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)

Course Code	**18MAT31**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(2:2:0)	SEE Marks	60
Credits	03	Exam Hours	03

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 2π 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.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbooks				
1	Advanced Engineering Mathematics	E. Kreyszig	John Wiley & Sons	10th Edition, 2016
2	Higher Engineering Mathematics	B.S. Grewal	Khanna Publishers	44th Edition, 2017
3	Engineering Mathematics	Srimanta Pal et al	Oxford University Press	3rd Edition, 2016
Reference Books				
1	Advanced Engineering Mathematics	C.Ray Wylie, Louis C.Barrett	McGraw-Hill Book Co	6th Edition, 1995
2	Introductory Methods of Numerical Analysis	S. S. Sastry	Prentice Hall of India	4th Edition 2010
3	Higher Engineering Mathematics	B.V. Ramana	McGraw-Hill	11th Edition,2010
4	A Text Book of Engineering Mathematics	N. P. Bali and Manish Goyal	Laxmi Publications	2014
5	Advanced Engineering Mathematics	Chandrika Prasad and Reena Garg	Khanna Publishing,	2018

Web links and Video Lectures:

1. http://nptel.ac.in/courses.php?disciplineID=111
2. http://www.class-central.com/subject/math(MOOCs)
3. http://academicearth.org/
4. VTU EDUSAT PROGRAMME - 20

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SEMESTER - III

CHEMICAL PROCESS CALCULATIONS

Course Code	**18CH32**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives: The students will 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: General steady state energy balance equation, Thermo physics, Thermo chemistry and laws, Heat capacity, Enthalpy, Heat of formation, Heat of reaction, Heat of combustion and Calorific values. Heat of solution, Heat of mixing, Heat of crystallization, determination of ΔH_R at standard and elevated temperatures, Theoretical flame temperature and adiabatic flame temperature.

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:

1. Bhatt B.I. and Vora S.M., **"Stoichiometry (SI Units)"**, 3rd edn, 1996, Tata McGraw Hill Publishing Ltd., New Delhi, 1996
2. Hougen O.A., Watson K.M. and Ragatz R.A., **"Chemical Process Principles - Part I"**

3. **"Material and Energy balances"**, 2nd edn, CBS publishers and distributors, New Delhi, 1995

REFERENCE BOOKS:

1. Himmelblau D.M., **"Basic principle and Calculations in Chemical Engineering"**, 6thedn, Prentice Hall of India, New Delhi,1997

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SEMESTER - III

MOMENTUM TRANSFER

Course Code	**18CH33**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(3:2:0)	SEE Marks	60
Credits	04	Exam Hours	03

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:

Type of fluids – shear stress and velocity gradient relation, Newtonian and Non- Newtonian fluids, Viscosity of gases and liquids. Types of flow – laminar and turbulent flow, Reynolds stress, Eddy viscosity. Flow in boundary layers, Reynolds number, and Boundary layer separation and wake formation.

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. **04 Hr**

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 Π- 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 –π 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:

1. McCabe, W.L., *et.al.,***"Unit Operations in Chemical Engineering"**, 5th edn., McGraw Hill, New York 1993
2. Kumar K.L., **"Engineering Fluid Mechanics"**, Eurasia Publishing House (p) Ltd., New Delhi, 3rd edn. 1984
3. Dr R K Bansal., "**A Text Book of Fluid Mechanics**" 1st edn., Laxmi Publications (P) Ltd., New Delhi. 2005.

REFERENCE BOOKS:

1. Coulson J.H. and Richardson J.F., **"Chemical Engineering"**, Vol-I, 5th edn., Asian Books (p) Ltd., New Delhi, 1998
2. Badger W.L. and Banchero J.T., **"Introduction to Chemical Engineering"**, Tata McGraw Hill, New York, 1997

B. E. PETROCHEM ENGINEERING
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SEMESTER - III

PHYSICAL, ORGANIC AND INORGANIC CHEMISTRY

Course Code	**18PC34**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

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 uncertainity 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:

1.M. K. Jain and S. C. Sharma 'Modern Organic Chemistry' 3rd Edition, Visal Publishing Company Co. (p.92-112)
2. B. R. Puri, L. R. Sharma, Kalia, Principles of Inorganic Chemistry, Milestone Publishers, New Delhi
3. P.C. Jain & Monica Jain. **"Engineering Chemistry"**, Dhanpat Rai Publications, New Delhi (Latest edition-2015).
4. P. W. Atkins**, "Physical Chemistry"**, Oxford Publications (Eighth edition-2006).

REFERENCE BOOKS:

1. R.V. Gadag & A. Nityananda Shetty., **"Engineering Chemistry"**, I K International Publishing House Private Ltd. New Delhi (Latest edition-2015).
2. "Wiley Engineering Chemistry", Wiley India Pvt. Ltd. New Delhi. SecondEdition-2013

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SEMESTER - III

INTRODUCTION TO PETROCHEMICAL ENGINEERING

Course Code	**18PC35**	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
1.Fundamental and methodologies in the petroleum refining processes
2.Concepts of petrochemicals, Testing methods, Origin of oil and gas and Oil recove.

Module-1

Introduction to Petrochemical Engineering: History and Overview of petrochemical industry, Role of Petrochemical Engineer. Major companies in India & abroad. Prospects & Future. Composition of crude oil, Physical properties of oil. Petroleum Materials – Native Materials, Manufactured Materials, Derived Materials.

Module-2

Origin of oil & gas – Biogenic & Abiogenic theory, Occurrence, Migration & accumulation of oil & gas. Basic Concepts of Petroleum Geology. Rocks and fluid properties: Physical properties of oil bearing rocks, Carbonate reservoirs Fracture, Anticlines etc, Type of reserves fluids.

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

Oil & gas exploration methods - Geological and Geophysical methods. Drilling: Introduction to drilling operations, Basics of drilling, Drilling rig, Drilling equipment & its components. Oil Field development, Well completion fundamentals.

Module-5

Reservoir drives & Oil Recovery - Primary oil recovery, Secondary oil recovery. Enhanced oil recovery methods: Chemical, Thermal & Others Recovery of Heavy Oil & Tar Sand Bitumen: Oil Mining & Non Mining Methods. Products and Product Quality.

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:

1. James G. Speight "The Chemistry and Technology of Petroleum", 4th edition, CD&W Inc. Laramie, Wyoming 2007.
2. Uttam Ray Chaudhuri "Fundamentals of Petroleum and Petrochemical Engineering", CRC Press, 2011.
3. B.K Bhaskar Rao "A textbook on Petrochemicals", 2/e, publishers-Delhi 1998.

REFERENCE BOOKS:

1. M.A Mian, "Petroleum processing", handbook for practicing engineer.
2. F. Abdulin, "Production of oil gas" Mir publishers, Moscow.
3. B.G. Deshpande "The world of petroleum", Wiley Eastern Industry.
4. Richard A. Dawe "Modern petroleum technology" volume 1 sixth edition john wiley & sons limited, New York.

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

INSTRUMENTAL METHODS OF CHEMICAL ANALYSIS

Course Code	**18PC36**	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:
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

General Introduction To Spectroscopy - Define Spectroscopy, Types of spectroscopy, Absorption spectrum, Emission spectra, Wave length and Wave number, Electromagnetic radiation, Visible spectrum, Stokes's shift, Hypochromicity, transmittance.
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

Polarography: Principles of polarographic measurements, polarograms, Description and working of dropping mercury electrode. Current and concentrations relationship. Supporting electrolyte. Limiting current, half wave potential. Factors affecting half wave potential. Migration current, Residual current and diffusion current. Modes of operation. Rapid scan polarography, differential pulse polarography, sinusoidal a.c. polarography.

Module-4

Introduction to Chromatography: Classification - Theory - distribution coefficient, rate oftravel, 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.
- The students will have to answer 5 full questions, selecting one full question from each module.

TEXT BOOKS:

1. Spectrometric Identification of organic compounds, R.M. Silverstein and W.P. Webster, 6th Edition, Wiley & Sons, 1999.

2. **Instrumental Methods of Analysis,** H.H.Willard, L.L. Merritt and J.A. Dean and F. A. Settle, CBS Publishers, 7th Edition, 1988.

REFERENCE BOOKS:

1.Instrumental methods of Chemical Analysis, G.W. Ewing, 5thEdition, McGraw-Hill,New York, 1988.

2.Principles of Instrumental Analysis, Skoog, D.A, S.J. Holler, T.A. Nilman

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SEMESTER - III

MOMENTUM TRANSFER LABORATORY

Course Code	**18PCL37**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(0:2:2)	SEE Marks	60
Credits	02	Exam Hours	03

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

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

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:
Dr R K Bansal., “A Text Book of Fluid Mechanics” 1stedn., Laxmi Publications (P) Ltd., New Delhi. 2005.

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SEMESTER - III

MOMENTUM TRANSFER LABORATORY

Course Code	**18PCL38**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(0:2:2)	SEE Marks	60
Credits	02	Exam Hours	03

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

Sl. No.	Experiments
1	Estimation of ASTM Distillation
2	Estimation of TDP Distillation
3	Estimation of Red Vapour Pressure
4	Determination of Calorific Value of the fuel
5	Determination of Copper strip corrosion
6	Determination of Moisture Content
7	Determination of Sulphur Content
8	Determination of Demulsibility number
9	Analysis of fertilizer
10	Determination of Aromatic Content Determination
11	Determination of foaming Characteristics
12	Determination of Aniline Point
13	Analysis of coal- Moisture Volatile matter & Ash content
14	Acid – Base Titration

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 andall 10experiments 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 procedurepart to be made zero.

Reference Books:

1. **Modern Petroleum Refining Processes,** Bhaskara Rao, 3rd Edition, Oxford & IBH Publication, Reprint, 1999.

B. E. (Common to all Programmes)
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER –II / III / IV

Aadalitha Kannada

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

ಆಡಳಿತ ಕನ್ನಡ ಕಲಿಕೆಯ ಉದ್ದೇಶಗಳು:

- ಪದವಿ ವಿದ್ಯಾರ್ಥಿಳಾಗಿರುವುದರಿಂದ ಆಡಳಿತ ಕನ್ನಡದ ಪರಿಚಯ ಮಾಡಿಕೊಡುವುದು.
- ವಿದ್ಯಾರ್ಥಿಗಳಲ್ಲಿ ಕನ್ನಡ ಭಾಷೆಯ ವ್ಯಾಕರಣದ ಬಗ್ಗೆ ಅರಿವು ಮೂಡಿಸುವುದು.
- ಕನ್ನಡ ಭಾಷಾ ರಚನೆಯಲ್ಲಿನ ನಿಯಮಗಳನ್ನು ಪರಿಚಯಿಸುವುದು.
- ಕನ್ನಡ ಭಾಷಾ ಬರಹದಲ್ಲಿ ಕಂಡುಬರುವ ದೋಷಗಳು ಹಾಗೂ ಅವುಗಳ ನಿವಾರಣೆ. ಮತ್ತು ಲೇಖನ ಚಿಹ್ನೆಗಳನ್ನು ಪರಿಚಯಿಸುವುದು.
- ಸಾಮಾನ್ಯ ಅರ್ಜಿಗಳು, ಸರ್ಕಾರಿ ಮತ್ತು ಅರೆ ಸರ್ಕಾರಿ ಪತ್ರವ್ಯವಹಾರದ ಬಗ್ಗೆ ಅರಿವು ಮೂಡಿಸುವುದು.
- ಭಾಷಾಂತರ ಮತ್ತು ಪ್ರಬಂಧ ರಚನೆ ಬಗ್ಗೆ ಅಸಕ್ತಿ ಮೂಡಿಸುವುದು.
- ಕನ್ನಡ ಭಾಷಾಭ್ಯಾಸ ಮತ್ತು ಸಾಮಾನ್ಯ ಕನ್ನಡ ಹಾಗೂ ಆಡಳಿತ ಕನ್ನಡದ ಪದಗಳ ಪರಿಚಯ ಮಾಡಿಕೊಡುವುದು.

ಪರಿವಿಡಿ (ಪಠ್ಯಪುಸ್ತಕದಲ್ಲಿರುವ ವಿಷಯಗಳ ಪಟ್ಟಿ)

ಅಧ್ಯಾಯ – 1 ಕನ್ನಡಭಾಷೆ – ಸಂಕ್ಷಿಪ್ತ ವಿವರಣೆ.

ಅಧ್ಯಾಯ – 2 ಭಾಷಾ ಪ್ರಯೋಗದಲ್ಲಾಗುವ ಲೋಪದೋಷಗಳು ಮತ್ತು ಅವುಗಳ ನಿವಾರಣೆ.

ಅಧ್ಯಾಯ – 3 ಲೇಖನ ಚಿಹ್ನೆಗಳು ಮತ್ತು ಅವುಗಳ ಉಪಯೋಗ.

ಅಧ್ಯಾಯ – 4 ಪತ್ರ ವ್ಯವಹಾರ.

ಅಧ್ಯಾಯ – 5 ಆಡಳಿತ ಪತ್ರಗಳು.

ಅಧ್ಯಾಯ – 6 ಸರ್ಕಾರದ ಆದೇಶ ಪತ್ರಗಳು.

ಅಧ್ಯಾಯ – 7 ಸಂಕ್ಷಿಪ್ತ ಪ್ರಬಂಧ ರಚನೆ (ಪ್ರಿಸೈಸ್ ರೈಟಿಂಗ್), ಪ್ರಬಂಧ ಮತ್ತು ಭಾಷಾಂತರ.

ಅಧ್ಯಾಯ – 8 ಕನ್ನಡ ಶಬ್ದಸಂಗ್ರಹ.

ಅಧ್ಯಾಯ – 9 ಕಂಪ್ಯೂಟರ್ ಹಾಗೂ ಮಾಹಿತಿ ತಂತ್ರಜ್ಞಾನ.

ಅಧ್ಯಾಯ – 10 ಪಾರಿಭಾಷಿಕ ಆಡಳಿತ ಕನ್ನಡ ಪದಗಳು ಮತ್ತು ತಾಂತ್ರಿಕ/ ಕಂಪ್ಯೂಟರ್ ಪಾರಿಭಾಷಿಕ ಪದಗಳು.

ಆಡಳಿತ ಕನ್ನಡ ಕಲಿಕೆಯ ಫಲಿತಾಂಶಗಳು:

- ಆಡಳಿತ ಭಾಷೆ ಕನ್ನಡದ ಪರಿಚಯವಾಗುತ್ತದೆ.
- ವಿದ್ಯಾರ್ಥಿಗಳಲ್ಲಿ ಕನ್ನಡ ಭಾಷೆಯ ವ್ಯಾಕರಣದ ಬಗ್ಗೆ ಅರಿವು ಮೂಡುತ್ತದೆ.
- ಕನ್ನಡ ಭಾಷಾ ರಚನೆಯಲ್ಲಿನ ನಿಯಮಗಳು ಮತ್ತು ಲೇಖನ ಚಿಹ್ನೆಗಳು ಪರಿಚಯಿಸಲ್ಪಡುತ್ತವೆ.
- ಸಾಮಾನ್ಯ ಅರ್ಜಿಗಳು, ಸರ್ಕಾರಿ ಮತ್ತು ಅರೆ ಸರ್ಕಾರಿ ಪತ್ರವ್ಯವಹಾರದ ಬಗ್ಗೆ ಅರಿವು ಮೂಡುತ್ತದೆ.
- ಭಾಷಾಂತರ ಮತ್ತು ಪ್ರಬಂಧ ರಚನೆ ಬಗ್ಗೆ ಅಸಕ್ತಿ ಮೂಡುತ್ತದೆ.
- ಕನ್ನಡ ಭಾಷಾಭ್ಯಾಸ ಮತ್ತು ಸಾಮಾನ್ಯ ಕನ್ನಡ ಹಾಗೂ ಆಡಳಿತ ಕನ್ನಡದ ಪದಗಳು ಪರಿಚಯಿಸಲ್ಪಡುತ್ತವೆ.

ಪರೀಕ್ಷೆಯ ವಿಧಾನ : ನಿರಂತರ ಆಂತರಿಕ ಮೌಲ್ಯಮಾಪನ – ಅಖಇ **(ಅಟಿಣಟಿಣಣಾ ಖಟಿಣಜಾಟಿಚಿಟ ಇತಿಚಿಟಣಚಿಣಟಿ):**
ಕಾಲೇಜು ಮಟ್ಟದಲ್ಲಿಯೆ ಆಂತರಿಕ ಪರೀಕ್ಷೆಯನ್ನು 100 ಅಂಕಗಳಿಗೆ ವಿಶ್ವವಿದ್ಯಾಲಯದ ನಿಯಮಗಳು ಮತ್ತು ನಿರ್ದೇಶನದಂತೆ ನಡೆಸತಕ್ಕದ್ದು.

ಪಠ್ಯಪುಸ್ತಕ : ಆಡಳಿತ ಕನ್ನಡ ಪಠ್ಯ ಪುಸ್ತಕ (ಏಚಿಟಿಟಿಚಿಜಚಿ ಜಿಠಡಿ ಂಜಟ್ಮಿಡಿಚಿಣಟಿ)

ಸಂಪಾದಕರು

ಡಾ. ಎಲ್. ತಿಮ್ಮೇಶ

ಪ್ರೊ. ವಿ. ಕೇಶವಮೂರ್ತಿ

ಪ್ರಕಟಣೆ : ಪ್ರಸಾರಾಂಗ, ವಿಶ್ವೇಶ್ವರಯ್ಯ ತಾಂತ್ರಿಕ ವಿಶ್ವವಿದ್ಯಾಲಯ, ಬೆಳಗಾವಿ.

B. E. (Common to all Programmes)
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER –II & III/IV

Vyavaharika Kannada

Course Code	**18KVK28/39/49**	CIE Marks	100
Teaching Hours/Week (L:T:P)	(0:2:0)		
Credits	01		

Course Learning Objectives:

The course will enable the students to understand Kannada and communicate in Kannada language.

Table of Contents:

Course Outcomes:

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

ಪರೀಕ್ಷೆಯ ವಿಧಾನ : ನಿರಂತರ ಆಂತರಿಕ ಮೌಲ್ಯಮಾಪನ – ಅಖಇ **(ಅಟಿಣಟಿಣಠಾ ಖಟಿಣಜಡಿಟಿಬಿಟ ಇತಟಿಣಟಿಣಟಿ):**

ಕಾಲೇಜು ಮಟ್ಟದಲ್ಲಿಯೆ ಆಂತರಿಕ ಪರೀಕ್ಷೆಯನ್ನು 100 ಅಂಕಗಳಿಗೆ ವಿಶ್ವವಿದ್ಯಾಲಯದ ನಿಯಮಗಳು ಮತ್ತು ನಿರ್ದೇಶನದಂತೆ ನಡೆಸತಕ್ಕದ್ದು.

ಖಿಜ್ಞಾಛಜ್ಞಾ (ಪಠ್ಯಪುಸ್ತಕ): ವ್ಯಾವಹಾರಿಕ ಕನ್ನಡ ಪಠ್ಯ ಪುಸ್ತಕ (ಗಿಥಿಬಿತಟಿಟಿಬಿಡಿಞಾಬಿ ಏಬಿಟಿಟಿಬಿಜಬಿ ಖಿಜ್ಞಾ ಃಜ್ಞಾ)

ಸಂಪಾದಕರು

ಡಾ. ಎಲ್. ತಿಮ್ಮೇಶ

ಪ್ರೊ. ವಿ. ಕೇಶವಮೂರ್ತಿ

ಪ್ರಕಟಣೆ : ಪ್ರಸಾರಾಂಗ, ವಿಶ್ವೇಶ್ವರಯ್ಯ ತಾಂತ್ರಿಕ ವಿಶ್ವವಿದ್ಯಾಲಯ, ಬೆಳಗಾವಿ.

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)

Course Code	**18CPC39/49**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(1:0:0)	SEE Marks	60
Credits	01	Exam Hours	02

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:
The Necessity of the Constitution, The Societies before and after the Constitution adoption. Introduction to the Indian constitution, The Making of the Constitution, The Role of the Constituent Assembly - Preamble and Salient features of the Constitution of India. Fundamental Rights and its Restriction and limitations in different Complex Situations. Directive Principles of State Policy (DPSP) and its present relevance in our society with examples. Fundamental Duties and its Scope and significance in Nation building.

Module-2

Union Executive and State Executive:
Parliamentary System, Federal System, Centre-State Relations. Union Executive – President, Prime Minister, Union Cabinet, Parliament - LS and RS, Parliamentary Committees, Important Parliamentary Terminologies. Supreme Court of India, Judicial Reviews and Judicial Activism. State Executives – Governor, Chief Minister, State Cabinet, State Legislature, High Court and Subordinate Courts, Special Provisions (Articles 370.371,371J) for some States.

Module-3

Elections, Amendments and Emergency Provisions:
Elections, Electoral Process, and Election Commission of India, Election Laws. Amendments - Methods in Constitutional Amendments (How and Why) and Important Constitutional Amendments. Amendments – 7,9,10,12,42,44, 61, 73,74, ,75, 86, and 91,94,95,100,101,118 and some important Case Studies. Emergency Provisions, types of Emergencies and its consequences.

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

Module-4

Professional / Engineering Ethics:
Scope & Aims of Engineering & Professional Ethics - Business Ethics, Corporate Ethics, Personal Ethics. Engineering and Professionalism, Positive and Negative Faces of Engineering Ethics, Code of Ethics as defined in the website of Institution of Engineers (India): Profession, Professionalism, and Professional Responsibility. Clash of Ethics, Conflicts of Interest. Responsibilities in Engineering Responsibilities in Engineering and Engineering Standards, the impediments to Responsibility. Trust and Reliability in Engineering, IPRs (Intellectual Property Rights), Risks, Safety and liability in Engineering.

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.

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.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Constitution of India, Professional Ethics and Human Rights	Shubham Singles, Charles E. Haries, and et al	Cengage Learning India	2018
2	Cyber Security and Cyber Laws	Alfred Basta and et al	Cengage Learning India	2018
Reference Books				
3	Introduction to the Constitution of India	Durga Das Basu	Prentice –Hall,	2008.
4	Engineering Ethics	M. Govindarajan, S. Natarajan, V. S. Senthilkumar	Prentice –Hall,	2004

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).
Vector Algebra: Scalar and vectors. Addition and subtraction and multiplication of vectors- Dot and Cross products, problems.

Module-2

Differential Calculus: Review of elementary differential calculus. Polar curves –angle between the radius vector and the tangent pedal equation- Problems. Maclaurin's series expansions, problems.
Partial Differentiation: Euler's theorem for homogeneous functions of two variables. Total derivatives - differentiation of composite function. Application to Jacobians of order two.

Module-3

Vector Differentiation: Differentiation of vector functions. Velocity and acceleration of a particle moving on a space curve. Scalar and vector point functions. Gradient, Divergence, Curl and Laplacian (Definitions only). Solenoidal and irrotational vector fields-Problems.

Module-4

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

Module-5

Ordinary differential equations (ODE's): Introduction-solutions of first order and first degree differential equations: Variable Separable methods, exact and linear differential equations of order one. Application to Newton's law of cooling.

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.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook				
1	Higher Engineering Mathematics	B.S. Grewal	Khanna Publishers	43rd Edition, 2015
Reference Books				
1	Advanced Engineering Mathematics	E. Kreyszig	John Wiley & Sons	10th Edition, 2015
2	Engineering Mathematics Vol.I	RohitKhurana	Cengage Learning	2015

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]

Course Code	**18MAT41**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(2:2:0)	SEE Marks	60
Credits	03	Exam Hours	03

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.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbooks				
1	Advanced Engineering Mathematics	E. Kreyszig	John Wiley & Sons	10th Edition,2016
2	Higher Engineering Mathematics	B.S. Grewal	Khanna Publishers	44th Edition, 2017
3	Engineering Mathematics	Srimanta Pal et al	Oxford University Press	3rd Edition,2016
Reference Books				
1	Advanced Engineering Mathematics	C.Ray Wylie, Louis C.Barrett	McGraw-Hill	6th Edition 1995
2	Introductory Methods of Numerical Analysis	S.S.Sastry	Prentice Hall of India	4th Edition 2010
3	Higher Engineering Mathematics	B.V.Ramana	McGraw-Hill	11th Edition,2010
4	A Text Book of Engineering Mathematics	N.P.Bali and Manish Goyal	Laxmi Publications	2014
5	Advanced Engineering Mathematics	Chandrika Prasad and Reena Garg	Khanna Publishing,	2018

Web links and Video Lectures:

1. http://nptel.ac.in/courses.php?disciplineID=111
2. http://www.class-central.com/subject/math(MOOCs)
3. http://academicearth.org/
4. VTU EDUSAT PROGRAMME - 20

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

CHEMICAL ENGINEERING THERMODYNAMICS

Course Code	**18CH42**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(3:2:0)	SEE Marks	60
Credits	04	Exam Hours	03

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

THERMODYNAMIC PROPERTIES OF PURE FLUIDS: Reference Properties, Energy Properties, Derived Properties, Work function, Gibbs free energy, Relationships among thermodynamic properties, Exact differential equations, Fundamental property relations, Maxwell's equations, Clapeyron equations, Entropy heat capacity relations, Modified equations for U & H, Effect of temperature on U, H & S, Relationships between C_P & C_V, Gibbs- Helmholtz equation, Fugacity, Fugacity coefficient, Effect of temperature and pressure on Fugacity, Determination of Fugacity of pure gases, Fugacities of solids and liquids, Activity, Effect of temperature and pressure on activity.

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.
2. Calculate entropy for the processes, and various types of energies such as internal energy, enthalpy, Helmholtz free energy and Gibbs free energy.
3. Differentiate between ideal and non-ideal solution and estimate partial molar properties.
4. Generate Vapor Liquid Equilibrium data for ideal and non-ideal solutions and check for their consistency by various methods.
5. 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:

1. Smith J.M. and Vanness H.C., "Introduction to Chemical Engineering Thermodynamics", 5thedn., McGraw Hill, New York, 1996
2. Rao Y.V.C., "Chemical Engineering Thermodynamics", New age International Publication, Nagpur, 2000

REFERENCE BOOKS:

1. Narayanan K.V., "Text book of Chemical Engineering Thermodynamics", Prentice Hall of India Private Limited, New Delhi, 2001.

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.
- Concepts of petrochemicals, Testing methods and Crude treatment methods.

Module-1

Indian Petroleum Industry: Prospects & Future. Major companies. World production, Markets, Offshore and onshore, Oil well technology.
Composition Of Crude: Classification. Evaluation of petroleum. UOP-k factor. TBP analysis. EFV analysis. Average boiling point. ASTM curves. Thermal properties of petroleum fractions.

Module-2

Product Properties And Test Methods: Gas. Various types of gas and LPG. Reid vapour pressure analysis. Gasoline and naptha. Octane No. Oxidation stability. Additives for gasoline. Kerosene. Characterization for flash point or fire point, volatility, burning qualities etc, Diesel, octane testing, viscosity etc. Grades of diesels e.g. HSD, LDO. Diesel additives. Lube oils : Types, tests-carbon residue and viscosity index..

Module-3

Crude Pretreatment: Pumping of crude oils. Dehydration of crude by chemical, gravity, centrifugal, electrical de-salter and comparision 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

Treatment Techniques: Types of impurities present and various desulfurisation processes. Production and treatment of LPG. LNG technology. Sweetening operations for gases including merox, ethanolamine, copper chloride, stertford etc. Catalytic de sulphonisation. Treatment of kerosene, De-aromatisation and merox. Treatment of diesel, naptha: desulpurisation by hydrogen and catalysts. Treatment of lubes: sulphuric acid, clay treatment, solvent treatmentphenol, furfural.
Thermal Processes: Thermal cracking reactions- theory of thermal cracking. Properties of cracked materials and factors influencing the properties of cracked materials. Visbreaking, dubbs two coil cracking process.

Module-5

Catalytic Cracking: Comparision of thermal and catalytic cracking. Carbonium ion chemistry. Feedback requirements. Cracking conditions. Commercial cracking analysis. Various catalytic cracking processes. Fixed bed crackers. Moving bed crackers. Fluid catalytic cracking-flexi cracking-ortho-flow reactor. Theory of coking: various types of coking processes. Delayed coking, fluid coking, contact coking, flexi coking. Naptha cracking, naptha cracking for ethylene as feed selection and gas yield. Hydro cracking. Theory of hydro cracking. Catalysts for hydro cracking.
Catalystic 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:

1. **Petroleum Refinery Engineering**, Nelson, 4th Edition, McGraw Hill, 14th Reprint, 1982.
2. **Modern Petroleum Refining Processes,** Bhaskara Rao, 3rd Edition, Oxford & IBH Publication, Reprint, 1999.

REFERENCE BOOKS:

1. **Petroleum Refining Technology,** Ram Prasad, I Edition, Khanna Publishers, 2000.
2. **Challenges in Crude Oil Evaluation,** Nagnal J.M., Gate, McGraw Hill, 1996.
3. **Petroleum Processing,** Bland W.F. and Davidson R.L. McGraw Hill, 1967.

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

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 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 C_1 Compounds - Manufacture of methanol, Formaldehyde, Trichloroethylene, Perchloroethylene.
Chemicals from C_2 Compounds – Ethylene and Acetylene via steam cracking of hydrocarbons, Ethylene dichloride production, Vinyl chloride production via acetylene – HCl reaction.

Module-4

Chemical from C_3 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 C_4 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:

1.Petrochemicals, B.K. Bhaskar Rao, CRC Press,1990.
2.Chemicals from Petroleum, A.L. Waddams, 2nd Edition, ELBS, London, 1970.

REFERENCE BOOKS:

1. **Dryden's Outlines of Chemical Technology,** Gopal Rao M and Marshall Sittig, 3rd Edition,East-West Press, 1997.
2. **Chemical process industries,** 5th edition, Shreve and Austin, McGraw Hill, 1984.
3. **Chemical Technology,** G.N. Pandey, 3rd Edition, Vikas Publishing House Pvt. Ltd., 1977.
4. **Chemical Technology,** Mukhlyonov, Mir Publications, 1982.

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

PROCESS HEAT TRANSFER

Course Code	**18CH45**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

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

INTRODUCTION: Various modes of heat transfer Viz. Conduction, Convection and Radiation.
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

EXTENDED SURFACES: Fins – Types of fins, Derivation of fin efficiency for longitudinal fins, Fin effectiveness, Elementary treatment of unsteady state heat conduction.
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

DESIGN OF HEAT TRANSFER EQUIPMENT: Elementary design of double pipe heat exchanger, shell and tube heat exchangers and condensers. Numerical Problems.

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, Stefen – 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.

TEXT BOOKS:

1.. Kern D.Q., **"Process Heat Transfer"**, McGraw Hill., New York, 1965
2. McCabe W.L., et.al., **"Unit Operations of Chemical Engineering"**, 5th edn., McGraw Hill, New York, 2000
3. Coulson J.M. and Richardson J.F., **"Unit Operations of Chemical Engineering"**, Vol-I, 5th edn., Chemical Engg,
Pergamon & ELBS, McGraw Hill, New York, 2000

REFERENCE BOOKS:

1. Rao Y.V.C., "Heat Transfer", 1st edn. Universities Press (India) Ltd., New Delhi, 2001.
2. Dutta, Binay K., "Heat Transfer: Principles and Applications", PHI Learning. 2000

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

RENEWABLE ENERGY RESOURCES AND SYSTEMS

Course Code	**18PC46**	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

- 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

Solar Energy: Solar radiation: measurements and prediction. Solar thermal collectors- flat plate collectors, concentrating collectors. Basic theory of flat plate collectors, solar heating of buildings, solar still, solar water heaters, solar driers; conversion of heat energy in to mechanical energy, solar thermal power generation systems. Solar Photovoltaic: Principle of photovoltaic conversion of solar energy, types of solar cells and fabrication. Photovoltaic applications : battery charger, domestic lighting, street lighting, water pumping, power generation schemes.

Module-3

Wind Energy: Atmospheric circulations, classification, factors influencing wind, wind shear, turbulence, wind speed monitoring, Betz limit, WECS: classification, characteristics, and applications.

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:

1.Non-Conventional Energy Sources, G.D. Rai, 4th Edition, Khanna Publications, Second Reprint, 1997.

REFERENCE BOOKS:

[1] D. Y. Goswami, F. Kreith and J. F. Kreider, Principles of Solar Engineering, Taylor and Francis, Philadelphia, 2000.
[2] C. S. Solanki, "Solar Photovoltaics: Fundamental Applications and Technologies, Prentice Hall of India, 2009.
[3] L.L. Freris, Wind Energy Conversion Systems, Prentice Hall, 1990.
[4] D. A. Spera, Wind Turbine Technology: Fundamental concepts of Wind Turbine Engineering, ASME Press.
[5] S.P. Sukhatme, Solar Energy: principles of Thermal Collection and Storage, Tata McGraw-Hill (1984).

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

HEAT TRANSFER LABORATORY

Course Code	**18PCL48**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(0:2:2)	SEE Marks	60
Credits	02	Exam Hours	03

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

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

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:

1.McCabe, W.L., Smith, J.C., and Harriot, P., "Unit Operations in Chemical Engineering", 6thEdn., McGraw-Hill, 2001.

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

CHEMICAL ENGINEERING DRAWING LABORATORY

Course Code	**18PCL47**	CIE Marks	40
Teaching Hours/Week (L:T:P)	0:2:2	SEE Marks	60
Credits	02	Exam Hours	03

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:
1.Gopal Krishna K.R., "Machine Drawing", 2nd revised edn., Sudhas stores, Bangalore, 1998
2.Bhat N.D., "Machine Drawing", 22nd edn., Charoter Publishing House, Anand, 1987
3.Joshi M.V., "Process Equipment Design", 3rd edn., Macmillan India publication", New Delhi, 1999

REFERENCE BOOKS:
Walas S.M., "Chemical Process Equipment", Butterworth Heinemann Pub., 1999
Ludwig E.E., "Applied Process Design", 3rd edn., Gulf Professional Publishing, New Delhi, 1994

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)

Course Code	**18CPC39/49**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(1:0:0)	SEE Marks	60
Credits	01	Exam Hours	02

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:
The Necessity of the Constitution, The Societies before and after the Constitution adoption. Introduction to the Indian constitution, The Making of the Constitution, The Role of the Constituent Assembly - Preamble and Salient features of the Constitution of India. Fundamental Rights and its Restriction and limitations in different Complex Situations. Directive Principles of State Policy (DPSP) and its present relevance in our society with examples. Fundamental Duties and its Scope and significance in Nation building.

Module-2

Union Executive and State Executive:
Parliamentary System, Federal System, Centre-State Relations. Union Executive – President, Prime Minister, Union Cabinet, Parliament - LS and RS, Parliamentary Committees, Important Parliamentary Terminologies. Supreme Court of India, Judicial Reviews and Judicial Activism. State Executives – Governor, Chief Minister, State Cabinet, State Legislature, High Court and Subordinate Courts, Special Provisions (Articles 370.371,371J) for some States.

Module-3

Elections, Amendments and Emergency Provisions:
Elections, Electoral Process, and Election Commission of India, Election Laws. Amendments - Methods in Constitutional Amendments (How and Why) and Important Constitutional Amendments. Amendments – 7,9,10,12,42,44, 61, 73,74, ,75, 86, and 91,94,95,100,101,118 and some important Case Studies. Emergency Provisions, types of Emergencies and its consequences.

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

Module-4

Professional / Engineering Ethics:
Scope & Aims of Engineering & Professional Ethics - Business Ethics, Corporate Ethics, Personal Ethics. Engineering and Professionalism, Positive and Negative Faces of Engineering Ethics, Code of Ethics as defined in the website of Institution of Engineers (India): Profession, Professionalism, and Professional Responsibility. Clash of Ethics, Conflicts of Interest. Responsibilities in Engineering Responsibilities in Engineering and Engineering Standards, the impediments to Responsibility. Trust and Reliability in Engineering, IPRs (Intellectual Property Rights), Risks, Safety and liability in Engineering

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.

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.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Constitution of India, Professional Ethics and Human Rights	Shubham Singles, Charles E. Haries, and et al	Cengage Learning India	2018
2	Cyber Security and Cyber Laws	Alfred Basta and et al	Cengage Learning India	2018
Reference Books				
3	Introduction to the Constitution of India	Durga Das Basu	Prentice –Hall,	2008.
4	Engineering Ethics	M. Govindarajan, S. Natarajan, V. S. Senthilkumar	Prentice –Hall,	2004

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
Credits	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

Linear Algebra: Introduction - rank of matrix by elementary row operations - Echelon form. Consistency of system of linear equations - Gauss elimination method. Eigen values and eigen vectors of a square matrix. Problems.

Module-2

Numerical Methods: Finite differences. Interpolation/extrapolation using Newton's forward and backward difference formulae (Statements only)-problems. Solution of polynomial and transcendental equations – Newton-Raphson and Regula-Falsi methods (only formulae)- Illustrative examples. Numerical integration: Simpson's one third rule and Weddle's rule (without proof) Problems.

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 $R(x) = e^{ax}, \frac{sinax}{cosax}, x^n \; for \; f(D)y = R(x)$.

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

Probability: Introduction. Sample space and events. Axioms of probability. Addition & multiplication theorems. Conditional probability, Bayes's theorem, problems.

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.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook				
1	Higher Engineering Mathematics	B.S. Grewal	Khanna Publishers	43rd Edition, 2015

Reference Books				
1	Advanced Engineering Mathematics	E. Kreyszig	John Wiley & Sons	10^{th} Edition, 2015
2	Engineering Mathematics Vol.I	RohitKhurana	Cengage Learning	2015.

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

MANAGEMENT AND ENTREPRENEURSHIP

Course Code	**18CH51**	CIE Marks	40
Teaching Hours/Week (L:T:P)	2:2:0	SEE Marks	60
Credits	03	Exam Hours	03

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.

Operation Research: Introduction, phases, scope, methodology, O R Models, techniques, applications of O R, Linear Programming, graphic method, simplex method, waiting line theory, game theory, Monte Carlo technique. Dynamic programming.

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 inter personal 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:

1. T R Banga S C Sharma Industrial Organization and Engineering Economics Khanna Publications 24th Edition ISBN No. 81-7409-078-9
2. Dr. Vilas Kulkarni & Hardik Bavishi Engineering Economics & Management: Vikas Publishing.

REFERENCES:

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

10th edn, ISBN: 978-81-317-2720-1.
2. James Stoner, Edward Freeman & Daniel Gilbert Jr, Management, PHI, 6th Edition, ISBN: 81-203-0981-2.

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

WELL DRILLING EQUIPMENT AND OPERATION

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

DRILLING MUDS AND COMPLETION SYSTEMS - Functions of Drilling Muds, Classifications, Testing of Drilling Systems, Completion and Workover Fluids, Safety Aspects of Handling Brines, Preventing Contamination.

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 DeviatedWell Drilling and Completions, Down hole 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.

WELL PRESSURE CONTROL – Introduction, Surface Equipment, When and How to Close the Well, Gas-Cut Mud, The Closed Well, Kick Control Procedures, Maximum Casing Pressure, Maximum Borehole Pressure.

Module-4.

FISHING OPERATIONS AND EQUIPMENT - Causes and Prevention, Pipe Recovery and Free Point, Parting the Pipe, Jars, Bumper Subs and Intensifiers, Attachment Devices, Fishing for Junk, Abandonment, Wirelines, Electrical Conductors, Simple Armored Wirelines, Armored Wirelines with Electrical Conductors, Wireline Operating and Breaking Strengths, Wireline Stretching.

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:

1. Rabia.H. 'Oil Well Drilling Engineering, Principles And Practices' Graham And Trotman Ltd. 1985
2. D.P Helander 'Fundamentals Of Formation Evaluation'.

REFERENCES BOOKS:

1 Standard Handbook of Petroluem and Natural Gas Engineering, 2nd Edition, William C Lyons, Gary C

Pilisga, Gulf Professional Publishing
2. Working guide to Drilling equipment and Operations, William c. Lyons, first edition 2010 Published by Elsevier.

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

RESERVOIR ENGINEERING

Course Code	**18PC53**	CIE Marks	40
Teaching Hours/Week (L:T:P)	3:2:0	SEE Marks	60
Credits	4	Exam Hours	03

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

Reservoir fluid behaviour and properties- classification of reservoir and reservoir fluids. Properties of natural gases. Direct calculation of compressibility factors. Methods of calculating viscosity of natural gases, properties of crude oil systems. Methods of calculating viscosity of the dead oil. Properties of reservoir water.
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:

1. L.P.Dake L Elsevier, “Fundamentals of Reservoir Engineering”, Development in Petroleum Science. 1980
2. Craft B.C and Hawkins M.F. – Applied Petroleum Reservoir Engineering” 2nd Edition. Prentice Hall Englewood Cliffs, N.J., 1991

REFERENCES BOOKS:

1.Dake, L.P. Practice of Reservoir Engineering Elsevier 2001
2. William C.Lyons, Gary J.Plisga “Standard Hand Book of Petroleum & Natural Gas Engineering” Second Edition – (Elsevier), Gulf Publishing, Burlington U.S.A (2005).

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

FUNDAMENTALS OF PETROLEUM GEOLOGY

Course Code	**18PC54**	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

- 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

Introduction to earth science - Origin of earth. Nature and properties of minerals and rocks. Sedimentation and sedimentary environment. Stratigraphy and geological time scale. Introduction of plate tectonics.

Module-2.

Sedimentalogy of Petroleum bearing sequences - Sedimentary basins. Generation and Migration of Petroleum. Physical and Chemical properties of Petroleum.

Module-3

Subsurface Environment – Formation fluids – Composition, temperature, pressure and dynamics. Traps and Seals. The Reservoir. Generation and Migration and Distribution.

Module-4.

Exploration Methods - Well drilling. Formation Evaluation. Geophysical. Borehole Seismic and 4D Seismic. Subsurface geology.

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:

1. Cox, P.A., “The Elements on Earth”, Oxford University Press, Oxford 1995.
2. Wilson, M., Igneous Petrogenesis”, Unwin Hyman, London 1989.

REFERENCES BOOKS:

1. Boggs, S., “Principles of Sedimentology and Stratigraphy”, second edition, Merrill Publishing Co., Toronto, 1995.
2. Krumblein, W.C. and Sloss, L.L., “Stratigraphy and Sedimentation”, second edition W.H. Freeman and Co., 1963.

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

MASS TRANSFER OPERATIONS

Course Code	**18PC55**	CIE Marks	40
Teaching Hours/Week (L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

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

Types of diffusion in fluids. Types of diffusion in solid. Measurement and calculations of diffusivities. Mass transfer coefficients and their correlations. Theories of mass Transfer. Inter phase mass transfer. M**a**terial balance for co-current, cross-current and counter-current operations. Concept of stages, cascades operation, NTU and HTU concepts.

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

Absorption: Absorption. Solvent selection for absorption. Material balance and concept of driving force and minimum solvent rates. Multistage absorption columns. Design of Plate columns. Absorption and desorption factors. Packed Tower Absorption: Liquid phase holdup and pressure drop in absorption towers. Design of packed towers (process design-height and diameter). Multi-component absorption. Absorption with chemical reaction.

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: Introduction Vapour liquid equilibria (T-x, y, P-x, y. H-x, y and x-y diagrams for binary mixtures). Relative volatility. Prediction of VLE from vapour pressure data using Raoult's law. VLE for multi-component systems. Non-ideal systems. Azeotropes. Immiscible systems. Steam distillation**,** Flash and simple distillation.

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

Liquid-Liquid Extraction: Ternary equilibrium. Solvent selection. Single stage. Multi-stage cross-current, counter-current extraction. Equipment for liquid-liquid extraction.

Leaching Operation: Equipment for leaching. Preparation of solids for leaching. Equilibrium diagrams. Calculation of single stage and multi-stage leaching operation.

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.

TEXT BOOKS:

1**. Mass Transfer Operations**-Robert E Treybal,3rd Edition, McGrawHill,1981.
2. **Unit Operations of ChemicalEngineering**-McCabe&Smith,6th Edition, Mc Graw Hill, 2001.

REFERENCE BOOKS:

1. **Chemical Engineering Vol I, II, IV and V -** Coulson and Richardson, 4th Edition, PergamonPress, 1998.
2. **Introduction to Chemical Engineering-**Badger & Banchero, TMH 6th Reprint1998.
3. **Principles of UnitOperations-**Foust*et.al.*, 2ndEdition, John Wiley, 1994.
4. **Transport Processes and Unit Operations-**Geankoplis C J, Prentice Hall (I), 2000.
5. **Applied Process Design for Chemical and Petrochemical Plant** Ludwig, 2nd Edition, Publishing, 2002.

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

POLYMER SCIENCE AND TECHNOLOGY

Course Code	**18PC56**	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 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

Polymer Reaction Engineering: Bulk, Solution, Suspension, Emulsion and Precipitation Polymerization. Viscoelastic Properties of polymers. Hooke's and Newton's equation. Maxwell, Voiget and Burger Model. Glass transition temperature, Heat distortion temperature.
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

Unit Operations in Polymer Processing: Extrusion- Single Screw and Twin Screw Extruders. Injection molding and variations – The injection unit, Hot runners, Insert molding, Gas assisted injection molding, Sher controlled injection molding, Reaction injection molding, Compression molding, Transfer Molding. Blow molding – Extrusion blow molding, Injection Blow molding. Rotational molding, Thermoforming.

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:

1. Charles E. Carraher. "Polymer Chemistry" 7TH Edition, CRC Press 2008
2. V R Gowriker , N V Vishwanath and Jayadev Sreedhar "Polymer Science", New age International(P) Ltd 1986

REFERENCE BOOKS:

1. George Odian "Principle of polymerization" John Wiley & Sons Inc. 2004

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

GEOLOGY LABORATORY

Course Code	**18PCL57**	CIE Marks	40
Teaching Hours/Week (L:T:P)	0:2:2	SEE Marks	60
Credits	02	Exam Hours	03

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
9	Sand – Silt – Clay ratio estimation.
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:
1. Amyx, J.W., Bass D.M. & Whiting., R.L., “Petroleum Reservoir Engineering” McGraw Hill 1998.
2. Boggs, S., “Principles of Sedimentology and Stratigraphy”, second edition, Merrill Publishing Co., Toronto, 1995.

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

MASS TRANSFER OPERATIONS LABORATORY

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.

3	Surface Evaporation
4	Determination of Diffusion Coefficient
5	Simple Distillation
6	Solid – liquid leaching
7	Adsorption studies
8	Tray dryer
9	Steam distillation
10	Extraction of oil from pyrolysis method
11	Liquid - liquid extraction
12	Vacuum Dryer
13	Ternary System
14	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:

1. Robert E Treybal, Mass Transfer Operations, 3rd Edition, McGraw Hill, 1981.
2. McCabe & Smith “Unit Operations in Chemical Engineering”, 6th Edition, McGraw Hill, 2001.

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

ENVIRONMENTAL STUDIES

Course Code	**18CIV59**	CIE Marks	40
Teaching Hours / Week (L:T:P)	(1:0:0)	SEE Marks	60
Credits	01	Exam Hours	02

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

Advances in Energy Systems (Merits, Demerits, Global Status and Applications)**:** Hydrogen, Solar, OTEC, Tidal and Wind.
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

Latest Developments in Environmental Pollution Mitigation Tools (Concept and Applications): G.I.S. & Remote Sensing, Environment Impact Assessment, Environmental Management Systems, ISO14001; Environmental Stewardship- NGOs.
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.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Environmental Studies	Benny Joseph	Tata Mc Graw – Hill.	2nd Edition, 2012

2.	Environmental Studies	S M Prakash	Pristine Publishing House, Mangalore	3rd Edition' 2018
3	Environmental Studies – From Crisis to Cure	R Rajagopalan	Oxford Publisher	2005
Reference Books				
1	Principals of Environmental Science and Engineering	Raman Sivakumar	Cengage learning, Singapur.	2nd Edition, 2005
2	Environmental Science – working with the Earth	G.Tyler Miller Jr.	Thomson Brooks /Cole,	11th Edition, 2006
3	Text Book of Environmental and Ecology	Pratiba Sing, AnoopSingh& PiyushMalaviya	Acme Learning Pvt. Ltd. New Delhi.	1st Edition

VI – SEMESTER

B. E. PETROCHEM ENGINEERING **Choice Based Credit System (CBCS) and Outcome Based Education (OBE)** **SEMESTER - VI**			
NATURAL GAS PROCESSING			
Course Code	**18PC61**	CIE Marks	40
Teaching Hours/Week (L:T:P)	3:2:0	SEE Marks	60
Credits	04	Exam Hours	03

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

Module-1

Natural gas technology: Branches of petroleum Industry. Sources of Information for natural gas engineering and its applications. Geology and earth sciences: Earth sciences-Historical geology, Sedimentation process, Petroleum reservoirs, Origin of petroleum. Earth temperatures & pressure, Earth temperatures, Earth pressure. Natural gas, LP gas, Condensate, Crude oil.

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.

Gas Liquid separation: Separation equipment, types of separators, separation principles- centrifuge separators, gravity settling, impingment. Factors affecting separation, gas cleaning, gas hydrates- hydrate phase behaviour, hydrate formation, prevention. Gas dehydration: Adsorption dehydration, types of adsorbents.

Module-5

Gas desulfurisation : Meaning of sour gas and sweet gas, reasons for removal of H_2S
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:

1.Katz D.L.et al., Natural Gas Engineering (Production & storage), McGraw-Hill, Singapore

REFERENCE BOOKS:

1.Standard Handbook of Petroleum and Natural Gas Engineering. 2nd Edition. William C Lyons, Gary C Plisga. Gulf Professional Publishing.

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

CHEMICAL REACTION ENGINEERING

Course Code	**18PC62**	CIE Marks	40
Teaching Hours/Week (L:T:P)	3:2:0	SEE Marks	60
Credits	04	Exam Hours	03

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

Scope of Chemical Reaction Engineering. Classification of reactions. Rate equation and rate of reaction. Factors affecting rate of reaction. Chemical kinetics and Thermodynamics Equilibrium. Temperature dependency of rate constant from Arrhenius, Collision and Transition state theories. Molecularity and order of reaction.

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

Module-2.

Homogeneous Reactions: Interpretation of batch reactor data. Constant & Variable Volume batch reactor. Analysis: Differential method, Integral method, half-life method. Method of excess and method of isolation (For Reversible and Irreversible reactions up to second order). Auto catalytic reactions.

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.

Basics of Non Ideal Flow: Importance & interpretation of RTD, C, E & F curves & Statistical interpretation. Dispersion model. Tanks in series model. Conversion in non- ideal flow reactors for simple systems.

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
TEXT BOOKS: **1. Chemical Reaction Engineering,** Octave Levenspiel, 3rde dition, JohnWiley & Sons ,2001. 2. **Elements of Chemical Reaction Engineering,** H. Scott Fogler, 3rd edition, Prentice Hall 2001.
REFERENCE BOOKS: **1. Chemical Engineering Kinetics,** J. M. Smith,3rd Edition, McGraw Hill,1984.

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

PROCESS EQUIPMENT DESIGN AND DRAWING

Course Code	18PC63	CIE Marks	40
Teaching Hours/Week (L:T:P)	3:2:0	SEE Marks	60
Credits	4	Exam Hours	03

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:

1. TEXT BOOKS:

1. **Process Equipment Design-** M.V. Joshi, 3rd edn., Macmillan & Co. India, Delhi, 1998.
2. **Process Equipment Design–Vessel Design,** Brownell & Young, John Wiley, 1959.
3. **Process Design of Equipment – Vol 1,** S. D. Dawande, 3rd edn, Central Techno Publications.2003.

REFERENCE BOOKS:

1. Chemical Engineers Handbook, Perry&Green,8th edn, Mc Graw Hill,1997.
2. **Pressure Vessel Code–IS2825,**IS Code, B.I.S., New Delhi,1969.
3. **Flow of Fluids through Valves, Fittings & Pipes**,CraneAmazon,2006.

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

PROFESSIONAL ELECTIVE – 1
PETROLEUM TRANSPORTATION ENGINEERING

Course Code	**18PC641**	CIE Marks	40
Teaching Hours/Week (L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

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. Wey mouth and pan handle equation, design factors. Pressure drop in non-horizontal pipeline. Stress conditions in pipeline and analysis.

Module-3

Branching and looping in pipelines and multiphase flow- equivalent diameter and length combined capacity. Steady state flow in pipes, flow networks. Flow pattern in gas- liquid flow, pressure drop estimation, design consideration. Pipe sizing, storage capacity, station spacing. Transportation problems and remedial measures, pressure surges, scaling, wax deposition, gas hydrate formation.

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

Auxiliary equipment/ facilities and pumps & compressor Station- valves, regulators, types and operating features. Metering & storage: flow meter types, Calibration, proving, heating value. Storage of crude, product, natural gas and LNG. Layout, equipment, instrumentation, prime movers: two stroke vs four stroke. Naturally Design aspirated vs super charged engines, gas turbines, single vs multi shaft turbines, Emission control.

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:

1. The Petroleum Shipping Industry: Operations and Practices, Penwell Books, 1996.

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

Course Code	**18PC642**	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 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:

1. J. S. Milton and J.C. Arnold, " Introduction to Probability and Statistics", Tata McGraw Hill, 4th edition, 2007. (For units 1 and 2)

2.R.A. Johnson and C.B. Gupta, "Miller and Freund‟s Probability and Statistics for Engineers", Pearson Education, Asia, 7th edition, (2007)

Reference Books:

1. Walpole, R. E., Myers, R. H. Myers R. S. L. and Ye. K, "Probability and Statistics for Engineers and Scientists", Seventh Edition, Pearsons Education, Delhi, 2002.

2. Navidi, W, "Statistics for Engineers and Scientists", Special Indian Edition, Tata McGraw-Hill Publishing Company Ltd, New Delhi,2008.

3. Spiegel, M.R, Schiller, J and Alu Srinivasan, R, "Schaum‟s Outlines Probability and Statistics", Tata McGraw-Hill Publishing Company Ltd. New Delhi, 2007.

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Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER – VI

18PC64X PROFESSIONAL ELECTIVE – 1
RESERVOIR ROCKS AND FLUID PROPERTIES

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

The earth, crust, plate tectonics and geologic times. Sedimentary geology, Basins and Margins. Origin, accumulation and migration of petroleum. Properties of subsurface fluids. Petroleum Chemistry..

Module-2.

Porosity and Permeability relationship – Porosity. Permeability. Porosity – Permeability relationship. Electrical properties of rocks. Measurement of formation resistivity. Correlation of FR with porosity, permeability and water saturation. FR of Shaley Reservoir rocks. Formation evaluation.

Module-3

Capillary Pressure and Well ability – Fluid Saturation and Capacity pressure. Determination of capillary pressure. Pore size distribution. Wettability. Evaluation of wettability and its effect on oil recovery. Alteration of wettability. Effect of wettability on electrical properties of rocks

Module-4.

Linear flow of incompressible fluids. Darcy's Law. Linear flow of gas. Darcy's and Poiseuille's laws. Various flow systems. Multiple permeability rocks.

Module-5

Reservoir fluid properties – Phase behaviour of hydrocarbon system. Fluid rock interactions. Reservoir fluid characteristics. PVT analysis. Flash liberation and differential liberation study.

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:

1. Craft, B.C. and Hawkins M.F. "Applied Petroleum Reservoir Engineering" second edition, Prentice-Hall (1991)
2. Djebbar Tiab : "Theory and pratice of measuring Reservoir rock and fluid Transport properties

Reference Books:

1. Amyx, J.W., Bass D.M. & Whiting., R.L., "Petroleum Reservoir Engineering" McGraw Hill 1998

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

18PC65X Open Elective –A
BIOCHEMICAL ENGINEERING

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

Introduction: Bioprocess engineering and technology. Role of a Chemical engineer in bioprocess industry. An introduction to basic biological sciences. Microbiology: Structure of cells: Prokaryotes and Eukaryotes. Classification of micro-organisms. Taxonomy, control of microorganisms – physical and chemical methods.

Module-2.

Enzymes and Proteins: Detailed structure of proteins and enzymes. Functions. Methods of Production and purification of Enzymes. Nomenclature and Classification of enzymes. Kinetics and mechanism of Enzyme action: Michaelis–Menten and Briggs-Haldane approach. Derivation

Module-3

Kinetics of Enzyme Action: Reversible Enzyme. Two-substrate. Multi-complexes enzyme kinetics (Derivation of rate equations). Experimental determination of rate parameters: Batch and continuous flow experiments. Lineweaver–Burk, Eadie-Hofstee and Hanes-Woolf Plots. Batch Kinetics (Integral and Differential methods).

Module-4.

Enzyme Inhibition: Effect of Inhibitors (Competitive, noncompetitive, uncompetitive, substrate and product inhibitions), Temperature and pH on the rates enzyme catalyzed reactions. Determination of kinetic parameters for various types of inhibitions. Dixon method. Enzyme immobilization: Uses. Methods of enzyme immobilization.

Module-5

Growth Kinetics of Microorganisms: Transient growth kinetics (Different phases of batch cultivation). Quantification of growth kinetics: Substrate limited growth, Models with growth inhibitors, Logistic equation, Filamentous cell growth model. Continuous culture: Optimum Dilution rate and washout condition in Ideal Chemostat. Introduction to Fed-batch reactors.

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:

1. **Biochemical Engineering Fundamentals,** Bailey and Ollis, II Edition, McGraw Hill,1976.
2. **Bioprocess Engineering,** Shuler M. L. and Kargi F., 2nd Edition, Prentice Hall, 2002.

Reference Books:

1. **Biochemical Engineering,** James Lee, Prentice Hall, 1992.
2. **Biochemical Reactors,** Atkinson B, Pion Ltd., London, 1974.
3. **Industrial Microbiology,** Casida, wiley, New York, 1968

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Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER – VI

18PC65X Open Elective –A
PHARMACEUTICAL TECHNOLOGY

Course Code	**18PC652**	CIE Marks	40
Teaching Hours/Week (L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

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:

1. Jain N.K, **Pharmaceutical Product Development**, CBS Publications and Distributions, New Delhi, 2006.
2. Sidnay H. Willing, Murray M. Tuckerman, and Williams Hitchings, **Good Manufacturing of Pharmaceuticals**, 3rd Edition, Marcell Dekker Inc., NY, 1982.
3. Evans, and Anderson, **Applied Production and Operations Management**, 3rd Edition, West Publishing Co. Ltd., St. Paul, 1997.

Reference Books:

1.Liberman, and Lachman, **"The Theory and Practice of Industrial Pharmacy"**, 3rd Edition, Lea & Febiger, Philedelphia, 1986.

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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:
Geometry of crystals – the Bravais lattices, Crystal directions and planes – the miller indices, Structure determination – X – Ray diffraction – Bragg law, The powder method.

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:
Phase rule, Single component systems, Binary phase diagrams, Lever rule, Typical phase diagrams for Magnesia-Alumina, Copper – Zinc, iron – carbon systems, Nucleation and growth, Solidification, Allotropic transformation, Cooling curve for pure iron, Iron – Carbon equilibrium diagram, Isothermal transformations (TTT curves).

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, Cyaniding, 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

TYPICAL ENGINEERING MATERIALS Ferrous metals, Non ferrous metals and alloys – Aluminum and its alloys, Copper and its alloys, Lead and its alloys, Tin, Zinc and its alloys, Alloys for high temperature service, Ceramic materials – Structure of ceramics, Polymorphism, Mechanical, electrical and thermal properties of ceramic phases, Refractories, Glasses, abrasives, Organic materials – Mechanism of polymerization, Additives to polymers, Plastics, fibres and elastomers, Organic protective coatings.

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:

1. Raghavan V., "Materials Science and Engineering – A First Course", 3rdedn., Prentice Hall of India Pvt. Ltd., New Delhi, 1996
2. Hajra Choudhury S.K., "Materials Science and Processes", Indian book distributing Co., 1982

Reference Books:

1. Van Vlack H.L., "Elements of Material Science", 2ndedn., Addison – Wesly Publishing Company, New York, 1964.

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Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - VI

CHEMICAL REACTION ENGINEERING LABORATORY

Course Code	**18PCL66**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(0:2:2)	SEE Marks	60
Credits	02	Exam Hours	03

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

Sl. No.	**Experiments**
1	Isothermal Batch Reactor – Integral Analysis
2	Isothermal Batch Reactor – Differential Analysis
3	Adiabatic Batch Reactor
4	Packed Bed Reactor
5	Effect Of Temperature On Rate Of Reaction
6	Kinetic Studies In Mixed Flow Reactor
7	RTD Studies In Mixed Flow Reactor
8	Plug Flow Reactor
9	Semi Batch Reactor
10	Batch Reactive Distillation
11	Gas-Liquid Reaction
12	Catalytic Reaction
13	Photochemical Reaction
14	CSTR in Series

Note: Minimum 10 experiments are to be conducted

Course Outcomes:

Conduct of Practical Examination:

- Minimum of 10 experiments are to be conducted and all 10experiments 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:

1. **Chemical Reaction Engineering,** Octave Levenspiel, 3rd Edition, John Wiley & Sons, 2001
.2. **Chemical Engineering Kinetics,** J.M. Smith, 3rd Edition, McGraw Hill.
3. **Elements of Chemical Reaction Engineering,** H. Scott Foggler, 3rd Edition, Prentice Hall, 2001.

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

PETROLEUM TESTING LABORATORY

Course Code	**18PCL67**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(0:2:2)	SEE Marks	60
Credits	02	Exam Hours	03

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

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 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:

1.**Modern Petroleum Refining Processes,** Bhaskara Rao, 3rd Edition, Oxford & IBHPublication, Reprint, 1999.

B. E. PETROCHEM ENGINEERING Choice Based Credit System (CBCS) and Outcome Based Education (OBE) SEMESTER - VI			
MINI-PROJECT			
Course Code	**18PCMP68**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(0:2:2)	SEE Marks	60
Credits	02	Exam Hours	03

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.

B. E. PETROCHEM ENGINEERING Choice Based Credit System (CBCS) and Outcome Based Education (OBE) SEMESTER - VI			
INTERNSHIP			
Course Code		CIE Marks	
Teaching Hours/Week (L:T:P)		SEE Marks	
Credits		Exam Hours	

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.

VII – SEMESTER

B. E. PETROCHEM ENGINEERING **Choice Based Credit System (CBCS) and Outcome Based Education (OBE)** **SEMESTER – VII**			
RESEARCH METHODOLOGY			
Course Code	**18PC71**	CIE Marks	40
Teaching Hours/Week (L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

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 **- S**urvey of literature - Primary and secondary sources.

Module-3

Sampling: Concepts- Types of Sampling - Probability Sampling and Non Probability Sampling, Errors in sampling. Data Collection: Primary data collection methods - Observations, survey, Interview and Questionnaire, Questionnaire design – Meaning - process of designing questionnaire. Secondary data -Sources – advantages and disadvantages.

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.

Intellectual Property Rights- Introduction, History of IPR in India, Protection of Intellectual Property Rights (IPRs)- A brief summary of: Patents, Copyrights, Trade Secret.

Patent Intellectual Property Rights and Regulatory Affairs: Definitions, Procedures for applying Indian Scenario - GATT, TRIPS, TRIMS AND WTO Legal aspects ISO 9000 series.

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:

1. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International.
2. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.

Reference Books:

1. William M C Trochi “Research Methods” 2nd edition Biztantra 2007.
2. Deepak Chawla and Neena Sondhi “Research Methodology” Vikas Publication 2014.
3. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, Ess Ess Publications. 2 volumes.
4. Subbarau NR-Handbook on Intellectual Property Law and Practice-S Viswanathan

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

PROCESS CONTROL AND INSTRUMENTATION

Course Code	**18CH72**	CIE Marks	40
Teaching Hours/Week (L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

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 gages. 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 System: Basic components. Servo and regulator control. Controllers – P, I, D and On –Off modes. Controller combinations - Final control elements - Valves, actuators and valve positioners.
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:**
2. **Process System Analysis and Control,** Coughner & Koppel, 2nd edn, McGraw Hill, NewDelhi, 1991.

Reference Books:
1. **Process Modeling, Simulation & Control for Chemical Engineers,** Luyben, 2nd edn, McGraw Hill, 1990.
2. **Chemical Process Control-**An Introduction to Theory & Practical, George Stephanopoules,Vol.3, Prentice Hall, New Delhi, 1998.

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

OPTIMIZATION TECHNIQUES FOR PROCESS INDUSTRIES

Course Code	**18PC731**	CIE Marks	40
Teaching Hours/Week (L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives:

1. To develop understanding of the principles, techniques, standard tools of process optimization.
2. To formulate multi objective optimization problem with and without constraints based on process requirements.

Module-1

Principles of Optimization- Introduction to optimization and its scope in chemical processes, Nature and organization of optimization problems, Design Variable, Constraints, Objective Function, Necessary and sufficient conditions.

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- Kuhn-Trucker Conditions, Transformation Methods: Penalty function method, Methods of multipliers, Sensitivity Analysis, Direct Search for Constrained Optimization, Feasible Direction Methods.

Module-5

Specialized Search Method- Integer Programming: Penalty Function method, Branch-and-Bound method, Geometric Programming, Mixed integer Programming, Dynamic Programming.

Evolutionary Global Optimization Techniques- Genetic Algorithms: Working Principles, GA Operators, Binary Coded GA, Real Coded GA, Non-dominated Sorting GA, Pareto Optimization. Simulated Annealing, Ant Colony Optimization, Particle Swarm Optimization.

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:

1. Edgar, T F, Himmelblau, D M, and Lasdon, L S, "Optimization of Chemical Processes." McGraw Hill, Boston, 2001
2. Rao, S. S., "Optimization Theory and Applications: Theory and Practice", New Age International, 3rd Edition, 1996.
3. Deb, Kalyanmoy "Optimization for Engineering Design", Prentice-Hall of India, 1995.

Reference Books:

1.Deb, Kalyanmoy "Multi-Objective Optimization using Evolutionary Algorithms", John Wiley & Sons Ltd. Chichester, West Sussex, England, 2001.

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

PROCESS ENGINEERING AND PLANT DESIGN

Course Code	**18PC732**	CIE Marks	40
Teaching Hours/Week (L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

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.

Flow sheet synthesis and Development – General procedure, Process information, Input/output structure, Function diagram, Operation diagram, Process flow sheet, Algorithmic flow sheet generation.
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:

1. Rudd D.F and Watson C.C, **Strategy of Process Engineering**, John Wiley and Sons.
2. Kumar Anil, Chemical process synthesis and engineering design, Tata McGraw Hill New Delhi.

Reference Books:

1. Max S Peters, Klaus D T and Ronald E W, **Plant Design and Economics for Chemical Engineers**, 5th edition 2011, McGraw Hill Education Pvt Limited. New Delhi.

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

ONSHORE AND OFFSHORE ENGINEERING AND TECHNOLOGY

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

Dynamic analysis of offshore structures. Centrifugal modeling. Anchor design. Break out resistance analysis and geotechnical aspects of offshore pipeline and cable design. Field instrumentation and performance observation.

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:
1. Standard Hand Book of Petroleum & Natural Gas Engineering" – 2nd Edition 2005-William C.Lyons & Gary Gulf-Gulf professional publishing comp (Elsevier).
2. Well site Geological Techniques for petroleum Exploration by Sahay.B et al.

Reference Books:
1. Petroleum Exploration Hand Book by Moody, G.B.

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Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER – VII

PETROLEUM CORROSION TECHNOLOGY

Course Code	**18PC741**	CIE Marks	40
Teaching Hours/Week (L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

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

Introduction to Corrosion - Definition of Corrosion, Basic corrosion principles, Corrosion in oil and gas production, Materials involved, Corrosion Agents in Drilling and Producing Operations, corrosion rate, Introduction to Electrochemistry, Electrochemical reactions. Electrode potentials-passivity-temperature-pressure-velocity-conductivity-pH-dissolved gases.

Module-2.

Forms of corrosion-uniform-pitting-Galvanic erosion-Intergranualar 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 (CO_2) in corrosion-Effect of temperature and pressure Corrosion of well tubing and other equipments. Role of hydrogen sulphide (H_2S)-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.

Corrosion Control and Detection - Detection of Corrosion, Measurement of Corrosion, Corrosion prevention- Cathodic protection. Principles of operation-applications Galvanic systems, corrosion prevention-coatings, corrosion prevention inhibitors, types of corrosion inhibitors, choice and selection.

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:

1. "Corrosion control in Petroleum production"-TPC 5-2-nd edition H.G.Byars Houston, texas, 1995.
2. Chemical engineering series, coulson and Richardson, Mc Graw Hill Publications.

Reference Books:

1. Standard Handbook of Petroleum and Natural Gas Engineering. 2nd Edition. William C Lyons, Gary C Plisga. Gulf Professional Publishing.

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SEMESTER – VII

PROFESSIONAL ETHICS IN ENGINEERING

Course Code	**18PC742**	CIE Marks	40
Teaching Hours/Week (L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

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: Morals, values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time – Cooperation – Commitment – Empathy – Self confidence – Character – Spirituality – Introduction to Yoga and meditation for professional excellence and stress management.

Module-2.

ENGINEERING ETHICS: Senses of 'Engineering Ethics' – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Models of professional roles - Theories about right action – Self-interest – Customs and Religion – Uses of Ethical Theories.

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: Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk - Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination.

Module-5

GLOBAL ISSUES: Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership –Code of Conduct – Corporate Social Responsibility.

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:

1. Mike W. Martin and Roland Schinzinger, "Ethics in Engineering", Tata McGraw Hill, New Delhi, 2003.
2. Govindarajan M, Natarajan S, Senthil Kumar V. S, "Engineering Ethics", Prentice Hall of India, New Delhi, 2004.

Reference Books:

1. Charles B. Fleddermann, "Engineering Ethics", Pearson Prentice Hall, New Jersey, 2004.
2. Charles E. Harris, Michael S. Pritchard and Michael J. Rabins, "Engineering Ethics – Concepts and Cases", Cengage Learning, 2009
3. John R Boatright, "Ethics and the Conduct of Business", Pearson Education, New Delhi, 2003
4. Edmund G Seebauer and Robert L Barry, "Fundametals of Ethics for Scientists and Engineers", Oxford University Press, Oxford, 2001
5. Laura P. Hartman and Joe Desjardins, "Business Ethics: Decision Making for Personal Integrity and Social Responsibility" Mc Graw Hill education, India Pvt. Ltd.,New Delhi 2013.

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SEMESTER – VII

GREEN CHEMISTRY

Course Code	**18PC743**	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 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

Introduction: Why green chemistry? Toxicity of chemicals. Accidents with chemicals. Waste and its minimisation. Sustainability (including social, political & economic factors).The green political movement. The roles and responsibilities of chemists and chemical engineers. Definition and overview of the twelve principles of green chemistry.

Module-2.

Green Synthesis: Establishing a full mass balance. Waste treatment/recycle. Synthetic Efficiency. Green Chemistry Metrics. Individual Reactions Analysis. Atom Economy, E-factor, & Reaction Mass Efficiency (RME).Synthesis Plans Analysis: Synthesis Tree Algorithms for Linear and Convergent Plans Raw Material Cost Estimate Material Efficiency & Synthetic Elegance Ranking. Trade off with economics. Less Hazardous Materials in Synthesis. Designing Safer Products. Renewable feedstocks. .

Module-3

Green Solvents: Safer Solvents and Auxiliaries. Critical review of organic solvents typically used in chemical processes. Critical review of: ionic liquids, supercritical CO2, water, fluorous phase chemistry, solvent-free / solid phase chemistry. Examples of green reagents.

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

Catalysis: Role of Catalysis. Heterogeneous Catalysis. Solid acids. Templated silica. Polymer-supported reagents. Homogeneous catalysis. Phase transfer catalysis. Biocatalysis. Photocatalysis.
Hazard Minimization: Design for Degradation. Rules for degradation. Process safety and thermal hazards. Process control using real-time analysis. Process intensification.

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:

1. Anastas, P.; Warner, J. Green Chemistry: Theory and Practice; Oxford University Press: London, 1998.
2. Lancaster, M.; Green Chemistry an Introductory Text, Royal Society of Chemistry, Cambridge, UK 2002.

Reference Books:

1. Albert S. Matlack; "Introduction to Green Chemistry" Marcel Dekker, Inc., New York, 2001.
2. Zimmerman, J.B.; Anastas, P.T. "The 12 Principles of Green Engineering as a Foundation for Sustainability" in Sustainability Science and Engineering: Principles. Ed. Martin Abraham, Elsevier Science, 2005.
3. Anastas, P.; Zimmerman, J. "Design through the Twelve Principles of Green Engineering," Environmental Science and Technology, 37, 94A – 101A, 2003

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SEMESTER – VII

ENVIRONMENTAL SCIENCE AND SOLID WASTE MANAGEMENT

Course Code	**18PC751**	CIE Marks	40
Teaching Hours/Week (L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

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.
General Aspects: Overview of material flow in society. Reduction in raw material usage. Reduction in solid waste generation. Reuse and material recovery. General effects on health and environment. Legislations.

Module-5

Hazardous Wastes: Classification. Origin and reduction at source. Collection and handling. Management issues and planning methods. Environmental Acts.
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:

1. Gilbert. M. Masters, „Introduction to Environmental Engineering and Science, 2nd Edition Pearson Education 2004.
2. T. G. Miller, ‟Environmental Science‟ Wads Worth publishing Co.
3. C. Townsend .J. Harper and Michael Bgon, Essentials of Ecology‟ Blackwell Science.
4. R. K. Trivedi and P .K. Goel‟ Introduction to Air pollution Techno science publications.
5. Integrated Solid Waste Management, George Tchobanoglous et al, 2nd Edition, McGraw Hill & Co, 1993.

Reference Books:

1. Bharuche Evach, „The Biodiversity of India‟ Mapin Publishing Limited, Ahmedabad, India.
2. R. K. Trivedi‟ handbook of Environmental laws, Rules, Guidelines, Compliances and Standards, Vol I and II, Enviromedia.
3. Dharmendra S. Sengar, 'Environmental law', Prentice hall of India PVT LTD, New Delhi, 2007.
4. Waste Treatment Plants, Sastry C.A. et al, Narosa Publishing House, 1995.
5. Hazardous Waste Management, Lagrega, McGraw Hill, 1994.

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SEMESTER – VII

PROCESS MODELING AND SIMULATION

Course Code	**18PC752**	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

- 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.
Mathematical Models of Chemical Engineering Systems- Uses of Mathematical Models, Scope of Coverage, Principles of Formulation, Fundamental Laws.

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.

Advanced Control Systems- Ratio Control, Cascade Control, Computed Variable Control, Override Control, Nonlinear and **Adaptive Control Valve -** Position Control. Frequency-Domain Analysis of Closed loop Systems- Nyquist Stability Criterion, Closed loop Specifications in the Frequency Domain, Frequency Response of Feedback Controllers.

Module-5

Process Identification- Direct Methods, Pulse Testing, Step Testing, Least-Squares Method, State Estimators, Relationships Among Time, Laplace, and Frequency Domains.
Multivariable Processes - Matrix Mathematics, Matrix Properties, Representation of Multivariable Processes, Open loop and Closed loop Systems, Computer Programs For Matrix Calculations Problems.

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:

1. Luyben W. L. “Process Modeling, Simulation and Control for Chemical Engineering” McGRAW Hill Publishing Company.

Reference Books:

1. Smith C. L., Pike R. L. and Murill P. W. “ Formulation and Optimization of Mathematical Models”. International Text, Pennsylvania 1970
2. Roger G. E. “ Modelling and Simulation in Chemical Engineering” Wiley Inter Science, New Jersey 2006.

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Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - VII

PROCESS CONTROL LABORATORY

Course Code	**18PCL76**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(0:2:2)	SEE Marks	60
Credits	02	Exam Hours	03

Course Learning Objectives: To determine experimentally, the methods of controlling the processes including measurements using instrumentation techniques.

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

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:

1. **Process System Analysis and Control,** Coughner & Koppel, II Edition, McGraw Hill, New Delhi,1991.

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SEMESTER - VII

COMPUTER APPLICATIONS LABORATORY

Course Code	**18PCL77**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(0:2:2)	SEE Marks	60
Credits	02	Exam Hours	03

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

Sl. No.	**Experiments**
	Part - A:
1	Non-linear algebraic equation- Newton Raphson (Specific volume of binary mixture)
2	Ordinary Differential Equation- R-K Method (dCa/dt=kCa2)
3	Numerical Integration- Simpson's 1/3 Rule (Batch Reactor to find time)
4	Curve Fitting-Least Square (Nrevs f)
5	Calculation of Bubble Point and Dew Point for Ideal multicomponent system
6	Flash Vaporisation for multi-component system
7	Design of Adiabatic Batch Reactor
8	Adiabatic Flame Temperature
9	Double pipe heat exchanger (Area, Length and Pressure drop)
10	Distillation Column (Bubble cap)
11	Pressure Pipe in a Drop 12. Distillation Column (Plates)
	Part - B:
1	Process simulation study involving mixing, reactor, distillation, heat exchanger for any of the following
2	Propylene - Propane Splitter
3	Reboiled Stripper from Seader and Henley
4	Extractive Distillation
5	Binary Distillation in a Double Feed Column
6	Distillation of Ethanol Water mixture
7	Homogeneous Azeotropic Distillation
8	Absorber
9	Reboiled Absorber

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 10experiments 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 procedurepart to be made zero.

Reference Books:

1. Pradeep Ahuja "Introduction to Numerical Methods in Chemical Engineering", PHI Learning PVT. Ltd. New Delhi.

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PROJECT WORK PHASE-1			
Course Code	**18PCP78**	CIE Marks	100
Teaching Hours/Week (L:T:P)	(0:0:2)		
Credits	01		

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.

The CIE marks awarded for the project work phase -1, shall be based on the evaluation of the project work phase -1 Report (covering Literature Survey, Problem identification, Objectives and Methodology), 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 -1, shall be based on the evaluation of project work phase -1 Report (covering Literature Survey, Problem identification, Objectives and Methodology), 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.

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INTERNSHIP			
Course Code			
Teaching Hours/Week (L:T:P)			
Credits			

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.

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SEMESTER – VII

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

Adsorptive Separations: Review of fundamentals. Mathematical modeling of column factors. Pressure swing & thermal swing adsorption. Counter current separations.
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

Surfactant Based Separations: Fundamentals. Surfactants at inter phases and in bulk. Liquid membrane permeation. Foam separations. Micellar separations.

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:

1. **Encyclopedia of Chemical Technology,** Kirk-Othmer, John Wiley & Sons,2001.
2. **Rate Controlled Separations,** Phillip C Wankat, Kluwer Academic Pub, 1990.
3. **Transportation and Separation Process,** Gaenkopolis, Printice Hall, 2003.
4. **Surfactant Based Separation,** T.O. Hatton, Vol 23.
5. **Supercritical Fluid Extraction**, M A McHugh & V. J. Krukonis, Butterworth, 1987.

Reference Books:

1. Handbook of Separation Process Technology, R.W.Rousseu, John Wiley & Sons, 1987.

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SEMESTER – VIII

TRANSPORT PHENOMENA

Course Code	**18PC81**	CIE Marks	40
Teaching Hours/Week (L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

1. **Course Learning Objectives:** 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:
Momentum Energy and Mass Transport Newton's law of viscosity (NLV). Newtonian and Non-Newtonian fluids. Fourier's law of heat conduction (FLHC), Fick's law of diffusion (FLD), Effect of temperature and pressure on transport properties of fluids.

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: Steady state Shell mass balances. General Boundary conditions applicable to mass transport problems of chemical engineering. Equimolar counter diffusion. Numerical problems.

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.

Text Books:

1. **Transport Phenomena,** Bird, Stewart and Lightfoot, Academic Press, 1994

Reference Books:

1. **Momentum Heat and Mass Transport,** Welty, Wikes and Watson, 4th edn., John Wiley, 2000.
2. **Principles of Unit Operations in Chemical engineering,** Foust *et al.*, 2nd edn, John Wiley, 1990.
3. **Transport Phenomena – A Unified Approach,** Robert S. BrodKey and Henry C. Hershley, Vol.2, Brodkey Publishing, 2003

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SEMESTER – VIII

RISK ASSESSMENT AND SAFETY ENGINEERING

Course Code	**18PC821**	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

- 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

Concepts of safety – Hazard classification chemical, physical, mechanical, ergonomics, biological and noise hazards – Hazards from utilities like air, water, steam. Hazard identification - Safety Audits - Checklists - What if Analysis – HAZAN – HAZOP -
Vulnerability models - Event tree and Fault tree Analysis - Past accident analysis - Flixborough - Mexico - Bhopal - Madras - Vizag accident analysis.

Module-2.

Hazops: Principles - Risk ranking - Guide word - Parameter - Deviation – Causes - Consequences - Recommendation - Coarse HAZOP study - Case studies - Pumping system - Reactor System - Mass transfer system.

Module-3

Introduction to Consequence Analysis - Fire and Explosion models: Radiation - Tank on fire - Flame length – Risk analysis- Radiation intensity calculation and its effect to plant, people & property, UCVCE -Explosion due to - Deflatration - Detonation - TNT, TNO & DSM model – Over pressure. Methods for determining consequences effects: Effect of fire- Effects of explosion - Risk contour - Flash fire - Jet fire - Pool fire - BLEVE - Fire ball.

Module-4.

Safety in plant design and layout – Safety provisions in the factory act 1948 – Indian explosive act 1884 – ESI act 1948 – Advantages of adopting safety laws.
Safety measures in handling and storage of chemicals – Fire chemistry and its control – Personnel protection – Safety color codes of chemicals.

Module-5

Risk Management & ISO14000: Overall risk analysis - Generation of Meteorological data - Ignition data - Population data. Overall risk analysis – E and FI model— Disaster management plan – Emergency planning – Onsite and offsite emergency planning – Risk management – Gas processing complex, refinery – First aids.

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:

1. Blake, R.P., “Industrial Safety”, Prentice Hall, 1953.
2. Lees, F.P., “Loss Prevention in Process Industries”, 2nd Edition, Butterworth Heinemann, 1996.
3. K. V. Raghavan and A A. Khan, “Methodologies in Hazard Identification and Risk Assessment”, Manual by CLRI, 1990.
4. V. C. Marshal, “Major Chemical Hazards”, Ellis Horwood Ltd., Chichester, United Kingdom. 1987.

Reference Books:

1 Geoff Wells, “Hazard Identification and Risk Assessment”, I.ChE.,John Ridley and John Channing, “Safety at Work”, 6th Edition. Butterworth-Heinemann, 2003.
2. “A Guide to Hazard Operability Studies”, Chemical Industry Safety and Health Council, 1977.

B. E. PETROCHEM ENGINEERING Choice Based Credit System (CBCS) and Outcome Based Education (OBE) SEMESTER – VIII			
PETROLEUM ECONOMICS			
Course Code	**18PC822**	CIE Marks	40
Teaching Hours/Week (L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03
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: 1. Industrial Economics – An Introductory Textbook. R.R.Barthwal, 2nd Edition, New Age International Publisher. 2. Managerial Economics – D.N.Divedi. 6th Revised Edition. Vikas Publishing House Private Ltd.			
Reference Books: 1. Petroleum Engineering Handbook. Bradely, H.B. Society of Petroleum Engineers. Richardson. Texas 2. The Encyclopedia Americana, International Edition Volume 9, Grolier Incorporated			

B. E. PETROCHEM ENGINEERING Choice Based Credit System (CBCS) and Outcome Based Education (OBE) SEMESTER – VIII			
PILOT PLANT AND SCALE UP METHODS			
Course Code	**18PC823**	CIE Marks	40
Teaching Hours/Week (L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03
Course Learning Objectives: To understand the basic quantitative theories and methodologist 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 Π 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.			
Scale up of mixing process, agitated vessel. Scale up of chemical reactor systems-Homogeneous reaction systems. Reactor for fluid phase processes catalysed by solids. Fluid-fluid reactors.			
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.			
1 **Text Books:** 1. **Scale up of Chemical Processes** ,Attilio Bisio, Robert L. Kabel, John Wiley & Sons, 1985 2. **Pilot Plants Models and scale up method in Chemical Engineering,** Johnstone and Thring, McGraw Hill, 1957.			
Reference Books: **1. Pilot Plants and Scale up Studies,** Ibrahim and Kuloor.			

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PROJECT WORK PHASE-2			
Course Code	**18PCP83**	CIE Marks	40
Teaching Hours/Week (L:T:P)	0:0:2	SEE Marks	60
Credits	08	Exam Hours	03
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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TECHNICAL SEMINAR			
Course Code	**18PCS84**	CIE Marks	100
Teaching Hours/Week (L:T:P)	0:0:2		
Credits	01		
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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INTERNSHIP			
Course Code	**18PCI85**	CIE Marks	100
Teaching Hours/Week (L:T:P)	0:0:2	SEE Marks	60
Credits	03	Exam Hours	03
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.			