VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM

SCHEME OF TEACHING AND EXAMINATION, 2017-2018

CHOICE BASED CREDIT SYSTEM (CBCS)

B.E: PETROCHEM ENGINEERING

III SEMESTER

Sl. No	Subject Code	Title	Teaching Dept.	Teaching Hrs/Week		Examination				Credits
				Theory	Pract./ Drg.	Duration Hrs	SEE Mark	CIE Mark	Total Marks	
1	17MAT311	Engineering Mathematics III*	Maths	04	--	03	60	40	100	4
2	17CH32	Momentum Transfer [D. C]	Chemical/Petrochemical	04	--	03	60	40	100	4
3	17CH33	Chemical Process Calculations [D.C]	Chemical/Petrochemical	04	--	03	60	40	100	4
4	17PC34	Instrumental Methods of Chemical Analysis [D.C]	Chemical/Petrochemical	04	--	03	60	40	100	4
5	17PC35	Introduction to Petrochemical Engineering [D.C.]	Petrochemical	04	--	03	60	40	100	3
6	17PC36	Fundamentals of Petroleum Geology [F.C]	Petrochemical	03	--	03	60	40	100	4
7	17PCL37	Momentum Transfer Laboratory	Chemical/Petrochemical	--	1I+2P	03	60	40	100	2
8	17PCL38	Geology Laboratory	Civil/ Petrochemical	--	1I+2P	03	60	40	100	2
9	17KL/CPH39/ 49	Kannada/Constitution of India, Professional Ethics and Human Rights	Humanities	01		01	30	20	50	1
TOTAL			**24**	**Theory: 24 Hours Practical:06 Hours**		**25**	**510**	**340**	**850**	**28**

NOTE: **Comm**. - Common to all Branches, **D.C** - Departmental Core, **F.C**- Foundation Course

1. **Departmental Core [D.C.]:** This is the course, which is to be compulsorily studied by a student as a core requirement to complete the requirement of a programme in a said discipline of study.

2. **Foundation Course [F.C.]:** This gives the fundamental knowledge about the discipline.
3. **Kannada/Constitution of India, Professional Ethics and Human Rights:** 50% of the programs of the Institution have to reach Kannada/ Constitution of India, Professional Ethics and Human Rights in cycle based concept during III and IV semesters.
4. **Audit Course: (i)** * All lateral entry students (except B.Sc candidates) have to register for Additional Mathematics-I, which is 03 contact hours per week

1	17MATDIP31	Additional Mathematics-I	Maths	03		03	60	--	60	--

(ii) Language English (Audit Course) be compulsorily studied by all lateral entry students (except B.Sc candidates) 1

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SCHEME OF TEACHING AND EXAMINATION, 2017-2018
CHOICE BASED CREDIT SYSTEM (CBCS)
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IV SEMESTER

Sl. No	Subject Code	Title	Teaching Dept.	Teaching Hrs/Week		Examination				Credits
				Theory	Pract./ Drg.	Duration Hrs	SEE Marks	CIE Mark	Total Marks	
1	17MAT41	Engineering Mathematics IV*	Maths	04	--	03	60	40	100	4
2	17PC42	Petroleum Refinery Engineering [D.C.]	Petrochemical	04	--	03	60	40	100	3
3	17CH43	Chemical Engg Thermodynamics [D. C]	Chemical/ Petrochemical	04	--	03	60	40	100	4
4	17PC44	Technology of Intermediate Petrochemicals [D.C]	Petrochemical	04	--	03	60	40	100	4
5	17CH45	Process Heat Transfer [D. C]	Chemical/ PetroChemical	04	--	03	60	40	100	4
6	17PC46	Renewable Energy Resources & systems [F.C]	Petrochemical	03	--	03	60	40	100	4
7	17PCL47	Chemical Engg. Drawing Lab	Chemical/ PetroChemical	--	1I+2P	03	60	40	100	2
8	17PCL48	Heat Transfer Lab	Chemical	--	1I+2P	03	60	40	100	2
9	17KL/CPH39/ 49	Kannada/Constitution of India, Professional Ethics and Human Rights	Humanities	01		01	30	20	50	1
TOTAL			**24**	**Theory: 24 Hours Practical:06 Hours**		**25**	**510**	**340**	**850**	**28**

NOTE: **Comm**. - Common to all Branches, **D.C** - Departmental Core, **F.C**- Foundation Course

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3. **Kannada/Constitution of India, Professional Ethics and Human Rights:** 50% of the programs of the Institution have to reach Kannada/ Constitution of India, Professional Ethics and Human Rights in cycle based concept during III and IV semesters.
4. **Audit Course: (i)** * All lateral entry students (except B.Sc candidates) have to register for Additional Mathematics-I, which is 03 contact hours per

week

1	17MATDIP41	Additional Mathematics-II	Maths	03		03	60	--	60	--

(ii) Language English (Audit Course) be compulsorily studied by all lateral entry students (except B.Sc candidates) 2

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
SCHEME OF TEACHING AND EXAMINATION, 2017-2018
CHOICE BASED CREDIT SYSTEM (CBCS)
B.EPETROCHEM ENGINEERING

V SEMESTER

Sl. No	Subject Code	Title	Teaching Dept.	Teaching Hrs/Week		Examination				Credits
				Theory	Pract./ Drg.	Duration Hrs	SEE Mark	CIE Marks	Total Marks	
1	17CH51	Process Industry Management [D.C.]	Chemical/ PetroChemical	04	--	03	60	40	100	4
2	17CH52	Mass Transfer Operations-I [D. C.]	Chemical/ PetroChemical	04	--	03	60	40	100	4
3	17CH53	Chemical Reaction Engineering-I [D. C.]	Chemical/ PetroChemical	04	--	03	60	40	100	4
4	17CH54	Chemical Equipment Design [D. C.]	Chemical/ PetroChemical	04	--	03	60	40	100	4
5	17PC55X	Professional Elective-I [P. E.]	Chemical/ PetroChemical	03	--	03	60	40	100	3
6	17PC56X	Open Elective-I [O.E.]	Any Dept.	03	--	03	60	40	100	3
7	17PCL57	Petroleum Product Analysis Laboratory	Chemical/ PetroChemical	--	1I+2P	03	60	40	100	2
8	17PCL58	Computer Applications Laboratory	Chemical/ PetroChemical	--	1I+2P	03	60	40	100	2
TOTAL			**24**	**Theory: 22 Hours Practical:06 Hours**		**24**	**480**	**320**	**800**	**26**

17PC55X: Professional Elective-I		17PC56X: Open Elective-I ***	
17PC551	Natural Gas Processing	17PC561	Composite materials

17PC552	Probability and Statistics	17PC562	Organic Chemistry
17PC553	Green Chemistry	17PC563	Reservoir Rocks and Fluid Properties
17PC554	Professional Ethics in Engineering	17PC564	Polymer Science and Technology
		17PC565	Essentials of NCC

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*******Students can select any one of the open electives offered by any Department (Please refer to consolidated list of VTU for open electives).

Selection of an open elective is not allowed, if: · The candidate has no pre –requisite knowledge, · The candidate has studied similar content course during previous semesters. The syllabus content of the selected open elective is similar to that of Departmental core course(s) or to be studied Professional elective(s).

Registration to open electives shall be documented under the guidance of Programme Coordinator and Adviser.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
SCHEME OF TEACHING AND EXAMINATION, 2017-2018
CHOICE BASED CREDIT SYSTEM (CBCS)
B.E: PETROCHEM ENGINEERING

VI SEMESTER

Sl. No	Subject Code	Title	Teaching Dept.	Teaching Hrs/Week		Examination				Credits
				Theory	Pract./ Drg.	Duration Hrs	SEE Mark	CIE Marks	Total Marks	
1	17CH61	Chemical Reaction Engineering-II [D. C.]	Chemical/ Petrochemical	04	--	03	60	40	100	4
2	17CH62	Mass Transfer Operations-II [D. C.]	Chemical/ Petrochemical	04	--	03	60	40	100	4
3	17PC63	Reservoir Engineering [D. C.]	Petrochemical	04	--	03	60	40	100	4
4	17CH64	Process Equipment Design and Drawing [D.C.]	Chemical/ Petrochemical	04	--	03	60	40	100	4
5	17PC65X	Professional Elective-II [P.E.]	Chemical/ Petrochemical	03	--	03	60	40	100	3
6	17PC66X	Open Elective-II [O.E.]	Any Dept.	03	--	03	60	40	100	3
7	17PCL67	Chemical Reaction Engineering Laboratory	Chemical/ Petrochemical	--	1I+2P	03	60	40	100	2
8	17PC L68	Mass Transfer Operations Laboratory	Chemical/ Petrochemical	--	1I+2P	03	60	40	100	2
TOTAL			**24**	**Theory: 22 Hours Practical:06 Hours**		**24**	**480**	**320**	**800**	**26**

17PC65X: Professional Elective-II		17PC66X: Open Elective-II	
17PC651	Petroleum Transportation Engineering	17PC661	Modern separation Techniques
17PC652	Mechanical Operations	17PC662	Process Modeling and Simulation
17PC653	Chemical Plant Utilities and Safety	17PC663	Material Science for Petrochemical Engineering
17PC654	Well Drilling Equipments and Operation	17PC664	Catalysis Science and Technology

1. **Departmental Core [D.C.]:** This is the course, which is to be compulsorily studied by a student as a core requirement to complete the requirement of a programme in

a said discipline of study**.**

2. **Professional Elective [P.E.]:** Elective relevant to chosen specialization/ branch**,**

3. **Open Elective [O.E.]:** Electives from other technical and/or emerging subject areas.

*******Students can select any one of the open electives offered by any Department (Please refer to consolidated list of VTU for open electives).

Selection of an open elective is not allowed, if: · The candidate has no pre –requisite knowledge, · The candidate has studied similar content course during previous semesters. The syllabus content of the selected open elective is similar to that of Departmental core course(s) or to be studied Professional elective(s).

Registration to open electives shall be documented under the guidance of Programme Coordinator and Adviser.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
SCHEME OF TEACHING AND EXAMINATION, 2017-2018
CHOICE BASED CREDIT SYSTEM (CBCS)
B.E: PETROCHEM ENGINEERING

VII SEMESTER

Sl. No	Subject Code	Title	Teaching Dept.	Teaching Hrs/Week		Examination				Credits
				Theory	Pract./ Drg.	Duration Hrs	SEE Marks	CIE Mark	Total Marks	
1	17PC71	Research Methodology [D. C.]	Chemical/ Petrochemical	04	--	03	60	40	100	4
2	17PC72	Drilling Fluids and Cementing Techniques [D. C.]	Petrochemical	04	--	03	60	40	100	4
3	17CH73	Process Control and Instrumentation [D. C.]	Chemical/ Petrochemical	04	--	03	60	40	100	4
4	17PC74X	Professional Elective-III [P.E.]	Chemical/ Petrochemical	03	--	03	60	40	100	3
5	17PC75X	Professional Elective -IV[P.E.]	Chemical/ Petrochemical	03	--	03	60	40	100	3
6	17PCL76	Process Control Laboratory	Chemical/ Petrochemical	--	1I+2P	03	60	40	100	2
7	17PCL77	Petroleum Testing Laboratory	Petrochemical	--	1I+2P	03	60	40	100	2
8	17PCP78	Project Phase –I + Project Work Seminar	Petrochemical	--	03	--	--	100	100	2
TOTAL			**24**	**Theory: 18 Hours Practical and Project: 09 Hours**		**21**	**420**	**380**	**800**	**24**

17PC74X : Professional Elective-III		17PC75X : Professional Elective-IV	
17PC741	Optimization Techniques for process Industries	17PC751	Environmental Science and Solid waste management
17PC742	Process Engineering and Plant Design	17PC752	Biochemical Engineering
17PC743	Fermentation Technology	17PC753	Integrated Oil/Gas Field Evaluation
17PC744	Onshore and Offshore Engineering and Technology	17PC754	Oils and Fats Technology

1. **Departmental Core [D.C.]:** This is the course, which is to be compulsorily studied by a student as a core requirement to complete the requirement of a programme in a said discipline of study**.**
2. **Professional Elective [P.E.]:** Elective relevant to chosen specialization/ branch**,**
3. **Project Phase –I and Project Work Seminar:** Comprises of Literature Survey, Problem identification, Objectives and Methodology. CIE marks shall be based on the report covering Literature Survey, Problem identification, Objectives and Methodology and Seminar presentation skill.

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SCHEME OF TEACHING AND EXAMINATION, 2017-2018
CHOICE BASED CREDIT SYSTEM (CBCS)
B.E: CHEMICAL ENGINEERING

VIII SEMESTER

Sl. No	Subject Code	Title	Teaching Dept.	Teaching Hrs/Week		Examination				Credits
				Theory	Pract./ Drg.	Duration Hrs	SEE Marks	CIE Marks	Total Marks	
1	17CH81	Transport Phenomena [D. C.]	Chemical	04	--	03	60	40	100	4
2	17PC82	Petroleum Corrosion Technology [D. C.]	Chemical/ Petrochemical	04	--	03	60	40	100	4
3	17PC83X	Professional Elective-V [P.E.]	Chemical/ Petrochemical	03	--	03	60	40	100	3
4	17PC84	Internship / Professional Practice	Petrochemical	Industry Oriented		03	50	50	100	2
5	17PC85	Project Work -II	Petrochemical	--	6	03	100	100	200	6
6	17PC86	Seminar	Chemical/ Petrochemical	--	4	-	--	100	100	1
TOTAL			**24**	**Theory: 11 Hours Project and Seminar: 10 Hours**		**15**	**330**	**370**	**700**	**20**

17PC83X: Professional Elective-V	
17PC831	Risk Assessment and Safety Engineering
17PC832	Pharmaceutical Technology
17PC833	Petroleum Economics
17PC834	Pilot Plant and Scale up Methods

1. **Departmental Core [D.C.]:** This is the course, which is to be compulsorily studied by a student as a core requirement to complete the requirement of a programme in a said discipline of study**.**
2. **Professional Elective [P.E.]:** Elective relevant to chosen specialization/ branch**,**
3. **Internship/ Professional Practice:** 4 Weeks internship to be completed between the (VI and VII semester vacation) and/or (VII and VIII semester vacation) period.

SEMESTER-III **ENGINEERING MATHEMATICS III [CORE]**

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

COMMON TO ALL BRANCHES

Subject Code	**: 17MAT31**	**IA Marks**	**: 40**
No. of Lecture Hours/Week	**: 04**	**Exam Marks**	**: 60**
Total No. of Lecture Hours	**: 50**	**Exam Hours**	**: 03**

CREDITS- 04

Course Objectives: This course enables students to

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module-1		
Module-2		
Module-3		
Module-4		
Module-5		

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

Graduate Attributes (as per NBA)

Question paper pattern:

5. The question paper will have Ten questions in total
6. Each full question consists of 16 marks.
7. There will be 2 full questions (with a maximum of four sub questions) from each module.
8. Each full question will have sub questions covering all the topics under a module.
9. The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

Reference Books:

MOMENTUM TRANSFER

Sub Code : 17CH32 IA Marks: 40
Hrs/Week : 04 Exam Hours: 03
Total Hrs : 50 Exam Marks : 60
Credits: 04

COURSE OBJECTIVES: The students will

5. 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.
6. Learn detailed explanation on types of fluids, stress and velocity relations, type of fluid flow and boundary layer relations.
7. Understand relationship between kinetic energy, potential energy, internal energy and work complex flow systems using Bernoulli's equation with application to industrial problems.
8. 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.
9. Study Flow of compressible fluids, Dimensional analysis, Dimensional homogeneity and various dimensionless numbers and their applications.
10. Understand principles and working of various types of pumps, transportation and metering of fluids using various experimental techniques and applications to industry.

Module 1	Content	Contact Hours	Blooms Taxonomy
FLUID STATICS AND ITS APPLCATIONS: 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.		**10 Hrs.**	**L-1, L-2**
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.			**L-1, L2**

Module 2	Content	Contact Hours	Blooms Taxonomy
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.		**10 Hrs.**	**L-2, L-3**
FLOW OF INCOMPRESSIBLE FLUIDS IN CONDUITS AND THIN LAYERS: Laminar flow through circular and non-circular conduits, Hagen			**L-2, L-3**

Poiseuille equation, Laminar flow of non-Newtonian liquids. Turbulent flow			
Module 3	**Content**	**Contact Hours**	**Blooms Taxonomy**
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		**10 Hrs**	**L-2, L-3**
FLOW OF COMPRESSEBLE 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).			**L-2, L-3**

Module 4	**Content**	**Contact Hours**	**Blooms Taxonomy**
TRANSPORTATION AND METERING OF FLUIDS: Pipes, Fittings and valves, Measurement of fluid and gas flow rates by orifice, venturi & rotameters. 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.		**10Hrs**	**L-2, L-3**

Module 5	**Content**	**Contact Hours**	**Blooms Taxonomy**
PUMPS: Performance and Characteristics of pumps-positive displacement and centrifugal pumps, Fans, compressors, and blowers.		**10 Hrs.**	**L-2, L-3**
DIMENSIONAL ANALYSIS: Dimensional homogeneity, Rayleigh's and Buckingham' s Π- methods, Significance of different dimensionless numbers, Elementary treatment of similitude between model and prototype.			**L-2, L-3**

COURSE OUTCOMES: On completion of this course the students will be able to

4. Analyze different types of fluids and they will be able to measure pressure difference for flow of fluids.
5. 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.
6. Analyze and calculate friction factor for different types of flow in various types of constructions.
7. Develop mathematical relations using Dimensional analysis by Rayleigh and Buckingham – π method.

GRADUATE ATTRIBUTES:

4. Design and Development of Solutions.

4. Problem Analysis

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:

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

CHEMICAL PROCESS CALCULATIONS

Sub Code : 17CH33 **IA Marks: 40**
Hrs/Week : 04 **Exam Hours : 03**
Total Hrs : 50 **Exam Marks : 60**
Credits: 04

COURSE OBJECTIVES: The students will

4. Learn basic laws about the behavior of gases, liquids and solids and some basic mathematical tools.
5. Understand systematic problem solving skills, enhance confidence, and generate careful work habits.
6. Learn what material balances are, how to formulate and apply them, how to solve them.
7. 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	Content	Contact Hours	Blooms Taxonomy
UNITS AND DIMENSIONS: Fundamental and derived units, Conversion, Dimensional consistency of equations, conversions of equations.		**10Hrs**	**L-1, L-2.**

BASIC CHEMICAL CALCULATIONS:

Concept of mole, mole fraction, Compositions of mixtures of solids, liquids and gases, Concept of Normality, Molarity, Molality, ppm, Use of semi-log, log-log, triangular graphs, Ideal gas law calculations.

Module 2	**Content**	**Contact Hours**	**Blooms Taxonomy**

MATERIAL BALANCE WITHOUT REACTION: General material balance equation for steady and unsteady state, Typical steady state material balances in distillation, absorption, extraction, crystallization,		**10Hrs**	**L-2, L3.**
Module 3	**Content**	**Contact Hours**	**Blooms Taxonomy**
MATERIAL BALANCE WITHOUT REACTION: Drying, mixing and evaporation, Elementary treatment of material balances involving bypass, recycle and purging, Psychrometry, Humidification and dehumidification.		**10Hrs**	**L-2, L3.**
Module 4	**Content**	**Contact Hours**	**Blooms Taxonomy**
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.		**10Hrs**	**L-2, L3.**

Module 5	**Content**	**Contact Hours**	**Blooms Taxonomy**
ENERGY BALANCE: General steady state energy balance equation, 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 H_R at standard and elevated temperatures, Theoretical flame temperature and adiabatic flame temperature.		**10Hrs**	**L-2, L3.**

COURSE OUTCOMES: On completion of this course the student will have

- Clear idea of various types of unit systems and they will be able to convert units from one form of the unit to other.
- Sound strategy for solving material and energy balance problems.
- Adopt the tools learned from the course from the numerical problems which contain more than two unit operations.
- Develop mathematical relations for mass balance and energy balances for any processes.

GRADUATE ATTRIBUTES:

1. Design and Development of Solutions.
2. Problem Analysis
3. Computational Knowledge.

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.

NOTE: QUESTION PAPER TO CONTAIN AT LEAST 30% THEORY

TEXT BOOKS:

1. Bhatt B.I. and Vora S.M., **"Stoichiometry (SI Units)"** , Third edition, 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"** , Second edition, CBS publishers and distributors, New Delhi, 1995

REFERENCE BOOK:

- Himmelblau D.M., **"Basic principle and Calculations in Chemical Engin eering"** , 6^{th} edn, Prentice Hall of India, New Delhi,1997

INSTRUMENTAL METHODS OF CHEMICAL ANALYSIS [D.C] [AS PER CHOICE BASED CREDIT SYSTEM (CBCS) SCHEME] SEMESTER-III			
Subject Code	**: 17PC34**	**IA Marks**	**: 40**
No. of Lecture Hours/Week	**: 04**	**Exam Marks**	**: 60**
Total No. of Lecture Hours	**: 50**	**Exam Hours**	**: 03**

CREDITS- 04

Course 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.

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
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 -** InfraredSpectroscopy,FlamePhotometry,Atomic Absorption Spectroscopy and Mass Spectrometry	10	L1, L2, L3
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.	10	L1, L2, L3
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. Applications of polarography-Identification and determination of concentration of analyte.	10	L1, L2, L3
Module-4		
Introduction to Chromatography: Classification - Theory - distribution coefficient, rate of travel, retention time, retention volume, adjusted retention volume, specific retention volume, column capacity, separation number, peak capacity, shapes of chromatic peak, column efficiency, resolution, optimization of column performance, Chromatogram, Void volume. **Thin Layer Chromatography:** Stationary phase, mobile phase, sample application, development techniques – evaluation and documentation, advantages and disadvantages of TLC.	10	L1, L2, L3
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.	10	L1, L2, L3
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.		
Graduate Attributes (as per NBA) 1. Engineering Knowledge 2. Problem Analysis 3. Design/development of solutions (Partly) 4. Interpretation of data.		

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.
   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, 5th Edition, McGraw-Hill, New York, 1988.
2. **Principles of Instrumental Analysis,** Skoog, D.A, S.J. Holler, T.A. Nilman, 5th Edn., Saunders college publishing, London, 1998.
3. **Instrumental Methods of Chemical Analysis,** Chatwal Anand, 3rd Edition ,Himalaya Publishing House,1986.
4. **Principles of Electroanalytical Methods,** T. Riley and C. Tomilinsom, John Wiley and Sons, 2008.
5. **Instrumental Methods of Chemical Analysis,** K. Sharma, Goel Publishing House Meerut 2000.

INTRODUCTION TO PETROCHEMICAL ENGINEERING [D.C]
[AS PER CHOICE BASED CREDIT SYSTEM (CBCS) SCHEME]
SEMESTER-III

Subject Code	**: 17PC35**	**IA**	**: 40**
No. of Lecture Hours/Week	**: 04**	**Exam Marks**	**: 60**
Total No. of Lecture Hours	**: 50**	**Exam Hours**	**: 03**

CREDITS- 04

Course Objectives: This course will enable students to

- Fundamental and methodologies in the petroleum refining processes
- Concepts of petrochemicals, Testing methods, Origin of oil and gas and Oil recovery

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
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 Mat erials, Manufactured Materials, Derived Materials.	10	L1, L2
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.	10	L1, L2
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)	10	L1, L2
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.	10	L1, L2
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.	10	L1, L2

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

Graduate Attributes (as per NBA)

- Engineering Knowledge
- Problem Analysis
- Design/development of solutions (Partly)
- Interpretation of data.

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 P etroleum", 4 th 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 pra cticing engineer.
2. F. Abdulin, "Production of oil gas" Mir publishers, Moscow.
3. B.G. Deshpande "The world of petroleum", Wiley East ern Industry.
4. Richard A. Dawe " Modern petroleum technology" volume 1 sixth edition john wiley & sons limited, New York.

FUNDAMENTALS OF PETROLEUM GEOLOGY [FC]
[AS PER CHOICE BASED CREDIT SYSTEM (CBCS) SCHEME]
SEMESTER-III

Subject Code	**: 17PC36**	**IA**	**: 40**
No. of Lecture Hours/Week	**: 04**	**Exam Marks**	**: 60**
Total No. of Lecture Hours	**: 50**	**Exam Hours**	**: 03**

CREDITS- 04

Course 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.

Modules	Teaching Hours	Bloom's Taxonomy (RBT) Level
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.	10	L1, L2
Module-2		
Sedimentalogy of Petroleum bearing sequences - Sedimentary basins. Generation and Migration of Petroleum. Physical and Chemical properties of Petroleum.	10	L1, L2
Module-3		
Subsurface Environment – Formation fluids – Composition, temperature, pressure and dynamics. Traps and Seals. The Reservoir. Generation and Migration and Distribution.	10	L1, L2
Module-4		
Exploration Methods - Well drilling. Formation Evaluation. Geophysical. Borehole Seismic and 4D Seismic. Subsurface geology.	10	L1, L2, L3
Module-5		
Non-conventional petroleum resources and reserve estimation. – Plastic and solid hydrocarbons. Tar sands. Oil an d gas shales. Coal bed methane. Assessment of reserves.	10	L1, L2

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.

Graduate Attributes (as per NBA)

- Engineering Knowledge
- Problem Analysis
- Design/development of solutions (Partly)
- Interpretation of data.

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 Universi ty Press, Oxford 1995.

2. Wilson, M., Igneous Petrogenesis”, Unwin Hyman, Lon don 1989.

Reference Books:

1. Boggs, S., “Principles of Sedimentology and S tratigraphy”, 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.

MOMENTUM TRANSFER LAB

Sub Code : 17PCL37 **IA Marks: 40**
Hrs/Week : 1T + 2L **Exam Hours : 03**
Total Hrs : 42 **Exam Marks : 60**

Credits: 02

The experiments are to be conducted on the following topics,

1. Friction in circular pipes.
2. Friction in non-circular pipes.
3. Friction in helical/spiral coils.
4. Flow measurement using venturi/orifice meters (incompressible fluid).
5. Local velocity measurement using Pitot tube
6. Flow over notches
7. Hydraulic coefficients – open orifice
8. Packed bed
9. Fluidized bed
10. Study of characteristics for centrifugal , Positive displacement pump

· Study of various pipe fittings and their equivalent lengths.

Compressible fluid flow

Reynolds apparatus.

Unsteady flows - Emptying of Tank

GEOLOGY LABORATORY

Laboratory Code	**: 15PCL77**	**IA Marks**	**: 20**
No. of Lecture Hours/Week	**01 Hr. Tutorial(Instructions) + 02 hours Laboratory**	**Exam Marks**	**: 80**
		Exam Hours	**: 03**

CREDITS- 02

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

Revised Bloom's Taxonomy Levels: L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

Laboratory Experiments:	**Revised Bloom's Taxonomy**

Minimum of 10 experiments are to be conducted	(RBT) Level
1. Describe and Identify the minerals based on their physical, special properties, chemical composition and uses	L3,L4,L5
2. Study of important rock forming minerals , ores and other important industrial minerals	L3,L4,L5
3. Describe and Identify the rocks of their physical properties	L3,L4,L5
4. Study of geological maps and their sections	L3,L4,L5
5. Calculation of True and Apparent Dip	L3,L4,L5
6. Borehole problems	L3,L4,L5
7. Estimation of Thickness, Distance and Depth of the ore body	L3,L4,L5
8. Study of symmetry elements and crystal systems of crystal models	L3,L4,L5
9. Sand – Silt – Clay ratio estimation.	L3,L4,L5
10. Grain – Size analysis.	L3,L4,L5
11. Estimation of Throw and Nature of the fault.	L3,L4,L5

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.

Graduate Attributes (as per NBA)

- Engineering Knowledge •

Problem Analysis

- Design/development of solutions (Partly)

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. Amyx, J.W., Bass D.M. & Whiting., R.L., "Petrole um Reservoir Engineering" McGraw Hill1998

2. Boggs, S., "Principles of Sedimentology and Stra tigraphy", second edition, Merrill PublishingCo., Toronto, 1995.

Note: Minim um of 10 experiments are to be conducted.

ENGINEERING MATHEMATICS IV [CORE]
[As per Choice Based Credit System (CBCS) Scheme]
SEMESTER-IV
COMMON TO ALL BRANCHES

Subject Code	**: 17MAT41**	**IA Marks**	**: 40**
No. of Lecture Hours/Week	**: 04**	**Exam Marks**	**: 60**
Total No. of Lecture Hours	**: 50**	**Exam Hours**	**: 03**

CREDITS- 04

Course Objectives: This course enables students to

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module-1		
Module-2		
Module-3		
Module-4		
Module-5		

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

Graduate Attributes (as per NBA)

QUESTION PAPER PATTERN:

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

Text Books:

Reference Books:

PETROLEUM REFINERY ENGINEERING [D.C]
[AS PER CHOICE BASED CREDIT SYSTEM (CBCS) SCHEME]
SEMESTER-IV

Subject Code	**: 17PC42**	**IA Marks**	**: 40**
No. of Lecture Hours/Week	**: 04**	**Exam Marks**	**: 60**
Total No. of Lecture Hours	**: 50**	**Exam Hours**	**: 03**

CREDITS- 04

Course Objectives: This course will enable students to

- Fundamental and methodologies in the petroleum refining processes
- Concepts of petrochemicals, Testing methods and Crude treatment methods.

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT)
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.	10	L1, L2
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.	10	L1, L2
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.	10	L1, L2

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.	10	L1, L2
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.	10	L1, L2

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

Graduate Attributes (as per NBA)

1. Engineering Knowledge
2. Problem Analysis
3. Design/development of solutions (Partly)
4. Interpretation of data.

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.

CHEMICAL ENGINEERING THERMODYNAMICS

Sub Code : 17CH43 **IA Marks : 40**
Hrs/Week : 04 **Exam Hours: 03**
Total Hrs : 50 **Exam Marks: 60**

Credits: 04

COURSE OBJECTIVES:

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

Module 4	Content	Contact Hours	Blooms Taxonomy
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.		**10Hrs**	**L-1, L-2.**

Module 2	Content	Contact Hours	Blooms Taxonomy
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, Compressibili ty 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.		**10Hrs**	**L-1, L-2, L-3,**

Module 3	Content	Contact Hours	Blooms Taxonomy
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, Thermodynamic diagrams		**10Hrs**	**L-1, L-2, L-3,**
Module 4	**Content**	**Contact Hours**	**Blooms Taxonomy**
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.		**10Hrs**	**L-1, L-2, L-3,**
Module 5	**Content**	**Contact Hours**	**Blooms Taxonomy**
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.		**10Hrs**	**L-1, L-2, L-3,**

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.

3. Analyze and find properties such as Pressure, Volume and temperature for equations of states and form the fundamentals of first law of thermodynamics.
8. Calculate entropy for the processes, and various types of energies such as internal energy, enthalpy, Helmholtz free energy and Gibbs free energy.
9. Differentiate between ideal and non-ideal solution and estimate partial molar properties.
10. Generate Vapor Liquid Equilibrium data for ideal and non-ideal solutions and check for their consistency by various methods.
11. Find the feasibility and extent of conversion for any reaction

GRADUATE ATTRIBUTES:

- Problem analysis.
- Design/development of solutions.

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.

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

TEXT BOOKS:

4. Smith J.M. and Vanness H.C., "Introduction to Chemi cal Engineering Thermodynamics", 5 th edn., McGraw Hill, New York, 1996
5. Rao Y.V.C., "Chemical Engineering Thermodynamics", New age International Publication, Nagpur, 2000

REFERENCE BOOK:

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

TECHNOLOGY OF INTERMEDIATE PETROCHEMICALS [D.C]

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

SEMESTER-IV

Subject Code	**: 17PC44**	**IA Marks**	**: 40**
No. of Lecture Hours/Week	**: 04**	**Exam Marks**	**: 60**
Total No. of Lecture Hours	**: 50**	**Exam Hours**	**: 03**

CREDITS- 04

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

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

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
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.	10	L1, L2
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.	10	L2,L3
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.	10	L2, L3

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.	10	L1, L2, L3
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.	10	L3, L4

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

Graduate Attributes (as per NBA)

- Engineering Knowledge
- Problem Analysis
- Design/development of solutions (Partly)
- Interpretation of data.

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:

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

4. **Chemical Technology,** Mukhlyonov, Mir Publications, 1982.

PROCESS HEAT TRANSFER

Sub Code : 17CH45 **IA Marks: 40**
Hrs/Week : 04 **Exam Hours : 03**
Total Hrs : 50 **Exam Marks : 60**

Credits: 04

COURSE OBJECTIVES:

- The students will Study various modes of Heat transfer and their fundamental relations.
- Study conduction heat transfer and develop mathematical relations for various solid geometries.
- Understand properties of insulation and critical thickness of insulation.
- Understand different types of heat transfer coefficients and their estimations in various types of flows in different geometries.
- Study the Boiling phenomenon and to generate pool boiling curve.
- 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.
- Understand the phenomenon of radiation, radiation shields and estimation of emissivity.

Module 1	**Content**	**Contact Hours**	**Blooms Taxonomy**
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.		**10Hrs**	**L-1, L-2, L-3**

Module 2	**Content**	**Contact Hours**	**Blooms Taxonomy**
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.		**10Hrs**	**L-1, L-2, L-3**
Module 3	**Content**	**Contact Hours**	**Blooms Taxonomy**
ANALOGY: Analogy between momentum and heat transfer- Reynolds, Colburn and Prandtl analogies. **HEAT TRANSFER WITH PHASE CHANGE:**Boiling phenomena,		**10Hrs**	**L-1, L-2, L-3**

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	**Content**	**Contact Hours**	**Blooms Taxonomy**
DESIGN OF HEAT TRANSFER EQUIPMENT: Elementary design of double pipe heat exchanger, shell and tube heat exchangers and condensers. Numerical Problems.		**10Hrs**	**L-1, L-2, L-3**
Module 4	**Content**	**Contact Hours**	**Blooms Taxonomy**
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, Vapor recompression evaporation. **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, Ki rchhoff's law, View factors, Radiation between surfaces, Radiation involving gases and vapors, Radiation shields.		**10Hrs**	**L-1, L-2, L-3,**

COURSE OUTCOMES: The students will be able to do the following

5. Write all fundamental heat transfer relations.
6. Derive equations for the calculation of heat flux and estimation of intermediate temperatures in multilayer systems.
7. Calculate critical thickness of insulation requires for different geometry of solids.
8. Write different dimensionless numbers and explain their significance.
9. Estimate LMTD and heat transfer coefficients for different types of flows.
10. Design Shell and tube and Double pipe heat exchanger, condensers and Evaporator.
11. Explain radiation in different type of solids and estimate emissivity.

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

GRADUATE ATTRIBUTES:

5. Problem analysis.
6. Design/development of solutions.

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, Perganon & ELBS, McGraw Hill, New York, 2000

REFERENCES:

1. Rao Y.V.C., "Heat Transfer", 1 st edn., Universities Press (India) Ltd., New Delhi, 2001.

Dutta, Binay K., “Heat Transfer: Principles and App lications”, PHI Learning. 2000

RENEWABLE ENERGY RESOURCES & SYSTEMS [FC]
[AS PER CHOICE BASED CREDIT SYSTEM (CBCS) SCHEME]
SEMESTER-IV

Subject Code	**: 17PC46**	**IA Marks**	**: 40**
No. of Lecture Hours/Week	**: 04**	**Exam Marks**	**: 60**
Total No. of Lecture Hours	**: 50**	**Exam Hours**	**: 03**

CREDITS- 04

Course 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.

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
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.	10	L1, L2
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.	10	L1, L2, L3
Module-3		

Wind Energy: Atmospheric circulations, classification, factors influencing wind, wind shear, turbulence, wind speed monitoring, Betz limit, WECS: classification, characteristics, and applications	10	L1, L2, L3

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.	10	L1, L2, L3
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.	10	L1, L2

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.

Graduate Attributes (as per NBA)

1. Engineering Knowledge
2. Problem Analysis
3. Design/development of solutions (Partly)
4. Interpretation of data.

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:

2. D. Y. Goswami, F. Kreith and J. F. Kreider, Principles of Solar Engineering, Taylor and Francis, Philadelphia, 2000.

3. C. S. Solanki, "Solar Photovoltaics: Fund amental Applications and Technologies, Prentice Hall of India, 2009.

[3] L.L. Freris, Wind Energy Conversion Systems, Prentice Hall, 1990.

1. D. A. Spera, Wind Turbine Technology: Fundamental concepts of Wind Turbine Engineering, ASME Press.

2. S.P. Sukhatme, Solar Energy: principles of Thermal Collection and Storage, Tata McGraw-Hill (1984).

CHEMICAL ENGG. DRAWING LAB
[AS PER CHOICE BASED CREDIT SYSTEM (CBCS) SCHEME]
SEMESTER-IV

Laboratory Code	**: 17PCL47**	**IA Marks**	**: 40**
No. of Lecture Hours/Week	**1 Hr. Tutorial(Instructions) + 2 hours Laboratory**	**Exam Marks**	**: 60**
		Exam Hours	**: 03**

CREDITS- 02

Course Objectives: This laboratory course enables students to get

- Practical experience in design and parts of equipment's.
- Assembly of joints

Laboratory Experiments: Note:	**Revised Bloom's Taxonomy (RBT) Level**
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. Examination consists of one question on proportionate drawing (30 marks) and one question on Assembly drawing (50 marks). 3. Examination to be conducted like other lab exams. Question paper should be prepared jointly by Internal and External examiner. 4. Computer Aided drawing Software: Solid Edge or Equivalent Software.	
SECTIONAL VIEWS: Representation of the sectional planes, Sectional lines and hatching, selection of section planes and types of sectional views.	L1, L2
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	L1, L2, L3
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)	L1, L2, L3

Course Outcomes: on completion of this laboratory course, the students will be able to:

1. Assemble simple engineering items
2. Study Terminology Drawing
3. Various types of lines Scales sections used at drawing

Graduate Attributes (as per NBA)

1. Engineering Knowledge
2. Problem Analysis
3. Design/development of solutions (Partly)

Conduct of Practical Examination:

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

Reference Books:

18. Gopal Krishna K.R., “Machine Drawing”, 2nd revised edn., Sudhas stores, Bangalore, 1998

19. Bhat N.D., “Machine Drawing”, 22ndedn., Charoter Pu blishing House, Anand, 1987

20. Joshi M.V., “Process Equipment Design”, 3rdedn., Ma cmillan India publication”, New Delhi, 1999

21. Walas S.M., “Chemical Process Equipment”, Butterwor th Heinemann Pub., 1999

22.Ludwig E.E., “Applied Process Design”, 3rdedn., Gulf Professional Publishing, New Delhi, 1994

HEAT TRANSFER LAB
[AS PER CHOICE BASED CREDIT SYSTEM (CBCS) SCHEME]
SEMESTER-IV

Laboratory Code	**: 17PCL48**	**IA Marks**	**: 40**
No. of Lecture Hours/Week	**1 Hr. Tutorial(Instructions) + 2 hours Laboratory**	**Exam Marks**	**: 60**
		Exam Hours	**: 03**

CREDITS- 02

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

Laboratory Experiments: **Minimum of 10 experiments are to be conducted**	**Revised Bloom's Taxonomy (RBT) Level**
1. Natural Convection in Bare and Finned tube	
2. Horizontal Shell and tube Heat exchanger	
3. Helical Coil Heat exchanger	
4. Vertical Shell and tube Heat exchanger (Condenser)	
1. Double Pipe Heat Exchanger	
2. Transient Heat Conduction	
3. Natural Convection	
4. Heat Transfer in Fluidized Beds	
5. Single stage Evaporator	
6. Heat Transfer in Packed Beds	
7. Determination of Insulation Thickness	
8. Heat Transfer in Agitated Vessels	

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 (as per NBA)

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

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

SEMESTER-V

PROCESS INDUSTRY MANAGEMENT(Common to CH & PC)					
Subject Code	:	17CH51	**IA Marks**	:	40
No. of Lecture Hrs/Week	:	04	**Exam Hours**	:	03
Total No. of Lecture Hours	:	50	**Exam Marks**	:	60
Credits	:	04			

Course Objectives: The students will be able to

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.

Revised Bloom's Taxonomy Levels: L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

Modules	Teaching Hours	Blooms Taxonomy
Module 1 **Content**		
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.	10	L1, L2
Module 2 **Content**		
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.	10	L1, L2
Module 3 **Content**		
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.	10	L2, L3, L4
Module 4 **Content**		
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.	10	L2, L3.

Module 5	Content		
	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.	10	L1, L2

Course outcomes: Students after completion of course are expected to

1. Understand the principles of management theory & Recognize the characteristics of an organization.

7. Demonstrate the importance of key performance areas in strategic management & decision-making process.

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.

Graduate Attributes

1. Critical Thinking
2. Problem solving
3. Use of modern tools
4 Life - long Learning

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 &HardikBavishiEngineering Economics & Management:Vikas Publishing

REFERENCE BOOKS:

1. Stephen Robbins, Mary Coulter &Neharika Vohra, Management, Pearson Education Publications, 10th Edition, ISBN: 978-81-317-2720-1.

2. James Stoner, Edward Freeman & Daniel Gilbert Jr, Management, PHI, 6th Edition, ISBN: 81-203-0981-2.

MASS TRANSFER OPERATIONS-I (Common to CH & PC)					
Subject Code	:	17CH52	**IA Marks**	:	40
No. of Lecture Hrs/Week	:	04	**Exam Hours**	:	03
Total No. of Lecture Hours	:	50	**Exam Marks**	:	60
Credits	:	04			

Course 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.

Revised Bloom's Taxonomy Levels: L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

Modules	Teaching Hours	Blooms Taxonomy
Module 1 **Content**		
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.	10	L1,L2, L3
Module 2 **Content**		
Humidification: General theory, Psychrometric chart. Concepts in humidification, dehumidification. Design of cooling towers.	10	L2,L3, L4
Module 3 **Content**		
Drying: Introduction, Equilibria, Drying rate curves. Mechanism of drying, types of dryers. Design of batch and continuous dryers.	10	L3,L4, L5
Module 4 **Content**		
Adsorption: Theories of adsorption. Isotherms, Industrial adsorbents. Equipment, Batch & continuous multistage adsorption.	10	L4,L5, L6
Module 5 **Content**		
Crystallization: Factors governing nucleation and crystal growth rates. Controlled growth of crystals. Incorporation of principles in to design of equipment. Different types of crystallizer equipment. **Introduction to Novel Separations:** Ion exchange**,** Membrane processes-Reverse Osmosis, Dialysis, Ultra and Micro-filtrations,Super-criticalfluidextraction.(Workingprinciplesand operations only)	10	L2,L3, L4

Course outcomes:

After studying this course, students will be able to:

1. Estimate mass transfer co-efficients 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.

Graduate Attributes

4. Critical Thinking
5. Problem solving
6. Use of modern tools
7. Life - long Learning

TEXT BOOKS:

1. **MassTransferOperations**-RobertE Treybal,3rd Edition,McGrawHill,1981.
2. **UnitOperationsof ChemicalEngineering**-McCabe&Smith,6th Edition,McGrawHill, 2001.

REFERENCE BOOKS:

1. **Chemical Engineering VolI, II, IV and V** - Coulson and Richardson, 4th Edition, PergamonPress,1998.
2. **IntroductiontoChemicalEngineering**-Badger&Banchero,TMH6th Reprint1998.
3. **Principlesof UnitOperations**-Foust*et.al.*,2nd Edition,JohnWiley,1994.
4. **TransportProcessesandUnitOperations**-GeankoplisCJ,PrenticeHall(I),2000.
5. **AppliedProcessDesignforChemicalandPetrochemicalPlant**Ludwig,2nd Edition,Gulf Publishing,2002.

CHEMICAL REACTION ENGINEERING-I (Common to CH & PC)					
Subject Code	:	17CH53	**IA Marks**	:	40
No. of Lecture Hrs/Week	:	04	**Exam Hours**	:	03
Total No. of Lecture Hours	:	50	**Exam Marks**	:	60
Credits	:	04			

Course Objectives:

The students will

1. Be able to Analyze and interpret the data to determine rate equation and estimate the performance equation of ideal systems.
2. Be able to formulate and analyze the rate equations for various reactions using suitable mechanisms.

Revised Bloom's Taxonomy Levels: L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

Modules	Teaching Hours	Blooms Taxonomy
Module 1 **Content**		
Introduction: 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 of rnon-elementary reactions. Types of reactors.	10	L1,L2,L3
Module 2 **Content**		
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	10	L2,L3,L4
Module 3 **Content**		
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.	10	L3,L4,L5
Module 4 **Content**		
Comparison Of Ideal Reactors: General graphical comparison. **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).	10	L4,L5,L6

Module 5	**Content**		
Non-Isothermal Reactors: Introduction, effect of temperature on equilibrium constant and heat of reaction, Material and Energy balances, conversions in adiabatic and non-adiabatic reactors. **Analysis of Non Isothermal Reactor:** Design procedure (For single/simple reactions only). Optimum temperature Progression.		10	L3,L4,L5

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.

Graduate Attributes

1. Critical Thinking
2. Problem solving
3. Use of modern tools
4. Life - long Learning

TEXT BOOKS:

1.**ChemicalReactionEngineering,**OctaveLevenspiel,3rdedition,JohnWiley&Sons,2001.
2. **ElementsofChemicalReactionEngineering,**H.ScottFogler,3rdedition,PrenticeHall 2001.

REFERENCE BOOKS:

1. **ChemicalEngineeringKinetics,**J.M.Smith,3rdEdition,McGrawHill,1984.

CHEMICAL EQUIPMENT DESIGN (Common to CH & PC)					
Subject Code	:	17CH54	**IA Marks**	:	40
No. of Lecture Hrs/Week	:	04	**Exam Hours**	:	03
Total No. of Lecture Hours	:	50	**Exam Marks**	:	60
Credits	:	04			

Course Objectives:
Students will

1. Understand advances and types in the design of Chemical equipment and its accessories.

Revised Bloom's Taxonomy Levels: L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

Modules		Teaching Hours	Blooms Taxonomy
Module 1	**Content**		
Introduction: Basic considerations in design. General design procedure. Equipment classification. Various components of process equipment. Design parameters. Pressure vessel codes. **Design Considerations**: Material selection. Factors affecting design. Stresses due to static and dynamic loads(Internal & External). Temperature effects. Economic considerations. **Design of Pressure Vessels:** Design parameters, conditions & stresses. Design of shell, and other vessel components. Vessel at low & high operating temperatures. Design problems using given process parameters. .		10	L1, L2, L3
Module 2	**Content**		
Vessel Component Design: Design of supports for vessels-Bracket, Leg, Saddle and Skirt supports. Design of flanges &nozzles, Classification of flanges. Flange thickness calculation, Gasket selection, Bolt selection, Nozzle Selection. Design of vessel closures-Flat plates, Formed heads, Elliptical &Hemispherical heads. .		10	L2, L3, L5
Module 3	**Content**		
Storage Vessels: Process conditions and design parameters for storage of volatile, non volatile fluids &gases. Design of cylindrical tanks with fixed roofs. Design of partially filled spherical tanks. Design of components, supports and selection of vessels accessories & mountings. Numericalproblems.		10	L2,
Module 4	**Content**		
Reaction Vessels: Design of reaction tanks with agitation and jacket. Types of agitators, baffles. Power requirement calculations. Design of tank dimensions and agitation system components. Drive calculations & selection of accessories. Design of jackets. Support calculations for the system. Numerical problems.		10	L1, L4
Module 5	**Content**		
Tall Vertical Vessels: Vessels subjected to various loads, Multi shell constructions. Determination of shell thickness. Supports for columns. **Pipe Line Design:** Pipeline sizing, Condensate and steam pipe design, optimum size of		10	L3,

delivery line in pumping operations.		

Course outcomes:

After studying this course, students will be able to:

1. Summarize on advances in process engineering design of many process equipment relating to heat and mass transfer.
2. Will handle process parameters toalter and design process Equipments.

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.

Graduate Attributes

1. Critical Thinking
2. Problem solving
3. Use of modern tools
4. Life - long Learning
5. Collaborative and multidisciplinary work

TEXT BOOKS:

1. **ProcessEquipmentDesign**-M.V.Joshi,3rd Edn.,Macmillan&Co. India,Delhi,1998.
2. **ProcessEquipmentDesign–VesselDesign,** Brownell&Young,JohnWilley,1959.
3. **Process D e s i g n o f Equipment – Vol1,** S. D. Dawande, 3rd Edn, Central Techno Publications.2003.

REFERENCE BOOKS:

1. **ChemicalEngineersHandbook,**Perry&Green,7th Edn,McGrawHill,1997.
2. **PressureVesselCode–IS2825,** ISCode,B.I.S.,NewDelhi,1969.
3. **Flowof FluidsthroughValves,Fittings&Pipes**,CraneAmazon,2006.

OPEN ELECTIVE - 17PC56X
NATURAL GAS PROCESSING
SEMESTER-V

Subject Code	**: 17PC551**	**IA Marks**	**: 40**
No. of Lecture Hours/Week	**: 03**	**Exam Marks**	**: 60**
Total No. Of Lecture Hours	**: 40**	**Exam Hours**	**: 03**

CREDITS- 03

Course Objectives:

Enable the students to learn the basic concept and applications of Natural Gas processing

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
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.	08	L1, L2
Module-2		
Phase behaviour fundamentals: Qualitative		

hydrocarbon phase behavior-phase rule, pressure-temperature diagram for single component and multicomponent 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.	08	L1, L2
Module-3		
GasCompression: Typesof compressors-Reciprocating Positive displacement and rotary positive displacement compressors and centrifugal compressors;Sliding-vanecompressors,two impeller straight lobe compressors, liquid piston compressors, centrifugal compressors, axial flow	08	L1, L2

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.	08	L1, L2
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 affectingorificemeteraccuracy,common measurement problems encountered in gas metering.	08	L1, L2

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.

Graduate Attributes

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

QUESTION PAPER PATTERN:

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

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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.

PROFESSIONAL ELECTIVE- 17PC55X
PROBABILITY AND STATISTICS
[As per Choice Based Credit System (CBCS) Scheme] SEMESTER-V

Subject Code	**: 17PC552**	**IA Marks**	**: 40**
No. of Lecture Hours/Week	**: 03**	**Exam Marks**	**: 60**
Total No. of Lecture Hours	**: 40**	**Exam Hours**	**: 03**

CREDITS- 03

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

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module-1		
RANDOM VARIABLES: Discrete and continuous random variables – Moments – Moment generating functions – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions.	8	L2, L3, L4
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).	8	L2, L3, L4
Module-3		
TESTINGOFHYPOTHESIS: 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, Chisquare and F distributions for mean, variance and proportion - Contingency table (test for independent) - Goodness of fit.	8	L2, L3, L4
Module-4		
DESIGN OF EXPERIMENTS: One way and Two way classifications - Completely randomized design – Randomized block design – Latin square design - 2^2 factorial design.	8	L2, L3, L4
Module-5		
STATISTICAL QUALITY CONTROL: Control charts for measurements (X and R charts) – Control charts for attributes (p, c and np charts) – Tolera nce limits - Acceptance sampling.	8	L2, L3, L4

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.		
Graduate Attributes • Critical Thinking • Problem solving • Use of modern tools • Research Skill • Life-long learning		
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, Pearson s Education, Delhi, 2002. 2. Navidi, W, "Statistics for Engineers and Scienti sts", Special Indian Edition, Tata McGraw-Hill Publishing Company Ltd, New Delhi,2008. 3. Spiegel, M.R, Schiller, J and AluSrinivasan, R, "Schaum ‟s Outlines Probability and Statistics", Tata McGraw-Hill Publishing Company Ltd. New Delhi ,2007.		

PROFESSIONAL ELECTIVE- 17PC55X GREEN CHEMISTRY SEMESTER-V			
Subject Code	**: 17PC553**	**IA Marks**	**: 40**
No. of Lecture Hours/Week	**: 03**	**Exam Marks**	**: 60**
Total No. of Lecture Hours	**: 40**	**Exam Hours**	**: 03**

CREDITS- 03

Course 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.

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
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.	8	L1, L2
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).SynthesisPlansAnalysis: 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.	8	L1, L2
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.	8	L1, L2

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.	8	L1, L2
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.	8	L1, L2

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.

Graduate Attributes

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

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 Chemis try” Marcel Dekker, Inc., New York, 2001.
2. Zimmerman, J.B.; Anastas, P.T. “The 12 Principle s of Green Engineering as a Foundation
for Sustainability” in Sustainability Science and E ngineering: Principles. Ed. Martin Abraham, Elsevier Science, 2005.
3. Anastas, P.; Zimmerman, J. “Design through the T welve Principles of Green Engineering,”

Environmental Science and Technology, 37, 94A – 101A, 2003

PROFESSIONAL ELECTIVE- 17PC55X
PROFESSIONAL ETHICS IN ENGINEERING
SEMESTER-V

Subject Code	**: 17PC554**	**IA Marks**	**: 40**
No. of Lecture Hours/Week	**: 03**	**Exam Marks**	**: 60**
Total No. of Lecture Hours	**: 40**	**Exam Hours**	**: 03**

CREDITS- 03

Course 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.

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
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 – Introductio n to Yoga and meditation for professional excellence and stress management.	8	L1, L2
Module-2		
ENGINEERING ETHICS: Senses of 'Engineering Ethics' – Variety of moral issues – Types of inquir y – Moral dilemmas – Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Models of professional roles - Theories about right action – Self-interest – Custo ms and Religion – Uses of Ethical Theories.	8	L1, L2
Module-3		
ENGINEERING AS SOCIAL EXPERIMENTATION: Engineering as Experimentation – Engineers as responsible Experimenters – Codes of Ethics – A Balanced Outlook on Law.	8	L1, L2
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 – Occupatio nal Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination .	8	L1, L2

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.	8	L1, L2

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.

Graduate Attributes

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

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 i n 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”, Pe arson 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 Bus iness”, Pearson Education, New Delhi, 2003
4. Edmund G Seebauer and Robert L Barry, “Fundameta ls of Ethics for Scientists and Engineers”, Oxford University Press, Oxford, 2001
5. Laura P. Hartman and Joe Desjardins, “Business E thics: Decision Making for Personal Integrity and Social Responsibility” McGraw Hill ed ucation, India Pvt.Ltd.,New Delhi 2013

OPEN ELECTIVE - 17PC56X
COMPOSITE MATERIALS
SEMESTER-V

Subject Code	**: 17PC561**	**IA Marks**	**: 40**
No. of Lecture Hours/Week	**: 03**	**Exam Marks**	**: 60**
Total No. of Lecture Hours	**: 40**	**Exam Hours**	**: 03**

CREDITS- 03

Course Objectives: This course will enable students to

- Understand concepts on properties and selection of metals, ceramics and polymers for design and manufacturing.
- Study detailed information on processing techniques based on reaction techniques.
- Learn information on Characteristics & applications in marine, aerospace.

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module-1		
Synthesis and Fabrication: of advanced and future materials with emphasis on ceramic, Semiconducting and Super-conducting materials with superior structural, optical and electrical properties. **Preparation Techniques:** Techniques for preparation of ultra-pure, ultra-fine powders: of oxides, nitrides, carbides etc., with very well defined characteristics and superior properties.	08	L1, L2
Module-2		
Processing Techniques: Techniques such as sintering, hot pressing, hot isostatic pressing, tape casting, sol-gel processing for the formation of monolithic ceramics. Composites (ceramic, ceramic metal, as well as metal matrix). SiO_2. Glasses from above powders**.** Reinforcement, additives, fillers for Polymer composite, master batch& compounding.	08	L1, L2
Module-3		
Processing Techniques Based on Reaction Methods: such as Chemical vapour deposition (CVD), vapour phase epitaxial, plasma-enhanced chemical vapour deposition (PECVD), chemical vapour infiltration (CVI). Self-propagating high temperature synthesis (SHS) for the preparation of monolithic ceramics, composites, coating, thin films, whiskers and fibres and semi	08	L1, L2

conducting materials such as Si and Gallium Arsenide.		
Module-4		
Synthesis and processing of mixed ceramic oxides with high temperature super conducting properties. Reinforcement, additives, fillers for polymer composite, master batch& compounding	08	L1, L2
Module-5		
Polymer composite. Fibre reinforced composites. Stress – Strain modulus relationship Nano composites. Characteristics & applications in marine, aerospace. Manufacturing methods, hand layouts.	08	L1, L2

Course Outcomes: At the end of the course students are able understand the useful of ceramic materials, Polymeric composite used in industries for the production of products and also study the characterization of the materials.

Graduate Attributes

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

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. **Introduction to Ceramics**,W.D. Kingrey, 2nd Edn., John Wiley, 1976.
2. **Advanced Composites,** Chawla, Kluner, Academic Publisher, 2003.

Reference Books:

1. **Introduction to Material Science for Engg.,** James T. Schockel Ford, 2nd Edition, McMillan Publications.
2. **Elements of Material Science and Engineering,** L.H. Van Vlack, 4th Edition, 1980.
3. **Fibre Reinforced Plastic Deskbook,** Nicholas P, Paul N, Chermisinoff, Ann Arbor science publishing Inc, 1978

OPEN ELECTIVE - 17PC56X ORGANIC CHEMISTRY SEMESTER-V			
Subject Code	**: 17PC562**	**IA Marks**	**: 40**
No. of Lecture Hours/Week	**: 03**	**Exam Marks**	**: 60**
Total No. of Lecture Hours	**: 40**	**Exam Hours**	**: 03**

CREDITS- 03

Course Objectives: This course to enable the students to learn the type of components in which organic reactions take place and also to know the preparation of the essential organic compounds.

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module-1		
Unit process - Definitions – reagents-mechanism – catalyst – illustrations of the following unit process–nitration – halogenation – oxidation & reduction – esterification.	08	L1, L2
Module-2		
Organic reactionsmechanism and estimation- Electrophilic reaction - Friedel craft reaction, RiemerTimenn Reaction; Nucleophilic reactions - Aldol condensation, Benzion condensation; Free radical reaction - Halogenation of Alkane, Addition HBR on Alkene in presence of peroxide.	08	L1, L2
Module-3		
Stereochemistry- Elements of symmetry, stereochemistry of compounds containing one and two carbon atoms. Racemates and their resolution, conformation of cyclic and acyclic systems, E and Z isomers of olefins, Idea of asymmetric synthesis.	08	L1, L2
Module-4		
Synthetic chemistry- Synthesis of different types of compounds like alcohol, aldehyde, acid, amine and synthesis of dicarboylicacids	08	L1, L2, L3

and unsaturated acids. Synthesis of azodyes – methyl orange and congo dye. Synthesis of triphenyl methane dyes – alizarin-melachite green.		
Module-5		
Amino acids and proteins- Amino acids and proteins- classification - synthesis of amino acids - reactions of carboxyl group and amino group - peptide linkage - end group analysis - colour reaction of proteins- denaturation.	08	L1, L2
Course Outcomes: At the end of the course students will be in a position to have knowledge on various reaction mechanism, preparation of organic compounds and their properties.		
Graduate Attributes • Critical Thinking • Problem solving • Use of modern tools • Research Skill • Life-long learning		
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. Tiwari K.S. Vishnoi N.K. and Marhotra S.N., A text book of Organic Chemistry, II Edition ,Vikas Publishing House Pvt.Ltd., (1998), New Delhi.		
Reference Books: 1. P. H. Groggins Unit processes in organic synthesis. (Third Edition). McGraw-Hill, New York, 1947.		

OPEN ELECTIVE - 17PC56X
RESERVOIR ROCKS AND FLUID PROPERTIES
SEMESTER-V

Subject Code	**: 17PC563**	**IA Marks**	**: 40**
No. of Lecture Hours/Week	**: 03**	**Exam Marks**	**: 60**
Total No. of Lecture Hours	**: 40**	**Exam Hours**	**: 03**

CREDITS- 03

Course Objectives: This course enables students to

- Petroleum reservoir system and fluid properties
- Basic principles and operations in upstream petroleum industry

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
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.	08	L1, L2
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.	08	L1, L2
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.	08	L1, L2

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.	08	L1, L2
Module-5		
Reservoir fluid properties – Phase behaviour of Hydrocarbon system. Fluid rock interactions. Reservoir fluid characteristics. PVT analysis. Flashliberation and differential liberation study.	08	L1, L2

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.

Graduate Attributes

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

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. DjebbarTiab : "Theory and pratice of measuring R eservoir rock and fluid Transport properties

Reference Books:

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

PROFESSIONAL ELECTIVE- 17PC55X
POLYMER SCIENCE AND TECHNOLOGY
[As per Choice Based Credit System (CBCS) Scheme]

SEMESTER-V

Subject Code	**: 17PC564**	**IA Marks**	**: 40**
No. of Lecture Hours/Week	**: 03**	**Exam Marks**	**: 60**
Total No. of Lecture Hours	**: 40**	**Exam Hours**	**: 03**

CREDITS- 03

Course Objectives: This course enables students to study the basic polymeric science about polymeric structure, chemical bonding and chemical reactions.

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
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.	8	L1, L2
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	8	L1, L2
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.	8	L1, L2
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. Polymeri c foams, reinforced plastics (composites) and laminates.	8	L1, L2

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.	8	L1, L2

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.

Graduate Attributes

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

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" 7 TH Edition, CRC Press 2008
2. V R Gowriker , N V Vishwanath and JayadevSreedhar " Polymer Science", New age International(P) Ltd 1986

Reference Books:

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

PETROLEUM PRODUCT ANALYSIS LABORATORY

Laboratory Code	**: 17PCL57**	**IA Marks**	**: 40**
No. of Lecture Hours/Week	**(1I + 2L)**	**Exam Marks**	**: 60**
		Exam Hours	**: 03**

CREDITS- 02

Course Objectives:
To impart practical knowledge on different petroleum testing methods

Laboratory Experiments: **Minimum of 10 experiments are to be conducted**	**Revised Bloom's Taxonomy (RBT) Level**
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	

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

Graduate Attributes

1. Critical Thinking
2. Problem solving
3. Use of modern tools
4. Life - long Learning
5. Collaborative and multidisciplinary work

Conduct of Practical Examination:

6. Minimum of 10 experiments are to be conducted andall 10experiments are to be included for practical examination.
7. Students are allowed to pick one experiment from the lot.
8. Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.
9. Change of experiment is allowed only once and 15% Marks allotted to the procedurepart to be made zero.

Reference Books:

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

COMPUTER APPLICATIONS LABORATORY SEMESTER-V			
Laboratory Code	**: 17PCL58**	**IA Marks**	**: 40**
No. of Lecture Hours/Week	**01 Hr. Tutorial(Instructions) + 02 hours Laboratory**	**Exam Marks**	**: 60**
		Exam Hours	**: 03**
CREDITS- 02			
Course Objectives: This course enables students to implement numerical techniques for chemical engineering applications.			

Laboratory Experiments: **Minimum of 6 experiments from Part Aand 4 experiments from Part B are to be conducted**	**Revised Bloom's Taxonomy (RBT) Level**
Part - A	
1. Non-linear algebraic equation- Newton Raphson (Specific volume of binary mixture)	
2. Ordinary Differential Equation- R-K Method ($dCa/dt=kCa^2$)	
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 multi-component 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	
Process simulation study involving mixing, reactor, distillation, heat exchanger for any of the following:	
13. Propylene - Propane Splitter	
14. Reboiled Stripper from Seader and Henley	
15. Extractive Distillation	
16. Binary Distillation in a Double Feed Column	
17. Distillation of Ethanol Water mixture	

18. Homogeneous Azeotropic Distillation	
19. Absorber	
20. Reboiled Absorber	

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.

Graduate Attributes

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

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. PradeepAhuja “Introduction to Numerical Methods in Chemical Engineering”, PHI Learning PVT. Ltd. New Delhi.

SEMESTER VI

CHEMICAL REACTION ENGINEERING-II (Common to CH & PC)					
Subject Code	:	17CH61	**IA Marks**	:	40
No. of Lecture Hrs/Week	:	04	**Exam Hours**	:	03
Total No. of Lecture Hours	:	50	**Exam Marks**	:	60
Credits	:	04			

Course Objectives:
The students will

10. Be able to understand and apply the principles of non-ideal flow in the design of reactor.
11. Be able to develop rate laws for heterogeneous reactions.

Revised Bloom's Taxonomy Levels: L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

Modules	Teaching Hours	Blooms Taxonomy
Module 1 **Content**		
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.	10	L1,L2,L3
Module 2		
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. **Fluid-Fluid Non Catalytic Reactions:** Kinetic regimes for mass transfer and reaction; rate equations.	10	L2,L3,L4
Module 3		
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.	10	L3,L4,L5
Module 4		
Solid Catalyzed Reactions: Heterogeneous reactions- Introduction, Kinetic regimes. Rate equation for surface kinetics. Pore diffusion resistance combined with surface kinetics. Thiele modulus and enhancement factor, Porous catalyst particles. Heat effects during reaction.	10	L4,L5
Module 5		

Solid Catalyzed Reactions (Contd.): Performance equations for reactors containing porous catalyst particles. Experimental methods for finding rates. Packed bed catalytic reactor & reactors with suspended solid catalyst. Fluidized reactors of various type. Gas-Liquid Reactors: Trickle bed, slurry reactors. Three phase fluidized bed.	10	L3,L4,L5

Course outcomes:

After studying this course, students will be able to:

11. Apply theoretical knowledge to distinguish between various RTD curves and predict the conversion from a non-ideal reactor using tracer information.
12. Acquire practical knowledge about design of reactors for non-catalytic and catalytic reactions.
13. Know the use of reactors for gas–liquid operatio ns with and without chemical 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.

Graduate Attributes

8. Critical Thinking
9. Problem solving
10. Use of modern tools
11. Life - long Learning

TEXT BOOKS:

12. **ChemicalReactionEngineering,**OctaveLevenspiel,3Edition,JohnWiley&Sons, 2001.
13. **ChemicalEngineeringKinetics,**J.M.Smith,3rd Edition,McGrawHill.
14. **ElementsofChemicalReactionEngineering,**H.ScottFoggler,3rd Edition,PrenticeHall, 2001.

REFERENCE BOOKS:

1. **Chemical&CatalyticReactionEngineering,**JamesJ.Carberry,McGrawHill,1976

MASS TRANSFER OPERATIONS-II (Common to CH & PC)					
Subject Code	:	17CH62	**IA Marks**	:	40
No. of Lecture Hrs/Week	:	04	**Exam Hours**	:	03
Total No. of Lecture Hours	:	50	**Exam Marks**	:	60
Credits	:	04			

Course Objectives:
The students will
8. Be able to understand different separation techniques.
9. Be able to design distillation column, absorber and calculations involved in liquid liquid extraction.

Revised Bloom's Taxonomy Levels: L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

Modules		Teaching Hours	Blooms Taxonomy
Module 1	**Content**		
Gas Liquid Contacting Systems: Types, construction and working of plate and packed columns, types and properties of industrial packing's, plate efficiencies, HETP and HTU concepts. **Absorption:** Absorption. Solvents election for absorption. Material balance and concept of driving force and minimum solvent rates. Multi stage absorption columns. Design of Plate columns. Absorption and desorption factors.		10	L1,L2,L3
Module 2	**Content**		
Packed Tower Absorption: Liquid phase hold up and pressure drop in absorpt Ion towers. Design of packed towers (process design-Height and diameter).Multi-component absorption. Absorption with chemical reaction. **Distillation:** Introduction. Vapour liquid equilibria (T-x,y,P-x,y.H-x,yandx-ydiagramsfor binary mixtures). Relative volatility. Prediction of VLE from vapour pressure data using Raoult'slaw. VLEformulti-component systems. Non-idealsystems. Azeotropes. Immiscible systems. Steam distillation**,** Flash and simple distillation.		10	L2,L3,L4
Module 3	**Content**		
Distillation (Contd.):.Multi-stage rectification column. Design using McCabe Thiele and Lewis-Sorel methods for binary mixtures. **Distillation(Contd.):**Ponchon-Savarit method.Introduction to Multi component distillation, Vacuum,molecular,extractive and azeotropic distillations.		10	L3,L4,L5
Module 4	**Content**		
		10	L3,L4,

Liquid- **Liquid Extraction**: Ternary equilibrium. Solvent selection. Single stage. Multi-stage cross-current counter-current extraction .Equipment for liquid-Liquid extraction.		L5
Module 5	**Content**	
Leaching Operation: Equipment for leaching. Preparation of solids for leaching .Equilibrium diagrams. Calculation of Single stage And multi-Stage leaching operation.	10	L2,L3,L4

Course outcomes:

After studying this course, students will be able to:

4. Apply theoretical knowledge for separation of components.
5. Acquire practical knowledge about design of mass transfer equipment.
6. Differentiate various separation techniques.

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.

Graduate Attributes

7. Critical Thinking
8. Problem solving
9. Use of modern tools
10. Life - long Learning

TEXT BOOKS:

4. **MassTransferOperations-**RobertE Treybal,3rd Edition,McGrawHill,1981.
5. **UnitOperationsin ChemicalEngineering**-McCabe&Smith,6th Edition,McGrawHill,2001.

REFERENCE BOOKS:

12. **Chemical Engineering VolI, II, IV and V -** Coulson and Richardson, 4th Edition, PergamonPress,1998.
13. **IntroductiontoChemicalEngineering-**Badger&Banchero,TMH6th Reprint1998.
14. **Principlesof UnitOperation-**Foust*et.al*.,2nd Edition,JohnWiley,1994.
15. **TransportProcessesandUnitOperation-**GeankoplisCJ,PrenticeHall(I),2000.
16. **AppliedProcessDesignforChemicalandPetrochemicalPlant**Ludwig,2nd Edition,Gulf Publishing,2002.

RESERVOIR ENGINEERING [DC]			
Subject Code	**: 17PC63**	**IA Marks**	**: 40**
No. of Lecture Hours/Week	**: 04**	**Exam Marks**	**: 60**
Total No. of Lecture Hours	**: 50**	**Exam Hours**	**: 03**

CREDITS- 4

Course 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

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
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.	10	L1, L2
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.	10	L1, L2
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	10	L1, L2

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.	10	L1, L2
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.	10	L1, L2

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

Graduate Attributes

- Critical Thinking
- Problem solving
- Use of modern tools
- Life - long Learning
- Collaborative and multidisciplinary work

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:

6. L.P.Dake L Elsevier, “Fundamentals of Reservoir Engineering”, Development in Petroleum Science. 1980

7. Craft B.C and Hawkins M.F. – Applied Petroleum R eservoir Engineering” 2nd Edition. Prentice Hall Englewood Cliffs, N.J., 1991

Reference Books:

2. Dake, L.P. Practice of Reservoir Engineering Elsevier 2001

3. William C.Lyons, Gary J.Plisga “Standard Hand Bo ok of Petroleum & Natural Gas Engineering” Second Edition – (Elsevier), Gulf Publ ishing, Burlington U.S.A (2005).

PROCESS EQUIPMENT DESIGN AND DRAWING (Common to CH and PC)					
Subject Code	:	17CH64	**IA Marks**	:	40
No. of Lecture Hrs/Week	:	04	**Exam Hours**	:	04
Total No. of Lecture Hours	:	50	**Exam Marks**	:	60
Credits	:	04			

Course Objectives:

The students will

9. Be able to understand advances and types in the design of heat and mass transfer equipment and its accessories.
10. Be able to develop modifications based on design.

Revised Bloom's Taxonomy Levels: L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

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, fulltop/side view depending on equipment and major components. □ **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.	Teachin	Blooms Y
Content		
1.DoublepipeHeatexchanger 2.ShellandTubeHeatexchanger 3.Condensers–Horizontalandvertical 4.Evaporator–Singleeffect 5.Sieve TrayDistillationColumn 6.Packed BedAbsorptionColumn 7.RotaryDryer.	07 07 08 07 07 07 07	L1,L2,L3 , L4,L5,L6

Course outcomes:

After studying this course, students will be able to:

- □ Design and modify process equipment relating to heat and mass transfer.
- □ Will handle process parameters to alter and design process Equipment.

Question Paper Pattern:

This question paper will have two questions. Each full question consists of 100 marks. Each full question will have sub questions covering design of the equipment and proportionate drawing Top view, front view and side view of equipment. The students will have to answer any one full question.

Note: ChemicalEngineersHandbook,Perry&Green,McGrawHill,1997.
IS2825,IS4503,B.I.S.,NewDelhi,1969 are permitted for exam and internal.

Graduate Attributes

1. Critical Thinking

5. Problem solving
6. Use of modern tools
7. Life - long Learning
8. Collaborative and multidisciplinary work

TEXT BOOKS:

3. **ProcessEquipmentDesign-**M.V.Joshi,3rd Edn.,Macmillan&Co. India,Delhi, 1998.
4. **ProcessEquipmentDesign–VesselDesign,** Brownell&Young,JohnWilley,1959.
5. **Process Desi gn ofEquipment – Vol1,** S. D. Dawande, 3rd Edn, Central Techno Publications.2003.

REFERENCE BOOKS:

5. **ChemicalEngineersHandbook,**Perry&Green,7th Edn,McGrawHill,1997.
6. **PressureVesselCode–IS2825,** ISCode,B.I.S.,NewDelhi,1969.
7. **Flowof FluidsthroughValves,Fittings&Pipes**,CraneAmazon,2006.

PROFESSIONAL ELECTIVE - 17PC65X
PETROLEUM TRANSPORTATION ENGINEERING

Subject Code	**: 17PC651**	**IA Marks**	**: 40**
No. of Lecture Hours/Week	**: 03**	**Exam Marks**	**: 60**
Total No. of Lecture Hours	**: 40**	**Exam Hours**	**: 03**

CREDITS- 03

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

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
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.	8	L1, L2
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 panhandle equation, design factors. Pressure drop in non-horizontal pipeline. Stress conditions in pipeline and analysis.	8	L1, L2
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.	8	L1, L2

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.	8	L1, L2
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.	8	L1, L2

Course Outcomes:

Students will have understanding on transportation techniques and the auxiliary equipments involved in the transportation process.

Graduate Attributes

- Critical Thinking
- Problem solving
- Use of modern tools
- Life - long Learning
- Collaborative and multidisciplinary work

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.

PROFESSIONAL ELECTIVE - 17PC65X MECHANICAL OPERATIONS			
Subject Code	**: 17PC652**	**IA Marks**	**: 40**
No. of Lecture Hours/Week	**: 03**	**Exam Marks**	**: 60**
Total No. of Lecture Hours	**: 40**	**Exam Hours**	**: 03**

CREDITS- 03

Course Objectives: This course will enable students to

- Study different properties of particulate solids, handling and mixing of solid particles.
- Study principles of commination and different types of equipment for size reduction like crushers, grinders etc.
- Understand mechanical separation aspect such as screening, filtration, sedimentation, transportation of solids etc.
- Understand energy requirements in solids handling, agitation and mixing, solid conveying and storage.

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module-1		
Particle technology: Particle shape, particle size, different ways of expression Of particle size, shape factor, sphericity, particle size Analysis, screens – ideal and actual screens, differential And cumulative size analysis, effectiveness of screen, Specific surface of a mixture of particles, number of Particles in a mixture, standard screens, industrial Screening equipment, motion of screen, grizzly, gyratory Screen, vibrating screen, trommels, sub sieve analysis - Air permeability.	8	L2, L3
Module-2		
Size reduction: Introduction – types of forces used for comminution , Criteriaforcommunition,characteristicsof comminuted Products, laws of size reduction, work index, energy Utilization, methods of operating crushers – free crushing, Choke feeding, open circu it grinding, closed circuit Grinding, wet and dry grinding, equipment for size Reduction – classifica tion of size reduction equipment, Equipment – blake jaw crusher, gyratory crusher, smoothroll crusher, toothed roll crusher, impactor, attrition mill, Ball mill, critical speed of ball mill, ultra-fine grinders, Fluid energy mill, colloid mill, cutters – knife cutter.	8	L2, L3
Module-3		
Flow of fluid past immersed bodies:	8	L2, L3

Drag, drag coefficient, pressure drop – kozeny-carm en Equation, blake-plummer, ergun equation, fluidization, Conditions for fluidization, minimum fluidization velocity, Types of fluidization, applications of fluidization, slurry Transport, pneumatic conveying. **Motion of particles through fluids:** Mechanics of particle motion, equation for one Dimensional motion of particles through a fluid in Gravitational and centrifugal field, terminal velocity, drag Coefficient, motion of spherical particles in stoke's region, Newton's region, and intermediate region, criterion for Settling regime, hindered settling, modification of Equation for hindered settling, centrifugal separators, Cyclones and hydro cyclones.		
Module-4		
Sedimentation: Batch settling test, application of batch settling test to Design of a continuous thickener, coe and clevenger Theory, kynch theory, thickener design, determination of Thickener area. **Filtration:** Introduction, classification of filtration, cake filtration, Clarification, batch and continuous filtration, pressure and Vacuum filtration, constant rate filtration and cake Filtration, characteristics of filter media, industrial filters, Sand filter, filter press, leaf filter, rotary drum filter, Horizontal belt filter, bag filter, centrifugal filtration – Suspended batch centrifuge, filter aid s, application of Filter aids, principles of cake filtration, modification of Kozeny – carmen for filtration.	8	L2, L3
Module-5		
Agitation and mixing: Application of agitation, agitation equipment, types of Impellers – propellers, paddles and turbines, flow Patterns in agitated vessels, prevention of swirling, Standard turbine design, power correlation and power Calculation, mixing of solids, types of mixers – changecan mixers, muller mixers, mixing index, ribbon blender, Internal screw mixer, tumbling mixer. **Sampling, storage and conveying of Solids:** Sampling of solids, storage of solids, open and closed Storage, bulk and bin storage, conveyors – belt Conveyers, chain conveyor, apron conveyor, bucket Conveyor, screw conveyor.	8	L2, L3
Course Outcomes: 2. Classify and suggest different type of separation processes required for the feed material.		

3. Suggest different types of size reduction methods such as crushing, grinding milling depending on the type and size of the material.
4. Calculate the power requirements for different type of mechanical operations.
5. Select different type of conveying methods.

Graduate Attributes

4. Critical Thinking
5. Problem solving
6. Use of modern tools
7. Life - long Learning
8. Collaborative and multidisciplinary work

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:

5. McCabe, W.L., et.al., "Unit Operations in Chemic al Engineering", 5thedn., McGraw Hill International, Singapore, 2000

6. Badger W.L. and Banchero J.T., "Introduction to Chemical Engineering", 3rd edn. Tata McGraw Hill International Edition, Singapore , 1999

7. Coulson J.H. and Richardson J.F., "Coulson and R ichardson's Chemical Engineering", Vol-II Particle Technology and Separation Process, 6th edn., Asian Books (p) Ltd., New Delhi, 1998

Reference Books:

1. Brown G.G., et.al., "Unit Operations", I edn., C BS Publisher, New Delhi, 1995

2. Perry R.H. and Green W.D., "Perry's Chemical Eng ineers' Hand Book", VII edn., McGraw Hill International Edition, New York, 2000

3. Sarkar Samir, "Fuels and Combustion", II edn., O rient Longman, New Delhi, 1980

4. Foust A.S., et.al., "Principles of Unit Operatio ns", III edn., John Wiley and Sons, New York, 1997

PROFESSIONAL ELECTIVE - 17PC65X
CHEMICAL PLANT UTILITIES AND SAFETY

Subject Code	**: 17PC653**	**IA Marks**	**: 40**
No. of Lecture Hours/Week	**: 03**	**Exam Marks**	**: 60**
Total No. of Lecture Hours	**: 40**	**Exam Hours**	**: 03**

CREDITS- 03

Course Objectives: This course enables students to study the role of utilities in process plant operations and criteria for selection and estimation of suitable utilities.

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module-1		
Introduction: Different utilities. Role of utilities in process plant operations and criteria for selection and estimation of suitable utilities. **Water:** Water resources. Process water, Cooling water, drinking water and boiler feed water Quality Standards. Water treatment processes for drinking, process and boiler feed. Storage and handling of water. Types and selection of pumps, piping and accessories. Water pre treatment,	8	L1, L2
Module-2		
Air: Compressed air, blower air, fan air. Types of compressor and vacuum pumps and selection. Power requirements, performance and related calculations. Booster and receivers. Quality of compressed air for instrumentsandprocesses.Compressedair distribution system- piping and accessories. Air-water vapour system: humidification/ dehumidification and evaporative cooling-related calculations.	8	L1, L2
Module-3		
Steam And Power: Steam generation in chemical plants. Types of boilers and waste heat boilers. Fuels-types, emissions and global warming, green fuels. Calorific value. Proximate and ultimate analysis. HHV, LHV and related calculations. Cogeneration power plants. CHPs and Boiler performance. Related Calculations. Economy of steam generation with different fuels, related calculation. Steam storage and handling-piping and accessories.	8	L1, L2
Module-4		
Refrigeration: Different refrigeration systems and	8	L1, L2

their characteristics. Air-conditioning systems. Coefficient of performance. Power requirements and refrigeration effect- related calculations for each type of refrigeration system. Refrigerant properties and selection. Some commonly used refrigerants and secondary refrigerants. **Insulation:** Insulation Materials & Selection- Economics of insulation. Insulating factors. Properties & Classification. Cold insulation and cryogenic insulation.		
Module-5		
Introduction To Process Safety: Intrinsic & Extrinsic Safety. The Hazards- Toxicity, Flammability, Fire, Explosions. Sources of ignition, Pressure. Hazard and risk assessment methods. MSDS. **Safety Devices:** Pressure relief valves. Ruptures discs. Blow down systems. Flare systems. Flame arrestors. Deflagration arrestors and explosion suppression. Personal safety devices.	8	L1, L2
Course Outcomes: At the end of the course students are able understand the role of utilities in process plant operations and criteria for selection and estimation of suitable utilities and the safety things required.		
Graduate Attributes 4. Critical Thinking 5. Problem solving 6. Use of modern tools 7. Life - long Learning 8. Collaborative and multidisciplinary work		
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: □ **Thermal Engineering,** B.K. Sarkar, Tata McGraw Hill, 8th Reprint, 1998. □ **Heat Engines,** K.P. Roy, Media Promoters and Publishers, 1995. □ **Power Plant Engineering,** P.K. Nag, 2nd Edition ,TataMcGraw Hill, 1998. □ **Water and Waste water engineering- Vol 2,** Gordon M Fair, John C. Geyer and Daniel A Okun, Jhon Hutey,1996.		

4. **Water and waste water Technology,** Mark J. Hammer Jr.,4thEdition, Prentice Hall, 1997.
5. **Chemical Engineers Handbook,** Perry, 8th Edition, 2007.
6. **Chemical Engineering- Vol 6,** R.K. Sinnot, Coulson and Richardson's, 3 rd Edition, BH, Reprint, 2000.

Reference Books:

1. **Loss prevention in chemical process industries, Vol. 1,2,3,** Frank P Lees, Butterworth-Heiremann,1980.

PROFESSIONAL ELECTIVE - 17PC65X WELL DRILLING EQUIPMENTS AND OPERATION			
Subject Code	**: 17PC654**	**IA Marks**	**: 40**
No. of Lecture Hours/Week	**: 03**	**Exam Marks**	**: 60**
Total No. of Lecture Hours	**: 40**	**Exam Hours**	**: 03**

CREDITS- 03

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

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module-1		
DRILLINGMUDSANDCOMPLETION 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	8	L1, L2
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.	8	L1, L2
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	8	L1, L2

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 ArmoredWirelines, ArmoredWirelines 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.	8	L1, L2
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** 8 L1, L2 **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		
Graduate Attributes 4. Critical Thinking 5. Problem solving 6. Use of modern tools 7. Life - long Learning 8. Collaborative and multidisciplinary work		
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: 23. Rabia.H. 'Oil Well Drilling Engineering, Principles And Practices' Graham And Trotman Ltd. 1985. 24. D.P Helander 'Fundamentals Of Formation Evaluation'.		
Reference 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.

OPEN ELECTIVE - 17PC66X
MODERN SEPARATION TECHNIQUES

Subject Code	**: 17PC661**	**IA Marks**	**: 40**
No. of Lecture Hours/Week	**: 03**	**Exam Marks**	**: 60**
Total No. of Lecture Hours	**: 40**	**Exam Hours**	**: 03**

CREDITS- 03

Course 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.

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
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, Ultrafiltration.	8	L1, L2
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.	8	L1, L2
Module-3		
Surfactant Based Separations: Fundamentals. Surfactants at inter phases and in bulk. Liquid membrane permeation. Foam separations. Micellar separations.	8	L1, L2
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 ho pes, Decaffeination of coffee, Rose process for separating residuum.	8	L1, L2

Module-5		
Other Techniques: Separations involving Lyophilization, Pervaporationand permeation techniques for solids, liquids and gases. Zone melting, Adductive crystallization. Heavy media separation.	8	L1, L2

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.

Graduate Attributes

5. Critical Thinking
6. Problem solving
7. Use of modern tools
8. Life - long Learning
9. Collaborative and multidisciplinary work

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:

· **Encyclopedia of Chemical Technology,** Kirk-Othmer, John Wiley & Sons,2001.
· **Rate Controlled Separations,** Phillip C Wankat, Kluwer Academic Pub, 1990.
· **Transportation and Separation Process,** Gaenkopolis, Printice Hall, 2003.
· **Surfactant Based Separation,** T.O. Hatton, Vol 23.
· **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.

OPEN ELECTIVE - 17PC66X
PROCESS MODELING AND SIMULATION

Subject Code	**: 17PC662**	**IA Marks**	**: 40**
No. of Lecture Hours/Week	**: 03**	**Exam Marks**	**: 60**
Total No. of Lecture Hours	**: 40**	**Exam Hours**	**: 03**

CREDITS- 03

Course 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

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module-1		
Introduction-Role of Process Dynamicsand 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.	08	L1, L2, L3
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.	08	L1, L2, L3
Module-3		
Time-Domain Dynamics and Control- Classification, Linearization and Perturbation Variables, Responses of Simple Linear Systems, Steadystate Techniques. **Conventional Control Systems and Hardware-** Control Instrumentation, Performance of Feedback Controllers, Controller Tuning.	08	L1, L2, L3
Module-4		
Advanced Control Systems- Ratio Control, Cascade Control, Computed Variable Control, Override Control, Nonlinear and **Adaptive Control Valve** -Position Control.	08	L1, L2, L3

Frequency-Domain Analysis of Closed loop Systems- Nyquist Stability Criterion, Closedloop 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, Openloop and Closedloop Systems, Computer Programs For Matrix Calculations Problems	08	L1, L2, L3

Course Outcomes:

After studying this course, students will be able to: learnt the basic concepts ofSimulation and mathematical models applicable in Chemical Engineering.

Graduate Attributes

2. Critical Thinking
3. Problem solving
4. Use of modern tools
5. Life - long Learning
6. Collaborative and multidisciplinary work

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 Cont rol for Chemical Engineering” McGRAW Hill Publishing Company.

Reference Books:

· Smith C. L., Pike R. L. and Murill P. W. “ Formu lation and Optimization of Mathematical Models”. International Text, Pennsylvania 1970

· Roger G. E. “ Modelling and Simulation in Chemi cal Engineering” Wiley Inter Science, New Jersey 2006

OPEN ELECTIVE - 17PC66X
MATERIALS SCIENCEFOR PETROCHEMICAL ENGINEERING

Subject Code	**: 17PC663**	**IA Marks**	**: 40**
No. of Lecture Hours/Week	**: 03**	**Exam Marks**	**: 60**
Total No. of Lecture Hours	**: 40**	**Exam Hours**	**: 03**

CREDITS- 03

Course 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

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
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, Crysta l directions and planes – the miller indices, Structu re 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.	8	L1, L2, L3
Module-2		
CRYSTAL IMPERFECTIONS:	8	L1, L2, L3

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.	8	L1, L2, L3
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.	8	L1, L2, L3
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.	8	L1, L2, L3
Course Outcomes: After studying this course, students will be able to: 3. Classify different types of engineering materials depending on structure property, crystal geometry and X-Ray diffraction. 4. Explain atomic structures, types of bonding and crystal imperfections. 5. Draw phase diagrams of different metals, TTT curves and explain deformation of materials. 6. 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.

1. Select materials depending on type of application.

Graduate Attributes

1. Critical Thinking
2. Problem solving
3. Use of modern tools
4. Life - long Learning
5. Collaborative and multidisciplinary work

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 Pro cesses", Indian book distributing Co., 1982

Reference Books:

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

OPEN ELECTIVE - 17PC66X
CATALYSIS SCIENCE AND TECHNOLOGY

Subject Code	**: 17PC664**	**IA Marks**	**: 40**
No. of Lecture Hours/Week	**: 03**	**Exam Marks**	**: 60**
Total No. of Lecture Hours	**: 40**	**Exam Hours**	**: 03**

CREDITS- 03

Course Objectives: This course enables students:

1. To understand the concepts of functionality of catalyst and kinetics of catalytic processes.
2. To develop idea of important properties of industrial catalysts, methods of manufacturing catalyst and its characterization.
3. To get acquainted with industrial catalytic reactors, their design and operations.

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module-1		
Catalytic Reaction Pathways- Heterogeneous Catalysis, Selectivity, activity, functionality, active site, Turnover number, Inhibitor, Reaction Pathways, Adsorption, Adsorption Isotherm, Important Characteristics of Industrial Catalysts. Homogeneous catalysis.	08	L1, L2, L3
Module-2		
Kinetics of Catalytic Reaction- Rate and Kinetics Models of Catalytic Reactions: Langmuir-Hinshelwood Model, Rideal Model, Identifying limiting step of reaction, Poisoning and Deactivation of Catalysts, Regenerability of Spent Catalyst.	08	L1, L2, L3
Module-3		
Manufacture of Catalysts and their Characterization- Catalyst preparation and manufacturing: Precipitation Method, Impregnation, Special preparative Methods, Catalyst Supports, Promoters, Catalyst Characterization, Surface area, Pore Volume, Pore size Distribution, Mechanical Properties.	08	L1, L2, L3
Module-4		
Different Type of Catalysts- Supported Metal Catalysts: Metal activity, Metal	08	L1, L2, L3

dispersion, Alloy catalysts, Sintering, Mobility, Redispersion, Carbon formation and Poisoning Acid Catalysts: Source of acidity, Determination of acid strength, correlations between acidity and catalytic activity, mechanism of catalytic cracking, Acid-Base catalysts Zelolites: Pore structure, Synthesis, Diffusion, Shape selective catalysis, Activity, Catalytic Cracking with zeolites.		
Module-5		
Industrial Applications in Petrochemical Industry- Manufacture of phthalic anhydride: Reactor configuration, hot spot formation, Ethylene to ethylene oxide, Steam reforming: Catalysts, Reforming process, Fischer-Tropsch synthesis: Mechanism, Catalysts, Process, Water gas shift reaction: High temperature shift catalyst, Low temperature shift catalyst, Methanol synthesis: High temperature process, Low temperature process, Kinetics, Ammonia synthesis: Reactor configuration.	08	L1, L2, L3
Course Outcomes: At the end of the course students are able understand the useful of catalysts used in industries for the production of products and also study the characterization of the catalyst activity.		
Graduate Attributes • Critical Thinking • Problem solving • Use of modern tools • Life - long Learning • Collaborative and multidisciplinary work		
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. Satterfield C. N., “Heterogeneous Catalysis in I ndustrial Practice”, Second Edition, McGraw Hill, 1993.		
Reference Books: 1. Smith J. M., “Chemical Engineering Kinetics”, Th ird Edition, McGraw Hill, 1984. 2. Froment G. F. and Bischoff, K. B. “Chemical Reac tor Analysis and Design”, John Wiley & Sons, 1995.		

CHEMICAL REACTION ENGINEERING LABORATORY

Laboratory Code	**: 17PCL67**	**IA Marks**	**: 40**
No. of Lecture Hours/Week	**01 Hr. Tutorial(Instructions) + 02 hours Laboratory**	**Exam Marks**	**: 60**
		Exam Hours	**: 03**

CREDITS- 02

Course Objectives:
Students develop a sound working knowledge on different types of reactors.

Laboratory Experiments: Minimum of 10 experiments are to be conducted	**Revised Bloom's Taxonomy (RBT) Level**
· Isothermal Batch Reactor – Integral Analysis	
· Isothermal Batch Reactor – Differential Analysis	
· Adiabatic Batch Reactor	
· Packed Bed Reactor	
· Effect Of Temperature On Rate Of Reaction	
· Kinetic Studies In Mixed Flow Reactor	
· RTD Studies In Mixed Flow Reactor	
· Plug Flow Reactor	
· Semi Batch Reactor	
· Batch Reactive Distillation	
· Gas-Liquid Reaction	
· Catalytic Reaction	
· Photochemical Reaction	
· CSTR in Series	

Course Outcomes:
To impart knowledge on reaction engineering by practice.

Graduate Attributes

- Critical Thinking
- Problem solving
- Use of modern tools
- Life - long Learning
- Collaborative and multidisciplinary work

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:

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

MASS TRANSFER LABORATORY
SEMESTER-V

Laboratory Code	**: 17PCL68**	**IA Marks**	**: 40**
No. of Lecture Hours/Week	**01 Hr. Tutorial(Instructions) + 02 hours Laboratory**	**Exam Marks**	**: 60**
		Exam Hours	**: 03**

CREDITS- 02

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

Laboratory Experiments: Minimum of 10 experiments are to be conducted	**Revised Bloom's Taxonomy (RBT) Level**
1. Surface Evaporation	
2. Determination of Diffusion Coefficient	
3. Simple Distillation	
4. Solid – liquid leaching	
5. Adsorption studies	
6. Tray dryer	
7. Steam distillation	
8. Extraction of oil from pyrolysis method	
9. Liquid - liquid extraction	
10. Vacuum Dryer	
11. Ternary System	
12. Solid dissolution	

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

Graduate Attributes

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

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. Robert E Treybal, Mass Transfer Operations, 3rd Edition, McGraw Hill, 1981.

2. McCabe & Smith “Unit Operations in Chemical Engi neering”, 6th Edition, McGraw Hill, 2001.

SEMESTER VII

RESEARCH METHODOLOGY [DC]

Subject Code	**: 17PC71**	**IA Marks**	**: 40**
No. of Lecture Hours/Week	**: 04**	**Exam Marks**	**: 60**
Total No. of Lecture Hours	**: 50**	**Exam Hours**	**: 03**

CREDITS- 04

Course Objectives:

To understand the principles, methodology and ethics of research.

Revised Bloom's Taxonomy Levels: L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
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.	10	L1, L2,L3
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.	10	L2, L3, L4
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:** Meaning, Types, characteristics, Formulation of Hypothesis, Errors in Hypothesis.	10	L2, L3, L4
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.	10	L4, L5, L6
Module-5		
Report Writing: Importance of report writing, types of research report, structure of the report, steps in research report writing, guidelines for effective research report writing.	10	L3, L4, L5

Course Outcomes:

Upon completion of this course, the students would have Learned to carry out literature survey, plan the methods and order of carrying of various research techniques, consolidate the data and preparation of report.

Graduate Attributes (as per NBA)

12. Engineering Knowledge
13. Problem Analysis
14. Design/development of solutions (Partly)
14. Interpretation of data.

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:

12. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International.

13. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.

Reference Books:

15. William M C Trochi “Research Methods” 2 nd edition Biztantra 2007.

16. Deepak Chawla and NeenaSondhi “Research Methodology ” Vikas Publication 2014.

17. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, EssEss Publications. 2nd volumes

18. Subbarau NR-Handbook on Intellectual Property Law and Practice-S Viswanathan Printers and Publishing Private Limited.1998.

DRILLING FLUIDS AND CEMENTING TECHNIQUES [DC]			
Subject Code	**: 17PC72**	**IA Marks**	**: 40**
No. of Lecture Hours/Week	**: 04**	**Exam Marks**	**: 60**
Total No. of Lecture Hours	**: 50**	**Exam Hours**	**: 03**
CREDITS- 04			
Course Objectives: To enable the students to understand the types of drilling fluids and cementing techniques			
Revised Bloom's Taxonomy Levels: L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating			

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module-1		
Basis of Well Completion Engineering - Grounds of Reservoir Geology and Reservoir Engineering, Core Analysis Techniques, Reservoir Sensitivity to Fluid and Working Fluid Damage Evaluation, Reservoir Stress Sensitivity Analysis, In Situ Stress and Mechanical Parameters of Rock, Technological Grounds of Petroleum Production Engineering. **Drilling fluids**- Introduction to the basic functions and properties of drilling fluids and cement slurries.Compositions and related properties of drilling fluids and cement slurries. Drilling fluids – classification – water base drilling fluids. Testin g of drilling fluids. Drilling fluidadditives**.**	10	L1, L2
Module-2		
Well Completion Mode Selection - Vertical, Slant, and Directional Well Completion **Selection and Determination of Tubing and ProductionCasing Sizes** - Overview of Nodal Analysis, Selection and Determination of Tubing and Production Casing Sizesfor Flowing Wells, Selection and Determination of Tubing and Production Casing Sizesfor Gas Wells, Selection and Determination of Tubing and Production Casing Sizesfor Artificial Lift Wells, Effects of Stimulation on Tubing and Production Casing Size Selection, Selection and Determination of Tubing and Production Casing Sizes for Heavy Oiland High Pour-Point Oil Production Wells	10	L3, L4
Module-3		
Completion and Perforating Fluids - Functions of Drilling and Completion Fluid andBasic		L3, L4

Requirements, Drilling and Completion Fluid Systems and Application, Shield-Type Temporary Plugging 10 Technique, Drilling and Completion Fluid for a Complicated Reservoir, Perforating Fluid, Perforating Technology, Perforated Well Productivity Influencing Rule Analysis, Perforating Differential Pressure Design, Optimizing the Perforation Design.		
Module-4		
Well Completion Formation Damage Evaluation - Principle of Formation Damage Evaluation by Well Testing, Formation Damage Diagnosis of Homogeneous Reservoir byGraphic Characteristics, Graphic Characteristics of a Dual Porosity Reservoir and a Reservoir witha Hydraulically Created Fracture, Distinguishing Effectiveness of Stimulation by GraphicCharacteristics, Quantitative Interpretation of Degree of Formation Damage, Well Logging Evaluation of Formation Damage Depth.	10	L4, L6
Module-5		
Cementing -Types of equipment and methods used in cementing operations. Drilling fluid and cement slurry hydraulics.Determination of torque and drag. Calculation of cutting transport efficiency. Placement technique of cements. Gas migration through cement columns. Well cementing – chemistry of cements. Cementing principles – primary cementing, secondary cementing, linear cementing, plug cementing, and single stage cementing, multistage casing cementing.	10	L3, L5

Course Outcomes: Upon completion of this course, the students would have Learned the concepts, applications of drilling fluids and the equipments involved in the cementing operations

Graduate Attributes (as per NBA)

10. Engineering Knowledge
11. Problem Analysis
12. Design/development of solutions (Partly)
7. Interpretation of data.

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.
11. Smith.P.K, 'Cementing' SPE Pulications 2nd Editi on 1976.
12. Cementing Technology – Powel Schlumberger Public ation 1984.

Reference Books:

6. Mc.Cray. A.W and Cole.F.W. 'Oil Well Drilling Technology' University of Oklahoma Press, Norman 1959.
7. Standard Handbook of petroleum and Natural Gas Engineering. 2nd Edition. William C Lyons, Gary C Plisga. Gulf Profession.

PROCESS CONTROL AND INSTRUMENTATION [D.C.]
[Common to CH & PC]

Subject Code	:	17CH73	**IA Marks**	:	40
No. of Lecture Hrs/Week	:	04	**Exam Hours**	:	03
Total No. of Lecture Hours	:	50	**Exam Marks**	:	60
Credits	:	04			

Course Objectives:
To gain the knowledge of different process instruments, To understand dynamic modeling of a physical process using first principles, To convert the model to a form amenable to solution and analysis, To design various control schemes, and To apply the control system in various processes.

Revised Bloom's Taxonomy Levels: L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

Modules	Teaching Hours	Blooms Taxonomy
Module 1 **Content**		
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.	10	L1, L2
Module 2 **Content**		
First Order Systems: Thermometer, level, mixing tank, STR, Linearization, 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.	10	L2, L3, L4
Module 3 **Content**		
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	10	L2, L3, L4

with various controller modes and their characteristics.		
Module 4 **Content**		
Stability: Stability of linear control systems. Routh Test. Frequency Response – Bode diagrams.	10	L3, L4,L5
Module 5 **Content**		
Control System Design by Frequency Response: Bode criterion. Gain and Phase margins, Ziegler – Nichols controlle r tuning, Cohen-Coon controller tuning. **Root Locus:** Rules for plotting and problems.	10	L3, L4,L5

Course outcomes:

After studying this course, students will be able to:

17. Knowledge of field instrumentations
18. Dynamic modeling and system behavior study
19. Design of controllers
20. Application of control systems in 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.

Graduate Attributes

8. Critical Thinking
9. Problem solving
10. Use of modern tools
11. Life - long Learning

TEXT BOOKS:

4. **Process System Analysis and Control,** Coughner& Koppel, II Edition, McGraw Hill, NewDelhi,1991.

REFERENCE BOOKS:

11. **Process Modeling, Simulation & Control for Chemical Engineers,** Luyben, II Edition, McGraw Hill, 1990.
12. **Chemical Engineering Vol. III, III Edition,** Coulson & Richardson, Pergamon Press,1998.
13. **Chemical Process Control-**An Introduction to Theory & Practical, George Stephanopoules,Vol.3, Prentice Hall, New Delhi, 1998.

PROFESSIONAL ELECTIVE-III: 17PC74X

OPTIMIZATION TECHNIQUES FOR PROCESS INDUSTRIES			
Subject Code	**: 17PC741**	**IA Marks**	**: 40**
No. of Lecture Hours/Week	**: 03**	**Exam Marks**	**: 60**
Total No. of Lecture Hours	**: 40**	**Exam Hours**	**: 03**

CREDITS- 03

Course Objectives:

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

Revised Bloom's Taxonomy Levels: L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
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.	8	L1, L2
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.	8	L1, L2
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.	8	L1, L3
Module-4		
Constrained Optimization Algorithms- Kuhn-Trucker Conditions, Transformation Methods: Penalty function method, Methods of multipliers, Sensitivity Analysis, Direct Search for Constrained Optimization,	8	L1, L4

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.	8	L1, L5
Course Outcomes: To gain exposure to application of optimization techniques in case of various petrochemical processes.		
Graduate Attributes (as per NBA) • Engineering Knowledge • Problem Analysis • Design/development of solutions (Partly) 9. Interpretation of data.		
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: 6. Edgar, T F, Himmelblau, D M, and Lasdon, L S, "O ptimization of Chemical Processes." McGraw Hill, Boston, 2001. 7. Rao, S. S., "Optimization Theory and Application s: Theory and Practice", New Age International, 3rd Edition, 1996. 8. Deb, Kalyanmoy "Optimization for Engineering Des ign", 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.		

PROCESS ENGINEERING AND PLANT DESIGN			
Subject Code	**: 17PC742**	**IA Marks**	**: 40**
No. of Lecture Hours/Week	**: 03**	**Exam Marks**	**: 60**
Total No. of Lecture Hours	**: 40**	**Exam Hours**	**: 03**

CREDITS- 03

Course Objectives: Students will learn the design considerations; software's used in process design, design strategy and optimization.

Revised Bloom's Taxonomy Levels: L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module-1		
Introduction – Plant design, General design considerations, Practical design Considerations, Engineering ethics in design. **Process design development –** Design database, Process – (creation, design and flow diagrams), Pip ing and Instrumentation diagrams.	8	L1, L2
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.	8	L1, L3
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.	8	L1, L4
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.	8	L1, L4
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.	8	L1, L5

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.

Graduate Attributes (as per NBA)

8. Engineering Knowledge
9. Problem Analysis
10. Design/development of solutions (Partly)

- Interpretation of data.

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:

5. Rudd D.F and Watson C.C, **Strategy of Process Engineering**, John Wiley and Sons.
6. 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.

FERMENTATION TECHNOLOGY

Subject Code	**: 17PC743**	**IA Marks**	**: 40**
No. of Lecture Hours/Week	**: 03**	**Exam Marks**	**: 60**
Total No. of Lecture Hours	**: 40**	**Exam Hours**	**: 03**

CREDITS- 03

Course Objectives: This course mainly to discuss**:**

- The role of microorganisms in bioprocess industry.
- The role of enzymes and microbes in biotechnology sectors.
- Effluent treatments in disposal methods.

Revised Bloom's Taxonomy Levels: L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module-1		
Introduction to Fermentation Processes: The range of fermentation Processes: Microbial Biomass, Enzymes, Metabolites and Transformation Processes; Development of fermentation Industry; Components of Fermentation Process.	8	L1, L2
Module-2		
Microbial Growth Kinetics – Review: Batch Culture; Continuous Culture; Fed-batch Culture; Applications. **Isolation, Preservation and Improvement of Industrial Microorganisms:** Isolation Methods Utilizing the selection of desired characteristics. Isolation Methods not utilizing the selection of desired characteristics; Preservation Methods: At Low temperature, Dehydration, and their quality control; The selection and Isolation of induced mutants improving yields of secondary metabolites; Use of recombinant systems for the improvement of industrial microorganisms.	8	L1, L3
Module-3		
Media for Industrial Fermentations: Typical Media and formulation; Sources of Energy, Carbon, Nitrogen, Minerals, vitamins, precursors, Oxygen and others. **Sterilization of Media:** Medium Sterilization; Design of Batch and Continuous Sterilization; Sterilization of Fermenter, Feed, Air; Filtration of Air and Design of Filters.	8	L2, L3
Module-4		
Development of Inocula for Industrial		L3, L4

		L4, L5
Fermentations: The development of Inocula for yeast, bacterial, fungal and streptomycete processes, Aseptic inoculation of plant Fermenters.	8	
Design of a Fermenter: Basic functions of a Fermenter, Body Construction, Aeration and Agitation, Maintenance of aseptic conditions, Valves, Fermenter types: Packed tower, Tower Fermenter; Waldhof-Fermenter, Acetators andCavitators, The cyclone column, Cylindro-conical vessels, Air-lift Fermenters, Deep-jet Fermenter, Rotating DiscFermenter etc.		
Module-5 **Recovery and Purification of Fermentation Products: Review:** Filtration, Centrifugation, Cell Disruption, Extraction,Chromatography, Ultra filtration, Drying, Crystallization and Whole broth processing. **Effluent Treatment:** Strength of fermentation effluents, Disposal Methods, Treatment processes: Aerobic and Anaerobic, By-products.	8	
Course Outcomes: Students will get knowledgeabout microorganisms used in bioprocess industries.		
Graduate Attributes (as per NBA) 3. Engineering Knowledge 4. Problem Analysis 5. Design/development of solutions (Partly) 6. Interpretation of data.		

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:

9. Bailey and Ollis, **Biochemical Engineering Fundamentals**, 2nd Edition, McGraw Hill, 1976.

10. Shuler M. L. and Kargi F, **Bioprocess Engineering**, 2nd Edition, Prentice Hall, 2002.

Reference Books:

1. Peter F. Stanbury, Alan Whitaker and Hope, **Principles of Fermentation Technology**, Pergamon Press.

ONSHORE AND OFFSHORE ENGINEERING AND TECHNOLOGY

Subject Code	**: 17PC744**	**IA Marks**	**: 40**
No. of Lecture Hours/Week	**: 03**	**Exam Marks**	**: 60**
Total No. of Lecture Hours	**: 40**	**Exam Hours**	**: 03**

CREDITS- 03

Course Objectives: To enable the students to:

- Learn the concepts of petroleum site exploration, analysis of offshore structure
- Understand the offshore soil mechanics.

Revised Bloom's Taxonomy Levels: L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
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**.**	8	L1, L2
Module-2		
Introduction; classification, properties of marine sediments. Consolidation and shear strength characteristics of marine sediments. Planning and site exploration.	8	L1, L3
Module-3		
Drilling. Sampling techniques. Laboratory testing, In situ testing methods and geophysical methods. Current design practices of pile supported and gravity offshore structures**.**	8	L3, L4
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.	8	L4, L5
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. onshore drilling equipments onshore rig structures-hydraulics applied in onshore rigs.	8	L5, L6

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

Graduate Attributes (as per NBA)

8. Engineering Knowledge
9. Problem Analysis
10. Design/development of solutions (Partly)
5. Interpretation of data.

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:

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

Reference Books:

1. Petroleum Exploration Hand Book by Moody, G.B.

PROFESSIONAL ELECTIVE-IV: 17PC75X

ENVIRONMENTAL SCIENCE AND SOLID WASTE MANAGEMENT			
Subject Code	**: 17PC751**	**IA Marks**	**: 40**
No. of Lecture Hours/Week	**: 03**	**Exam Marks**	**: 60**
Total No. of Lecture Hours	**: 40**	**Exam Hours**	**: 03**
CREDITS- 03			

Course 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.

Revised Bloom's Taxonomy Levels: L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
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).	8	L1, L2
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.	8	L1, L2
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	8	L1, L2

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.	8	L1, L2
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 pow er stations, textile industry, oil refinery, distillery, sugar industry, and radioactive waste generation units.	8	L1, L2

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.

Graduate Attributes (as per NBA)

3. Engineering Knowledge
4. Problem Analysis
5. Design/development of solutions (Partly)

- Interpretation of data.

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:

7. Gilbert. M. Masters, „Introduction to Environmen tal Engineering and Science, 2nd Edition Pearson Education 2004.

8. T. G. Miller, Environmental Science, Wads Worth publishing Co.

9. C. Townsend .J. Harper and Michael Bgon, Essentials of Ecology, Blackwell Science.

10. R. K. Trivedi and P .K. Goel, Introduction to Air pollution Techno science publications.

11. Integrated Solid Waste Management, George Tchobanoglous *et al*, 2nd Edition, McGraw Hill & Co, 1993.

Reference Books:

1. BharucheEvach, The Biodiversity of India, Mapin Publishing Limited, Ahmedabad, India.

9. R. K. Trivedi‟ handbook of Environmental laws, Rules, Guidelines, Compliances and Standards, Vol I and II, Enviromedia.
10. Dharmendra S. Sengar, ‘Environmental law’, Prent ice hall of India PVT LTD, New Delhi, 2007.
11. Waste Treatment Plants, Sastry C.A. et al, Narosa Publishing House, 1995.
12. Hazardous Waste Management, Lagrega, McGraw Hill, 1994.

BIOCHEMICAL ENGINEERING

Subject Code	**: 17PC752**	**IA Marks**	**: 40**
No. of Lecture Hours/Week	**: 03**	**Exam Marks**	**: 60**
Total No. of Lecture Hours	**: 40**	**Exam Hours**	**: 03**

CREDITS- 03

Course Objectives: This course mainly to discuss**:**

- The role of a Chemical engineer in bioprocess industry.
- The role of enzymes and microbes in biotechnology sectors.

Revised Bloom's Taxonomy Levels: L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
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.	8	L1, L2
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.	8	L2, L3
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).	8	L3, L4
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	8	L4, L5

of inhibitions. Dixon method. Enzyme immobilization: Uses. Methodsof 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.	8	L4, L5
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.		
Graduate Attributes (as per NBA) 5. Engineering Knowledge 6. Problem Analysis 7. Design/development of solutions (Partly) 25. Interpretation of data.		
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: 10. **Biochemical Engineering Fundamentals,** Bailey and Ollis, II Edition, McGraw Hill,1976. 11. **Bioprocess Engineering,** Shuler M. L. and Kargi F., 2nd Edition, Prentice Hall, 2002.		
Reference Books: 9. **Biochemical Engineering,** James Lee, Prentice Hall, 1992. 10. **Biochemical Reactors,** Atkinson B, Pion Ltd., London, 1974. 11. **Industrial Microbiology,** Casida, wiley, New York, 1968		

INTEGRATED OIL / GAS FIELD EVALUATION

Subject Code	**: 17PC753**	**IA Marks**	**: 40**
No. of Lecture Hours/Week	**: 03**	**Exam Marks**	**: 60**
Total No. of Lecture Hours	**: 40**	**Exam Hours**	**: 03**

CREDITS- 03

Course Objectives: To impart knowledge on different oil/gas field evaluations in order to maximize the production and improvement of facilities.

Revised Bloom's Taxonomy Levels: L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module-1		
Geological studies: - Structural contour maps and various geological models. Estimation of reserves. Hydrodynamic Study, Techno-economic Evaluation for normal and marginal fields. Innovative ways to asset development**.**	8	L1, L2
Module-2		
Petroleum project evaluation-mineral project evaluation case studies. The design and evaluation of well drilling systems-Economic appraisal methods for oil field developmental project evaluation including risk analysis, probability and statistics in decision-making and evaluations. Case studies.	8	L1, L2
Module-3		
An integrated reservoir description in petroleum engineering-usageofgeophysical,geological, petrophysical and engineering data-emphasis on reservoir and well data analysis and interpretation, reservoir modeling (simulation), reservoir management (production optimization of oil and gas fields) and economic analysis (property evaluation)	8	L3, L4
Module-4		
An integrated reservoir development in petroleum engineering-reservoir and well evaluation production Optimization-nodal analysis, stimulation, artificial lifts facilities-surveillance.	8	L5, L6
Module-5		
Evaluation of well completions-placement of casing, liners and well tubing. Evaluation,performance of horizontal wells. Evaluation of acidization treatments.	8	L5, L6

Course Outcomes: Students will be able to understand the different evaluation methods of oil/gas fields andreserves.

Graduate Attributes (as per NBA)

- Engineering Knowledge
- Problem Analysis
- Design/development of solutions (Partly)
- Interpretation of data.

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:

7. Katz D.L.et al., Natural Gas Engineering (Production & storage), McGraw-Hill, Singapore.
8. Mc.Cray. A.W and Cole.F.W. 'Oil Well Drilling Technology' University of Oklahoma Press,
Norman 1959.

Reference Books:

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

OILS AND FATS TECHNOLOGY

Subject Code	**: 17PC754**	**IA Marks**	**: 40**
No. of Lecture Hours/Week	**: 03**	**Exam Marks**	**: 60**
Total No. of Lecture Hours	**: 40**	**Exam Hours**	**: 03**

CREDITS- 03

Course Objectives: This course mainly to discuss theComposition, Extraction and Refining processes and uses of oils.

Revised Bloom's Taxonomy Levels: L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module-1		
Introduction: Classification of fats and oil. Characteristic of oils. Utilization of fat and oils. Composition of oils (general). **Obtaining Oils and Fats from Source Materials:** Mechanical pre-treatment. Mechanical expression. Solvent extraction (two types of extractors).	8	L1, L2
Module-2		
Process Techniques: Refining and hydrogenation (H_2 production and catalyst). Degumming. Alkali refining and bleaching.	8	L3, L4
Module-3		
Deodorization: Theoretical consideration and operation of commercial deodorizer.	8	L3, L4
Module-4		
Vegetable Oils: Composition. Extraction. Refining processes and uses of coconut oil, cottonseed oil. Refining processes and uses of palm oil, Soya been oil, peanut oil, sunflower oil.	8	L4, L5
Module-5		
Marine Oils: Composition. Extraction. Refining processes and uses of fish oils.	8	L4, L5

Course Outcomes: The main of learning this subject is that student will be able to understand the basics of process techniques involved in Composition, Extraction and Refining processes and uses of oils.

Graduate Attributes (as per NBA)

- Engineering Knowledge • Problem Analysis
- Design/development of solutions (Partly) • Interpretation of data.

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. **Basily Industrial Oil and Fat Products – Vol I to V ,** Y.H.Hery John Wiley International, 2nd Edition,1976.

Reference Books:

2. **Chemistry and Technology of Oil and Fats,** Devine J and Williams P.N, 1961.

3. **Chemical process Industries,** Austin G. T., Shreve's Fifth Edition, McGraw-Hill international Book Company, Singapore, 1984.

4. **Outlines of Chemical Technology,** Dryden C. E., Edited by Gopala Rao. M and M. Sittig, Second Edition, Affiliated East West Press, 1993.

5. **Hand Book of Industrial Chemistry**, Kent J.A (Ed) Riegel's Van Nostrand Reinhold, 1974.

PROCESS CONTROL LABORATORY

Laboratory Code	**: 17PCL76**	**IA Marks**	**: 40**
No. of Lecture Hours/Week	**01 Hr. Tutorial(Instructions) + 02 hours Laboratory**	**Exam Marks**	**: 60**
		Exam Hours	**: 03**

CREDITS- 02

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

Revised Bloom's Taxonomy Levels: L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

Laboratory Experiments: Minimum of 10 experiments are to be conducted	**Revised Bloom's Taxonomy (RBT) Level**
1. Thermometer	L3,L4,L5
2. Single tank - Step Response	L3,L4,L5
3. Single tank - Impulse Response	L3,L4,L5
4. Interacting Tanks - Step Response	L3,L4,L5
5. Interacting Tanks - Impulse Response	L3,L4,L5
6. Non Interacting Tanks - Step Response	L3,L4,L5
7. Non Interacting Tanks - Impulse Response	L3,L4,L5
8. U – Tube Manometer	L3,L4,L5
9. Thermocouple	L3,L4,L5
10. Thermistor	L3,L4,L5
11. Valve characteristics	L3,L4,L5
12. Cascade control system	L3,L4,L5
13. Pressure system	L3,L4,L5
14. Level/Flow/Pressure/pH/Temperature control – PID Controller	L3,L4,L5

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

Graduate Attributes (as per NBA)

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

Conduct of Practical Examination:

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

Reference Books:

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

PETROLEUM TESTING LAB
[AS PER CHOICE BASED CREDIT SYSTEM (CBCS) SCHEME]
SEMESTER-III

Laboratory Code	**: 17PCL77**	**IA Marks**	**: 40**
No. of Lecture Hours/Week	**1 Hr. Tutorial(Instructions) + 2 hours Laboratory**	**Exam Marks**	**: 60**
		Exam Hours	**: 03**

CREDITS- 02

Course Objectives:

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

Laboratory Experiments: **Minimum of 10 experiments are to be conducted**	**Revised Bloom's Taxonomy (RBT) Level**
26. Testing of petroleum and its analysis	
27. 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	
12. Determination of melting point and drop melting point of wax	
13. Determination of cloud point and pour point	
14. Carbon residue test	
15. 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	

Course Outcomes:

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

Graduate Attributes (as per NBA)

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

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:

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

PROJECT PHASE 1 + SEMINAR

Subject Code	:	17PCP78	**IA Marks**	:	100
CREDITS	:	**02**	**Contact Hours/week**	:	1 I + 2 P

The students in a group will be assigned an experimental, design, a case study or an analytical problem, to be carried out under the supervision of a guide. The project has to be assigned at the beginning of the seventh semester. The project group should complete the preliminary literature survey & plan of project and submit the synopsis at the end of seventh semester. The project work should be carried out and completed at the end of eighth semester.

The students are required to give the comprehensive presentation in the form of seminar on the project work. The seminar shall be evaluated as internal assessment. While evaluating, emphasis shall be given on the presentation and communication skills.

SEMESTER VIII

TRANSPORT PHENOMENA [D. C.](Common to CH & PC)					
Subject Code	:	17CH81	**IA Marks**	:	40
No. of Lecture Hrs/Week	:	04	**Exam Hours**	:	03
Total No. of Lecture Hours	:	50	**Exam Marks**	:	60
Credits	:	04			

Course Objectives:

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

Revised Bloom's Taxonomy Levels: L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

Modules	Teaching Hours	Blooms Taxonomy
Module 1 **Content**		
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. Numerical problems on the application and use of NLV, FLHC and FLD	10	L-1, L-2
Module 2 **Content**		
Velocity Distribution in Laminar Flow: Different Flow situations, Steady state Shell momentum balances, Boundaryconditions 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.	10	L-1, L-2, L-3
Module 3 **Content**		
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.	10	L-1, L-2, L-3

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	**Content**	
Concentration Distributions in Laminar Flow: Diffusion through stagnant gas and liquid films, Diffusion with homogeneous reaction, Diffusion with heterogeneousreaction Diffusion into falling film – Forced convection mass transfer.	10	L-1, L-2, L-3
Module 5	**Content**	
Analogies between Momentum, Heat and Mass Transport: 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.	10	L-1, L-2

Course outcomes: Students after completion of course will be able to

6. Explain types of fluids,comprehend effect of temperature and pressure on transport properties of fluids and apply transport laws to solve numerical.
7. Derive overall heat transfer coefficient, Temperature distribution with and without energy sources
8. Determine velocity profile and shear stress profiles in different flow situations
9. Derive molar flux for stagnant gas, liquid films, homogeneous and heterogeneous reactions and applications to falling film forced convection mass transfer
10. 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.

Graduate Attributes

3. Critical Thinking
4. Problem solving
5. Use of modern tools
6. 4 Life - long Learning

TEXT BOOKS:

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

REFERENCE BOOKS:

4. **Momentum Heat and Mass Transport,** Welty, Wikes and Watson, 4th Edn., John Wiley, 2000.
5. **Principles of Unit Operations in Chemical engineering,** Foust et al, 2nd Edition, John

Wiley, 1990.
3. **Transport Phenomena – A Unified Approach,** Robert S. Brodley and Henry C. Hershley,
Vol.2, Brodkey Publishing, 2003.

PETROLEUM CORROSION TECHNOLOGY [DC]			
Subject Code	**: 17PC82**	**IA Marks**	**: 40**
No. of Lecture Hours/Week	**: 04**	**Exam Marks**	**: 60**
Total No. of Lecture Hours	**: 50**	**Exam Hours**	**: 03**

CREDITS- 04

Course 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.

Modules	**Teaching Hours**	**Revised Bloom's Taxonomy (RBT) Level**
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.	10	L1, L2
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.	10	L1, L2
Module-3		
Casing and Pipeline Corrosion – Introduction, Types of Casing, Corrosion of Steel, Protection of Casing	10	L1, L2

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.	10	L1, L2
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 holeequipments.	10	L1, L2

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

Graduate Attributes (as per NBA)

- Engineering Knowledge
- Problem Analysis
- Design/development of solutions (Partly)
- Interpretation of data.

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:

3. "Corrosion control in Petroleum production"-TPC 5-2-nd edition H.G.Byars Houston, Texas, 1995.

4. Chemical engineering series, Coulson and Richardson, McGraw Hill Publications.

Reference Books:

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

PROFESSIONAL ELECTIVE-V: 17PC83X

RISK ASSESSMENT AND SAFETY ENGINEERING			
Subject Code	**: 17PC831**	**IA Marks**	**: 40**
No. of Lecture Hours/Week	**: 03**	**Exam Marks**	**: 60**
Total No. of Lecture Hours	**: 40**	**Exam Hours**	**: 03**

CREDITS- 03

Course 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

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module-1		
Concepts of safety – Hazard classification chemical , physical, mechanical, ergonomics, biological and noise hazards – Hazards from utilities like air, wa ter, 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.	8	L1, L2, L3
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.	8	L2, L3, L4
Module-3		
Introduction to Consequence Analysis - Fire and Explosion models: Radiation - Tank on fire - Flame length –Risk analysis- Radiation intensity calculat ion 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.	8	L2, L3, L4
Module-4		
Safety in plant design and layout – Safety provisio ns in the factory act 1948 – Indian explosive act 1884 - ESI act 1948 – Advantages of adopting safety laws.	8	L3, L4, L5

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 – Onsite and offsite emergency planning – Risk management – Gas processing complex, refinery – First aids.	8 L1, L2, L3	Emergency planning –
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.		
Graduate Attributes (as per NBA) • Engineering Knowledge • Problem Analysis • Design/development of solutions (Partly) • Interpretation of data.		
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: 15. Blake, R.P., "Industrial Safety", Prentice Hall, 1953. 16. Lees, F.P., "Loss Prevention in Process Industri es", 2nd Edition, Butterworth Heinemann, 1996. 17.K. V. Raghavan and AA. Khan, "Methodologies in H azard Identification and Risk Assessment", Manual by CLRI, 1990. 18.V. C. Marshal, "Major Chemical Hazards", Ellis H orwood Ltd., Chichester, United Kingdom. 1987.		
Reference Books: 10. Geoff Wells, "Hazard Identification and Risk Ass essment", I.ChE.,John Ridley and John Channing, "Safety at Work", 6th Edition. Butterwort h-Heinemann, 2003. 11. "A Guide to Hazard Operability Studies", Chemica l Industry Safety and Health Council, 1977.		

PHARMACEUTICAL TECHNOLOGY			
Subject Code	**: 17PC832**	**IA Marks**	**: 40**
No. of Lecture Hours/Week	**: 03**	**Exam Marks**	**: 60**
Total No. of Lecture Hours	**: 40**	**Exam Hours**	**: 03**

CREDITS- 03

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

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
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.	8	L1, L2
Module-2		
Pharmaceutical Dosage Form and Design – Preformulation, Bio-pharmaceutics, Statistical Application in the pharmaceutical science.	8	L2, L3
Module-3		
Pharmaceutical Dosage Forms – Tablets, Tablet coating, Capsules, Sustained release dosage forms, Liquids.	8	L2, L3
Module-4		
Pharmaceutical Dosage Forms – Pharmaceutical suspensions, Emulsions, Semisolids, Suppositories, Pharmaceutical aerosols, Sterilization, Sterile products.	8	L3, L4
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.	8	L4, L5

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

Graduate Attributes (as per NBA)

- Engineering Knowledge
- Problem Analysis
- Design/development of solutions (Partly)
- Interpretation of data.

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.

PETROLEUM ECONOMICS			
Subject Code	**: 17PC833**	**IA Marks**	**: 40**
No. of Lecture Hours/Week	**: 03**	**Exam Marks**	**: 60**
Total No. of Lecture Hours	**: 40**	**Exam Hours**	**: 03**

CREDITS- 03

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

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module-1		
Supply and demand curves, the elasticity of supply and demand, public finance concepts suchas consumer surplus, excise and export taxes. Forecasting techniques for the energy industry,including energy prices. Demand and supply for natural gas, cured oil and pipelinetransportation, determinants of energy demand, energy markets, energy pricing, stability and performance of energy markets.	8	L1, L2
Module-2		
The economics of investment, Discounted cash flow analysis, Cost Benefit Analyses, InternalRate of Return, NPV, Profitability Index, Natural Monopoly theory, National competition Policy,Gas Market Regulation, taxation of the oil and gas industry, government policy and tradepermits, Monte Carlo analysis, Net Back Pricing, Transfer Pricing and regulatory aspects.	8	L2, L4
Module-3		
Application of petroleum engineering principles and economics to the evaluation of oil and gasprojects, evaluation principles, time value of money concepts, investment measures, costestimation, price and production forecasting, risk and uncertainty, project selection and capitalbudgeting inflation, escalation, operating costs, depreciation, cost recovery**.**	8	L4, L5
Module-4		
Petroleum exploration and production contracts. Sharing of the economic rent, portfoliomanagement. Value creation, Corporate finance & return on capital, economic appraisalmethods for oil filed development, reservoir model costs and calculations.	8	L3, L5
Module-5		
Case studies: Economic study of an oil filed	8	L4, L5

development project, petrochemical plant project,natural gas breakeven price, natural gas liquefaction cost, LGN transport cost, investmentprofitability study for a gas pipeline.		

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

Graduate Attributes (as per NBA)

- Engineering Knowledge
- Problem Analysis
- Design/development of solutions (Partly)
- Interpretation of data.

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 E dition. Vikas Publishing House Private Ltd.
3. Standard Handbook of Petroleum and Natural Gas Engineering. 2nd Edition. William C Lyons, Gary, C Plisga. Gulf Professional Publishing.

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.

PILOT PLANT AND SCALE UP METHODS			
Subject Code	**: 17PC834**	**IA Marks**	**: 40**
No. of Lecture Hours/Week	**: 03**	**Exam Marks**	**: 60**
Total No. of Lecture Hours	**: 40**	**Exam Hours**	**: 03**

CREDITS- 03

Course Objectives: To understand the basic requirement and problem solving for pilot plant and scale up methods.

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
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.	8	L1, L2
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.	8	L2, L4
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.	8	L3, L5
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.	8	L4, L6
Module-5		
Stage wise mass transfer processes. Continuous mass transfer processes. Scale up of momentum and heat transfer systems. Environmental challenges of scale up.	8	L3, L5

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

Graduate Attributes (as per NBA)

- Engineering Knowledge
- Problem Analysis

- Design/development of solutions (Partly)

1. Interpretation of data.

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. **Scale up of Chemical Processes** ,AttilioBisio, 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.

INTERNSHIP / PROFESSIONAL PRACTICE					
Subject Code	:	17PC84	**IA Marks**	:	50
			Exam Hours	:	03
			Exam Marks	:	50
Credits	:	02			

The students should undergo in-plant training in any chemical/petroleum industry or in a reputed research laboratory with pilot plant facility. This shall be for a minimum period of two weeks during the vacation of sixth or seventh semester. If it is not possible, the students may be permitted to go on industrial visit for a period of two weeks and they should visit a minimum of five major chemical industries. Each student should submit a report separately, at the beginning of the eighth semester, which is evaluated by a committee constituted by the HOD for internal assessment.

An external examiner has to be called for viva voce and internal guide together with external examiner should evaluate the performance as examination. The student has to give a presentation on in-plant training or industrial visit to the External and internal examiners and answer for queries.

PROJECT WORK PHASE -II					
Subject Code	:	17PC85	**IA Marks**	:	100
No. of Lecture Hrs/Week	:	06	**Exam Hours**	:	03
			Exam Marks	:	100
Credits	:	06			

Course Objectives:

Students will

1. Learn to plan and perform experiments related to project work.
2. Learn to compile data and analyze.
3. Learn to publish data in reputed journals.
4. Learn to prepare report of work.

Student has to complete project work, submit thesis (Corrected from guide) to the Head of the department through the guide and give presentation on the complete project work at the end of VIII Semester which should be evaluated for IA Marks by the departmental committee.

An external examiner has to be called for viva voce and internal guide together with external examiner should evaluate the performance as examination. The student has to give a presentation on project work to the External and internal examiners and answer for queries.

Course outcomes:

After studying this course, students will be able to:

1. Perform experiments, obtain results, analyze the results and publish in reputed journals.
2. Complete project thesis as per the standard format by consulting the guides.

Graduate Attributes:

1. Research Skill.
2. Use of Modern Skills.
3. Project Management and Finance.
4. Independent and reflective thinking.

SEMINAR					
Subject Code	:	17PC86	**IA Marks**	:	100
No. of Lecture Hrs/Week	:	04			
Credits	:	01			

Course Objectives:
Students will

1. Develop skills in searching technical literature, analyzingand evaluating it to compare the various approaches and prepare a written report and also presenting it orally.

The student has to prepare, submit a seminar report and make a presentation on Seminar topicallotted. The seminar shall be evaluated as internal assessment by a committee constituted bythe HOD.

Course outcomes:

After studying this course, students will be able to:

1. Prepare reports and compile data.
2. Prepare presentation and communicate findings to audience.

Graduate Attributes

1. Critical Thinking
2. Usages of Modern Tools
3. Collaborative and Multidisciplinary Work
4. Life Long Learning