: Complex Numbers: Definitions and properties. Modulus and amplitude of a complex number, Argand’s diagram, De-Moivre’s theorem (without proof).

Module-2

Module-3

Module-4
Integral Calculus: Review of elementary integral calculus. Statement of reduction formulae for \( \sin^n x, \cos^n x, \) and \( \sin^n x \times \cos^n x \) and evaluation of these with standard limits-Examples. Double and triple integrals, problems.

Module-5

Course Outcomes: At the end of the course the student will be able to:
• CO1: Apply concepts of complex numbers and vector algebra to analyze the problems arising in related area.
• CO2: Use derivatives and partial derivatives to calculate rate of change of multivariate functions.
• CO3: Analyze position, velocity and acceleration in two and three dimensions of vector valued functions. CO4: Learn techniques of integration including the evaluation of double and triple integrals.
• CO5: Identify and solve first order ordinary differential equations.

Question paper pattern:
• The question paper will have ten full questions carrying equal marks.
• Each full question will be for 20 marks.
• There will be two full questions (with a maximum of four sub- questions) from each module.

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<thead>
<tr>
<th>Sl. No.</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Name of the Publisher</th>
<th>Edition and Year</th>
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<tbody>
<tr>
<td></td>
<td>Reference Books</td>
<td></td>
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</tr>
</tbody>
</table>
### IV-SEMESTER

#### B. E. PETROCHEM ENGINEERING

Choice Based Credit System (CBCS) and Outcome Based Education (OBE)

**SEMESTER - IV**

**COMPLEX ANALYSIS, PROBABILITY AND STATISTICAL METHODS**

(Common to all programmes)

[As per Choice Based Credit System (CBCS) scheme]

<table>
<thead>
<tr>
<th>Course Code</th>
<th>18MAT41</th>
<th>CIE Marks</th>
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</thead>
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<tr>
<td>Credits</td>
<td>03</td>
<td>Exam Hours</td>
<td>03</td>
</tr>
</tbody>
</table>

**Course Learning Objectives:**
- To provide an insight into applications of complex variables, conformal mapping and special functions arising in potential theory, quantum mechanics, heat conduction and field theory.
- To develop probability distribution of discrete, continuous random variables and joint probability distribution occurring in digital signal processing, design engineering and microwave engineering.

**Module-1**

**Calculus of complex functions:** Review of function of a complex variable, limits, continuity, and differentiability. Analytic functions: Cauchy-Riemann equations in Cartesian and polar forms and consequences.

**Construction of analytic functions:** Milne-Thomson method-Problems.

**Module-2**

**Conformal transformations:** Introduction. Discussion of transformations: \( w = z^2, w = e^z, w = z + \frac{1}{z}, (z \neq 0). \) Bilinear transformations- Problems.

**Complex integration:** Line integral of a complex function-Cauchy’s theorem and Cauchy’s integral formula and problems.

**Module-3**

**Probability Distributions:** Review of basic probability theory. Random variables (discrete and continuous), probability mass/density functions. Binomial, Poisson, exponential and normal distributions- problems (No derivation for mean and standard deviation)-Illustrative examples.

**Module-4**

**Statistical Methods:** Correlation and regression-Karl Pearson’s coefficient of correlation and rank correlation -problems. Regression analysis- lines of regression –problems.

**Curve Fitting:** Curve fitting by the method of least squares- fitting the curves of the form: \( y = ax + b, y = ax^b \) and \( y = ax^2 + bx + c. \)

**Module-5**

**Joint probability distribution:** Joint Probability distribution for two discrete random variables, expectation and covariance.

**Sampling Theory:** Introduction to sampling distributions, standard error, Type-I and Type-II errors.

Test of hypothesis for means, student’s t-distribution, Chi-square distribution as a test of goodness of fit.

**Course Outcomes:**
At the end of the course the student will be able to:
- Use the concepts of analytic function and complex potentials to solve the problems arising in electromagnetic field theory.
- Utilize conformal transformation and complex integral arising in aerofoil theory, fluid flow visualization and image processing.
- Apply discrete and continuous probability distributions in analyzing the probability models arising in engineering field.
- Make use of the correlation and regression analysis to fit a suitable mathematical model for the statistical data.
- Construct joint probability distributions and demonstrate the validity of testing the hypothesis.

**Question paper pattern:**
- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub-questions) from each module.

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<tr>
<th>Sl. No.</th>
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<th>Authors</th>
<th>Publisher</th>
<th>Edition and Year</th>
</tr>
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<tbody>
<tr>
<td>5</td>
<td>Advanced Engineering Mathematics</td>
<td>Chandrika Prasad and Reena Garg</td>
<td>Khanna Publishing</td>
<td>2018</td>
</tr>
</tbody>
</table>

**Web links and Video Lectures**

1. [http://nptel.ac.in/courses.php?disciplineID=111](http://nptel.ac.in/courses.php?disciplineID=111)
2. [http://www.class-central.com/subject/math(MOOCs)](http://www.class-central.com/subject/math(MOOCs))
4. [VTU EDUSAT PROGRAMME - 20](http://academicearth.org/)
### B. E. PETROCHEM ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)

#### SEMESTER - IV

**CHEMICAL ENGINEERING THERMODYNAMICS**

<table>
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<tr>
<th>Course Code</th>
<th>CIE Marks</th>
<th>SEE Marks</th>
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<tr>
<td>18CH42</td>
<td>40</td>
<td>60</td>
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**Course Learning Objectives:** The students will

1. Learn fundamentals of thermodynamics such as types of properties, processes and laws of thermodynamics for flow and non-flow process.
2. Understand the clear concepts on P-V-T behavior, Equations of state, thermodynamic diagrams and compressibility charts, entropy, irreversibility and problem solving skills.
3. Learn the thermodynamic properties of pure fluids, energy relations and fugacity concepts.
4. Study the estimation of partial molar properties, property changes of mixing, and ideal and non ideal solutions.
5. Learn the fundamentals of phase equilibrium, concept of chemical potential and generation and consistency check for VLE data.
6. Understand fundamentals of chemical reaction equilibrium to find feasibility and extent of conversion for the industrial reactions.

#### Module-1

**BASIC CONCEPTS:** System, Surrounding and processes, Closed and Open systems, state and Properties, Intensive and Extensive Properties, State and Path functions, equilibrium state and Phase rule, Zeroth law of thermodynamics, Heat reservoir and Heat engines, Reversible and Irreversible processes.

**FIRST LAW OF THERMODYNAMICS:** General statement of First law of thermodynamics, First law for cyclic process and non-flow processes, Heat capacity.

**HEAT EFFECTS ACCOMPANYING CHEMICAL REACTIONS:** Standard heat of reaction, formation, combustion, Hess’s law of constant heat summation, effect of temperature on standard heat of reaction.

#### Module-2

**P-V-T BEHAVIOUR:** P-V-T behavior of pure fluids, Equations of state and ideal gas law, Processes involving ideal gas law: Constant volume, constant pressure, constant temperature, adiabatic and polytropic processes. Equation of state for real gases: vander Waals equation, Redlich – Kwong equation, Peng – Robinson equation, Virial equation, Compressibility charts: Principles of corresponding states, generalized compressibility charts.

**SECOND LAW OF THERMODYNAMICS:** General statements of the Second law, Concept of Entropy, The Carnot Principle, calculation of entropy changes, Clausius Inequality, Entropy and Irreversibility, Third law of Thermodynamics.

#### Module-3


#### Module-4

**PROPERTIES OF SOLUTIONS:** Partial molar properties, Chemical potential, Fugacity in solutions, Henry’s law and dilute solutions, activity in solutions, Activity coefficients, Gibbs – Duhem’s equation, Property changes of mixing, excess properties.

#### Module-5

**PHASE EQUILIBRIA:** Criteria of phase Equilibria, Criterion of stability, Duhem’s theorem, Vapor – Liquid Equilibria, VLE in ideal solutions, Non-Ideal solutions, VLE at low pressures, VLE at high pressures, consistency test for VLE data, Calculation of Activity coefficients using Gibbs – Duhem’s equation.

**CHEMICAL REACTION EQUILIBRIUM:** Reaction Stoichiometry, Criteria of chemical reaction equilibrium, Equilibrium constant and standard free energy change, Effect of temperature, Pressure on equilibrium constants and other factors affecting equilibrium conversion, Liquid phase reactions, heterogeneous reaction equilibrium, phase rule for reacting systems.

**Course Outcomes:** The students are expected to do the following
1. Calculate the heat and work requirements for the given flow or non-flow processes.
2. Analyze and find properties such as Pressure, Volume and temperature for equations of states and from the fundamentals of first law of thermodynamics.
3. Calculate entropy for the processes, and various types of energies such as internal energy, enthalpy, Helmholtz free energy and Gibbs free energy.
4. Differentiate between ideal and non-ideal solution and estimate partial molar properties.
5. Generate Vapor Liquid Equilibrium data for ideal and non-ideal solutions and check for their consistency by various methods.
6. Find the feasibility and extent of conversion for any reaction.

**QUESTION PAPER PATTERN:**
- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**TEXT BOOKS:**

**REFERENCE BOOKS:**
B. E. PETROCHEM ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - IV
PETROLEUM REFINERY ENGINEERING

Course Code 18PC43  CIE Marks 40
Teaching Hours/Week (L:T:P) (3:0:0)  SEE Marks 60
Credits 03  Exam Hours 03

Course Learning Objectives: This course will enable students to
- Fundamental and methodologies in the petroleum refining processes.

Module-1

Module-2

Module-3
Crude Pretreatment: Pumping of crude oils. Dehydration of crude by chemical, gravity, centrifugal, electrical de-salter and comparison of each. Heating of crude- heater, different types of pipe still heaters including box type, cylindrical etc. Crude distillation, arrangement of towers for various types of reflux. Design aspects for atmospheric and vacuum column. Atmospheric distillation distillation unit: internals and operational.

Module-4

Module-5
Catalytic Reforming: Theory of reforming. Factors influencing reforming, reforming catalysts, feedstock requirements. Plat-forming, isoplus hondriforming, refining forming, power forming and flexi forming etc.

Course Outcomes: At the end of the course students are able understand the unit process involved in the petroleum refining process.

QUESTION PAPER PATTERN:
- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

TEXT BOOKS:
REFERENCE BOOKS:
TECHNOLOGY OF INTERMEDIATE PETROCHEMICALS

Course Code: 18PC44
CIE Marks: 40
Teaching Hours/Week (L:T:P): (3:0:0)
SEE Marks: 60
Credits: 03
Exam Hours: 03

Course Learning Objectives:
This course will enable students to expose to process industries of engineering importance

- Able to identify unit operations & unit process involved
- Able to understand lay out of material flow diagrams
- Terminology of equipment’s employed
- Identify problems associated & involved at manufacturing activities
- Identify feed stocks & by-products involved at manufacturing activities.

Module-1
**Petrochemicals** – Definition, Petrochemical Industries in India, Petrochemical Industry Characteristics, Principal raw materials.

**Petroleum Industries** – Origin of petroleum, Composition of crude petroleum, Processing of crude petroleum, Petroleum refinery products.

Module-2
**Fertilizers** – Ammonia, Urea, Ammonium chloride, Ammonium nitrate, Ammonium phosphate, Ammonium sulphate, DAP.

**Coal Chemicals** – Classification of coals, Destructive of coal, Coking of coal, Coal tar distillation and Chemicals from coals.

Module-3
**Chemicals from C1 Compounds** – Manufacture of methanol, Formaldehyde, Trichloroethylene, Perchloroethylene.

**Chemicals from C2 Compounds** – Ethylene and Acetylene via steam cracking of hydrocarbons, Ethylene dichloride production, Vinyl chloride production via acetylene – HCl reaction.

Module-4
**Chemical from C3 Compounds** – Production of Isopropyl alcohol by indirect hydration of propylene, Cumene (Isopropyl benzene) via propylene alkylation of benzene, Production of Acrylonitrile from propylene ammonia oxidation method, Production of Isoprene from propylene dimer.

**Chemical from C4 Compounds and Aromatics** – Production of Butadine via dehydrogenation of butane, Oxydehydrogenation versus straight dehydrogenation, Synthetic chemicals and intermediates from aromatics, Phenol from toluene oxidation.

Module-5
**Fermentation Industries** – Production of alcohol, Distilled liquors, Acetic acid and Citric acid.

**Metallurgical Industries** – Pig iron production, Flow scheme for steel manufacture, Purification of alumina from bauxite by Bayer process, Flow scheme for copper ore concentrate.

Course Outcomes: After studying this course, students will be able to:

- Identify raw materials, by-products operations & processes associated
- Process parameters & Safety measures associated during manufacturing
- Understand importance of process industry in nation building.
- Engineering problems involved at manufacturing activities.

QUESTION PAPER PATTERN:

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

TEXT BOOKS:

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B. E. PETROCHEM ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER – IV

PROCESS HEAT TRANSFER

<table>
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<td>Exam Hours</td>
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Course Learning Objectives: The students will
1. Study various modes of Heat transfer and their fundamental relations.
2. Study conduction heat transfer and develop mathematical relations for various solid geometries.
3. Understand the working of Heat exchangers and to learn design of double pipe, shell and tube heat exchangers and design of evaporators and conduct experiments and to submit the report.
4. Understand the phenomenon of radiation, radiation shields and estimation of emissivity

Module-1
CONDUCTION: Fourier’s law, Steady state unidirectional heat flow through single and multiphase layers slabs, cylinders and spheres for constant and variable thermal conductivity.
INSULATION: Properties of insulation materials, Types of insulation, Critical and Optimum thickness.

Module-2
CONVECTION: Individual and overall heat transfer coefficient, LMTD, LMTD correction factor, Dimensionless numbers, Dimensional analysis, Empirical correlation for forced and natural convection.

Module-3
ANALOGY: Analogy between momentum and heat transfer- Reynolds, Colburn and Prandtl analogies.
HEAT TRANSFER WITH PHASE CHANGE: Boiling phenomena, Nucleate and Film boiling, Condensation - Film and Drop wise condensation, Nusselts equations.
HEAT TRANSFER EQUIPMENT: Double pipe heat exchangers, Shell and tube heat exchangers – Types of shell and tube heat exchangers, Construction details, Condenser, types of condensers.

Module-4

Module-5
EVAPORATORS: Types of evaporators, performance of tubular evaporator – Evaporator capacity, Evaporator economy, Multiple effect evaporator – Methods of feeding, effect of liquid head and boiling point elevation.
RADIATION: Properties and definitions, Absorptivity, Reflectivity, Emissive power and intensity of radiation, Black body radiation, Gray body radiation, Stefan – Boltzmann law, Wein’s displacement law, Kirchhoff’s law.

Course Outcomes: The students will be able to do the following
• Write all fundamental heat transfer relations.
• Derive equations for the calculation of heat flux and estimation of intermediate temperatures in multilayer systems.
• Calculate critical thickness of insulation requires for different geometry of solids.
• Write different dimensionless numbers and explain their significance.
• Estimate LMTD and heat transfer coefficients for different types of flows.
• Design Shell and tube and double pipe heat exchanger, condensers and Evaporator.
• Explain radiation in different type of solids and estimate emissivity.

Note: Use of steam tables permitted in examination and internal assessment test.

QUESTION PAPER PATTERN:
• The question paper will have ten questions.
• Each full Question consisting of 20 marks
• There will be 2 full questions (with a maximum of four sub questions) from each module.
• Each full question will have sub questions covering all the topics under a module.
• The students will have to answer 5 full questions, selecting one full question from each module.
<table>
<thead>
<tr>
<th>TEXT BOOKS:</th>
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B. E. PETROCHEM ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER – IV

RENEWABLE ENERGY RESOURCES AND SYSTEMS

<table>
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<th>18PC46</th>
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<td>SEE Marks</td>
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</tr>
<tr>
<td>Credits</td>
<td>03</td>
<td>Exam Hours</td>
<td>03</td>
</tr>
</tbody>
</table>

Course Learning Objectives: This course enables students to
- Provide an overview of the promising areas of new and renewable sources of energy.
- Provide analysis of energy conversion, utilization and storage for renewable technologies.

Module-1
Introduction: Current energy requirements, growth in future energy requirements, Review of conventional energy resources- Coal, gas and oil reserves and resources, Tar sands and Oil Shale, Nuclear energy Option.
08Hr

Module-2

Module-3

Module-4
Ocean Energy: Ocean energy resources-ocean energy routes - Principles of ocean thermal energy conversion systems- ocean thermal power plants- Principles of ocean wave energy conversion and tidal energy conversion.

Module-5
Other Sources: Hydropower, Nuclear fission and fusion-Geothermal energy: Origin, types of geothermal energy sites, site selection, geothermal power plants; Magneto-hydro-dynamic (MHD) energy conversion.

Course Outcomes: At the end of the course students are able to understand of environmental consequences of energy conversion and how renewable energy can reduce air pollution and positively affect the global climate change.

QUESTION PAPER PATTERN:
- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

TEXT BOOKS:

REFERENCE BOOKS:
**Course Code**: 18PCL48  
**CIE Marks**: 40

**Choice Based Credit System (CBCS) and Outcome Based Education (OBE)**

**SEMESTER - IV**

**HEAT TRANSFER LABORATORY**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Experiments</th>
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<tbody>
<tr>
<td>1</td>
<td>Effectiveness of fin</td>
</tr>
<tr>
<td>2</td>
<td>Horizontal Shell and tube Heat exchanger</td>
</tr>
<tr>
<td>3</td>
<td>Helical Coil Heat exchanger</td>
</tr>
<tr>
<td>4</td>
<td>Vertical Shell and tube Heat exchanger (Condenser)</td>
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<tr>
<td>5</td>
<td>Double Pipe Heat Exchanger</td>
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<tr>
<td>6</td>
<td>Transient Heat Conduction</td>
</tr>
<tr>
<td>7</td>
<td>Natural Convection</td>
</tr>
<tr>
<td>8</td>
<td>Heat Transfer in Fluidized Beds</td>
</tr>
<tr>
<td>9</td>
<td>Single stage Evaporator</td>
</tr>
<tr>
<td>10</td>
<td>Heat Transfer in Packed Beds</td>
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<tr>
<td>11</td>
<td>Determination of Insulation Thickness</td>
</tr>
<tr>
<td>12</td>
<td>Heat Transfer in Agitated Vessels</td>
</tr>
<tr>
<td>13</td>
<td>Forced Convection</td>
</tr>
<tr>
<td>14</td>
<td>Thermal Conductivity</td>
</tr>
<tr>
<td>15</td>
<td>Overall heat transfer coefficient of a composite wall</td>
</tr>
</tbody>
</table>

**Course Learning Objectives**: This course enables: To train the students on different types of heat transfer equipments.

**Note**: Minimum 10 experiments are to be conducted

**Course Outcomes**: At the end of the course:

- Student should be able to calculate heat transfer by conduction, different types of convection
- Using classical models for these phenomena

**Graduate Attributes**
- Engineering Knowledge
- Problem Analysis
- Design/development of solutions (Partly)

**Conduct of Practical Examination**:
1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

**Reference Books**:
### CHEMICAL ENGINEERING DRAWING LABORATORY

<table>
<thead>
<tr>
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<th>CIE Marks</th>
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<tr>
<td>Credits</td>
<td>02</td>
<td>Exam Hours</td>
<td>03</td>
</tr>
</tbody>
</table>

**Content:**
- **SECTIONAL VIEWS:**
  Representation of the sectional planes, Sectional lines and hatching, selection of section planes and types of sectional views.

**PROPRTIONATE DRAWINGS**
- Equipment and piping symbols, Vessels components: Vessel openings, Manholes, Vessel enclosures, Vessel support, Jackets, Shell and tube heat exchanger, Reaction vessel and different types of Evaporators. P & I Diagrams

**ASSEMBLY DRAWINGS:**
- **Joints:** Cotter joint with sleeve, Socket and Spigot joint, Flanged pipe joint, Union joint, Stuffing box and Expansion joint (Screw type or flanged type)

**Note:**
1. Assignments to be given to students to practice all the drawings and weightage shall be given to these assignments while awarding IA marks.
2. Minimum of Ten drawing are to be conducted.
3. Examination consists of one question on proportionate drawing (30 marks) and one question on Assembly drawing (70 marks).
4. **Examination to be conducted like other lab exams. Question paper should be prepared jointly by Internal and External examiners.**
5. Computer Aided drawing Software: Solid Edge or Equivalent Software.

**TEXT BOOKS:**

**REFERENCE BOOKS:**
# B. E. CHEMICAL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)

## SEMESTER - III

### CONSTITUTION OF INDIA, PROFESSIONAL ETHICS AND CYBER LAW (CPC)
(Mandatory Learning Course: Common to All Programmes)

<table>
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<tr>
<td>Exam Hours</td>
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</tbody>
</table>

### Course Learning Objectives:
To
- know the fundamental political codes, structure, procedures, powers, and duties of Indian government institutions, fundamental rights, directive principles, and the duties of citizens
- Understand engineering ethics and their responsibilities; identify their individual roles and ethical responsibilities towards society.
- Know about the cybercrimes and cyber laws for cyber safety measures.

---

### Module-1
**Introduction to Indian Constitution:**

### Module-2
**Union Executive and State Executive:**

### Module-3
**Elections, Amendments and Emergency Provisions:**

**Constitutional special provisions:**
Special Provisions for SC and ST, OBC, Women, Children and Backward Classes.

### Module-4
**Professional / Engineering Ethics:**

### Module-5
**Internet Laws, Cyber Crimes and Cyber Laws:**
Internet and Need for Cyber Laws, Modes of Regulation of Internet. Types of cyber terror capability, Net neutrality, Types of Cyber Crimes, India and cyber law, Cyber Crimes and the information Technology Act 2000, Internet Censorship. Cybercrimes and enforcement agencies.

### Course Outcomes:
On completion of this course, students will be able to,
- CO 1: Have constitutional knowledge and legal literacy.
- CO 2: Understand Engineering and Professional ethics and responsibilities of Engineers.
- CO 3: Understand the the cybercrimes and cyber laws for cyber safety measures.
The SEE question paper will be set for 100 marks and the marks scored by the students will proportionately be reduced to 60. The pattern of the question paper will be objective type (MCQ).

For the award of 40 CIE marks, refer the University regulations 2018.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Name of the Publisher</th>
<th>Edition and Year</th>
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<tr>
<td>1</td>
<td>Constitution of India, Professional Ethics and Human Rights</td>
<td>Shubham Singles, Charles E. Haries, and et al</td>
<td>Cengage Learning India</td>
<td>2018</td>
</tr>
<tr>
<td>2</td>
<td>Cyber Security and Cyber Laws</td>
<td>Alfred Basta and et al</td>
<td>Cengage Learning India</td>
<td>2018</td>
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</table>

**Reference Books**

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<th>Title of the Book</th>
<th>Author/s</th>
<th>Publisher</th>
<th>Edition and Year</th>
</tr>
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<tbody>
<tr>
<td>3</td>
<td>Introduction to the Constitution of India</td>
<td>Durga Das Basu</td>
<td>Prentice –Hall,</td>
<td>2008</td>
</tr>
<tr>
<td>4</td>
<td>Engineering Ethics</td>
<td>M. Govindarajan, S. Natarajan, V. S. Senthilkumar</td>
<td>Prentice –Hall,</td>
<td>2004</td>
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</table>
B. E. CHEMICAL ENGINEERING
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - IV
ADDITIONAL MATHEMATICS – II
(Mandatory Learning Course: Common to All Branches)
(A Bridge course for Lateral Entry students under Diploma quota to BE/B. Tech programmes)

Course Code 18MATDIP41
CIE Marks 40

Teaching Hours/Week (L:T:P) (2:1:0) SEE Marks 60
CIE Hours 00
Exam Hours 03

Course Learning Objectives:
• To provide essential concepts of linear algebra, second & higher order differential equations along with methods to solve them.
• To provide an insight into elementary probability theory and numerical methods.

Module-1

Module-2

Module-3
Higher order ODE’s: Linear differential equations of second and higher order equations with constant coefficients. Homogeneous /non-homogeneous equations. Inverse differential operators. [Particular Integral restricted to $R(x) = e^{ax}, \frac{\sin ax}{\cos ax}, x^n \text{ for } f(D)y = R(x)$].

Module-4
Partial Differential Equations (PDE’s): Formation of PDE’s by elimination of arbitrary constants and functions. Solution of non-homogeneous PDE by direct integration. Homogeneous PDEs involving derivative with respect to one independent variable only.

Module-5

Course Outcomes: At the end of the course the student will be able to:
• Solve systems of linear equations using matrix algebra.
• Apply the knowledge of numerical methods in modelling and solving of engineering problems.
• Apply the knowledge of numerical methods in modelling and solving of engineering problems.
• Classify partial differential equations and solve them by exact methods.
• Apply elementary probability theory and solve related problems.

Question paper pattern:
• The question paper will have ten full questions carrying equal marks.
• Each full question will be for 20 marks.

<table>
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<th>Sl. No.</th>
<th>Title of the Book</th>
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<th>Name of the Publisher</th>
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B. E. PETROCHEM ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - V

MANAGEMENT AND ENTREPRENEURSHIP

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<tr>
<td>Credits</td>
<td>03</td>
<td>Exam Hours</td>
<td>03</td>
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</tbody>
</table>

**Course Learning Objectives:** The students will.
1. Understand the roles of managers and historical evolution of various approaches to the study of management.
2. Demonstrate the process of planning which can be used as a tool for decision-making in organizations.
3. Create logical relationships between various organizational structures and designs.
4. Implement leadership practices towards the management and development of people within organizations.

**Module-1**

*Organization and Management:* Forms of Business Organization, Basic concepts of management-classification, characteristics, objectives, Functions of management-planning, organizing, staffing, directing, Organization Structure-linear, functional, line and staff, staff and functional, Management by objectives, Management information system.

**Module-2**

*Personnel (Human Resource) Management:* Acquisition of manpower-functions and objectives of personnel management, manpower planning, Job analysis and evaluation, Induction, Orientation, Training and development, Maintenance of human resource. Industrial relations, Trade Unionism.

**Module-3**

*Entrepreneurship and Project Management:* Entrepreneurship- Types, Growth, functions, qualities, Project Planning-project implementation, monitoring and control, evaluation strategies, Gantt charts, Critical path method, Performance evaluation and review technique, application of network techniques.

**Module-4**


**Module-5**

*Materials Management:* Purchasing, make or buy decision, stores management, inventory control, spare parts management, value engineering.

*Marketing:* Marketing research, marketing management, consumer behavior and market promotion.

**Course Outcomes:** On successful completion of this course students will be able to
1. Understand the principles of management theory & recognize the characteristics of an organization.
2. Demonstrate the importance of key performance areas in strategic management & decision-making process.
3. Design appropriate organizational structures and possess an ability to conceive organizational dynamics.
4. Evaluate attitudes and personality traits for interpersonal effectiveness and development within organizations.
5. Implement the right leadership practices in organizations that would enable systems orientation.

**QUESTION PAPER PATTERN:**
- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**TEXT BOOKS:**

**REFERENCES:**
1. Stephen Robbins, Mary Coulter & Neharika Vohra, Management, Pearson Education Publications,

**Course Code:** 18PC52  
**CIE Marks:** 40  
**Teaching Hours/Week (L:T:P):** 3:2:0  
**SEE Marks:** 60  
**Credits:** 04  
**Exam Hours:** 03

**Course Learning Objectives:** This course enables students to learn about the Drilling Process and Drilling Equipments.

**Module-1**

**DRILL STRING: COMPOSITION AND DESIGN** - Drill Collar, Drill Pipe, Drill String Inspection Procedure.

**Module-2**
**AIR AND GAS DRILLING** - Bottomhole Pressure, Minimum Volumetric Flow Rate, Drill Bit Orifices or Nozzles, Injection Pressure, Water Injection, Saturation of Gas, Eliminate Stickiness, Suppression of Hydrocarbon Combustion, Aerated Drilling (Gasified Fluid Drilling), Stable Foam Drilling, Completions Operations, Compressor and Inert Air Generator Units, Highly Deviated Well Drilling and Completions, Downhole Motors.

**DIRECTIONAL DRILLING** - Glossary of Terms used in Directional Drilling, Dogleg Severity (Hole Curvature) Calculations - Tangential Method, Radius of Curvature Method, Deflection Tool Orientation, Vectorial Method of D. Ragland, Three-Dimensional Deflecting Model.

**Module-3**
**SELECTION OF DRILLING PRACTICES** - Health, Safety and Environment, Production Capacity, Well Planning and Implementation, Drilling Implementation, Post-Run Evaluation.


**Module-4**

**CASING AND CASING STRING DESIGN** - Types of Casing, Casing Data, Combination Casing Strings, Running and Pulling Casing.

**Module-5**
**TUBING AND TUBING STRING DESIGN** - API Physical Property Specifications, Running and Pulling Tubing, Preparation and Inspection before Running, Packers, Protecting the Casing.

**ENVIRONMENTAL CONSIDERATIONS FOR DRILLING OPERATIONS** – Introduction, Well Site, Environmental Regulations, Site Assessment and Construction, Environmental Concerns While in Operation.

**Course Outcomes:** At the end of the course:
Students will understand the concepts and techniques used in well drilling. They will learn the design requirements of well planning and construction. Students would be able to optimize the design of a drilling program.

**QUESTION PAPER PATTERN:**
- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**TEXT BOOKS:**

**REFERENCES BOOKS:**
Pilsga, Gulf Professional Publishing
B. E. PETROCHEM ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - V

RESERVOIR ENGINEERING

<table>
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Course Learning Objectives: To enable the students to
- Understand the rock and fluid properties of a hydrocarbon reservoir
- Describe the nature of the fluid flow and pressure distribution in a reservoir
- Understand the effects of production/injection on recovery of reserves

Module-1

Introduction to Reservoir Engineering: Activities in reservoir engineering, The role of reservoir engineers, Technical responsibilities of reservoir engineers, The physical principles of reservoir engineering.

The Appraisal of Oil and Gas Fields: Introduction, Pressure-volume-temperature fluid properties for oil, Calculation of the stock tank oil initially in place, Field unitization/equity determination, Calculation of gas initially in place, Pressure-depth plotting.

Module-2

Reservoir Geology and Geophysics: Geological models, Hydrocarbon generation and migration, reservoirs, Traps, Seismic development survey, Example of reservoirs.

Fundamentals of reservoir fluid flow: reservoir geometry, fluid flow equations, steady state and unsteady state flow, constant terminal pressure solution. Horizontal and vertical oil well and gas well performance.

Module-3


Analysis of reservoir fluid and rock properties: composition of reservoir fluid, separation test, laboratory analysis of gas condensate system, porosity and capillary pressure. Rock compressibility, reservoir heterogeneity. Dynamic pseudo-relative permeabilities, two phase and three phase relative permeability.

Module-4

Recovery mechanism and material balance: primary recovery mechanism, material balance equation, performance prediction methods and relating reservoir performance to time. Volumetric method and the material balance equations as a straight line in gas reservoir.

Oil well Testing: Introduction, Essential observations in well testing, Well testing literature, The purpose of well testing, Basic. Radial flow equation, Constant terminal rate solution of the radial diffusivity equation, The transient constant terminal rate solution of the radial diffusivity equation, Pressure build-up testing, Miller, Dyes. Hutchinson (MDM) pressure build-up analysis, Pressure support during appraisal well testing.

Module-5

Water flooding and vapour liquid phase equilibrium: factors to consider in water flooding, optimum time to water flooding, selection of flooding patterns, overall recovery efficiency, displacement efficiency, vertical sweep efficiency. Equilibrium ratio, flash calculations, equilibrium ratios for real solution. Application of the equilibrium ratio in reservoir engineering.

Course outcomes: Students will understand the location, formation, fluid content of a hydrocarbon reservoir; understand the definitions of reserves; be aware of the role of reservoir engineering in exploration and development.

QUESTION PAPER PATTERN:
- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

TEXT BOOKS:

REFERENCES BOOKS:
1. Dake, L.P. Practice of Reservoir Engineering Elsevier 2001
B. E. PETROCHEM ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - V

FUNDAMENTALS OF PETROLEUM GEOLOGY

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</table>

Course Learning Objectives: This course enables students to

- Have basic understanding of broad array of tools used in the search for and production of hydrocarbon reserves
- Learn the principles of mapping a subsurface reservoir and estimating the volumetric

Module-1

Module-2

Module-3

Module-4

Module-5
Non-conventional petroleum resources and reserve estimation. – Plastic and solid hydrocarbons. Tar sands. Oil and gas shales. Coal bed methane. Assessment of reserves.

Course outcomes: At the end of the course students are able to understand how geologists conduct the search for petroleum resources through the value chain or the life cycle of a petroleum resource.

QUESTION PAPER PATTERN:
- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

TEXT BOOKS:

REFERENCES BOOKS:
## B. E. PETROCHEM ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)

### SEMESTER - V

### MASS TRANSFER OPERATIONS

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**Course Learning Objectives:** The students will

1. Be able to formulate equations for estimation of diffusivities in fluids & solids using first principles of engineering sciences.
2. Be able to apply mass transfer fundamentals to calculate mass transfer rates and design the mass transfer equipment.

### Module-1

**Humidification:** General theory, Psychrometric chart. Concepts in humidification dehumidification. Design of cooling towers.

### Module-2
**Drying:** Introduction, Equilibria, Drying rate curves. Mechanism of drying, types of dryers. Design of batch and continuous dryers.

**Adsorption:** Theories of adsorption. Isotherms, Industrial adsorbents. Equipment, Batch & continuous multistage adsorption.

### Module-3

**Crystallization:** Factors governing nucleation and crystal growth rates. Controlled growth of crystals. Incorporation of principles into design of equipment. Different types of crystallizer equipment.

### Module-4

**Distillation (Contd.):** Multi-stage rectification column. Design using McCabe Thiele and Lewis-Sorel methods for binary mixtures.

**Distillation (Contd.):** Ponchon-Savarit method. Introduction to Multicomponent distillation, Vacuum, molecular, extractive and azeotropic distillations.

### Module-5


**Course outcomes:** After studying this course, students will be able to:

1. Estimate mass transfer co-efficient and provide valid conclusions on suitability of the operation.
2. Apply the analogies in transport processes for validating and reaching substantiated conclusions.

### QUESTION PAPER PATTERN:
- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.
<table>
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# POLYMER SCIENCE AND TECHNOLOGY

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<td>Exam Hours</td>
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**Course Learning Objectives:** This course enables students to study the basic polymeric science about polymeric structure, chemical bonding and chemical reactions.

## Module-1

**Introduction:** types of polymers and polymerizations, nomenclature of polymers, linear, branched, and cross-linked polymers, molecular weight of polymers, physical state, applications of polymers.

**Polymerization mechanisms:** chain reaction polymerization, ionic and coordination polymerization, step-growth polymerization, ring opening polymerization.

## Module-2

**Chemical Bonding and Polymer Structure:** Introduction, Chemical Bonding, Primary Structure, Secondary Structure, Tertiary Structure, Crystallinity and Polymer Properties.

**Spectrometric Characterization of Polymers:** NMR, Infrared Spectroscopy, Raman Spectroscopy, X-Ray Spectroscopy and Electron Paramagnetic Resonance Spectroscopy.

## Module-3


**Polymerization Reactors:** Batch, Tubular (Plug flow) and Continuous Stirred Tank Reactor.

## Module-4

**Polymer technology:** polymer processing—spinning and fiber production – melt spinning, dry spinning, wet spinning and other spinning. Non-spinning fiber production – natural fibers. Elastomers – elastomer processing. Film and sheets – calendering. Polymeric foams, reinforced plastics (composites) and laminates.

## Module-5


**Course outcomes:** At the end of the course students are able to understand the basic polymeric science and technology and unit operations involved in polymer processing.

## QUESTION PAPER PATTERN:

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

## TEXT BOOKS:

2. V R Gowriker , N V Vishwanath and Jayadev Sreedhar “Polymer Science”, New age International(P) Ltd 1986

## REFERENCE BOOKS:

## B. E. PETROCHEM ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - V

### GEOLOGY LABORATORY

<table>
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<tr>
<td>Credits</td>
<td>02</td>
<td>Exam Hours</td>
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</table>

### Course Learning Objectives:
To demonstrate various methods involved in the preparation of structural maps and interpretation and calculation the thickness of the beds, studying depositional environment using grain size analysis and find out sediment types using Sand – Silt – Clay ratio.

### Experiments:
The following experiments are to be carried out; the data are to be analysed based on the theoretical aspects, and recorded with comments.

1. Describe and Identify the minerals based on their physical, special properties, chemical composition and uses
2. Study of important rock forming minerals, ores and other important industrial minerals
3. Describe and Identify the rocks of their physical properties
4. Study of geological maps and their sections
5. Calculation of True and Apparent Dip
6. Borehole problems
7. Estimation of Thickness, Distance and Depth of the ore body
8. Study of symmetry elements and crystal systems of crystal models
10. Grain – Size analysis
11. Estimation of Throw and Nature of the fault.

### Note: Minimum 10 experiments are to be conducted

### SOFTWARES SUGGESTED:
- Aspen Plus
- ChemCAD
- COCO simulator
- Design-II
- DWSIM
- Hysys
- Open Modelica
- Prosim

### Course Outcomes:
Students will be able to understand the preparation of Geological maps and identify the rock specimens by Megascopic and Microscopic, Identify the Depositional environment and Sediment types.

### Conduct of Practical Examination:
Minimum of 10 programs/simulations are to be conducted and all are to be included for practical examination. Students are allowed to pick one experiment from the lot.
Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.
Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

### Graduate Attributes
1. Critical thinking
2. Usages of modern tools
3. Collaborative and multidisciplinary work
4. Lifelong learning
5. Independent and reflective learning

### Reference Books:
Course Code: 18PCL58
CIE Marks: 40

Teaching Hours/Week (L:T:P): 0:2:2
SEE Marks: 60

Credits: 02
Exam Hours: 03

Course Learning Objectives:
Students develop a sound working knowledge on different types of mass transfer equipments.

Experiments:
The following experiments are to be carried out; the data are to be analysed based on the theoretical aspects, and recorded with comments.

1. Surface Evaporation
2. Determination of Diffusion Coefficient
3. Simple Distillation
4. Solid – liquid leaching
5. Adsorption studies
6. Tray dryer
7. Steam distillation
8. Extraction of oil from pyrolysis method
9. Liquid - liquid extraction
10. Solid dissolution
11. Vacuum Dryer
12. Ternary System
13. Solid dissolution

Note: Minimum 10 experiments are to be conducted

SOFTWARES SUGGESTED:
- Aspen Plus
- ChemCAD
- COCO simulator
- Design-II
- DWSIM
- Hysys
- Open Modelica
- Prosim

Course Outcomes:
To impart knowledge on mass transfer by practice on equipments.

Conduct of Practical Examination:
Minimum of 10 programs/simulations are to be conducted and all are to be included for practical examination. Students are allowed to pick one experiment from the lot. Strictly follow the instructions as printed on the cover page of answer script for breakup of marks. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

Graduate Attributes
- Critical Thinking
- Problem solving
- Use of modern tools
- Research Skill
- Life-long learning

REFERENCE BOOKS:
B. E. CHEMICAL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER – V
Common to all programmes

ENVIRONMENTAL STUDIES

<table>
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<tr>
<td>Credits</td>
<td>01</td>
<td>Exam Hours</td>
<td>02</td>
</tr>
</tbody>
</table>

Module - 1

Ecosystems (Structure and Function): Forest, Desert, Wetlands, Riverine, Oceanic and Lake. 02 Hrs
Biodiversity: Types, Value; Hot-spots; Threats and Conservation of biodiversity, Forest Wealth, and Deforestation.

Module - 2

Natural Resource Management (Concept and case-studies): Disaster Management, Sustainable Mining, Cloud Seeding, and Carbon Trading.

Module - 3

Environmental Pollution (Sources, Impacts, Corrective and Preventive measures, Relevant Environmental Acts, Case-studies): Surface and Ground Water Pollution; Noise pollution; Soil Pollution and Air Pollution.
Waste Management & Public Health Aspects: Bio-medical Wastes; Solid waste; Hazardous wastes; E-wastes; Industrial and Municipal Sludge.

Module - 4

Global Environmental Concerns (Concept, policies and case-studies): Ground water depletion/recharging, Climate Change; Acid Rain; Ozone Depletion; Radon and Fluoride problem in drinking water; Resettlement and rehabilitation of people, Environmental Toxicology.

Module - 5

Field work: Visit to an Environmental Engineering Laboratory or Green Building or Water Treatment Plant or Waste water treatment Plant; ought to be Followed by understanding of process and its brief documentation.

Course outcomes: At the end of the course, students will be able to:

- CO1: Understand the principles of ecology and environmental issues that apply to air, land, and water issues on a global scale.
- CO2: Develop critical thinking and/or observation skills, and apply them to the analysis of a problem or question related to the environment.
- CO3: Demonstrate ecology knowledge of a complex relationship between biotic and a biotic components.
- CO4: Apply their ecological knowledge to illustrate and graph a problem and describe the realities that managers face when dealing with complex issues.

Question paper pattern:
- The Question paper will have 100 objective questions.
- Each question will be for 01 marks
- Student will have to answer all the questions in an OMR Sheet.
- The Duration of Exam will be 2 hours.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Title of the Book</th>
<th>Name of the Author/s</th>
<th>Name of the Publisher</th>
<th>Edition and Year</th>
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<tbody>
<tr>
<td></td>
<td>Environmental Studies</td>
<td>S M Prakash</td>
<td>Pristine Publishing House, Mangalore</td>
<td>3rd Edition 2018</td>
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<tr>
<td>3</td>
<td>Environmental Studies – From Crisis to Cure</td>
<td>R Rajagopalan</td>
<td>Oxford Publisher</td>
<td>2005</td>
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</table>

**Reference Books**

|---|--------------------------------------------------|----------------|-----------------------------|------------------|
VI – SEMESTER

B. E. PETROCHEM ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - VI

NATURAL GAS PROCESSING

<table>
<thead>
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<th>Course Code</th>
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<th>CIE Marks</th>
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<tr>
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</table>

Course Learning Objectives:
Enable the students to learn the basic concept and applications of Natural Gas processing

Module-1


Module-2

Phase behaviour fundamentals: Qualitative hydrocarbon phase behavior-phase rule, pressure-temperature diagram for single component and multi component systems, vapor-liquid equilibrium. Equations of state- real and ideal gases, the compressibility factor approach, van der wals equation, Redlich-Kwong equation, Peng Robinson equation. Viscosity of gases, specific heat for hydrocarbon gases.

Module-3

Gas Compression: Types of compressors- Reciprocating Positive displacement and rotary positive displacement compressors and centrifugal compressors; Sliding-vane compressors, two impeller straight lobe compressors, liquid piston compressors, centrifugal compressors, axial flow compressors. Compressible flow fundamentals, Compressible Flow in Pipes, Fundamental equations of flow: continuity, momentum, energy equations.

Module-4


Module-5

Gas desulfurisation : Meaning of sour gas and sweet gas, reasons for removal of H2S
Gas flow measurement: Attributes of flow devices, methods of measurement-different types of flowmeter, The orifice metering systems. Factors affecting orifice meter accuracy, common measurement problems encountered in gas metering.

Course outcomes: Students will be able to understand the Natural gas processing, Gas Compression, Gas Gathering and Transport Installation, Operation and trouble shooting of natural gas pipelines.

QUESTION PAPER PATTERN:
• The question paper will have ten questions.
• Each full Question consisting of 20 marks
• There will be 2 full questions (with a maximum of four sub questions) from each module.
• Each full question will have sub questions covering all the topics under a module.
• The students will have to answer 5 full questions, selecting one full question from each module

TEXT BOOKS:

REFERENCE BOOKS:
**B. E. PETROCHEM ENGINEERING**  
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)  
**SEMESTER - VI**  
**CHEMICAL REACTION ENGINEERING**

<table>
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<tr>
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<td>Exam Hours</td>
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</table>

**Course Learning Objectives:** The students will

- Be able to analyze and interpret the data to determine rate equation and estimate the performance equation of ideal systems.
- Be able to formulate and analyze the rate equations for various reactions using suitable mechanisms.
- Be able to understand and apply the principles of non-ideal flow in the design of reactor.

**Module-1**


**Non-Elementary Reactions:** Difference between elementary and non-elementary reactions. Kinetic models and mechanisms for non-elementary reactions. Types of reactors.

**Module-2**


**Design of Ideal Reactors:** Concept of ideality. Development of design equations for batch, tubular and stirred tank reactors for both constant and variable volume reactions. Evaluation of rate equations from data obtained in these reactors. Numerical Problems.

**Module-3**

**Multiple Reactor Systems:** Plug flow and/or Mixed flow reactors in Series, parallel and series parallel. Reactors of different types and sizes in series.

**Design of Reactors for Multiple Reactions:** Design of Batch reactor, Plug and Mixed flow reactors for Parallel, Series and Series-Parallel reactions (Only irreversible reactions must be considered).

**Non-Isothermal Reactors:** Introduction, effect of temperature one equilibrium constant and heat of reaction. Material and Energy balances, conversions in adiabatic and non-adiabatic reactors.

**Module-4**


**Introduction to Heterogeneous Systems:** Rate equations, contacting patterns, fluid-particle non catalytic reactions, URC model, Spherical particles of unchanging size, shrinking spherical particles, determination of rate controlling steps. Heterogeneous reactions- Introduction, Kinetic regimes. Rate equation for surface kinetics.

**Module-5**

**Fluid-Fluid Non Catalytic Reactions:** Kinetic regimes for mass transfer and reaction; rate equations.  
**Catalysis:** Introduction to catalysis. Properties of catalysts. Estimation methods for catalytic properties. Promoters, inhibitors etc, Mechanism of catalysis. Rate equations for different rate controlling step.

**Deactivation:** Deactivating catalyst. Mechanism, rate & performance equation.

**Course outcomes:** After studying this course, students will be able to:
1. Apply theoretical knowledge for interpretation of experimental data.  
2. Acquire practical knowledge of reactors.  
3. Know the use of reactors, problems associated and modifications.

**QUESTION PAPER PATTERN:**

- The question paper will have ten questions.
- Each full Question consisting of 20 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module

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**B. E. PETROCHEM ENGINEERING**
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)

**SEMESTER - VI**

**PROCESS EQUIPMENT DESIGN AND DRAWING**

<table>
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<td>Credits</td>
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<td>Exam Hours</td>
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</table>

**Course Learning Objectives:** The students will be able to
1. Understand advances and types in the design of heat and mass transfer equipment and its accessories.
2. Develop modifications based on design.

Detailed chemical engineering process design of the following equipment should be studied. Standard code books are to be used. The detailed proportionate drawings shall include sectional front view, full top/side view depending on equipment and major components.

1. **Class work:** Students are to design the equipment. They shall also be trained to draw free hand proportionate sketches.
2. **Final Examination:** Students have to answer any one of the two questions given in the examination. After completing the design, free hand proportionate sketches are to be drawn as required.

**Content**

1. Double Pipe Heat exchanger
2. Shell and Tube Heat exchanger
3. Condenser–Horizontal
4. Evaporator–Singleeffect
5. Sieve Tray Distillation Column
6. Packed Bed Absorption Column

**Course outcomes:** After studying this course, students will be able to:
1. Design and modify process equipment relating to heat and mass transfer.
2. Will handle process parameters to alter and design process Equipment

**TEXT BOOKS:**


**REFERENCE BOOKS:**

B. E. PETROCHEM ENGINEERING  
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)  
SEMESTER - Vi  
PROFESSIONAL ELECTIVE – 1  
PETROLEUM TRANSPORTATION ENGINEERING  

<table>
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<td>Credits</td>
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</table>

**Course Learning Objectives:**
- To get familiar with modes of transportation for oil and gas. To understand various transportation techniques, problems and remedial measures.

**Module-1**

Modes of crude oil, product and gas transportation and pipeline transportation - tank-trucks and rail transportation, oceanic tanker transportation, inland water, coastal and oceanic, tanker size, power, cargo space, marine storage terminals, shore installation. Line specifications, plastic pipes.

**Module-2**

Liquid transport & gas transportation - crude oil and product flow characteristics, transportation of cryogenic liquids, heat flux estimation, temp gradient in flowing fluid in exposed and buried pipeline, insulation types and thickness, rheology and non-newtonian behaviour, stress and pressure drop calculations. Flow equation, pressure drop calculations. Weymouth and pan handle equation, design factors. Pressure drop in non-horizontal pipeline. Stress conditions in pipeline and analysis.

**Module-3**


**Module-4**

Pipeline practice and equipment and surface protection - route survey, transportation, trenching, stringing, bending, cleaning and coating, lowering And back filling, inspection, testing, internal cleaning, road, bridge and river crossing. Welding: techniques and equipment Internal and external corrosion & protection, cathode protection system.

**Module-5**


**Course outcomes:**
Students will have understanding on transportation techniques and the auxiliary equipments involved in the transportation process.

**QUESTION PAPER PATTERN:**
- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module..

**TEXT BOOKS:**

**REFERENCE BOOKS:**
1. Introduction to the Oil Pipeline Industry (Oil Pipeline Transportation Practices), he University of Texas at Austin - Petroleum Extension Service; 3rd edition 1984.
### B. E. PETROCHEM ENGINEERING

Choice Based Credit System (CBCS) and Outcome Based Education (OBE)

**SEMESTER – VI**

**PROFESSIONAL ELECTIVE – 1**

**PROBABILITY AND STATISTICS**

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<tr>
<td>Credits</td>
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<td>Exam Hours</td>
<td>03</td>
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</table>

**Course Learning Objectives:**
- This course aims at providing the required skill to apply the statistical tools in engineering problems.

**Module-1**

**RANDOM VARIABLES:** Discrete and continuous random variables – Moments – Moment generating functions – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions.

**Module-2.**

**TWO-DIMENSIONAL RANDOM VARIABLES:** Joint distributions – Marginal and conditional distributions – Covariance – Correlation and Linear regression – Transformation of random variables – Central limit theorem (for independent and identically distributed random variables).

**Module-3**

**TESTING OF HYPOTHESIS:** Sampling distributions - Estimation of parameters - Statistical hypothesis - Large sample test based on Normal distribution for single mean and difference of means - Tests based on t, Chi square and F distributions for mean, variance and proportion - Contingency table (test for independent) - Goodness of fit.

**Module-4.**

**DESIGN OF EXPERIMENTS:** One way and Two way classifications - Completely randomized design – Randomized block design – Latin square design - $2^2$ factorial design.

**Module-5**

**STATISTICAL QUALITY CONTROL:** Control charts for measurements (X and R charts) – Control charts for attributes (p, c and np charts) – Tolerance limits - Acceptance sampling.

**Course outcomes:**
- The students will have a fundamental knowledge of the concepts of probability. Have knowledge of standard distributions which can describe real life phenomenon. Have the notion of sampling distributions and statistical techniques used in engineering and management problems.

**QUESTION PAPER PATTERN:**
- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Text Books:**

**Reference Books:**
## Course Code
18PC643

## CIE Marks
40

## TEaching Hours/Week (L:T:P)
3:0:0

## SEE Marks
60

## Credits
03

## Exam Hours
03

### Course Learning Objectives:
This course enables students to
- Petroleum reservoir system and fluid properties
- Basic principles and operations in upstream petroleum industry

### Module 1

### Module 2

### Module 3

### Module 4

### Module 5

### Course Outcomes:
At the end of the course students are able to learn the use of Darcy’s Law to calculate permeability of single phase; definition of interfacial tension; use of capillary pressure to determine saturation changes in reservoir; definition of effective and relative permeability; use of drainage/imbibition curves to characterize reservoir relative permeability

### Question Paper Pattern:
- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

### Text Books:
2. Djebbar Tiab : “Theory and pratice of measuring Reservoir rock and fluid Transport properties

### Reference Books:
**Course Code**: 18PC651  
**CIE Marks**: 40  
**Teaching Hours/Week (L:T:P)**: 3:0:0  
**SEE Marks**: 60  
**Credits**: 03  
**Exam Hours**: 03

**Course Learning Objectives**: This course mainly to discuss:
- The role of a Chemical engineer in bioprocess industry.
- The role of enzymes and microbes in biotechnology sectors.

**Module-1**

**Module-2**

**Module-3**

**Module-4**

**Module-5**

**Course outcomes**: Students will develop the ability to design novel bioprocesses for their research in various areas. They attain the ability to find solutions to the problems which occur when materials and processes interact with the environment.

**QUESTION PAPER PATTERN:**
- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module

**Text Books:**

**Reference Books:**
## Course Code

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## CIE Marks

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## SEE Marks

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### Course Learning Objectives:

To understand the basic knowledge about Pharmaceutical processing, Dosage form and Design, Product Processing, Packing, Evaluation and Regulations

### Module-1

**Principle of pharmaceutical processing** – Mixing, Milling, Drying, Compression and Consolidation of powdered solids, Basics chemical principle related to emulsion and suspension, Pharmaceutical Rheology, Clarification and filtration.

### Module-2

**Pharmaceutical Dosage Form and Design** – Preformulation, Bio-pharmaceutics, Statistical Application in the pharmaceutical science.

### Module-3

**Pharmaceutical Dosage Forms** – Tablets, Tablet coating, Capsules, Sustained release dosage forms, Liquids.

### Module-4

**Pharmaceutical Dosage Forms** – Pharmaceutical suspensions, Emulsions, Semisolids, Suppositories, Pharmaceutical aerosols, Sterilization, Sterile products.

### Module-5

**Product Processing, Packing, Evaluation and Regulations** – Pilot plant scale-up techniques, Packing material science, Production management, Kinetic principles and stability testing, Quality control and Assurance, Drug regulatory affairs.

### Course outcomes:

Students will be able to understand the concept and principles of Pharmaceutical Technology.

### QUESTION PAPER PATTERN:

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

### Text Books:


### Reference Books:

B. E. PETROCHEM ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - VI

18PC65X Open Elective –A
MATERIALS SCIENCE ENGINEERING

Course Code  18PC653  CIE Marks  40
Teaching Hours/Week (L:T:P)  3:0:0  SEE Marks  60
Credits  03  Exam Hours  03

Course Learning Objectives: This course will enable students to
- Understand concepts on properties and selection of metals, ceramics, and polymers for design and manufacturing.
- Study variety of engineering applications through knowledge of atomic structure, electronic structure, chemical bonding, crystal structure, x-rays and x-ray diffraction, defect structure.
- Study Microstructure and structure-property relationships, Phase diagrams, heat treatment of steels.
- Study detailed information on types of corrosion and its prevention.
- Learn information on selection of materials for design and manufacturing.

Module-1
INTRODUCTION:
Introduction to material science, Classification of engineering materials, Level of structure, Structure property relationships in materials.

CRYSTAL GEOMETRY AND STRUCTURE DETERMINATION:

ATOMIC STRUCTURE, CHEMICAL BONDING AND STRUCTURE OF SOLIDS:
Structure of atom, Periodic table, Ionization potential, Electron affinity and Electro-negativity, Primary and secondary bonds, variation of bonding character and properties, Covalent solids, Metals and alloys, Ionic solids, structure of silica and silicates, Polymers.

Module-2
CRYSTAL IMPERFECTIONS:
Point Imperfections, Line imperfections – edge and screw dislocations, the Burgers vector, line energy of dislocations, Surface imperfections.

PHASE DIAGRAM AND PHASE TRANSFORMETIONS:

Module-3
DEFORMATION OF MATERIALS AND FRACTURE:
Elastic deformation, Plastic deformation, Creep, Visco-elastic deformation, Different types of fracture.

HEAT TREATMENT:
Annealing, normalizing, Hardening, Martempering, Austempering, Hardenability, Quenching, Tempering, Carburising, Cyanidng, Nitriding, Flame hardening.

Module-4
CORROSION AND ITS PREVENTION:
Direct corrosion, Electro-chemical corrosion, Galvanic cells, High temperature corrosion, Passivity, factors influencing corrosion rate, Control and prevention of corrosion modification of corrosive environment, Inhibitors, Cathodic protection, Protective coatings.

Module-5

Course outcomes: After studying this course, students will be able to:
- Classify different types of engineering materials depending on structure property, crystal geometry and X-Ray diffraction.
- Explain atomic structures, types of bonding and crystal imperfections.
- Draw phase diagrams of different metals, TTT curves and explain deformation of materials.
- Suggest different type of heat treatment techniques depending on the type of the material and they can analyze different types of corrosions and suggest preventive methods.
- Select materials depending on type of application.

**QUESTION PAPER PATTERN:**
- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Text Books:**

**Reference Books:**
B. E. PETROCHEM ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)

SEMESTER - VI

CHEMICAL REACTION ENGINEERING LABORATORY

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<tr>
<td>Credits</td>
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<td>Exam Hours</td>
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</table>

**Course Learning Objectives:** This course enables: To train the students on different types of heat transfer equipments.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Experiments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Isothermal Batch Reactor – Integral Analysis</td>
</tr>
<tr>
<td>2</td>
<td>Isothermal Batch Reactor – Differential Analysis</td>
</tr>
<tr>
<td>3</td>
<td>Adiabatic Batch Reactor</td>
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<tr>
<td>4</td>
<td>Packed Bed Reactor</td>
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<tr>
<td>5</td>
<td>Effect Of Temperature On Rate Of Reaction</td>
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<td>6</td>
<td>Kinetic Studies In Mixed Flow Reactor</td>
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<tr>
<td>7</td>
<td>RTD Studies In Mixed Flow Reactor</td>
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<tr>
<td>8</td>
<td>Plug Flow Reactor</td>
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<tr>
<td>9</td>
<td>Semi Batch Reactor</td>
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<td>10</td>
<td>Batch Reactive Distillation</td>
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<td>11</td>
<td>Gas-Liquid Reaction</td>
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<td>12</td>
<td>Catalytic Reaction</td>
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<tr>
<td>13</td>
<td>Photochemical Reaction</td>
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<td>14</td>
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</table>

**Note:** Minimum 10 experiments are to be conducted

**Course Outcomes:**

**Conduct of Practical Examination:**
- Minimum of 10 experiments are to be conducted and all 10 experiments are to be included for practical examination.
- Students are allowed to pick one experiment from the lot.
- Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.
- Change of experiment is allowed only once and 15% marks allotted to the procedure part to be made zero.

**Reference Books:**
B. E. PETROCHEM ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - VI

PETROLEUM TESTING LABORATORY

<table>
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<td>Exam Hours</td>
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</table>

Course Learning Objectives: On completion of the course, the students should be conversant with the theoretical principles and experimental procedures for quantitative estimation.

Course Learning Objectives:

Sl. No. | Experiments
1 | Testing of petroleum and its analysis
2 | Determination of acidity of petroleum
3 | Determination of smoke point and in flammability of petroleum & petroleum products
4 | Determination of Specific gravity and API gravity of petroleum and petroleum products
5 | Determination of flash point and fire point of petroleum products
6 | Determination of melting point and drop melting point of wax
7 | Determination of cloud point and pour point
8 | Carbon residue test
9 | Drop point of grease and determination of viscosity.
10 | Sediment content of grease and softening point
11 | Freezing point of aqueous engine coolant solution
12 | Corrosion testing of petroleum oils on metals
13 | Coking tendency of oil
14 | Water separately of petroleum products

Note: Minimum 10 experiments are to be conducted

Course Outcomes: Students would be able to understand basic principles involved in testing of Petroleum products by different techniques.

- Conduct of Practical Examination:
  - All laboratory experiments are to be included for practical examination.
  - Students are allowed to pick one experiment from the lot.
  - Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.
  - Change of experiment is allowed only once and 15% marks allotted to the procedure part to be made zero.

Reference Books:
**MINI-PROJECT**

<table>
<thead>
<tr>
<th>Course Code</th>
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<tr>
<td>Credits</td>
<td>02</td>
<td>Exam Hours</td>
<td>03</td>
</tr>
</tbody>
</table>

Mini-project work:
Based on the ability/abilities of the student/s and recommendations of the mentor, a single discipline or a multidisciplinary Mini-project can be assigned to an individual student or to a group having not more than 4 students.

CIE procedure for Mini-project:
(i) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide. The CIE marks awarded for the Mini-project work, shall be based on the evaluation of project report, project presentation skill and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.
(ii) Interdisciplinary: Continuous Internal Evaluation shall be group wise at the college level with the participation of all the guides of the college. The CIE marks awarded for the Mini-project, shall be based on the evaluation of project report, project presentation skill and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.

SEE for Mini-project:
(i) Single discipline: Contribution to the Mini-project and the performance of each group member shall be assessed individually in the semester end examination (SEE) conducted at the department.
(ii) Interdisciplinary: Contribution to the Mini-project and the performance of each group member shall be assessed individually in semester end examination (SEE) conducted separately at the departments to which the student/s belongs to.

**INTERNSHIP**

<table>
<thead>
<tr>
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<th>CIE Marks</th>
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</thead>
<tbody>
<tr>
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<td></td>
</tr>
<tr>
<td>Teaching Hours/Week (L:T:P)</td>
<td>SEE Marks</td>
</tr>
<tr>
<td>Credits</td>
<td>Exam Hours</td>
</tr>
</tbody>
</table>

Internship: All the students admitted to III year of BE/B.Tech shall have to undergo mandatory internship of 4 weeks during the vacation of VI and VII semesters and /or VII and VIII semesters. A University examination shall be conducted during VIII semester and the prescribed credit shall be included in VIII semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared fail and shall have to complete during subsequent University examination after satisfying the internship requirements.
## Course Learning Objectives:
To understand the principles, methodology and ethics of research.

### Module-1
**Research Methodology** - Introduction, definition, objectives of research, types of research, various steps in research process, research purposes, ethics in research, types of research approaches, criteria for a good research. Developing a research plan.

### Module-2
**Research Problems** - Defining the research problem - Selecting the problem - Necessity of defining the problem - Techniques involved in defining the problem - Importance of literature review in defining a problem - Survey of literature - Primary and secondary sources.

### Module-3

**Hypothesis** - Testing of hypotheses - Basic concepts - Procedure for hypotheses testing flow diagram for hypotheses testing - Data analysis with Statistical Packages – Correlation and Regression - Important parametric test - Chi-square test - Analysis of variance and Covariance.

### Module-4


### Module-5
**Interpretation and report writing** - Techniques of interpretation - Structure and components of scientific reports - Different steps in the preparation - Layout, structure and language of the report - Illustrations and tables - Types of report - Technical reports and thesis.

### QUESTION PAPER PATTERN:
- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

### Text Books:

### Reference Books:
B. E. PETROCHEM ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER – VII

PROCESS CONTROL AND INSTRUMENTATION

<table>
<thead>
<tr>
<th>Course Code</th>
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<td>Credits</td>
<td>03</td>
</tr>
<tr>
<td>Exam Hours</td>
<td>03</td>
</tr>
</tbody>
</table>

**Course Learning Objectives:**
To gain the knowledge of different process instruments, To understand dynamic modeling of a physical process using first principles, To design various control schemes, To apply the control system in various processes.

**Module-1**

**Instrumentation:** Fundamentals Static and dynamic characteristics. Indicators and recorders. Pressure measurement- Bourdon, diaphragm and bellow type gauges. Vacuum measurements. Temperature measurement- Bimetal and resistance thermometers, thermocouples and pyrometers.

**Module-2**

**First Order Systems:** Thermometer, level, mixing tank, STR, Linearisation, I order systems in series. Response for various input forcing functions. **Second Order Systems:** Characteristics of manometer and damped vibrator. Transfer functions. Response for various input forcing functions, response for step input for under damped case – Terms associated with it. Transportation lag.

**Module-3**


**Closed Loop Response:** Block diagram, Closed loop transfer function, Transient response of servo and regulator control systems with various controller modes and their characteristics.

**Module-4**

**Stability:** Stability of linear control systems. Routh Test. Frequency Response – Bode diagrams.

**Module-5**

**Control System Design By Frequency Response:** Bode criterion. Gain and Phase margins, Ziegler – Nichols controller tuning, Cohen-Coon controller tuning. **Root Locus:** Rules for plotting and problems.

**QUESTION PAPER PATTERN:**
- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

1. **Text Books:**

**Reference Books:**
### Course Code: 18PC731

<table>
<thead>
<tr>
<th>Course Learning Objectives:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. To develop understanding of the principles, techniques, standard tools of process optimization.</td>
<td></td>
</tr>
<tr>
<td>2. To formulate multi objective optimization problem with and without constraints based on process requirements.</td>
<td></td>
</tr>
</tbody>
</table>

#### Module-1: Principles of Optimization


#### Module-2: Single Variable Optimization Algorithms

- Optimality Criteria, Bracketing Methods, Region Elimination Methods: Fibonacci search and Golden section search methods, Gradient Based Methods: Newton-Raphson, Bisection, Secant methods.

#### Module-3: Multivariable Optimization

- Optimality criteria, Hessian matrix, Unidirectional search, Direct Search: Simplex search, Powell’s conjugate gradient methods, Gradient based methods: Steepest Descent Method, Newton’s methods, Marquardt’s method.

#### Module-4: Constrained Optimization Algorithms


#### Module-5: Specialized Search Method


#### Evolutionary Global Optimization Techniques


### Course Outcomes:

To gain exposure to application of optimization techniques in case of various petrochemical processes.

### QUESTION PAPER PATTERN:

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

### Text Books:


### Reference Books:

**B. E. PETROCHEM ENGINEERING**  
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)  
SEMESTER – VII

### PROCESS ENGINEERING AND PLANT DESIGN

<table>
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</tr>
<tr>
<td>Credits</td>
<td>03</td>
<td>Exam Hours</td>
<td>03</td>
</tr>
</tbody>
</table>

**Course Learning Objectives:** Students will learn the design considerations; software’s used in process design, design strategy and optimization

#### Module-1

**Introduction** – Plant design, General design considerations, Practical design Considerations, and Engineering ethics in design.

**Process design development** – Design database, Process – (creation, design and flow diagrams), Piping and Instrumentation diagrams.

#### Module-2


**Software Use in Process design** – Software structure, capabilities, process design, selection and software use.

#### Module-3

**Analysis and Cost estimation** – Cash flow for industrial operation, Factors affecting investment and production cost, Capital investment, Estimation and Indexes.

**Material and Fabrication selecting** – Factors Contributing to corrosion, Properties of materials, Tabulating data for selecting materials of construction, selection of materials, Fabrication of equipment.

#### Module-4

**Optimum design and Design Strategy** – Defining the optimization problem, Selecting and objective function, sub optimization, Programming optimization problems, Application of graphical and analytical methods of optimization, Optimization solution methodologies. Optimization applications.

#### Module-5

**Material handling equipment design cost** – Basic concept of fluid transport, piping fluid transport processes, Pumping of fluids, Compression and expansion of fluids, Agitation and mixing of fluids, Flow measurement of fluids, Storage and containment of fluids, Transport of solids, Handling of solids.

### Course Outcomes:

Upon completion of this course, the students will be able to understand the: Process design development, Flow sheet synthesis and Development, Analysis and Cost estimation, Material and Fabrication selecting, Optimum design and Design Strategy, Material handling equipment design cost.

### QUESTION PAPER PATTERN:

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

### Text Books:


### Reference Books:

Course Code 18PC733
Teaching Hours/Week (L:T:P) 3:0:0
Credits 03
CIE Marks 40
SEE Marks 60
Exam Hours 03

Course Learning Objectives
To enable the students to:
1. Learn the concepts of petroleum site exploration, analysis of offshore structure
2. Understand the offshore soil mechanics.

Module-1
Introduction to offshore oil and gas operations. Sea States and Weather, Offshore Fixed and mobile Units, Offshore Drilling, Difference in drilling from land, from fixed platform, jack up, ships and semi submersibles. Offshore Well Completion, Offshore Production systems, Deep-water technology, Divers and Safety, Offshore Environment.

Module-2
Introduction; classification, properties of marine sediments. Consolidation and shear strength characteristics of marine sediments. Planning and site exploration.

Module-3
Drilling. Sampling techniques. Laboratory testing, In situ testing methods and geophysical methods. Current design practices of pile supported and gravity offshore structures

Module-4

Module-5
Offshore soil mechanics; Offshore pile foundations and caissons; Design of breakwaters; Buoy design and mooring systems; Offshore drilling systems and types of platforms; Ocean mining and energy systems. ROV. Onshore drilling-on shore oil rigs. On shore drilling equipments onshore rig structures-hydraulics applied in onshore rigs.

Course Outcomes:
Students will learn the basics of onshore and offshore oil and gas operations. They will learn the Laboratory testing methods, In situ testing methods and geophysical methods.

QUESTION PAPER PATTERN:
• The question paper will have ten questions.
• Each full Question consisting of 20 marks
• There will be 2 full questions (with a maximum of four sub questions) from each module.
• Each full question will have sub questions covering all the topics under a module.
• The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

Reference Books:
1. Petroleum Exploration Hand Book by Moody, G.B.
B. E. PETROCHEM ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER – VII

PETROLEUM CORROSION TECHNOLOGY

<table>
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<th>Course Code</th>
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<tbody>
<tr>
<td>CIE Marks</td>
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<td>SEE Marks</td>
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<tr>
<td>Credits</td>
<td>03</td>
</tr>
<tr>
<td>Exam Hours</td>
<td>03</td>
</tr>
</tbody>
</table>

Course Learning Objectives: To understand the types of corrosion found in the petroleum industries. This course will provide the student with knowledge of the analytical methods needed to diagnose, treat, and monitor corrosion to reduce costs, protect the environment, and increase safety.

Module-1


Module-2

Forms of corrosion-uniform-pitting-Galvanic erosion-Intergranular and weld corrosion, selective Leaching, stress corrosion. Hydrogen embitterment-Fatigue. Role of oxygen in oil filed corrosion-downhole and surface equipment-water flood Removal of oxygen, analysis and criteria for control.
Role of carbon dioxide (CO₂) in corrosion-Effect of temperature and pressure Corrosion of well tubing and other equipments. Role of hydrogen sulphide (H₂S)-Corrosion in downhole, surface, storage and pipelines.

Module-3

Casing and Pipeline Corrosion – Introduction, Types of Casing, Corrosion of Steel, Protection of Casing from Corrosion, Interaction of Old with New Pipeline.
Scaling - Hardness and Alkalinity, Mineral Scales, Prediction of Scale Formation, Solubilities of Various Sulfates and Carbonates, Solubility of Calcite, Dolomite, and Magnesite and Mixture of These Carbonates, Relative Permeability Concepts, Scale Inhibition

Module-4


Module-5

Oil treatment corrosion-crude oil properties-desalting-distillation and other processing case histories, sweetening processes-subsea systems corrosion. Inspection and corrosion monitoring case history-oil storage tank corrosion-Oilfield and oil treating facilities-offshore platforms-down hole equipments.

Course Outcomes: Students will identify and define the various types of petroleum corrosion and prevention technologies.

QUESTION PAPER PATTERN:
- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

Reference Books:
B. E. PETROCHEM ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER – VII

PROFESSIONAL ETHICS IN ENGINEERING

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<td>Credits</td>
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<td>Exam Hours</td>
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</table>

**Course Learning Objectives:**
To enable the students to create an awareness on Engineering Ethics and Human Values, to Instil Moral and Social Values and Loyalty and to appreciate the rights of others

**Module-1**
**HUMAN VALUES:**

**Module-2.**
**ENGINEERING ETHICS:**

**Module-3**
**ENGINEERING AS SOCIAL EXPERIMENTATION:**
Engineering as Experimentation – Engineers as responsible Experimenters – Codes of Ethics – A Balanced Outlook on Law.

**Module-4.**
**SAFETY, RESPONSIBILITIES AND RIGHTS:**

**Module-5**
**GLOBAL ISSUES:**

**Course Outcomes:**
Upon completion of the course, the student should be able to apply ethics in society, discuss the ethical issues related to engineering and realize the responsibilities and rights in the society.

**QUESTION PAPER PATTERN:**
- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Text Books:**

**Reference Books:**
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<td>SEE Marks</td>
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</tr>
<tr>
<td>Exam Hours</td>
<td>03</td>
</tr>
</tbody>
</table>

**Course Learning Objectives:** This course enables students:

To get acquainted with the development of latest technologies and methodologies for environmentally benign processes currently practiced in various industrial sectors with an emphasis on the design, manufacture, and use of chemicals and processes that have little or no pollution potential or environmental risk and are both economically and technologically feasible.

**Module-1:**


**Module-2:**


**Module-3:**


**Module-4:**

Energy Efficiency: Energy Efficiency. Quantifying and minimising the use of utilities and other inputs. Overview of emerging frontiers in energy efficient synthesis such as Photochemistry, Microwave Chemistry, Sono-chemistry, Electro-synthesis.

**Module-5:**


**Course Outcomes:** At the end of the course students are able to acquire a fundamental understanding of basic chemistry/technology principles within the framework of Green Chemistry.

**QUESTION PAPER PATTERN:**

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Text Books:**

**Reference Books:**
B. E. PETROCHEM ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER – VII
ENVIRONMENTAL SCIENCE AND SOLID WASTE MANAGEMENT

<table>
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<tr>
<td>Credits</td>
<td>03</td>
<td>Exam Hours</td>
<td>03</td>
</tr>
</tbody>
</table>

**Course Learning Objectives:**
The objective of studying this subject is that student will be able identifies different Environmental Factors.
Become a skilled person in hazard analysis and able to find out the root cause of a solid waste treatment.

**Module-1**

**Environment** - definition, scope and importance of risk and hazards; chemical hazards, physical hazards, Biological hazards in the environment.

**Ecosystems** – concept of an ecosystem – structure and function of an Ecosystem, oxygen cycle and nitrogen cycle, structure and function of the (a) forest ecosystem (b) grassland Ecosystem (c) desert ecosystem (d) aquatic ecosystems (ponds, streams, lakes, rivers, oceans, Estuaries).

**Module-2.**

**Pollution of the Environment:** Air pollution, composition and evaluation of atmosphere; Earth radiation balance: Particles, ions and radicals in the atmospheres, chemical and photochemical reactions, depletion of the ozone layer, greenhouse effect. Air pollutant and their effects.

**Water pollution:** Water resources. The hydrologic cycle, complexation in natural water and waste water, microorganisms-catalysts of aquatic chemical reaction, eutirification, water pollutants inorganic, organic sediments, radioactive materials. 

**Module-3**

**Waste pollution Control processes:** Study of physical and biological process employed for biological processes employed for pollution control, removal of suspended, colloidal and dissolved phases of pollution.

**Module-4**

**Solid Waste:** Definition, characteristics and perspectives of solid waste. Types of solid waste. Physical and chemical characteristics. Variation of composition and characteristics. Municipal, industrial, special and hazardous wastes.


**Module-5**


**Case Studies:** Major industries and management methods used in typical industries – Coal fired power stations, textile industry, oil refinery, distillery, sugar industry, and radioactive waste generation units.

**Course Outcomes:** The main of learning this subject is that student will be able to understand the basics of Environmental Science. Learnt the basic concepts relating to hazards waste and risk. They also gain the knowledge of quantitatively analyze release and energy recovery.

**QUESTION PAPER PATTERN:**
- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Text Books:**
2. T. G. Miller, “Environmental Science” Wads Worth publishing Co.
Reference Books:
B. E. PETROCHEM ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER – VII

### PROCESS MODELING AND SIMULATION

<table>
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<tr>
<td>Credits</td>
<td>03</td>
</tr>
<tr>
<td>Exam Hours</td>
<td>03</td>
</tr>
</tbody>
</table>

**Course Learning Objectives:** This course enables students to
- To take an overview of mathematical models of Chemical Engineering systems
- To understand the various simulation examples
- To get acquainted with the advanced control systems

**Module-1**
**Introduction**- Role of Process Dynamics and Control, Laws and Languages of Process Control.

**Module-2**
**Computer Simulation**- Computer Programming, Iterative Convergence Methods, Numerical Integration of Ordinary Differential Equations.
**Simulation Examples**- Gravity-Flow Tank, Three CSTRs in Series, Nonisothermal CSTR, Binary Distillation Column, Multicomponent Distillation Column.

**Module-3**
**Time-Domain Dynamics and Control**- Classification, Linearization and Perturbation Variables, Responses of Simple Linear Systems, Steady state Techniques.
**Conventional Control Systems and Hardware**- Control Instrumentation, Performance of Feedback Controllers, Controller Tuning.

**Module-4**

**Module-5**

**Course Outcomes:** After studying this course, students will be able to: learnt the basic concepts of Simulation and mathematical models applicable in Chemical Engineering.

**QUESTION PAPER PATTERN:**
- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Text Books:**

**Reference Books:**
B. E. PETROCHEM ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - VII

PROCESS CONTROL LABORATORY

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Experiments</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>Thermometer</td>
</tr>
<tr>
<td>2</td>
<td>Single tank - Step Response</td>
</tr>
<tr>
<td>3</td>
<td>Single tank - Impulse Response</td>
</tr>
<tr>
<td>4</td>
<td>Interacting Tanks - Step Response</td>
</tr>
<tr>
<td>5</td>
<td>Interacting Tanks - Impulse Response</td>
</tr>
<tr>
<td>6</td>
<td>Non Interacting Tanks - Step Response</td>
</tr>
<tr>
<td>7</td>
<td>Non Interacting Tanks - Impulse Response</td>
</tr>
<tr>
<td>8</td>
<td>U – Tube Manometer</td>
</tr>
<tr>
<td>9</td>
<td>Thermocouple</td>
</tr>
<tr>
<td>10</td>
<td>Thermistor</td>
</tr>
<tr>
<td>11</td>
<td>Valve characteristics</td>
</tr>
<tr>
<td>12</td>
<td>Cascade control system</td>
</tr>
<tr>
<td>13</td>
<td>Pressure system</td>
</tr>
<tr>
<td>14</td>
<td>Level/Flow/Pressure/pH/Temperature control – PID controller</td>
</tr>
</tbody>
</table>

Note: Minimum 10 experiments are to be conducted

Course Outcomes: The student would have practical knowledge on the measurement of liquid level systems and characteristics at different operating conditions.

- Conduct of Practical Examination:
- All laboratory experiments are to be included for practical examination.
- Students are allowed to pic one experiment from the lot.
- Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.
- Change of experiment is allowed only once and 15% marks allotted to the procedure part to be made zero.

Reference Books:
B. E. PETROCHEM ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - VII

COMPUTER APPLICATIONS LABORATORY

<table>
<thead>
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<tbody>
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<td>Credits</td>
<td>02</td>
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<tr>
<td>Exam Hours</td>
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</tbody>
</table>

### Course Learning Objectives:
This course enables students to implement numerical techniques for chemical engineering applications.

### Sl. No. Experiments

**Part - A:**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Experiments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Non-linear algebraic equation- Newton Raphson (Specific volume of binary mixture)</td>
</tr>
<tr>
<td>2</td>
<td>Ordinary Differential Equation- R-K Method (dCa/dt=kCa²)</td>
</tr>
<tr>
<td>3</td>
<td>Numerical Integration- Simpson’s 1/3 Rule (Batch Reactor to find time)</td>
</tr>
<tr>
<td>4</td>
<td>Curve Fitting-Least Square (Nrevs f)</td>
</tr>
<tr>
<td>5</td>
<td>Calculation of Bubble Point and Dew Point for Ideal multicomponent system</td>
</tr>
<tr>
<td>6</td>
<td>Flash Vaporisation for multi-component system</td>
</tr>
<tr>
<td>7</td>
<td>Design of Adiabatic Batch Reactor</td>
</tr>
<tr>
<td>8</td>
<td>Adiabatic Flame Temperature</td>
</tr>
<tr>
<td>9</td>
<td>Double pipe heat exchanger (Area, Length and Pressure drop)</td>
</tr>
<tr>
<td>10</td>
<td>Distillation Column (Bubble cap)</td>
</tr>
<tr>
<td>11</td>
<td>Pressure Pipe in a Drop 12. Distillation Column (Plates)</td>
</tr>
</tbody>
</table>

**Part - B:**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Experiments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Process simulation study involving mixing, reactor, distillation, heat exchanger for any of the following</td>
</tr>
<tr>
<td>2</td>
<td>Propylene - Propane Splitter</td>
</tr>
<tr>
<td>3</td>
<td>Reboiled Stripper from Seader and Henley</td>
</tr>
<tr>
<td>4</td>
<td>Extractive Distillation</td>
</tr>
<tr>
<td>5</td>
<td>Binary Distillation in a Double Feed Column</td>
</tr>
<tr>
<td>6</td>
<td>Distillation of Ethanol Water mixture</td>
</tr>
<tr>
<td>7</td>
<td>Homogeneous Azeotropic Distillation</td>
</tr>
<tr>
<td>8</td>
<td>Absorber</td>
</tr>
<tr>
<td>9</td>
<td>Reboiled Absorber</td>
</tr>
</tbody>
</table>

**Note:** Minimum of 6 experiments from Part A and 4 experiments from Part B are to be conducted

### Course Outcomes:
At the end of the course students are able to apply numerical techniques to analyse and solve chemical engineering problems using computer programmes.

- **Conduct of Practical Examination:**
  - Minimum of 10 experiments are to be conducted and all 10 experiments are to be included for practical examination.
  - Students are allowed to pick one experiment from the lot.
  - Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.
  - Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

### Reference Books:
**PROJECT WORK PHASE-1**

<table>
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</tr>
<tr>
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</table>

**Project work:**

Based on the ability/abilities of the student/s and recommendations of the mentor, a single discipline or a multidisciplinary project can be assigned to an individual student or to a group having not more than 4 students. In extraordinary cases, like the funded projects requiring students from different disciplines, the project student strength can be 5 or 6.

**CIE procedure for Project Work Phase - 1:**

(i) **Single discipline:** The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide.

(ii) **Interdisciplinary:** Continuous Internal Evaluation shall be group wise at the college level with the participation of all guides of the college. Participation of external guide/s, if any, is desirable.

**INTERNSHIP**

<table>
<thead>
<tr>
<th>Course Code</th>
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<tbody>
<tr>
<td>Teaching Hours/Week (L:T:P)</td>
<td></td>
</tr>
<tr>
<td>Credits</td>
<td></td>
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</tbody>
</table>

**Internship:** All the students admitted to III year of BE/B.Tech shall have to undergo mandatory internship of 4 weeks during the vacation of VI and VII semesters and /or VII and VIII semesters. A University examination shall be conducted during VIII semester and the prescribed credit shall be included in VIII semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared fail and shall have to complete during subsequent University examination after satisfying the internship requirements.
# MODERN SEPARATION TECHNIQUES

**Course Code**: 18PC753  
**CIE Marks**: 40  
**Teaching Hours/Week (L:T:P)**: 3:0:0  
**SEE Marks**: 60  
**Credits**: 3  
**Exam Hours**: 03

**Course Learning Objectives**: This course enables students to understand the role of separation techniques in process plant operations and criteria for selection and estimation of suitable techniques.

**Module-1**
- **Membrane Technology**: Overview of membrane science and technology, Membrane transport theory, Membranes and Modules, Reverse osmosis, Ultra filtration.

**Module-2**
- **External Field Induced Separations**: Magnetic field separations. Centrifugal separations. Separation by thermal diffusion.
- **Mechanical–Physical Separation Process**: Introduction, Classification, Filtration in solid liquid separation. Settling & sedimentation in particle fluid separation.

**Module-3**

**Module-4**
- **Super Critical Fluid Extraction**: Principle, Supercritical fluid solvents and their properties, Phase diagram, Extraction process unit, Advantages, Applications – Extraction of bitter flavour from hopes, Decaffeination of coffee, Rose process for separating residuum.

**Module-5**
- **Other Techniques**: Separations involving Lyophilization, Pervaporation and permeation techniques for solids, liquids and gases. Zone melting, Adductive crystallization. Heavy media separation.

**Course Outcomes**: At the end of the course students are able understand the role of separation techniques in process plant operations and criteria for selection and estimation of suitable techniques and the safety things required.

**QUESTION PAPER PATTERN:**
- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Text Books:**

**Reference Books:**
B. E. PETROCHEM ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER – VIII

TRANSPORT PHENOMENA

<table>
<thead>
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</tr>
</tbody>
</table>

1. **Course Learning Objectives:**
   1. To introduce the students about basic laws of momentum, heat and mass transfer.
   2. To determine the heat transfer rate and temperature distribution for different heat transfer situations.
   3. To determine the mass transfer rate and concentration distribution for different mass transfer situations.
   4. To study the different analogies between mass, momentum and mass transfer.

**Module-1**

**Introduction:**

**Module-2**

**Velocity Distribution in Laminar Flow:**
Different Flow situations, Steady state Shell momentum balances, Boundary conditions applicable to momentum transport problems, Flow over a flat plate, Flow through a circular tube, Flow through Annulus.

**Steady State Shell Energy Balances:**
General Boundary conditions applicable to energy transport problems of chemical engineering. Heat conduction through compound walls. Overall heat transfer coefficient.

**Module-3**

**Temperature Distribution in Solids and in Laminar Flow:**
Different situations of heat transfer: Heat conduction with internal generation by electrical and nuclear energy sources, Heat conduction in a cooling fin: Forced and free convection heat transfer.

**Concentration Distributions in Laminar Flow:**

**Module-4**

**Concentration Distributions in Laminar Flow:**
Diffusion through stagnant gas and liquid films, Diffusion with homogeneous reaction, Diffusion with heterogeneous reaction Diffusion into falling film – Forced convection mass transfer.

**Module-5**

**Analogies between Momentum, Heat and Mass Transport:**
Reynold’s, Prandtl’s and Chilton & Colburn analogies

**Equations of Change:**
Equation of continuity, Equation of motion; Navier – Stokes equation.

**Course Outcomes:**
1. Explain types of fluids, comprehend effect of temperature and pressure on transport properties of fluids and apply transport laws to solve numerical problems.
2. Derive overall heat transfer coefficient, Temperature distribution with and without energy sources.
3. Derive molar flux for stagnant gas, liquid films, homogeneous and heterogeneous reactions and applications to falling film forced convection mass transfer.
4. Determine HT & MT coefficient using various analogies.

**QUESTION PAPER PATTERN:**
- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.
<table>
<thead>
<tr>
<th>Text Books:</th>
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<tr>
<th>Reference Books:</th>
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## RISK ASSESSMENT AND SAFETY ENGINEERING

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<tr>
<td>Credits</td>
<td>03</td>
<td>Exam Hours</td>
<td>03</td>
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</tbody>
</table>

### Course Learning Objectives:
- Become a skilled person in hazard analysis and able to find out the root cause of an accident
- Gain knowledge in devising safety policy and procedures to be adopted to implement total safety in a plant

### Module-1

### Module-2

### Module-3

### Module-4
Safety measures in handling and storage of chemicals – Fire chemistry and its control – Personnel protection – Safety color codes of chemicals.

### Module-5

### Course Outcomes:
After studying this course, students will be able to: learnt the basic concepts relating to chemical hazards, risk, and ethics. They also gain the knowledge of quantitatively analyze release and dispersion rates of liquids and vapors.

### QUESTION PAPER PATTERN:
- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

### Text Books:

### Reference Books:
# B. E. PETROCHEM ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)

## SEMESTER – VIII

### PETROLEUM ECONOMICS

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<tr>
<td>Credits</td>
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<td>Exam Hours</td>
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</tbody>
</table>

**Course Learning Objectives:** To understand the basic quantitative theories and methodologist in oil sector.

### Module-1

Supply and demand curves, the elasticity of supply and demand, public finance concepts such as consumer surplus, excise and export taxes. Forecasting techniques for the energy industry, including energy prices. Demand and supply for natural gas, cured oil and pipeline transportation, determinants of energy demand, energy markets, energy pricing, stability and performance of energy markets.

### Module-2

The economics of investment, Discounted cash flow analysis, Cost Benefit Analyses, Internal Rate of Return, NPV, Profitability Index, Natural Monopoly theory, National competition Policy, Gas Market Regulation, taxation of the oil and gas industry, government policy and trade permits, Monte Carlo analysis, Net Back Pricing, Transfer Pricing and regulatory aspects.

### Module-3

Application of petroleum engineering principles and economics to the evaluation of oil and gas projects, evaluation principles, time value of money concepts, investment measures, cost estimation, price and production forecasting, risk and uncertainty, project selection and capital budgeting inflation, escalation, operating costs, depreciation, cost recovery.

### Module-4

Petroleum exploration and production contracts. Sharing of the economic rent, portfolio management. Value creation, Corporate finance & return on capital, economic appraisal methods for oil field development, reservoir model costs and calculations.

### Module-5

Case studies: Economic study of an oil field development project, petrochemical plant project, natural gas breakeven price, natural gas liquefaction cost, LGN transport cost, investment profitability study for a gas pipeline.

**Course Outcomes:** Students will be able to understand the concept and fundamentals of engineering economics of energy industry.

**QUESTION PAPER PATTERN:**
- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Text Books:**

**Reference Books:**
### B. E. PETROCHEM ENGINEERING

Choice Based Credit System (CBCS) and Outcome Based Education (OBE)

**SEMMESTER – VIII**

**PILOT PLANT AND SCALE UP METHODS**

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<tbody>
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</tr>
<tr>
<td>Exam Hours</td>
<td>03</td>
</tr>
</tbody>
</table>

**Course Learning Objectives:** To understand the basic quantitative theories and methodology in oil sector.

**Module-1**

**Pilot Plants:** Evolution of process system. Need of pilot plants. Concept of prototypes, models, scale ratios, element.

**Principles Of Similarity:** Geometric similarity. Distorted similarity. Static, dynamic, kinematics, thermal and chemical similarity with examples.

**Module-2**

**Dimensional Analysis:** (Review of Rayleigh’s, Buckingham II methods), Differential equation for static systems, flow systems, thermal systems, mass transfer processes, chemical processes homogeneous and heterogeneous.

**Module-3**

**Regime Concept:** Static regime. Dynamic regime. Mixed regime concepts. Criteria to decide the regimes. Equations for scale criteria of static, dynamic processes, Extrapolation. Boundary effects.

**Module-4**


**Module-5**

Stage wise mass transfer processes. Continuous mass transfer processes. Scale up of momentum and heat transfer systems. Environmental challenges of scale up.

**Course Outcomes:** After studying this course, students will be able to understand the challenges come under pilot plant and scale up methods.

**QUESTION PAPER PATTERN:**

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Text Books:**


**Reference Books:**

1. *Pilot Plants and Scale up Studies*, Ibrahim and Kuloor.
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SEMESTER – VIII

PROJECT WORK PHASE-2

<table>
<thead>
<tr>
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<tr>
<td>Credits</td>
<td>08</td>
<td>Exam Hours</td>
<td>03</td>
</tr>
</tbody>
</table>

Project Work
CIE procedure for Project Work Phase - 2:
(i) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide.
The CIE marks awarded for the project work phase -2, shall be based on the evaluation of project work phase -2 Report, project presentation skill and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.
(ii) Interdisciplinary: Continuous Internal Evaluation shall be group wise at the college level with the participation of all guides of the college. Participation of external guide/s, if any, is desirable.
The CIE marks awarded for the project work phase -2, shall be based on the evaluation of project work phase -2 Report, project presentation skill and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.

SEE for Project Work Phase - 2:
(i) Single discipline: Contribution to the project and the performance of each group member shall be assessed individually in semester end examination (SEE) conducted at the department.
(ii) Interdisciplinary: Contribution to the project and the performance of each group member shall be assessed individually in semester end examination (SEE) conducted separately at the departments to which the student/s belongs to.

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SEMESTER – VIII

TECHNICAL SEMINAR

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</table>

CIE procedure for Technical Seminar: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide.
The CIE marks awarded for Technical Seminar shall be based on the evaluation of Seminar Report, Presentation skill and Question and Answer session in the ratio 50:25:25.

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SEMESTER – VIII

INTERNSHIP

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</tr>
<tr>
<td>Credits</td>
<td>03</td>
<td>Exam Hours</td>
<td>03</td>
</tr>
</tbody>
</table>

Internship: Those, who have not pursued/completed the internship, shall be declared as fail and have to complete during subsequent University examination after satisfying the internship requirements.