SAVITRIBAI PHULE PUNE UNIVERSITY

STRUCTURE AND SYLLABUS

OF

B.E. (PETROCHEMICALENGINEERING)

(COURSE–2012)

(w.e.f. Academic Year 2015-16)

SAVITRIBAI PHULE UNIVERSITY OF PUNE

Structure and Syllabus of B.E. (Petrochemical Engineering) - (2012 Course)
(w.e.f. Academic Year 2015-16)

SEMESTER-I

Subject Code	Subject	Teaching Scheme Hrs/Week			Examination Scheme					Marks Total
		Lect	Tut.	Pr.	In-Semester Assessment	TW	OR	PR	End Semester Exam	
412401	Reaction Engineering-II	3	--	--	30	--	--		70	**100**
412402	Process Dynamics and Control	3	--	2	30	--	--	50	70	**150**
412403	Refinery Process Design	4	--	2	30	--	--	50	70	**150**
412404	Elective-I	3	--	2	30	--	50		70	**150**
412405	Elective-II	3	--	--	30	--	--		70	**100**
412406	Professional Ethics	--	--	2	--	50			--	**50**
412407	Project Phase-I	--	2	--	--	50	--		--	**50**
	Total →	**16**	**02**	**08**	**150**	**100**	**50**	**100**	**350**	**750**

SEMESTER-II

Subject Code	Subject	Teaching Scheme Hrs/Week			Examination Scheme					Marks Total
		Lect	Tut.	Pr.	In-Semester Assessment	TW	OR	PR	End Semester Exam	
412408	Environmental Engineering	3	--	2	30	--	--	50	70	**150**
412409	Plant Design and Economics	3	--	2	30	--	50		70	**150**
412410	Elective-III	3	--	2	30	--	50		70	**150**
412411	Elective-IV	3	--	--	30	--	--		70	**100**
412412	Petrochemical Engineering Practice	--	--	2	--	50	--		--	**50**
412407	Project Work	**-**	**6**	**--**	**--**	**50**	**100**		--	**150**
	Total →	**12**	**06**	**08**	**120**	**100**	**200**	**50**	**280**	**750**

Lect: Lectures / week, **Pr**: Practical / week, **Tut**: Tutorial, **TW:** Term Work, **OR**: Oral, **PR:** Practical

LIST OF ELECTIVES

Semester I, Elective – I, 412404

412404 A	Novel Separation Processes
412404 B	Fluidization Engineering
412404 C	Green Technology
412304 D	Flow Assurance

Semester I, Elective – II, 412405

412405 A	Bioprocess Engineering
412405 B	Piping Engineering
412405 C	Natural Gas Engineering
412405 D	Colloidal and Interface Science

Semester II, Elective – III, 412410

412410 A	Process Modeling and Simulation
412410 B	Energy Engineering
412410 C	Process Development for Fine Chemicals
412410 D	Polymer Reaction Engineering

Semester II, Elective – IV, 412411

412411 A	Petroleum Engineering
412411 B	Catalysis Technology
412411 C	Project Finance and Management
412411 D	Open Elective *

Open Elective

1. Financial Engineering
2. Computational Fluid Dynamics
3. Entrepreneurship
4. Artificial Intelligence

* The students can opt for any elective subject of the same semester which is not offered or taken before. The elective subject may be related to the program or may be offered by any program under Faculty of Engineering, Savitribai Phule Pune University. An elective proposed by an industry may alsobe offered to students with the permission of Board of Studies and Faculty of Engineering. The procedure related to same has to be completed by before 30th November for smooth functioning of elective.

B.E. (Petrochemical Engineering) - 2012 Course, Semester-I

REACTION ENGINEERING-II [412401]

Code	Subject	Teaching Scheme (Weekly Load in hrs)			Examination Scheme (Marks)					
		Lect.	Tut	Pract.	Theory		TW	PR	OR	Total
					In Sem.	End Sem.				
412401	**Reaction Engineering-II**	3	-	--	30	70	-	--	--	**100**

COURSE OBJECTIVES

1. To study the real reactors considering RTD in various reactors and obtain actual design parameters
2. To learn catalytic phenomena with extensions to reactor design and catalyst characterization.
3. To get acquainted with the principles used in design of multiphase reactor.

COURSE OUTCOMES:

By the end of the course students should be able to

1. account for deviations from ideal mixing behaviour
2. identify critical parameters affecting the design and performance of catalytic reactors
3. formulate the kinetics of fluid-solid non-catalytic reactions
4. design equipment for handling fluid-fluid reactions
5. characterize a given catalyst and formulate its deactivation kinetics
6. do preliminary calculations involved in scale-up of a reactor

Unit – I Non-Ideal Flow and Mixing of Fluids (06 hrs)

Review of basic concepts, Analysis of RTD from pulse input and step input, Models for predicting conversion from RTD data, Segregation and maximum mixedness model, One parameter: Dispersion model, Tank in series model, Early and late mixing of fluid, mixing of two miscible fluids.

Unit – II Heterogeneous and Solid Catalysed Rections (06 hrs)

Global rate of reaction, Complications of the rate equation and the contacting patterns for multiphase contact, Rate equation for surface kinetics, ore diffusion, Pore diffusion resistance combined with surface kinetics, Model of a single cylindrical pore, Effectiveness factor, Performance equations for reactions containing porous catalyst particles, Experimental methods for finding rates.

Unit – III Fluid-Particle Reactions (Non-catalytic Reactions) (06 hrs)

Selection of a model for gas-solid reactions Un-reacted core and Shrinking core model, Rate controlling resistances, Determination of the rate controlling steps, Application to fluidized bed design.

Unit – IV Fluid –Fluid Reactions: ***(06 hrs)***

Industrial examples of absorption with reaction, liquid-liquid reactions, Rate equations for straight mass transfer and mass transfer accompanied with reaction (all important regimes), Slurry reaction kinetics, Equipment used in fluid- fluid contacting with reaction, Application of fluid -fluid reaction rate equation to equipment design, Tower design for fast and slow reactions.

Unit – V Catalysis Fundamentals and Deactivating Catalysts: ***(06 hrs)***

Catalysis, Nature of catalytic reactions, adsorption isotherm, Rates of adsorption, Classification of catalysts, Catalyst preparation, Promoters and inhibitors, Use of catalysts in refining and petrochemical industry.

Types of deactivation, Mechanism of deactivation, Rate equation for deactivation, Regeneration of catalyst.

Unit – VI Scale-Up in Reactor Design: ***(06 hrs)***

Challenges in scaling up of reactors, Similarity criteria , Scale-up in relation to various factors, Dimensional analysis and Scale-up equations, Scale-up of a reactor.

Text Books:

1) Levenspiel O., “Chemical Reaction Engineering”, Third Edition, John Wiley and Sons, 2003.
2) Scott Fogler H., “Elements of Chemical Reaction Engineering”, Prentice-Hall of India, 1997.

Reference Books:

1) Smith J. M., “Chemical Engineering Kinetics”, McGraw-Hill, 1981.
2) Sharma M. M. and L. K. Doraiswamy, “Heterogeneous Reactions – Vol. I and II”, John Wiley and Sons, 1984.
3) Carberry J.J., “Chemical and Catalytic reaction Engineering”, McGraw-Hill, New York, 2001
4) E. Bruce Nauman , “Chemical Reactor Design, Optimization, and Scale up”, Second Edition, Wiley Publishers, 2008
5) Donati, G., Paludetto, R., “Scale-up of Chemical reactors”. *Catalysis Today,* **34**(1997), 483-533

B.E. (Petrochemical Engineering) - 2012 Course, Semester-I

PROCESS DYNAMICS AND CONTROL [412402]

Code	Subject	Teaching Scheme (Weekly Load in hrs)			Examination Scheme (Marks)					
		Lect.	Tut	Pract.	Theory		TW	PR	OR	Total
					In Sem.	End Sem.				
412402	**Process Dynamics and Control**	3	2	--	30	70	-	50	--	**150**

COURSE OBJECTIVES:

1. To understand the importance of system dynamics and feedback control
2. To be able to design a control system to meet desired objectives
3. To be able to perform model-based design and tuning of controllers
4. To understand Advanced Process Control systems

COURSE OUTCOMES:

By the end of the course students should be able to

1. model a process system from control objective
2. design a control strategy
3. learn advance and multi variable process control
4. analyse the system stability
5. get familiar with digital process control

Unit – I Introduction to Process Control (06 hrs)

Introduction to Process control and Process dynamics, Process control hardware, P&ID Diagram, codes and symbols, Review of Laplace Transform, Forcing functions, Partial fraction expansions, concept of poles and zeros

Development of Process control models for First, second and higher order systems, interacting and Non-interacting systems, Transfer Functions, dynamic behaviour of pure gain, pure capacitive, first-order, second-order systems, dead- time systems, Degrees of freedom analysis, linearization of nonlinear ODEs

Unit – II Design of Feedback Control Systems (06 hrs)

Review of Feedback control system, its components and basic block diagram, Development and Reduction of Block diagram for a chemical process system, Closed loop transfer functions, overall transfer function for single and multiloop systems, Transient response for servo and regulatory problems, Basic control modes PI – PD – PID – Integral wind- up and prevention- Auto/Manual transfer, Selection of control modes for processes involving temperature -pressure- level and flow.

Unit – III Advance and Multivariable Process Control (06 hrs)

Process control for large time-delay systems, inverse response systems, cascade, selective, split range control, feed forward, ratio, adaptive and inferential control systems, Introduction to multivariable systems, transfer function and state-space models, poles and zeros of multivariable systems, multiple single- loop controllers for multivariable systems

Unit – IV Part A : Industrial Process Control and Process Safety
Part B : Stability Analysis ***(06 hrs)***

Part A : Design of basic regulatory control schemes such as Distillation, Heat Exchanger, Batch and Continuous Reactor, Flash Drum, Boilers, Fluid flow operations, pumps, compressors. Introduction to Process Safety, International Standards, SIS, ISS, Critical control system, Safety shutdown system, Equipment protection system, Interlock, Alarms

Part B: Concept of stability, Stability criterion, Routh- Hurwitz test for stability, Concept of root locus, Plotting root locus diagrams.

Unit – V Part A : Frequency Analysis
Part B : Controller Tuning Methods ***(06 hrs)***

Part A : The Bode stability criterion. Bode diagrams for various Gain and Phase margins, Nyquist stability criterion.

Part B : Controller tuning Methods: Evaluation criteria - IAE, ISE, ITAE. Process reaction curve method,-Ziegler –Nichol's tuning- damped oscillation method- Closed loop response of I & II order systems with and without valve –measuring element dynamics

Unit – VI Part A: Introduction to Plant wide process control
Part B: Digital Process Control ***(06 hrs)***

Part A : Procedures for the Design of Plant wide Control Systems, Systematic Procedure for Plant wide Control System Design, Plant Wide Control Case Study

Part B: Introduction to Z-transforms, Sampling of continuous signals, State-of-the-art technologies in industrial automation such as DCS, PLC, SCADA, Field bus technology

Term-Work

Term work shall consist conduct of minimum of *Any 3 practicals* in each of the following Parts *(Total 9 Practicals)*

Part A: Experiments based on Physical Process Control Systems

1. Study of P,PI,PID Control actions on Temperature, Pressure Feedback control systems
2. Study of Cascade control strategy for a Shell and Tube Heat Exchanger
3. Study of Ratio Control of flow system
4. Study of dynamic response of a Flow and Level control system
5. Controller Tuning Using Zeigler Nichol Tuning Rules on a Temperature control system
6. Study of PLC and SCADA systems for different applications such as Level control, AC motor drive, alarm systems etc

Part B: Experiments based on MATLAB, SIMULINK, ASPEN HYSYS /UniSim Design

1. Study of Transient Response of First Order, Second Order systems for standard Inputs using MATLAB
2. Study of P, PI, PID control actions for a process control system using MATLAB
3. Development of a Process Model and Study of control actions using SIMULINK
4. Development of a Dynamic Process Simulation Model Using ASPEN HYSYS/ UniSim Design for a Distillation Column/Heat Exchanger/Flash Drum, Pump etc process control
5. Development of a Plant Wide Process Control Model using ASPEN HYSYS/ UniSim Design

Part C: Exercises based on P&ID Diagram, PLC Ladder Diagram Constructions

1. Standards, Codes and Symbols of a P & ID diagram
2. P & ID reading exercise for a Manufacturing process plant
3. Drawing of a P & ID Diagram
4. Construction of a PLC Ladder Diagram for any application its and successful Demonstration on PLC trainer

Text Books

1. Donald K. Coughanowr; "Process System Analysis and Control"; McGraw Hill, Third Edition, New York, 2001
2. Seborg D. E., T. F. Edgar, D. A. Mellichamp; "Process Dynamics and Control"; Second Edition, John Wiley and Sons, New York, 2004.
3. Stephanopoulos G.; "Chemical Process Control: Introduction to Theory and Practice"; Prentice-Hall of India, 1995.

Reference Books

1. Bella G Liptak, ,Instrument Engineers' Handbook (Process Measurement), Third Edition, Elsevier, 2005
2. Bella G , Liptak, Instrument Engineers' Handbook (Process Control), Third Edition, Elsevier, 2005
3. Thomas E. Marlin; "Process Control: Designing Processes and Control Systems for Dynamic Performance", Second Edition, McGraw-Hill, New York, 2000.
4. Ogunnaike B. A., W. H. Ray; "Process Dynamics, Modeling and Control", Oxford University Press, 1994.

REFINERY PROCESS DESIGN [412403]

Code	Subject	Teaching Scheme (Weekly Load in hrs)			Examination Scheme (Marks)					
		Lect.	Tut	Pract.	Theory		TW	PR	OR	Total
					In Sem.	End Sem.				
412403	**Refinery Process Design**	4	-	2	30	70	-	50	--	**150**

COURSE OBJECTIVES

1. To familiarize the student with process design of distillation columns involving multicomponent and complex mixtures encountered in Petrochemical industry
2. To introduce methodologies practiced in rating and designing heat transfer equipment used in refining and process industry
3. To equip the student for tasks in Petrochemical manufacturing and design sector

COURSE OUTCOMES

By the end of the course students should be able to

1. Handle multicomponent and complex mixtures VLE and use it in process design of distillation column and any phase change equipment
2. Do design and rating of a shell and tube heat exchanger for a refinery duty.
3. Carry out preliminary design calculations related to furnace heaters used in refinery
4. Approach operational problems in Petrochemcal distillation in an informed manner

Unit – I : Multicomponent Distillation (06 hrs)

Dew point and bubble point for multicomponent hydrocarbon mixtures, Design of multicomponent distillation Column using short cut methods, Plate-to-plate calculations, Introduction to rigorous solution procedures.

Unit – II : Petroleum Refinery Distillation-I (06 hrs)

TBP, EFV, ASTM distillation curves and their relevance, CDU and VDU products and processes. Over flash, furnace heater, side strippers, and types of refluxes, Vacuum devices, Material balance and flash zone calculations, Overall energy requirements and energy conservation strategies.

Unit – III : Petroleum Refinery Distillation-II (06 hrs)

Pump around and pump back calculations, Estimation of number of equilibrium stages, Design using Packie charts and Watkins method, Introduction to rigorous solution procedure based on pseudo components.

Unit – IV : Column Operation and Trouble-shooting **_(06 hrs)_**

Flooding behaviours, Ways to avoid flooding and weeping, Types of Trays .Structured packings, Pressure drops. Sensing tray, A typical P&ID for a distillation column, Case studies in troubleshooting.

Unit – V : Heat Exchanger Design **_(06 hrs)_**

Kern's method, Bell's method, Heat transfer coefficients in condensation and boiling, Considerations involved in design of reboilers and condensers, air-cooled exchangers. Introduction to TEMA codes, Basic introduction to Pinch Technology.

Unit – VI : Furnace Heater Design **_(06 hrs)_**

Heat load calculations for furnace heaters, Typical heat flux values, Basic constructional features, Different furnace types, Review of factors to be considered in the design of fired heaters, Introduction to manual calculations methods such as Hottel's method.

Text Books:

1. Watkins, "Petroleum Refinery Distillation", McGraw Hill, 1993
2. Sinnott R. K., "Coulson and Richardson's Chemical Engineering", Vol. 6, Third Edition, Butter Worth-Heinemann, 1999.
3. Kern D. Q., "Process Heat Transfer", McGraw Hill, 1965.
4. Cao Eduardo, "Heat Transfer in Process Engineering", McGraw Hill,2010

Reference Books:

1. Kayode Coker, "Ludwig's Applied Process Design for Chemical and Petrochemical Plants", Fourth Ed, Elsevier, 2007
2. Van Winkle M., "Distillation", McGraw Hill, 1967

Term Work:

Every student should carry out minimum *eight* experiments from the following list and submit the journal, which will form the term work.

List of Practicals:

1. Design calculations for multicomponent distillation column using rigorous procedure
2. Design calculations for a refinery distillation column using rigorous procedure
3. Simulation of multicomponent distillation column using a commercial process simulator such as Aspen Plus.
4. Simulation of multicomponent absorption column using a commercial process simulator such as Aspen Plus.
5. Simulation of Petroleum Refinery Distillation using a commercial process simulator such as Aspen Plus.
6. Detailed process design of a shell and tube heat exchanger for a given duty using TEMA codes.
7. Detailed process design of a shell and tube heat exchanger for a given duty using HTRI software.

8. Performance analysis of a shell and tube heat exchanger.

9. Design calculations for a refinery furnace heater using an empirical method.
10. Heat exchanger network synthesis for a refining unit using a commercial simulator such as Aspen Plus.

Reference Books:

1. Van Winkle M., "Distillation", McGraw Hill, 1967.
2. Watkins, "Petroleum Refinery Distillation", McGraw Hill, 1993
3. Treybal, "Mass Transfer Operations", McGraw Hill,
4. Sinnott R. K., "Coulson and Richardson's Chemical engineering", Vol. 6, Third Edition, Butter Worth-Heinemann, 1999.
5. Kern D. Q., "Process Heat Transfer", McGraw Hill, 1965.
6. Maddox Hines, "Principles of Mass Transfer Operations", McGraw Hill, 1993

B.E. (Petrochemical Engineering) - 2012 Course, Semester-I

Elective-I

NOVEL SEPARATION PROCESSES [412404-A]

Code	Subject	Teaching Scheme (Weekly Load in hrs)			Examination Scheme (Marks)					
		Lect.	Tut	Pract.	Theory		TW	PR	OR	Total
					In Sem.	End Sem.				
412404 A	**Novel Separation Processes**	3	-	2	30	70	-	-	50	**150**

COURSE OBJECTIVES

1. To provide an understanding of the general principles of separation processes to allow students to make sensible options given a separation task.
2. To identify the multiple factors influencing the choice of separation techniques.
3. To be able to qualitatively and quantitatively address the fundamental aspects of novel separation processes.
4. To learn conceptual design of separation processes and design of equipment involved.

COURSE OUTCOMES:

By the end of the course students should be able to

1. understand various chemical engineering separation processes
2. select appropriate separation technique for intended problem
3. ability to formulate and solve engineering problems involving design of membranes and membrane modules for gas separation, reverse osmosis, filtration, dialysis.
4. analyze the separation system for multi-component mixtures
5. design separation system for the effective solution of intended problem
6. understand modern separation technique in various applications in industry

Unit I: Overview of Separation Processes and their Selection (06 hrs)

Characteristics and selection of separation process: Importance and variety of separation, economic significance, characteristics, inherent separation factor, factors influencing the choice of separation process, solvent selection, selection of equipment. Recent advances in separation techniques based on size, surface properties, ionic properties and other special characteristics of substances, Rate based versus equilibrium separation processes, Energy requirements of separation processes.

Unit II: Surfactant Based Separation Techniques (06 hrs)

Basic principles, classifications, Surfactants at inter phases and in bulk, Foam fractionation, Foam flotation, Adsorptive bubble separations, Ion flotation, Microemulsion/Macroemulsions, Hydrotopes, Solvent ablation.

Unit III: Membrane Separations Processes **_(06 hrs)_**

Introduction, Type and choice of membranes, Plate and frame, tubular, spiral wound and hollow fiber membrane reactors and their relative merits, Membrane filtration, Microfiltration, Ultrafiltration, Reverse Osmosis, Dialysis, Models for membrane separations, Design and economics of membrane separation processes.

Unit IV: Separation by Adsorption Techniques **_(06 hrs)_**

Mechanism, Types and choice of adsorbents, Heat effects, Equilibrium relations for adsorbent, Adsorption isotherm theory and types, Normal adsorption techniques, Commercial methods for adsorption separations, Types of equipment and processes, Design of fixed-bed adsorption columns, Recent advances, Process design and economics.

Unit V: Ionic Separations **_(06 hrs)_**

Mechanism, Ion exchange resins, Capacity, Equilibrium and kinetics, Ion exchange equipment-Design and operation, Principles of electrophoresis, ion exchange chromatography and electrodialysis, Two phase partitioning, Reserve micelle extraction, Isoelectric Focusing.

Unit VI: Recent Advanced Separation Processes **_(06 hrs)_**

Separations involving Lyophilization, Pervaporation and permeation techniques for solids, liquids and gases, Addluctive crystallization, Super critical fluid extraction, Bio-filtration, Reactive separations, Bioseparations, Parametric pumping, Cryogenic Separation, Zone melting.

Term Work:

Every student should carry out minimum *eight* experiments from the following list and submit the journal, which will form the term work.

List of Practicals:

1. Oxygen separation from air using a membrane laboratory unit.
2. Water softening using a laboratory scale reverse osmosis unit.
3. Reverse osmosis of saline solution
4. Separation of multicomponent mixture by batch and continuous reactive distillation
5. Separation of chemicals using ultra-filtration.
6. Ultrafiltration of some dilute solutions
7. Microfiltration of raw material.
8. Water softening or deionization by ion exchange.
9. Clean up of a gas stream by activated carbon adsorption.
10. Design of a gas separation experiment using pressure swing adsorption
11. Design of an experiment for separation of trace organics (or dewatering of an organic) using Pervaporation.
12. Lab. Experiment on ion exchange column
13. Lab. Experiment on Electrodialysis.
14. Lab. Experiment on Gas Chromatography.

Text books:

1. Geankoplis C.J., "Transport Processes and Separation Process Principles", Fourth Edition, Prentice-Hall of India, 2003
2. Ronald W. Roussel, "Handbook of Separation Process Technology", John Wiley, New York, 1987.
3. King, C.J. "Separation Processes", Tata McGraw–Hill Publishing Co. Ltd., 1982.

Reference Books:

1. Lacey, R.E. and S. Looeb, "Industrial Processing with Membranes", Wiley – Inter Science, New York, 1972.
2. Richardson and Coulson; "Chemical Engineering"; Volume-II, Pergamon Press, 1993
3. Philip Schweitzer; "Handbook of Separation Techniques for Chemical Engineers", Third Edition, Tata McGraw Hill New York, 1997.

B.E. (Petrochemical Engineering) - 2012 Course, Semester-I

ELECTIVE-I
FLUIDIZATION ENGINEERING [412404 B]

Code	Subject	Teaching Scheme (Weekly Load in hrs)			Examination Scheme (Marks)					
		Lect.	Tut	Pract.	Theory		TW	PR	OR	Total
					In Sem.	End Sem.				
412404B	Fluidization Engineering	3	-	2	30	70	-	--	50	**150**

COURSE OBJECTIVES

1. To understand the concepts of fluidization and use it for betterment of petrochemical processes.
2. To develop idea of important models and semi-empirical relations of fluidization and their usage.
3. To get acquainted with industrial applications of fluidization and the challenges involved.

COURSE OUTCOMES:

By the end of the course students should be able to

1. understand the fluidization process and its importance.
2. understand of different modes of fluidization and classification of powders.
3. know different distributor and the associated design calculations.
4. understand of fluidized bed hydrodynamics.
5. learn broad overview of heat and mass transfer in fluidized bed operation.
6. Know fluidization applications in different industrial processes and the scale-up issues.

Unit – I : Flow through Fixed Bed and Fluidized Bed (06 hrs)

Fixed Bed Bulk Voidage, Flow through Packed Bed, Blakes Correlation, Carman and Kozeny Correlations, Ergun Correlation, Gas Velocity Distribution in packed beds, Fluidized State, Advantage and Disadvantage of Fluidization, Superficial Velocity
.

Unit – II : Modes of Fluidization and Classification of Particles (06 hrs)

Various Modes of Fluidization, Incipient Fluidization, Bubbling Fluidization, Slug Bed, Geldarts Classification of Powders, Bed Collapsing, Theoretical and Empirical Prediction of Fluidization Velocity, Terminal Velocity, Quality of Fluidization.

Unit – III : Distributor and Pleanum Design in Fluidized Bed (06 hrs)

Various types of distributors, their working principles and relative advantages and disadvantages, Grid Design Criteria, Jet Penetration, Design of perforated plates for fluidized bed, Particle attrition at grid, Erosion, Power Consumption.

Unit – IV : Hydrodynamics of Fluidized Bed ***(06 hrs)***

General bed behavior pressure drop, Flow regimes, pressure fluctuations, phase holdups, Single rising bubble, Davidson Model, Coalescence and spitting of bubbles, Bubble size and bubble growth, Clouded bubble and cloudless bubbles. Freeboard region, Pressure and Temperature Effects, Agglomeration.

Unit – V : Heat and Mass Transfer in Fluidized Bed ***(06 hrs)***

Dense bubbling fluidized bed, Heat transfer between particle and gas, Ranz Marshal Correlation, Bed – Surface Heat Transfer, Mass transfer between single sphere and surrounding gas, Transfer between fixed bed particles and flowing gas, Transfer between fluidized bed particles and fluidizing gas, Interchange coefficients.

Unit – VI: Industrial Operations ***(06 hrs)***

Multiphase Measuring Techniques, Temperature sensors, Heat Flux Probes, Optical Sensors, Modern Sensors, Data Processing and visualization.

Fluidized bed Dryer, Operation of Fluidized bed Boiler, Reactor Models for Fluidized bed, Two phase Models, Bubbling Bed Model, Kunii Levenspiel Model, Challenges in scaleup of fluidized bed, Means of fluidization for difficult to fluidize beds.

Term Work:

Every student should carry out minimum *eight* experiments from the following list and submit the journal, which will form the term work.

List of Practicals:

1. Experiments on fluidization regimes on Fluidized bed.
2. Determination of minimum fluidization velocity and pressure drop for fluidized bed.
3. Design of gas distributors for a fluidized bed.
4. Experimentation on Fluidized bed heat transfer.
5. Design of a fluidized bed dryer.
6. Development of mathematical models of a fluidized bed reactor.
7. Simulation of fluidized bed reactor using MATLAB
8. Calculation of residence time in a fluidized bed system.
9. Scale up strategies and challenges for Fluidized bed reactor
10. Simulation of Fluidized Bed in commercial mathematical software like ASPEN
11. Application of commercial CFD package on Fluidized bed Hydrodynamics

Text Books:

1. Kunii, D., Levenspiel, O. “Fluidization Engineering”, Second Edition, Butterworth
2. Heinemann, Newton ,1991
3. Geldart, D., Ed., “Gas Fluidization Technology”, John Wiley Sons, New York, 1986
4. Froment G. F. and Bischoff, K. B. “Chemical Reactor Analysis and Design”, 2nd Edition, John Wiley & Sons, New York, 1986

Reference Books:

1. Yates, J. G., “Fundamentals of Fluidized-Bed Chemical Processes”, Butterworths, London, 1983
2. Yang, W. C. Ed. “Handbook of Fluidization and Fluid Particle systems”, Marcel Dekker, New York, 1986

B.E. (Petrochemical Engineering) - 2012 Course, Semester-I
ELECTIVE-I
GREEN TECHNOLOGY [412410-C]

Code	Subject	Teaching Scheme (Weekly Load in hrs)			Examination Scheme (Marks)					
		Lect.	Tut	Pract.	Theory		TW	PR	OR	Total
					In Sem.	End Sem.				
412410 C	**Green Technology**	3	-	--	30	70	-	--	50	**150**

COURSE OBJECTIVES

1. To acquire a fundamental understanding of basic chemistry/technology principles within the framework of Green chemistry.
2. To get acquainted with the development of latest technologies and methodologies for environmentally benign processes currently practiced in various industrial sectors
3. To identify the tools of green technology and zero waste systems.
4. To understand environmental laws , carbon credit and life cycle assessment methods and tools
5. To acquire methods for pollution prevention and learn to design for environment

COURSE OUTCOMES:

By the end of the course students should be able to

1. understand environment laws, carbon credits, ISO 14000 series
2. explicate the importance of green technology in sustainable development.
3. applyappropriate technology to match a green engineering problem.
4. understand the issues and ethics of responsible, safe design
5. justify tools of green technology and life cycle assessment.
6. understand pollution prevention planning and environment friendly design

Unit – I Introduction to Green Technology *(06 hrs)*

Green chemistry and technology for sustainable development, Waste and its minimization, Green political movement, roles and responsibilities of chemical engineers, Twelve principles of green engineering, carbon credits, environmental management system standards- ISO 14000 series.

Unit – II Green Chemistry and Synthesis *(06 hrs)*

Green chemistry, Green chemistry methodologies, feedstocks, solvents, synthesis pathways, Functional group approaches to green chemistry,Waste treatment/recycle, Synthetic efficiency, Green chemistry metrics, individual reactions analysis, Atom economy, E-factor and reaction mass efficiency, material efficiency and synthetic elegance ranking, Quantitative/Optimization-based frameworks for the design of green chemical synthesis pathways,Green chemistry expert system, case studies.

Unit III Evaluation of Environnemental Performance During Process Synthesis (06 hrs)

Introduction, Tier-1Environmental performance tools: Economic and environmental criteria, Threshold Limit Values (TLVs), Permissible Exposure Limits (PELs), and Recommended Exposure Limits (RELs), Evaluatingalternative synthetic pathways, Tier-2Environmental performance tools:environmental release assessment, Release quantification methods, modeled release estimates, release characterization and documentation, Assessing environmental performance

Unit – IV Catalysis for Green Technology (06 hrs)

Role of catalysis, Catalysis and sustainable green chemistry, Heterogeneous catalysis, Solid acids, Solid base catalysis ,Templated silica, Polymer-supported reagents, Catalysis in novel reaction media, Homogeneous catalysis, Phase transfer catalysis, Biocatalysis, Photocatalysis, Process integration and cascade catalysis.

Unit – V Flow sheet Analysis For Pollution Prevention (06 hrs)

Pollution prevention planning, Structure of the pollution prevention process, Pollution prevention in material selection for unit operations, Pollution prevention for chemical reactors, separation devices, Storage tanks and fugitive sources,Integrating risk assessment with process design, Process energy integration, Process mass integration, Case study of process flow sheet.

Unit – VI Risk Hazard Minimization: (06 hrs)

Overview of risk assessment concepts, Hazard and Exposure assessment, Risk characterization, Design for degradation, Real-time analysis for pollution prevention, inherently safer design for accident prevention, Process safety and thermal hazards, Process control using real-time analysis. Process intensification,Life-Cycle Assessment

Term Work:

Every student should carry out minimum *eight* experiments/Assignments from the following list and submit the journal, which will form the term work.

List of Practicals:

1. Acetylation of primary Amine.
2. Base Catalysed Aldol condensation.
3. Synthesis of Biodiesel by transesterification reaction.
4. Radical coupling reaction.
5. Synthesis of Adipic acid by green oxidation reaction.
6. Preparation of Benzopinacol by green photochemical reaction.
7. Electrophilic aromatic substitution reaction by green approach to prepare p-Bromoacetanilide.
8. Coenzyme catalyst benzoin condensation.
9. Preparation of Benzillic acid by rearrangement with green approach.
10. Case study of Biomass utilization as green technology
11. Preparation of Benzopinacolone by rearrangement.
12. Bromination of Trans-stilbene by green technology.
13. To study Transesterification of dimethyl oxalate with phenol over TiO_2/SiO_2

Text Books:

1. Anastas, P.; Warner, J., “Green Chemistry: Theory and Practice”, Oxford University Press, London, 1998.
2. David Allen, D and Shonnard, D., “Green *engineering:* Environmentally conscious design of chemical processes”: Prentice-Hall, New Jersey, 2002
3. Albert S. Matlack, “Introduction to Green Chemistry” Marcel Dekker, Inc., New York, 2001.
4. Zimmerman, J.B.; Anastas, P.T. “The 12 Principles of Green Engineering as a foundation for Sustainability” in Sustainability Science and Engineering: Principles. Ed. Martin Abraham, Elsevier Science, 2005.

Reference Books:

1. Boyle, Godfrey, Bob Everett, Janet Ramage, “Energy Systems and Sustainability: Power for a Sustainable Future”, Oxford University Press, 2004
2. Paul L. Bishop, Pollution Prevention: Fundamentals and Practice, McGraw Hill, 2000.
3. Anastas, P.; Zimmerman, J. “Design through the twelve principles of green engineering, *Environmental Science and Technology*, **37,** (2003), 94 –101
4. Garcsıa-Serna , Perez-Barrig and Cocero, “New trends for design towards sustainability in chemical engineering: Green engineering” ***Review Article***, C*hemical Engineering Journal*,**133** (2007), 7–30

B.E. (Petrochemical Engineering) - 2012 Course, Semester-I

ELECTIVE-I
FLOW ASSURANCE [412404-D]

Code	Subject	Teaching Scheme (Weekly Load in hrs)			Examination Scheme (Marks)					
		Lect.	Tut	Pract.	Theory		TW	PR	OR	Total
					In Sem.	End Sem.				
412404 D	**Flow Assurance**	3	-	2	30	70	-	-	50	**150**

COURSE OBJECTIVES

1. To be aware of the challenges in transportation of hydrocarbons and their mitigation techniques.
2. To understand the behaviour of organic deposits in crude oil viz. waxes, asphaltenes and their impact on the transportation and production of hydrocarbons.

COURSE OUTCOMES:

At the end of the course, the student will be able to

1. predict the phase behaviour of hydrocarbons under different operating conditions.
2. perform slug handling and pressure surge analysis
3. implement a thermal management strategy in pipelines transporting hydrocarbons
4. predict the formation of paraffin waxes, asphaltenes and hydrates in crude oil
5. apply the appropriate method for prevention and removal of organic deposits.

Unit – I Introduction to Flow Assurance (06 hrs)

Flow Assurance concerns and challenges ; Economic impact of Flow Assurance problems, components of typical Flow Assurance process ; Composition and Properties of Hydrocarbons ; Equations of State ; Phase behaviour of hydrocarbons, Compositional and Physical Characterization of Crude oil.

Unit – II Hydraulics in Flow Assurance (06 hrs)

Hydrocarbon flow, single phase and multi phase flow, Two phase flow correlations , Slugging and Liquid Handling, Types of slugs, Slug prediction, detection and control systems ; Pressure surge analysis ; Hydraulic/Pressure drop calculations.

Unit – III Heat Transfer in Flow Assurance (06 hrs)

Buried pipeline heat transfer, Temperature prediction along the pipeline in steady state and transient modes; Thermal management strategy like external coating systems, direct heating, pipe in pipe, etc; Insulation performance.

Unit – IV Characterization and Formation Mechanism for Organic Deposits (06 hrs)

Characterization, Formation mechanism, prediction and models for deposition and stability for wax (Paraffins), Asphaltenes and Gas Hydrates

Unit – V Organic Deposits Removal Methods (06 hrs)

Mechanical Removal Methods like Coiled Tubing, Pigging, Pressurization Depressurization, etc; Chemical Solvents and Dispersants, Other techniques like Ultrasonic, Laser Technology, etc, Bacterial Removal Methods

Unit – VI Organic Deposits Prevention Methods (06 hrs)

Heating in Wellbore and Piping; Cold flow methods; Chemical inhibitors for waxes, asphaltenes and hydrates; Dehydration of Natural Gas; Special Materials and Coatings

Term-Work:

Every student will carry out minimum *eight* exercises from the following list and submit the journal, which will form the term work. Exercises will be based on physical experimentation or simulation on commercial simulation softwares like ASPEN HYSYS, COMSOL, OLGA, etc

1. Determination of Wax Appearance Temperature (WAT)
2. Prediction of Paraffin wax deposition
3. Study of wax inhibition using chemicals
4. Wax remediation using unconventional methods like magnetic, ultrasonic methods, etc.
5. Prediction of Hydrate formation
6. Study of hydrate inhibition
7. Determination of Asphaltene content in crude oil
8. Determination of temperature profile in subsea pipelines
9. Calculation of insulation thickness for crude oil transportation pipelines
10. Performing Cool down calculations in subsea pipelines
11. Pressure drop calculations in crude oil transportation pipelines
12. Pressure surge analysis in pipelines
13. Prediction of slug formation during crude oil transportation

Text Books:

1. Bai, Y and Bai, Q. (2005). *Subsea Pipelines and Risers*. I Edition. Elsevier
2. Danesh, Ali. (1998). PVT and Phase Behaviour of Petroleum Reservoir Fluids, First Edition, Edition, Elsevier
3. Frenier, W. W., Zainuddin, M., and Venkatesan, R. (2010). *Organic Deposits in Oil and Gas Production.* Society of Petroleum Engineers.

Reference Books

1. Katz, Donald. (1959). Handbook of Natural Gas Engineering. I Edition. McGraw Hill Higher Education.
2. Yen, T.F and Chilingarian, G.V. (2000). *Asphaltenes and Asphalts, 2* from *Developments in Petroleum Science.* Volume 40 B, Elsevier

B.E. (Petrochemical Engineering) - 2012 Course, Semester-I
ELECTIVE-II
BIOPROCESS ENGINEERING [412405-A]

Code	Subject	Teaching Scheme (Weekly Load in hrs)			Examination Scheme (Marks)					
		Lect.	Tut	Pract.	Theory		TW	PR	OR	Total
					In Sem.	End Sem.				
412405 A	**Bioprocess Engineering**	3	-	2	30	70	-	-	-	**100**

COURSE OBJECTIVES

1. To understand the concepts of bioprocess engineering.
2. To develop idea of applying chemical engineering principles in enzymetic processes and other bio-process operations.
3. To get acquainted of various common industrial operations carried out in biotech industries.

COURSE OUTCOMES:

By the end of the course students should be able

1. to understand the importance and application of bioprocess engineering
2. to understand Biochemical Engineering Kinetics
3. to develop overview and understanding of enzymetic processes.
4. to understand the importance of transport phenomena in bioprocess engineering
5. to develop idea of various bioreactors often used in industry
6. to have broad overview of various bioseparation operations.

Unit – I Principles of Bioprocess Engineering (06 hrs)

An overview of pharmaceutical and biopharmaceutical industry, Current status and future prospects. A review of industrial fermentation and enzymatic processes and products, Role of a bioprocess engineer in bioprocess industry, Process flow sheeting.

Unit – II Biochemical Reaction Kinetics (06 hrs)

Media for industrial fermentations, batch growth, balanced growth, effect of substrate concentration. Monod model, Growth kinetics with plasmid instability, Determining cell kinetic parameters from batch data, Kinetics of cell growth.

Unit – III Enzyme Engineering (06 hrs)

Simple enzyme kinetics- Michaelis-Menten and Briggs-Haldane approach, Evaluation of parameters in Michaelis-Menten equation, Inhibition of enzyme reactions competitive and non-competitive inhibition, Influence of pH, temperature, shear on enzyme activity, Deactivation models and kinetics, Strategies for enzyme stabilization.

Unit – IV Transport Phenomena in Bioprocess Systems ***(06 hrs)***

Gas-liquid mass transfer in cellular systems, Determinations of oxygen transfer rates, Mass transfer in sparged vessels, Factors affecting mass transfer coefficients, Mass and heat transfer correlations, Scale-up considerations.

Unit – V Special Bioreactors ***(06 hrs)***

Design of Heterogeneous Catalytic Processes, Main Types of Industrial Reactors: Tubular Reactors, Tubular Reactors, Up-flow Riser Reactors, Multiple Shell and Radial Reactors, Honeycomb catalysts in adiabatic reactors, Slurry bed Reactors, Key issues in design and operation of multiphase catalytic reactors.

Unit – VI Bioseparations ***(06 hrs)***

Product recovery operations, Recovery of cells and solid particles, Filtration, Centrifugation, Sedimentation, Foam separation, Extraction, Sorption, Chromatography, Membrane separations, Drying, Electrophoresis, New trends, Bioprocess economics.

Text Books:

1. James E. Bailey and David F. Ollis, “Biochemical Engineering Fundamentals”, McGraw Hill, 1986.
2. Michael L Schuler & Fikret Kargi “ Bioprocess Engineering”, Second Edition Prentice Hall of India ,2001
3. Shivshanker B., “Bioseparations Principles and Techniques”, Prentice Hall, New Delhi,2005
4. Subramanian Ganapathy, Bioseparation & Bioprocessing, Second Edition, Wiley-VCH, 2007

Reference Books:

1. Roger Harrison, Paud Todd, Scott Rudge, Demetri Petrides, “Bioseparations Science and Engineering”, Oxford University Press, 2003
2. Wulf Crueger and Anneliese Crueger “A Textbook of Industrial Microbiology”, Second Edition, Panima Publishing Corporation , 2004
3. Moo-Young. M Editor, “ Comprehensive Biotechnology” Pergamon Press, Oxford ,1985

B.E. (Petrochemical Engineering) - 2012 Course, Semester-I
ELECTIVE-II

PIPING ENGINEERING [412405-B]

Code	Subject	Teaching Scheme (Weekly Load in hrs)			Examination Scheme (Marks)					
		Lect.	Tut	Pract.	Theory		TW	PR	OR	Total
					In Sem.	End Sem.				
412405 B	Piping Engineering	3	-	2	30	70	-	-	-	100

COURSE OBJECTIVES:

1. To introduce students to the crucial role of piping engineer in turn key projects
2. To make students understand the approval drawings and execute the work adhering to procedures and standards
3. To understand the layout and manage the work with adequate safety and reliability

COURSE OUTCOMES:

By the end of the course students should be able

1. understand the piping fundamentals, codes and standards
2. understand pipe fittings, selections, drawings and dimensioning
3. understand Pipe Material specifications
4. understand pressure design of pipe systems

Unit – I Introduction to Piping Engineering Fundamentals (06 hrs)

Scope of piping in projects, Plant piping systems and transportation, Difference between codes and standards, ASME / API Codes and Standards. Principles for piping design, Major piping standards, Pipe designators -NPS, IPS, NB, Pipe wall thickness and Schedule, Pipe weights, Lengths, grades, Ends, Joining methods, Methods of manufacture, Pipe ratings, Pipe symbols.

Unit – II Pipe Fittings and Flanges – ASME Standards, Selection, Application, Drawing Symbols and Dimensioning. (06 hrs)

Types of fittings, Pipe bends branch connections, Reducers , Offset calculation, Stub ends and types, Application of Stub Ends, Fabricated branch connections, Welding minimums for Stub In, Branch reinforcements, Types of flange and Couplings, Dimensioning, Minimum pipe requirements, Screwed and Socket weld fittings – Drawing representations, Dimensioning exercises.

Unit – III Piping Material Specification, Pipe Supports, Pipe Racks and Utility Stations (06 hrs)

Piping material Specifications (PMS), PMS creation requirements, Piping specifications, Material selection, P-T ratings, Valve data, PMS Application, Piping supports, Anchors, Pipe guides, Limit stops, Pipe shoe, Shoe guides / Hold down guides, support, Rigid hangers, Manifold Supports, Pipe rack design, Pipe arrangements, Control station and Utility station on pipe racks.

Unit – IV Process Flow Diagrams and Piping Drawings ***(06 hrs)***

Block and process flow diagrams, Utility flow diagram, Piping & Instrumentation diagram, Line Numbering, Line Designation table/ Line list creation, Print reading exercise, Flow Diagram versus Piping drawings, Symbols and abbreviations, Equipment vendor data, Instrument types and symbols – flow, temperature pressure and level, Instrument hook-up drawings, Plot plan and Equipment layout.

Unit – V Pressure Design of Process Piping Systems – ASME B 31. 3: ***(06 hrs)***

Scope of ASME B 31.3, B31.4 & B 31.8, Code interpretation – ASME B 31.3 ASME B 31.3 Fluid service categories, Design pressure and temperature for piping systems, Pressure design of straight pipe under internal pressure. – wall thickness calculations, Maximum design pressure for piping systems, Maximum allowable operating pressure for pipelines, Piping material Selection per ASME Code, ASME piping materials for fluid service categories.

Unit – VI Miscellaneous Topics. ***(06 hrs)***

Steam piping, Corrosion and protection, Thermal insulation, costing, Pipe color coding, Fabrication and installation, Valves, its types and selection, Introduction to Subsea piping.

Pipe Stress Analysis: objectives and definition of stress analysis. Critical line list, Information required for stress analysis, Piping loads, Introduction to Pipe stress analysis software CAESAR II

Flexibility Analysis: Concept of thermal expansion, minimum leg required to absorb thermal Expansion, Stress monographs for pump and Vessel piping, Types of expansion loops.

Text Books:

1. Macetta, John. “Piping Design Handbook”, M.Dekker , 1992
2. Mohinder Nayyar , “Piping Handbook” Seventh Edition , McGraw-Hill, New York, 2000

Reference Books

1. Ed Bausbacher and Roger Hunt, ‘Process Plant Layout and Piping Design’, First Edition, Prentice Hall, 1993
2. Robert A. Rhea, Roy A Parisher, “Pipe Drafting and Design”, Second Edition, Gulf Professional Publishing, 2003

B.E. (Petrochemical Engineering) - 2012 Course, Semester-I
ELECTIVE-II

NATURAL GAS ENGINEERING [412405-C]

Code	Subject	Teaching Scheme (Weekly Load in hrs)			Examination Scheme (Marks)					
		Lect.	Tut	Pract.	Theory		TW	PR	OR	Total
					In Sem.	End Sem.				
412405 C	**Natural Gas Engineering**	3	-	2	30	70	-	-	-	**100**

COURSE OBJECTIVES

1. To understand markets, capacities, sources and technologies issues involved in natural gas production, processing and transport.
2. To get acquainted with technologies used in consumption of natural gas.

COURSE OUTCOMES:

By the end of the course students should be able to

1. know the natural gas resources.
2. understand design aspects of various surface facilities and natural gas properties.
3. acquire understanding of gas hydrates.
4. get conversant with natural gas processing.
5. understand natural gas transport and storage.
6. know natural gas outlets.

Unit – I : Natural Gas Resources *(06 hrs)*

Oil and gas reserves, natural gas and associated gas, outlook for world gas production, Indian Scenario, future sources of natural gas – coal Bed methane and hydrates.

Composition of natural gas, origin of hydrocarbon & non-hydrocarbon components, formation of natural gas reservoirs, sweet and sour gas.

Unit – II : Natural Gas Properties *(06 hrs)*

Phase diagram of a reservoir fluid, cricondentherm and cricondenbar, retrograde condensation, dry gas, wet gas, condensate gas, associated gas, chemical components.
Sampling methods for natural gas, measurements taken during sampling.
Volumetric properties of natural gas, equations of state, viscosity, thermal conductivity, surface and interfacial tension, Net and Gross Heating value – VLE calculations for natural gas.

Unit – III : Hydrates ***(06 hrs)***

Water-hydrocarbon systems hydrate structures, thermodynamic conditions for hydrate formation, kinetics of hydrate formation, hydrate formation during drilling, hydrate prevention.

Unit – IV : Natural Gas Processing ***(06 hrs)***

Introduction, different specifications required for transport and use, separation of condensates, gas-liquid separators and their design, fractionation and purification operations, dehydration methods, hydrocarbon liquids recovery, acid gas removal, removal of nitrogen, helium and mercury, integrated natural gas processing.

Unit – V : Natural Gas Transport & Storage ***(06 hrs)***

Different gas chains – Pipeline transport systems, steady state flow calculations for a pipeline, pipeline thickness calculation, welding problems in large diameter steel pipelines, corrosion protection, recompression stations, types of compressors, instrumentation, monitoring and control, safety considerations, expansion systems, flow measurement.

LNG transport chain, natural gas liquefaction, LNG carriers, Natural gas storage-cryogenic and underground.

Unit – VI: Natural Gas Outlets ***(06 hrs)***

Downstream utilization technologies for natural gas in petrochemical, fertilizer and power sectors.

Lower hydrocarbons upgradation technologies, methane conversion technologies.

Text Books:

1. Rojey, C. Jaffret, “Natural Gas Production, Processing, Transport”, Second Editions Technip, 1994.
2. Chi U. Ikoku, “Natural Gas Production Engineering”, John Wiley and Sons, 1984.

Reference Books:

1. Kohl and F. Riesenfeld, “Gas Purification”, Gulf Publishing Company, 1985.
2. Sanjay Kumar, “Gas Production Engineering’, Gulf Publishing Company, 1987.

B.E. (Petrochemical Engineering) - 2012 Course, Semester-I
ELECTIVE-II
COLLOIDAL AND INTERFACE SCIENCE [412405-D]

Code	Subject	Teaching Scheme (Weekly Load in hrs)			Examination Scheme (Marks)					
		Lect.	Tut	Pract.	Theory		TW	PR	OR	Total
					In Sem.	End Sem.				
412405 D	**Colloidal and Interface Science**	3	-	2	30	70	-	-	-	**100**

COURSE OBJECTIVES

1. To familiarize student with language of interface and colloid science.
2. To prepare the student for career in research in areas related to interface and colloid science.

COURSE OUTCOMES

By the end of the course students should be able to

1. understand the basic terminology used in interface and colloid science.
2. apply formation and stability considerations in case of a colloidal system.
3. write basic governing equations for interfacial phenomena

Unit I: Introduction to Interface and Collodial Science: *(06 hrs)*

Examples of surface and colloidal phenomena in industry and nature, Historical perspective. Areas where future research is needed, nature of interfaces, Surface free energy, Work of cohesion and adhesion, Surface activity and surfactant structures, Physical and chemical interactions between atoms and molecules interactions between surfaces and particles, Surface tension.

Unit II: Unit II: Adsorption: *(06 hrs)*

Gibbs Surface Excess, Gibbs Adsorption Isotherm, Adsorption at solid-vapour interface, Energetic considerations, Physical adsorption versus chemisorption, Chemisorption and catalysis, Solid-Vapour adsorption isotherms: Langmuir, Freundlich, BET, Adsorption at solid-liquid interfaces. Adsorption at liquid-liquid interfaces, Gibbs monolayers.

Unit III: Capillarity: *(06 hrs)*

Capillary flow, Driving forces, Interfacial tension, Contact angle, Laplace expression for pressure difference across a curved interface, Capillary flow and spreading processes, Contact angle effects, Some practical capillary systems such as wetting in woven fibers and papers, repellency control, detergency, enhanced oil recovery.

Unit IV: Electrostatic Forces and Electrical Double Layer: ***(06 hrs)***

Sources of interfacial charge, Electrostatic theory, Coulomb's law, Boltzmann's distribution and the Electrical double layer., Double layer thickness, Specific ion adsorption and the stern layer, Overview of electrokinetic phenomena (Electro-osmosis and Electrophoresis).

Unit V: Colloids and Colloidal Stability: ***(06 hrs)***

Working definition of colloids, Practical applications of colloids and colloids phenomena. Mechanisms of colloid formation, Sources of colloidal stability, Steric or entropic stabilization. Coagulation kinetics, DLVO theory and its applications.

Unit VI: Emulsions: ***(06 hrs)***

Emulsion formation, Classification of emulsifiers and stabilizers, Flocculation and coalescence. Adsorption at liquid-liquid interfaces, General considerations of emulsion formation and stability. Mechanistic details of stabilization, Solubility parameters, Hydrophilic-Lipophile balance. Phase inversion temperature, Association colloids such as micelles, Ionic and nonionic surfactants, Kraft temperature, Critical micelle concentration, Microemulsions.

Reference Books:

1. Drew Myers, "Surfaces, Interfaces and Colloids: Principles and Applications", Second Edition, Wiley-VCH, 1999.
2. Hiemenz P. C., Rajagopalan R., "Principles of Colloid and Surface Science", Third Edition, Marcel Dekker, 1997.

B.E. (Petrochemical Engineering) - 2012 Course, Semester-I

PROFESSIONAL ETHICS [412406]

Code	Subject	Teaching Scheme (Weekly Load in hrs)			Examination Scheme (Marks)					
		Lect.	Tut	Pract.	Theory		TW	PR	OR	Total
					In Sem.	End Sem.				
412406	**Professional Ethics**	-	-	2	-	-	50	-	-	**50**

COURSE OBJECTIVES

1. To familiarize students with contemporary ethical and professional conduct issues
2. To provide students with guidelines for evaluating and resolving ethical dilemmas and decision-making in Professional career
3. Understand the importance of involvement in professional organizations and Professional registration.
4. Understand concepts of IPR and trade secrets

COURSE OUTCOMES:

By the end of the course students should be able to

1. Identify ethical issues and determine when ethical principles apply.
2. Manage differing opinions on complex ethical scenarios.
3. Understanding of IPR importance in various reports and documents.
4. Gather evidence that can be used to support a claim or conclusion
5. Undestanding the problems related to globalization and global warming
6. Analyze alternative courses of action and determine the ethical consequences of these.
7. Understand the role of ethics within the profession and in relation to the concept of social responsabilité.

Term work:

Term work and theory are considered to be integral part of the course. Term work shall consist of a journal consisting of regular assignments and presentations completed in the practical class and at home. As far as possible, submission should be word processed on a computer using a standard package by the student himself. Oral presentations exercises and group discussions should be conducted batch wise so that there is a closer interaction.

Every student should carry out minimum *Six Assignments* from the following list and submit the journal, which will form the term work.

Professional Ethics case studies in following areas:

1. Professional ethics
2. Engineering Ethics – Moral Issues, Ethical theories and their uses
3. AIChE Code of Professional Ethics
4. Social consequences of an engineering policy decision
5. Safety analysis of a process plant / Engineer's Responsibility for Safety
6. Environmental impact analysis of a process
7. IPR infringement case studies
8. Global issues of engineering ethics
9. Problems of globalization
10. Business Ethics Case Studies
11. Right to Information (RTI)
12. CSR – Corporate Social Responsibility

Reference books:

1. Mike Martin and Roland Schinzinger, "Ethics in Engineering", McGraw Hill, New York 1996.
2. M. Govindarajan, S.Natarajan, V.S. Senthilkumar, "Engineering Ethics" Prentice – Hall of India Pvt. Ltd. New Delhi, 2004
3. R.S. Naagarazan, Professional ethics and human values, New Age international Publishers, 2004
4. Charles D.Fleddermann, "Engineering Ethics", Prentice Hall, New Mexico, 1999.

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PROJECT PHASE-I [412407]

Code	Subject	Teaching Scheme (Weekly Load in hrs)			Examination Scheme (Marks)					
		Lect.	Tut	Pract.	Theory		TW	PR	OR	Total
					In Sem.	End Sem.				
412407	Project Phase-I	-	2	-	-	-	50	-	-	**50**

COURSE OBJECTIVES:

1. To work in a team in a planned manner on a chosen engineering topic based on the knowledge gained throughout the program
2. To develop skills in the students whereby they apply the totality of knowledge and skills gained through the course in the solution of particular problem or undertaking a project.
3. To understand and get acquaint with the standard practice followed by the professionals to make a successful career in engineering and management.

COURSE OUTCOMES:

By the end of the course students should be able to

1. apply the engineering and allied skills acquired to the specific problem
2. identify and describe the problem, and relevance with industry
3. search the literature and develop an overview of the problem
4. apply systematic methodology by applying knowledge of science and engineering to develop solution for the problem.
5. apply design principles, and carry out experimental work to develop data
6. use modern engineering tools to analyse and interpret data
7. apply professional ethics by acknowledging the source of information.
8. synthesize data to derive meaningful conclusion and present the same in a systematic way
9. understand importance of teamwork
10. understand importance of lifelong learning skills
11. communicate the results effectively in written, oral and graphical form.

Contents:

Every student will be required to submit a project report in a typed form in standard format. Three identical copies should be bound and embossed according to University regulations. This project should be related to the curriculum, and should be either selected by the student or approved by the faculty member, who will guide the student, or assigned by the department.

The project work will consist of an investigation work, computer simulation, design problem or experimentation or set up of prototype equipment related to curriculum. Every student will be orally examined in the topic incorporated in the project and in the related area of specialization.

Students will be allotted project in a group. The project is to be completed in two parts: Project Phase-I in Semester I and Project Phase- II in Semester II. Each project will have one guide from the faculty. Students may be encouraged to choose a co guide from the industry, wherever possible.

Students are expected to carry out an in-depth literature survey based on chemical/engineering abstracts, national/international journals using online/print media. The project work shall be divided in to two parts spread over two terms of final year of engineering. Project stage I shall be inclusive of problem identification and relevant updated literature survey and methodology to evolve solution for the same.

A proper planning of the project work is expected. The project group should prepare activity chart and submit the same along with the reports for Phase- I and Phase- II. The group should also submit and present the work completed in semester I in an appropriate format. The actual contents of the project report may be decided in consultation with the project guide.

The students shall submit printed copy of project stage I and present the same in effectively. Assessment shall be based on quality and originality of work submitted and presented.

Format of report for the project work:

Formats of the report for the complete project to be submitted at the end of Phase -II (Semester II) are given below. The actual contents of the project report may be decided in consultation with the project guide.

(A) Plant Design Project:

In case of a Plant Design Project, the report should consist of the following heads:

(i) Introduction (including market report)
(ii) Process Selection
(iii) Material and Energy Balance
(iv) Sizing and detailed design of major equipment/s
(v) Thermodynamics and Kinetics
(vi) Instrumentation & Process Control
(vii) Plant Layout
(viii) Waste Treatment & Safety Aspects
(ix) Cost Analysis
(x) References

(B) Research / Experimental Project:

In case of a project involving research / experimental work, the report should consist of the following heads:

(i) Abstract
(ii) Objectives
(iii) Introduction/background
(iv) Literature Review
(v) Methodology
(vi) Results
(vii) Discussion
(viii) Conclusion and recommendations
(ix) References
(x) Appendices

(C) Modeling and Simulation Project:

In case of a project based on mathematical modeling and computer simulation the report may consist of the following heads:

(i) Introduction
(ii) Literature Review
(iii) Overview of the equipment / system to be modeled
(iv) Modeling of the equipment / system
(v) Simulation of the model
(vi) Sensitivity Analysis
(vii) Conclusion & recommendations
(viii) Nomenclature
(ix) References
(x) Appendices

Stage I: This stage will include a report consisting of synopsis, the plan for experimental/theoretical work and the summary of the literature survey carried out till this stage. This stage will include comprehensive report on literature survey, design and fabrication of experimental set up and/or development of model, relevant computer programs and the plan for stage II.

Stage II: This is the final stage in the Project work. This stage will include comprehensive report on the work carried out at this stage and relevant portions from stage I, including experimental studies, analysis and/or verification of theoretical model, conclusions.

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ENVIRONMENTAL ENGINEERING [412408]

Code	Subject	Teaching Scheme (Weekly Load in hrs)			Examination Scheme (Marks)					
		Lect.	Tut	Pract.	Theory		TW	PR	OR	Total
					In Sem.	End Sem.				
412408	**Environmental Engineering**	3	-	2	30	70	-	50	-	**150**

COURSE OBJECTIVES

1. To learn to appreciate interrelationship between various components of ecosystem.
2. To get acquainted with characterization of treatment methods for air and water pollution in process industry.
3. To know regulatory framework for pollution prevention.

COURSE OUTCOMES:

By the end of the course students should be able to

1. understand key current environmental problems.
2. identify and value the effect of the pollutants on the environment: atmosphere, water and soil.
2. analyze an industrial activity and identify the environmental impact and problems.
3. plan strategies to control, reduce and monitor pollution.
4. select the most appropriate technique to purify and/or control the emission of pollutants.
5. conversant with basic environmental legislation.

Unit I: Components of Environment and Current Environmental Issues: (6 hrs)

Ecosystem - Structure and functional components of ecosystem, Impact of man on the environment, Natural and man-made impacts on water, air and land,Current environmental issues, Hazardous waste and Bio-medical waste, Global issues - Biodiversity, Impacts of Climatic change, Ozone layer depletion, Carbon Credit,Kyoto Protocol, Clean Development Mechanisms (CDM), Understanding carbon foot prints, Role of the environmental engineer.

Unit II: Air Pollution and Control Methods: (06 hrs)

Sources and classification of air pollutants, Major emissions from global sources, Air pollution laws and standards, Air pollution sampling and measurements, Control methods, Cleaning of gaseous effluents, Particulate and Gaseous emission control, Control of specific gaseous pollutants such as Sox & NOx emission, carbon monoxide, hydrogen sulphide and hydrocarbons, organic vapor from effluent gases.Flaring of gases and its impact.

Unit III: Meteorological Aspects and Air pollution control: (06 hrs)

Metrological aspects of air pollution dispersion, Temperature lapse rates and stability, Wind velocity and turbulence, Plume behavior, Dispersion of air pollutants.

Air pollution control from major process industries such as Petroleum refining and petrochemical plants, Thermal power plants, Cement industry.

Unit IV: Sources and Classification of Water Pollutants: (06 hrs)

Origin of wastewater, General standards for quality of water for different purposes, Water intake structures, Types of water pollutants and their effects, Water pollution laws and discharge standards, Waste water characteristics: physical characteristics and chemical characteristics.

Unit V: Wastewater Treatment Technologies: (06 hrs)

Design of Biological Treatment: Preliminary, Primary and Secondary treatments, Activated Sludge Process (ASP), Trickling Filters (TF), Sludge treatment and disposal, Low cost waste treatment systems, Advanced processes like MBR (Membrane Bio Reactor), Moving Bed Bio Reactor (MBBR), Powder activated carbon assisted treatment (PACT), Ultrasonic Treatment, Wet Air Oxidation, Anaerobic Digestion with biogas generation, Up flow anaerobic sludge blanket (UASB), Anaerobic Fluidized Bed Reactor (AFBR), H_2S & CO_2 removal from biogas with methane enrichment.

Unit VI: Wastewater Treatment for Specific Industries and Environment Regulations (06 hrs)

Wastewater Treatment for Specific Industries

Sources, characteristics and methodology for the treatment of industrial wastes of Oil refinery and Petrochemical plants, Dairy, sugar Beverage, Paper and pulp mills, Fertilizer plant.

Environmental Regulations:

OSHA, Regulatory framework, Regulation of hazardous materials and substances, ISO 14000, Pollution control standards of WHO, BIS, Role of MPCB and CPCB.

Term Work:

Every student should carry out minimum *eight* experiments from the following list and submit the journal, which will form the term work.

List of Practicals:

1) To analyze a given hydrocarbon waste for Dissolved oxygen.
2) To analyze a given hydrocarbon waste for Chemical Oxygen Demand (COD)
3) To analyze a given hydrocarbon waste for Biological Oxygen Demand (BOD)

4) To analyze a given hydrocarbon waste for Total solids: Suspended solids, Dissolved solids, volatile solids, settleable solids and non settleable solids
5) To calculate Sludge Volume Index (SVI) of given sample.
6) To analyze a given hydrocarbon waste for Conductivity / Salt concentration.
7) To analyze a given hydrocarbon waste for Heavy metals (at least two).
8) To separate dust from gas using electrostatic precipitator.
9) To separate solids from gas using ventury scrubber.
10) To analyze a given gaseous effluent sample for SO_x, NO_x.
11) To analyze a gaseous sample for volatile organics using Gas Chromatograph.
12) To analyze a given hydrocarbon waste for Total organic carbon.

Text Books:

1. Rao C. S.; “Environmental Pollution Control Engineering”; Wiley Eastern Ltd., 1996.
2. Peavy H. S., Rowe D. R. and Tchobanoglous George; “Environmental Engineering”; McGraw Hill, 1985.
3. Rao M. N. and H. V. N. Rao; “Air Pollution”; Tata McGraw Hill Publishing Company Limited, New Delhi, 2001.

Reference Books:

1. George Technoglobus; Burton F. L.; “Wastewater Engineering: Treatment and Reuse”; Fourth Edition, Metcalf and Eddy, Inc.; Tata McGraw Hill, 2003.
2. De Nevers, “Air Pollution Control and Engineering”, McGraw Hills, 1993
3. "Standard Methods for the Examination of Water and Wastewater", Twenth Edition, American Public Health Association, Washington. D.C. 1998 of Hazardous waste treatment and disposal, Second Edition, McGraw-Hill, New York, 1997.

B.E. (Petrochemical Engineering) - 2012 Course, Semester-II

PLANT DESIGN AND ECONOMICS [412409]

Code	Subject	Teaching Scheme (Weekly Load in hrs)			Examination Scheme (Marks)					
		Lect.	Tut	Pract.	Theory		TW	PR	OR	Total
					In Sem.	End Sem.				
412409	**Plant Design and Economics**	3	-	2	30	70	-	-	50	**150**

COURSE OBJECTIVES

1. To understand the concept of process plant design and economics
2. To understand the engineering drawings and interdisciplinary nature of a manufacturing process plant
3. To understand the importance of Health , Safety and Environment in Plant Design

COURSE OUTCOMES:

By the end of the course students should be able to

1. understand the stages involved in a development of a process plant
2. understand various flow diagrams, drawings, standards and codes
3. understand the HSE aspects involved in process design
4. perform cost estimation of a process plant
5. analyse the profitability of the process plant

Unit I: Process Engineering and Plant Design *(06 hrs)*

General overall design considerations, Anatomy of chemical engineering projects, Process design codes, Standard sources of information, Environmental Protection, Plant location, Plant layout, Plant operation and control.

Process Development: Feasibility study, Development of design database, Process development and commercialization, Importance of laboratory development to pilot plant, scale up methods, Process creation, Process, process licensing, selection of contractor, scope and contract types, Plant, Erection and commissioning.

Unit II: Engineering Flow Diagrams and Process Safety *(06 hrs)*

Process Design, Diagrams / Documents: Introduction to block, process flow, Logic, Information flow diagrams. Preparation of PID, trip and interlock systems, MOC and valve selection, color code of pipeline, Equipment datasheets, Layout engineering (Plot Plan)

Safety In Process and Plant Design: Intrinsic / extrinsic safety, Safety of personnel, equipment and plant classification of plant areas, Fire protection systems, Flare systems, Safety relief valves, Flame arrestors, rupture disc and explosion venting etc., Health , Safety and Environmental hazards, Loss Prevention: Hazard Assessment Techniques: HAZOP, HAZAN, Fault Tree Analysis, etc

Unit III:* Plant Design, Process Safety Design Case Studies** ***(06 hrs)

Plant Design case studies for any one of the chemical, Petrochemical and Polymer products: Process synthesis, Development of process flow diagram, Mass and energy balance, P& ID diagram, Environmental and process safety analysis, Use of process design softwares Such as ASPEN HYSYS/ UniSim Design, Technical project report writing

Unit IV: Overview of Process Economics and Cost Estimations ***(06 hrs)***

Economic decision making in the CPI, Process plant components, elements of costing and principles of accounting, Total cost components, Types and methods of cost estimation, Interest, taxes and insurance, depreciations, Cost estimation for equipment and plant, Direct / indirect manufacturing costs, Various cost indices, William's sixth tenth rule, methods of estimation of fixed capital, product cost estimation

Unit V: Equipment Design, Costing, Utility Costing and Optimum Design strategy ***(06 hrs)***

Materials transfer, handling, and treatment, Equipment-design and costs, Heat transfer equipment-design and costs, Mass transfer and reactor equipment-design and costs, Utility requirement estimations and costing Optimum design and design strategy

Unit VI: Profitability Analysis: Alternative Investments and Replacements ***(06 hrs)***

Profitability: Alternative investments and replacements, profitability standards, discounted cash flow, rate of return, capitalized cost, payment period, alternative investments, analysis with small investments, increments and replacements, Break Even Analysis.

Case studies of process plant design costing and economic analysis and estimation of payback period for any one of the chemical, Petrochemical and Polymer products.

Term Work:

Every student should carry out minimum eight experiments from the following list and submit the journal, which will form the term work and oral exam will be conducted on the same

List of Practicals:

Part A: Chemical Engineering Drawings

1. Standard symbols (IS code) for PFDS / P and ID etc.
2. Development of Block diagrams/ Process flow diagrams
3. Development of Piping and Instrumentation (P&ID) diagrams.
4. Development Trip and interlock systems / Logic diagrams.
5. Development of Layout drawings
6. Development of Process Design Basis Data Sheet, Equipment Specifications Data Sheet, Material Safety Data Sheet , Pump and Line sizing Data Sheet

Part B: Use of Softwares

1. Process flow sheet development and plant design using commercial process simulator such as Aspen Plus/Hysys/UniSim
2. MS-Excel Based Mass and Energy Balance Calculations on a complete process plant

Part C: Costing and Process Safety Analysis

1. Estimation of Utility Requirement for a given case study and costing, Equipment Costing
2. Total Cost Estimation and Breakeven Analysis for a plant design
3. Technical Analysis Presentation of Case Study of Actual Process Industry Accident
4. HAZAN, HAZOP Case study

Text Book:

1. Warren D. Seider, J. D. Seader, Daniel R. Lewin, Soemantri Widagdo, " Product and Process Design Principles: Synthesis, Analysis and Design", Third Edition, John Wiley & Sons, 2014
2. Guidelines for Engineering Design for Process Safety, Second Edition, Centre for Chemical Process Safety (CCPS)**,** 2012

Reference Books:

1. M.S. Peters and K. D. Timmerhaus, "Plant Design and Economics for Chemical Engineers", Fourth Edition, McGraw Hill International Book Co., 1991
2. James R. Cooper, "Process Engineering Economics", Marcel Delkker Inc, New York, 2003
3. Coulson, J.M., Richardson J.E. and Sinnott R.K., "Chemical Engineering", Vol. VI, Pergamon Press, 1991.
4. R. Turton, R. C. Bailie, W. B. Whiting, and J. A. Shaeiwitz, " Analysis, Synthesis, and Design of Chemical Processes", Prentice Hall, Upper Saddle River, New Jersey, 1998.

B.E. (Petrochemical Engineering) - 2012 Course, Semester-II
ELECTIVE-III

PROCESS MODELING AND SIMULATION [412410-A]

Code	Subject	Teaching Scheme (Weekly Load in hrs)			Examination Scheme (Marks)					
		Lect.	Tut	Pract.	Theory		TW	PR	OR	Total
					In Sem.	End Sem.				
412410A	Process Modeling and Simulation	3	-	2	30	70	-	--	50	**150**

COURSE OBJECTIVES

1. To get introduced to modeling and simulation of steady state and dynamic behavior of chemical processes.
2. To understand physical and empirical modeling techniques.
3. To gain hands-on experience with commercial simulators.

COURSE OUTCOMES:

By the end of the course students should be able to

1. understand the need and usefulness of Models
2. develop Mathematical Models for Chemical Processes.
3. know numerical simulation techniques.
4. understand the principles of process simulators.
5. understand the state space models and their usefulness.
6. know of empirical models and their applications.

Unit – I : Principles of Process Modeling *(06 hrs)*

Need of Mathematical Model, Scope of Coverage, Principles of Formulation, Fundamental Laws, Mathematical models, their classification (deterministic vs stochastic, linear vs nonlinear, lumped parameter vs. distributed parameter, dynamic vs steady state with examples) Model building, Change in Models based on addition or relaxation of assumptions.Incorporation of fluid thermodynamics, chemical equilibrium, reaction kinetics, feed / productproperty estimation in mathematical models.

Unit – II : Mathematical Model of Chemical Engineering Systems *(06 hrs)*

Input-output models, Degrees of freedom analysis, Dynamic models of representative chemical engineering processes like binary distillation column, Heat Exchanger, CSTR, Gas Absorber, Flash vaporizer etc.

Unit – III : Numerical Simulation Techniques ***(06 hrs)***

Linear Algebric Equations; Crammers Rule, Gauss Elimination Methods, LU Decomposition,Gauss Seidal Iterative Method, Computation of Eigen values and Eigen vectors.Nonlinear Algebric Equations: Bisection Method, Newton Raphson Method, Secant Method.Solution of Ordinary Differential Equation Initial Value Problem: Eulers Method, Runge-KuttaMethods, Milne predictor corrector method, Stiff Differential Equation, Solution of PartialDifferential Equation: Finite Difference Method.

Unit – IV : Process Simulation ***(06 hrs)***

Process simulation, Scope of process simulation, Steady state and dynamic simulation, Formation of problem, Process simulation approaches for steady state and dynamic simulation, Process simulator, Structure of process simulator, Integral process simulation, Simulation tools, Modular approaches, Equation solving approach, Decomposition of networks.

Unit – V : State – Space Representations of Chemical Engineering Systems ***(06 hrs)***

State variables and state equations for chemical process, State-space representations. Selectionof state variables, and typical examples from petrochemical engineering, Lumped parameter and distributed parameter models.

Unit – VI: Empirical Process Models ***(06 hrs)***

Development of empirical models from process data, Linear and nonlinear regression, Advantages and Disadvantages of Empirical Models, Artificial Neural Networks: Supervised Learning, Multilayer Perceptron, Error Back Propagation, Generalization, Fuzzy Logic: Membership Functions, Fuzzy Logic, Rule based Modeling

Term Work:

Every student should carry out minimum *eight* experiments from the following list and submit the journal, which will form the term work.

List of Practicals:

1. Modeling and simulation of batch reactor using mathematical software such as MATLAB
2. Simulation with Recycle: Sequential and Simultaneous Solution Methods
3. Calculation of bubble point / dew point for multicomponent hydrocarbon mixture with help of commercial process simulator such as Aspen plus
4. Flash calculations for a multicomponent hydrocarbon mixture with help of commercial process simulator such as Aspen Plus
5. Simulation of continuous stirred tank reactor simulation
6. Mathematical modeling and simulation of a reactor with help of commercial process simulator such as Aspen plus
7. Mathematical modeling and simulation of multicomponent distillation column
8. Mathematical modeling and simulation of lumped parameter model of tray column
9. Simulation of Ammonia Process
10. Simulation of Catalytic Reformer

Text Books:

1. Luyben W. L., "Process Modeling, Simulation and Control for Chemical Engineering", McGraw Hill Book Company, Singapore, 1990.
2. Seborg D. E., T. F. Edger, D. A. Mellichamp, "Process Dynamics and Control", John Wiley, Indian Edition, 1989.
3. Finlayson, B. A., "Introduction to Chemical Engineering Computing", John Wiley & Sons, New Jersey, 2006.

Reference Books:

1. Ogunnaike B. A., W. H. Ray; "Process Dynamics, Modeling and Control", Oxford University Press, New York, 1994
2. Baughman, D. R., Liu, Y. A., "Neural Networks in Bioprocessing and Chemical Engineering", Academy Press Inc. London ,1995

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ELECTIVE-III
ENERGY ENGINEERING [412410-B]

Code	Subject	Teaching Scheme (Weekly Load in hrs)			Examination Scheme (Marks)					
		Lect.	Tut	Pract.	Theory		TW	PR	OR	Total
					In Sem.	End Sem.				
412410B	Energy Engineering	3	-	2	30	70	-	-	50	**100**

COURSE OBJECTIVES

1. To understand processing and limitations of fossil fuels (coal, petroleum and natural gas) and necessity of harnessing alternate energy resources
2. To know about the conventional energy resources and their effective utilization

COURSE OUTCOMES:

By the end of the course students should be able to

1. understand the energy demand of world, nation and available resources to fulfill the demand
2. identify available nonconventional (renewable) energy resources and techniques to utilize them effectively
3. know about energy policy and energy planning
4. acquire the knowledge of modern energy conversion technologies
5. know various tools and components energy auditing
6. know the management of energy conservations in Process Industries

Unit – I Energy Ressources : A Global View (06 hrs)

Energy sources; coal oil, natural gas; nuclear energy, hydroelectricity, other fossil fuels, geothermal, supply and demand, energy need of growing economy, long term energy scenario, energy pricing depletion of resources, energy strategy for future ,need for conservation, uncertainties, national and international issues.

Unit – II Energy and Environment (06 hrs)

Energy policy and energy planning various forms, energy storage, energy & economy, transportation of energy, per capita energy consumption structural properties of environment, bio-geochemical Cycles, society and environment population and technology.

Unit – III Energy and Technological Society (06 hrs)

Energy and evolution, growth and change; patterns of consumption in developing and advances countries, commercial generation of power requirements and benefit.

Unit – IV Energy Audit and Energy Monitoring (06 hrs)

Introduction, need, types and procedure of energy audits, modern techniques and instruments for energy audit, Defining monitoring and targeting, element of monitoring and targeting, data and information analysis, techniques- energy consumption, production and cumulative sum of differences (CUSUM), Energy conservation opportunity, electrical and thermodynamic ECOs, ECOs in chemical process industries, waste management and recycling of discard material and energy

Unit –V Management of Energy Conservation in Process Industries (06 hrs)

Chemical industries; classification; conservation in unit operation such as separation, cooling tower; drying; conservation applied to fertilizers, cement, pulp and paper, food industries, chloroalkali industries, Energy conservation in different units of refinery likes FCCU, HCU & ADU

Unit – VI Advancement in Technological and Future Energy Alternatives (06 hrs)

Recent advancement in energy technology towards 21st century, transport of energy, ethanol as a fuel, Fusion – introduction potential, condition for fusion, magnetic confinement fusion reactor, cold fusion laser induced fusion, Biomass –introduction, municipal waste, biomass conversion, wood combustion, Geothermal energy – introduction, origin, nature, resources and exploration, environment impact, low temperature geothermal resources, Sources of continuous power, wind and water; geothermal; tidal and solar power, MHD,fuel cells, hydrogen as fuel.

Term Work:

Every student should carry out minimum *eight* experiments from the following list and submit the journal, which will form the term work.

1. Coefficient of Performance of refrigeration Cycle
2. Efficiency of Heat Engine
3. Rankine Cycle for low temperature heat recovery
4. Efficiency of Solar Panel
5. Calorific Value of different types of Biomass
6. Energy yield from a Biogas plant
7. Energy audit of a Petrochemical process
8. Steam economy in Process units
9. Efficiency of steam generation unit
10. Study of Heat Exchanger Network Synthesis.

Text Books:

1. Hinrich and Kleinbach "Energy: its use and the environment" 4th Edition, Thomson Brooks/Cole 2006
2. Boyle "Renewable Energy: Power for a sustainable future" Oxford.
3. Rao S. and Parulekar B.B. "Energy technology" Khanna publisher
4. Capenart and Turner "Guide to energy management" 6 ed. Keinnedu Fairmont press

Reference Books:

1. Krentz, J. H., "Energy Conservation and Utilization ", Allyn and Bacon Inc., 1982.
2. Gramlay, G. M., "Energy ", Macmillan Publishing Co., New York, 1975.
3. Rused, C. K., "Elements of Energy Conservation ", McGraw-Hill Book Co., 1985.

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ELECTIVE-III

PROCESS DEVELOPMENT OF FINE CHEMICALS [412410-C]

Code	Subject	Teaching Scheme (Weekly Load in hrs)			Examination Scheme (Marks)					
		Lect.	Tut	Pract.	Theory		TW	PR	OR	Total
					In Sem.	End Sem.				
412410C	Process Development for Fine Chemicals	3	-	2	30	70	-	--	50	**150**

COURSE OBJECTIVES

1. To familiarize the student with fine chemicals, their markets and technologies
2. To enable the student to gain a foothold in fine chemicals process design sector

COURSE OUTCOMES:

By the end of the course students should be able to

1. know functional groups conversions involved in fine chemicals manufacture
2. carry out material and energy balances and kinetic studies based on laboratory data
3. devise effective heat removal or heat addition strategies
4. handle scale-up issues

Unit I: Fine Chemicals Overview *(06 hrs)*

Fine chemical sector in national and global economy. Review of functional group conversions. Types of reactions, Chemistry of Nitration, Oxidation, Chlorination, Esterification, Hydrogenation. Engineering problems, Examples of fine chemicals from dyes, pharmaceutical and agrochemical sectors.

Unit II: Process Selection *(06 hrs)*

Economic considerations in choice of process routes, Green synthesis, Laboratory studies, Interpretation of laboratory data obtained using GCMS, HPLC and other modern instrumental methods of analysis, Material and energy balances, yield, selectivity and conversion in series and parallel reactions.

Unit III: Chemical Kinetics *(06 hrs)*

Interpretation of batch data, Choice between homogeneous and heterogeneous catalysts, Kinetic vs Mass transfer limitations in heterogeneous catalysis. Reversible reactions, Optimality considerations, Parametric sensitivity studies.

Unit-IV: Separation Strategies **(06 hrs)**

Choice of separation method, Selection of solvents and adsorbents, Generation of equilibrium data, VLE, LLE review, Novel separation methods applicable in fine chemical sector.

Unit-V : Process Intensification **(06 hrs)**

Practical aspects of 'gaining more from less', Ensuring maximum through-put through process equipment. Heat of reaction. Strategies for heat removal in exothermic reactions, Process Intensification strategies applicable to fine chemicals manufacture.

Unit-VI: Scale-up Issues **(06 hrs)**

Scaling-up strategies, Prototype building, Pilot plants, Multi-product plants, Design and Scheduling of Batch Plants, Production Planning and Scheduling, Principles of good manufacturing practice.

Term Work:

Every student should carry out minimum *eight* experiments from the following list and submit the journal, which will form the term work.

List of Practicals:

1. Synthesis of sodium dodecyl benzene sulfonate.
2. 12 Alkyl dimethyl benzyl ammonium chloride
3. Determination of Acid value, iodine value, saponification value
4. Preparation of detergent
5. Preparation of vanishing cream flavor
6. Synthesis of benzyl alcohol
7. Synthesis of Cinnamaldehyde
8. Synthesis of Methoxynaphthalene
9. Synthesis of coumarin VI Pesticides
10. Preparation of water-soluble phenolic resin adhesive
11. Synthesis of urea-formaldehyde resin adhesive and modulation
12. Polyvinyl acetate latex paint preparation
13. Preparation of polyacrylate latex paint
14. Gel Preparation of Barium Titanate Nano-Powder

Text Books:

1. Groggins P H, ‘Unit Processes in Organic Synthesis’, Tata McGraw Hill, Fifth Edition, 1995
2. Levenspeil, O., ‘Chemical Reaction Engineering’, 3rd. edition, John Wiley & Sons, 2001
3. McCabe W. L., Smith J.C., Harriot P., “Unit Operations of Chemical Engineering” Tata McGraw Hill, Seventh Edition, 2007

Reference Books:

1. Rao C.S., “The Chemistry of Process Development in Fine Chemical and Pharmaceutical Industry”, Second Edition, John Wiley & sons, 2006
2. Stanley M., “Catalysis for Fine Chemical Synthesis”, John Wiley & Sons, 2006.

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ELECTIVE-III

POLYMER REACTION ENGINEERING [412410-D]

Code	Subject	Teaching Scheme (Weekly Load in hrs)			Examination Scheme (Marks)					
		Lect.	Tut	Pract.	Theory		TW	PR	OR	Total
					In Sem.	End Sem.				
412410D	**Polymer Reaction Engineering**	3	-	2	30	70	-	--	50	**150**

COURSE OBJECTIVES

1. To familiarize the student with crucial aspects of polymer manufacture
2. To introduce different types of polymerization

COURSE OUTCOMES:

By the end of the course students should be able to

1. understand role of polymer reaction engineering in petrochemical sector
2. learn concepts in Polyaddition reactions
3. understand the kinetics of chain chemical reactions
4. Set up governing equations for a polymerization process
5. know emulsion and suspension polymerization
6. know various reactors for carrying out polymerization reactions

Unit I Introduction: ***(06 hrs)***

Addition polymerization kinetics, Condensation polymer kinetics, Ionic polymerization kinetics, kinetic chain length and average degree of polymerization.

Unit II Polyaddition Reactions ***(06 hrs)***

Kinetics and rates of polymerization of styrene, Methyl methacrylate, Ethylene, Polycondensation reactions –Characteristics, Homogeneous and heterogeneous polycondensation reaction kinetics, Maximum degree of polycondensation, Industrial polycondensation

Unit III Kinetics of Chain Chemical Reactions: ***(06 hrs)***

Characteristics of chain reactions, Stationary and non-stationary chain reactions, Kinetics of branched chain reactions, Auto acceleration and inhibition of chain kinetics, Kinetics of inhibition.

UNIT-IV Copolymerization: ***(06 hrs)***

Introduction, Classification of copolymers, Basic principles of copolymers, Kinetics of copolymerization, Mayo's copolymer equation, Determination of feed and polymer, Determination of monomer Reactivity ratios, Copolymerization for limiting cases, Types of copolymesr behavior, Overall rate of copolymerization, Rates of copolymerization for chemical and diffusion controlled termination.

Unit V Emulsion and Suspension Polymerization ***(06 hrs)***

Introduction to Smith- Ewart's emulsion polymerization kinetics, Experimental techniques in emulsion polymerization, Rates of polymerization for case I and case II, Estimation of total number of particles, Empirical correlations for emulsion polymerization, Vinyl Chloride suspension polymerization.

Unit VI Reactors for Polymerization ***(06 hrs)***

Batch, PFR, CSTR with residence time, average molecular weight and control strategies, Programmed operation of Polyaddition reactors, Low and high conversion reactors, Industrial Polymerization reactors.

Text Books:

1. G.N. Burnett, “Mechanism of polymerization reaction”, Interscience, 1954.
2. Anil Kumar, S.K. Gupta, “Fundamentals of Polymer Science and Engineering”, Wiley, 1978.

Reference Books:

1. G.S. Misra, “Introductory Polymer Chemistry”, Wiley Eastern Ltd., New Delhi, 1993.
2. F. Wilkinson, “Chemical Kinetics and Reaction Mechanism”, Van Norstrand Reinhold Company Ltd, England, 1980.
3. Jose Asua (Editor), “ Polymer Reaction Engineering”, Wiley-Blackwell, 2007
4. George Odian, “Principles of Polymerization”, 2nd Edition John Wiley and Sons, New York 1981.

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ELECTIVE-IV

PETROLEUM ENGINEERING [412411-A]

Code	Subject	Teaching Scheme (Weekly Load in hrs)			Examination Scheme (Marks)					
		Lect.	Tut	Pract.	Theory		TW	PR	OR	Total
					In Sem.	End Sem.				
412411A	Petroleum Engineering	3	-	-	30	70	-	--	-	**100**

COURSE OBJECTIVES

1. To understand distinguishing features and challenges involved in the upstream oil and gas industry
2. To get acquainted with technologies used in petroleum industry
3. To know about recent developments in upstream industries

COURSE OUTCOMES:

By the end of the course students should be able to

1. know the principles involved in exploration of hydrocarbons
2. acquire the knowledge of formation of hydrocarbons
3. know the properties of reservoir rocks and fluids
4. understand the fundamemantals of drilling engineering
5. know the applications of well engineering
6. understand recent developments in upstream industries

Unit – I : Exploration of Hydrocarbons (06 hrs)

Worldwide distribution of oil and gas reserves, Subsurface data sampling and data interpretation, Measurement scaling.

Unit – II : Formation of Hydrocarbons (06 hrs)

Origin of hydrocarbons, accumulation and migration of hydrocarbons, Reservoir traps.

Unit – III : Reservoir Properties (06 hrs)

Properties of reservoir rocks and fluids, Rock – fluid interface, Reservoir description by direct and indirect methods, Oil and Gas in place.

Unit – IV : Drilling Engineering ***(06 hrs)***

Drilling of oil and gas wells, Classification of wells, Drilling operating systems, Drilling fluids, New trends in drilling engineering.

Unit – V : Well Engineering ***(06 hrs)***

Well completions and stimulations, Gun perforating, Hydrocarbon production techniques, Hydrocarbon recovery mechanisms, Artificial lift technique, Secondary recovery.

Unit – VI : Recent Developments in Upstream Industries ***(06 hrs)***

Non-conventional hydrocarbon energy sources, International trading in oil and gas, Recent developments.

Reference Books:

1. Bradley, "Petroleum Engineering Handbook", SPE
2. Mian, M. A., "Petroleum Engineering Handbook for Practicing Engineer", Vol. I and II, Pennwell Publication, 1992.
3. Deshpande, B.G., "World of Petroleum", Wiley, 1990.
4. John, F., Cook, M., and Graham, M., "Hydrocarbon Exploration and Production", Elsevier, 1998.

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ELECTIVE-IV

CATALYSIS TECHNOLOGY [412411-B]

Code	Subject	Teaching Scheme (Weekly Load in hrs)			Examination Scheme (Marks)					
		Lect.	Tut	Pract.	Theory		TW	PR	OR	Total
					In Sem.	End Sem.				
412411B	Catalysis Technology	3	-	-	30	70	-	--	-	100

COURSE OBJECTIVES

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.

COURSE OUTCOMES:

By the end of the course students should be able to

1. understand the need and usefulness of catalysts.
2. understand reaction kinetics of catalytic reaction.
3. understand synthesis and characterization of catalyst.
4. know about Zeolites and Molecular Sieves.
5. understand the performance of catalytic reactors and the multiphase behaviour.
6. know the application of Catalyst in modern grassroot refinery operations.

Unit – I : Catalysis (06 hrs)

Need of Catalyst and its importance, Catalyst Selectivity, activity, functionality, active site, Turnover number, Heterogeneous Catalysis, Homogeneous catalysis.
Negative Catalysis, Inhibitor, Reaction Pathways, Adsorption, Adsorption Isotherm, Important Characteristics of Industrial Catalysts.

Unit – II : Catalytic Reaction Kinetics (06 hrs)

Kinetics, Models of Catalytic Reactions: Langmuir-Hinshelwood Model, Rideal Model, Identifying limiting step of reaction, Poisoning and Deactivation of Catalysts, Coke Deposition, Regenerability of Spent Catalyst, Sintering Phenomena

Unit – III : Synthesis of Catalyst and its Characterization (06 hrs)

Conventional Methods of Catalyst Synthesis: Precipitation Method, Impregnation, Special Methods, Catalyst Supports, Promoters, Catalyst Characterization, Surface area, Pore Volume, Pore size Distribution, Mechanical Properties, XRD Techniques, SEM Study, Solid State NMR, IR Spectroscopy.

Unit – IV : Zeolites and Molecular Sieves ***(06 hrs)***

Definition of Zelolites, Framework of Zeolites, Cubic Morphology, Pore structure, Synthesis of Zeolites, When Molecular Sieves are not Zeolites, Molecular Sieves for Advanced Materials Applications, Diffusion, Shape Selective Catalysis, Activity, Catalytic Cracking with Zeolites.

Unit – V : Multiphase Reactor Operations ***(06 hrs)***

Design of Heterogeneous Catalytic Processes, Main Types of Industrial Reactors: Tubular Reactors, Tubular Reactors, Up-flow Riser Reactors, Multiple Shell and Radial Reactors, Honeycomb catalysts in adiabatic reactors, Slurry bed Reactors, Key issues in design and operation of multiphase catalytic reactors.

Unit – VI: Catalysts in Integrated Refineries ***(06 hrs)***

Mechanism of catalytic cracking, Catalytic cracking, Catalytic reforming, Cyclizxation, Isomerization, Hydrodesulfurization, Manufacture of phthalic anhydride, Ethylene to ethylene oxide, Steam reforming: Catalysts, Reforming process, Fischer-Tropsch synthesis, Water gas shift reaction: High temperature shift catalyst, Low temperature shift catalyst, Methanol synthesis: High temperature process, Low temperature process, Kinetics, Ammonia synthesis.

Text Books:

1. Satterfield C. N., “Heterogeneous Catalysis in Industrial Practice”, Second Edition, McGraw Hill, New York, 1993.
2. Smith J. M., “Chemical Engineering Kinetics”, Third Edition, McGraw Hill, Singapore, 1984.
3. Froment G. F. and Bischoff, K. B. “Chemical Reactor Analysis and Design”, 2nd Edition, John Wiley & Sons, New York, 1995.

Reference Books:

1. Bartholomew, C. H. and Farrauto, R. J. “Fundamentals of Catalytic Processes”, Second Edition Wiley & Sons, 2006.
2. Rothenberg, G., “Catalysis: Concepts and Green Applications”, Wiley VCH, Weinheim ,2008

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ELECTIVE-IV

PROJECT FINANCE AND MANAGEMENT [412411-C]

Code	Subject	Teaching Scheme (Weekly Load in hrs)			Examination Scheme (Marks)					
		Lect.	Tut	Pract.	Theory		TW	PR	OR	Total
					In Sem.	End Sem.				
412411C	Project Finance and Management	3	-	-	30	70	-	--	-	100

COURSE OBJECTIVES

1. To understand and apply project finance and management principles to complete the project in desire time
2. To understand Project life cycle and financial issues in a project
3. To learn concepts in Project risk analysis

COURSE OUTCOMES:

By the end of the course students should be able to

1. Comprehend advanced methods and tools of project management
2. Apply realistic application of methods (strengths, limitations) and strategic issues
3. Apply principles of project management methods to optimize time for project completion.
4. Apply decision supporting tools.
5. Apply principles of engineering economics in the realization of project feasibility and profitability
6. Use risk analysis concepts and iteration for the effects of uncertainty parameters on project implementation

Unit – I : Introduction to Project Finance and Management (06 hrs)

Introduction, Features of a project, Operation and project – Similarities and comparison, Key considerations in a project, Classification of projects, Sub-projects, Uses of project finance, Motivations for using project finance, Unique features of infrastructure projects, Essential elements of project financing, Trends in project financing

Unit – II : Project Life Cycle (06 hrs)

Introduction, Project phases analysis, Project life cycle phases, Issues in managing project life cycle

Unit – III : Strategic Issues in Project Management (06 hrs)

Strategic Issues - Nature and scope, Strategic issues – Features, Project management - strategic uses, Managing project strategic issues , Strategic Issues - Project failure and success, Risk and uncertainty, elements, sources, government regulations, EMV and decision tree analysis, Monte Carlo simulation, risk management techniques for identifying, tracking and mitigating risks.

***Unit – IV : Project Financing* (06 hrs)**

Introduction, Project Financing participants and agreements: first Step in a project financing: Feasibility study, principal advantages and disadvantages

Financial plan and control in projects, Financial plan, Project cash flows, Measuring project cash Flows, Principle of incremental cash flows, Principle of long term funds, Principle of financing costs exclusion, Principle of Post-tax, Cash flow stream components

***Unit – IV : Project Formulation* (06 hrs)**

Introduction, Steps in Preparation of Project report, Contents of a detailed project report, Appraisal of project by Lenders

Project Appraisal: Technical appraisal, commercial appraisal or market appraisal (Demand of the product, supply of the product, distribution channels, pricing of the product and government policies, economic appraisal, Management appraisal (assessing the willingness of the borrower to repay the loan), and financial appraisal

Hints for Financial working in the project report: Project equity - Various options for Financing, Debt, Post-project Reviews

***Unit – V : Project Management* (06 hrs)**

Overview of project management, Development of a project system, Components of a project management system, Steps in project management, Project management environment, Benefits of project management, Obstacles in project management, Project planning, Project implementation stages, Project control, Crashing the Project, Project Abandonment

Network techniques - PERT and CPM,

***Unit – VI : Project Report : Format and Content* (06 hrs)**

Financial aspects, Marketing aspects, Management aspects, Technical aspects, Regulatory Social-public issues, DPR and sensitivity analysis

Text books:

1. David I. CIeland, -"Project Management-Strategic Design and Implementation" - McGraw -Hill International, 2005
2. Prasanna Chandra - "Projects, Planning, Analysis, Selection, Implementation & Review" - Tata McGraw Hill, 2004

Reference books:

1. Abol Ardalan, “Economic and Financial Analysis for Engineering & Project Management”, Technomic Publishing Company, USA, 2000
2. Stefano Gatti, , “ Project Finance in Theory and Practice” Academic Press , 2007

B.E. (Petrochemical Engineering) - 2012 Course, Semester-II
ELECTIVE-IV

FINANCIAL ENGINEERING [412411-1D]
(OPEN ELECTIVE)

Code	Subject	Teaching Scheme (Weekly Load in hrs)			Examination Scheme (Marks)					
		Lect.	Tut	Pract.	Theory		TW	PR	OR	Total
					In Sem.	End Sem.				
4124111D	Financial Engineering	3	-	-	30	70	-	--	-	100

COURSE OBJECTIVES

1. To introduce financial engineering concepts especially relevant for engineering students.
2. To familiarize the concepts underlying the economic analysis of engineering projects
3. To know concepts of cash flow engineering , swap engineering and equity instruments

COURSE OUTCOMES:

By the end of the course students should be able to

1. understand the financial markets and instruments
2. acquire knowledge of cash flow Engineering and forward contracts
3. know the principles of engineering simple interest rate derivatives
4. understand concepts in swap engineering
5. understand the pricing tools in financial engineering
6. know the engineering of equity instruments

Unit – I : Introduction to Financial Engineering (06 hrs)

Overview of financial engineering, financial markets and financial instruments, Unique instrument, Money market problem, Markets and Players, Mechanics of deals, Market conventions, Interest rates, present and future values of cash flow streams, Taxation, Trading Volatility

Unit –II : Cash Flow Engineering and Forward Contracts (06 hrs)

Introduction, Synthetic, cash flows, Cash Flows in different currencies and market risks, Cash flows with different credit risks and volatilities, Forward contracts, Currency forwards, Synthetics, Money market synthetic, synthetic with T-Bills, Synthetics and pricing, Contractual equation, Applications

Unit –III : Engineering Simple Interest Rate Derivatives (06 hrs)

Convergence trade, Libor and other Benchmarks, Forward loans, Replication of forward loan, Contractual equations, applications, Forward rate agreements, Eliminating credit risk, FRA contractual equation, Futures: Eurocurrency contracts, Forward rates and term structure, Bond prices, Conventions and digression.

Unit –IV : Introduction to Swap Engineering (06 hrs)

Swap logic, applications, Instrument: Swaps, Types of swaps, Engineering interest rate swaps, Uses of swaps, Mechanics of swapping new issues, Some conventions, Currency swaps versus FX swaps, Dynamic replication methods and synthetics, Mechanics of options, Repo market strategies in financial engineering.

Unit –V : Pricing Tools in Financial Engineering (06 hrs)

Option strategies, Volatility-based strategies,, Exotics, Quoting conventions, Summary of pricing approaches , Framework, Application, Implications of the fundamental theorem, Arbitrage-free dynamics, Selection criteria for pricing method.

Unit –VI : Engineering of Equity Instruments : Pricing and Replications (06 hrs)

Introduction, Equity: comparison of approaches, Case of stocks, Analytical formulas, Engineering equity products, Making the convertibles callable, Convertibles, Warrants, Financial engineering of securitization, Choosing cash Flows, Critical step: securing the cash flow, Introduction to fixed-income engineering

Text books:

1. S. N. Neftci, Principles of Financial Engineering, Second Edition, Academic Press/Elsevier India, 2009
2. M. Capinski and T. Zastawniak, Mathematics for Finance: An Introduction to Financial Engineering, 2nd Ed., Springer, 2010.

Reference Books:

1. P. Wilmott, Derivatives: The Theory and Practice of Financial Engineering, Wiley, 1998.
2. Sheldon Ross, “An Elementary Introduction to Mathematical Finance: Options and Other Topics”, Second Edition , Cambridge University Press, 2003
3. J Rebonato, R. , “ Volatility and Correlation: In the Pricing of Equity, FX and Interest-Rate Options”, John Wiley and Sons, New Jersey, 2000

B.E. (Petrochemical Engineering) - 2012 Course, Semester-II
ELECTIVE-IV

COMPUTATIONAL FLUID DYNAMICS [412411-2D]
(OPEN ELECTIVE)

Code	Subject	Teaching Scheme (Weekly Load in hrs)			Examination Scheme (Marks)					
		Lect.	Tut	Pract.	Theory		TW	PR	OR	Total
					In Sem.	End Sem.				
412411 2D	Computational Fluid Dynamics	3	-	-	30	70	-	--	-	**100**

COURSE OBJECTIVES

1. To understand the need of CFD in engineering applications.
2. To understand the numerical simulation running at back end of any commercial CFD package.
3. To get acquainted with pre-processor, solver and post-processor operations.

COURSE OUTCOMES:

By the end of the course students should be able to

1. understand the importance of CFD and the conservation laws.
2. understand turbulence.
3. understand finite volume method of solving partial derivative equations.
4. perform pressure – velocity coupling and staggered grid calculations.
5. implement the boundary conditions and the knowledge of erros in CFD.
6. Apply CFD in various industrial operations.

Unit – I : Introduction to CFD and Conservation Laws ***(06 hrs)***

Introduction to CFD, CFD code, Problem solving with CFD, Governing equations of fluid flow and heat transfer, Navier Stokes Equation.

Unit – II : Turbulence and its Modeling ***(06 hrs)***

Turbulence, Descriptors of turbulent flow, Characteristics of simple turbulent flows, Effect of turbulent fluctuations on properties of the mean flow, Turbulent flow calculations, RANS turbulence model, Mixing length model, k-ε model, Large eddy simulation.

Unit – III : Finite Volume Method ***(06 hrs)***

Finite volume method for one dimensional steady state diffusion, Finite Volume method for two dimensional diffusion problems, Finite volume method for three dimensional diffusion problems. Finite volume method for convection – diffusion problems, Steady state one dimensional convetion and diffusion, Central differencing scheme.

Unit – IV : Solution Strategies ***(06 hrs)***

Solution algorithms for pressure – velocity coupling in steady state flows, Staggered grid, Momentum equation, SIMPLE algorithm, Assembly of a complete method, Solution of discretized equations, The TDMA, Applications of TDMA in two dimensional problems.

Unit – V : Boundary Conditions and Errors ***(06 hrs)***

Implementation of boundary conditions, Inlet Boundary conditions, Outlet boundary conditions, Wall boundary conditions, Constant pressure boundary conditions. Errors and uncertainties in CFD, Numerical errors, Input uncertainty, Physical model uncertainty, Verification and validation.

Unit – VI: Applications of CFD in Engineering Industry ***(06 hrs)***

CFD simulation of pipe flow, CFD modeling of mixing, CFD modeling of particle suspension in a stirred vessel, Modeling of a cyclone separator using CFD, CFD modeling of bubble column reactor, CFD modeling of fixed bed reactor, CFD modeling of combustion.

Text Books:

1. Versteeg, H. K., Malalasekera, W. "An Introduction to Computational Fluid Dynamics: The Finite Volume Method", Second Edition, Pearson Education, Indian Edition, New Delhi, 2008.
2. Tu, J., Yeoh, G. H. and Liu, C., "Computational Fluid Dynamics: A Practical Approach", Butterworth-Heinemann, Waltham, Mass, 2011.
3. Anderson, J. D., "Computational Fluid Dynamics: The Basics with Applications", 6^{th} Edition, Tata McGraw Hill, New Delhi, 2012.

Reference Books:

1. Muralidhar, K. and Sundararajan, T., "Computational Fluid Flow and Heat Transfer", Second Edition, Narosa Publishing House, New Delhi, 1995.
2. Patankar, S. V., "Numerical Heat Transfer and Fluid Flow", Taylor and Francis, 1980.
3. Ferziger, J. H. and Peric, M., "Computational Methods for Fluid Dynamics", Third Edition, Springer, New York, 2002.
4. Ranade, V. V. "Computational Flow Modeling for Chemical Reactor Engineering", Academic Press, London, 2002.

B.E. (Petrochemical Engineering) - 2012 Course, Semester-II
ELECTIVE-IV

ENTERPRENEURSHIP [412411-3D]
(OPEN ELECTIVE)

Code	Subject	Teaching Scheme (Weekly Load in hrs)			Examination Scheme (Marks)					
		Lect.	Tut	Pract.	Theory		TW	PR	OR	Total
					In Sem.	End Sem.				
412411 3D	Entrepreneurship	3	-	-	30	70	-	--	-	100

COURSE OBJECTIVES:

1. Opportunity identification & evaluation.
2. Understanding the steps required to start a new business.
3. Understanding of the sources of innovation opportunities and development of the skills to identify and analyze these opportunities for entrepreneurship and innovation.

COURSE OUTCOMES:

By the end of this course, the student should be able to:

1. identify a real-world problem and apply engineering and entrepreneurial skills to analyze, design, and implement a new technology-based prototype product and associated business plan.
2. use formal product development and project tools to create and track project development and Management plans.
3. work effectively and efficiently as a leader and member of a team.
4. develop their business planning and presentation skills.
5. create and deliver presentations to develop idea of new entrepreneurship venture
6. evaluate the environmental, societal, legal and ethical impacts of their new product and business ideas

Unit: 1 Engineering and Entrepreneurship (06 hrs)

Engineers and entrepreneurs, essential skills of entrepreneurs, understanding the scope of process and product, Basic business structure diagram, entrepreneurial toolkit, Traits of successful technology entrepreneurs, Planning a New Business Venture, starting of a technology business venture, Types of business venture plans, The business planning process.

Unit: 2 Industry Analysis and Trends (06 hrs)

Description of Industry, Trends in industry, Strategic opportunities in industry, Sensitivity to economic cycles, Seasonality, Technological change and opportunity created, Regulation and certification requirements, Supply channels, Distribution channels, Customers and Target Markets, Focusing on customers, Customers and markets, Market research, Defining target market

Unit 3 Business Strategies and Positioning (06 hrs)

Types of strategic positions, Competitive advantage, Market-product strategies, Goals and objectives, Strategies and tactics, Tasks and assignments, Risks and Contingencies, Murphy's Law, Types of risks, Using SWOT to evaluate risks and develop contingencies, Emergencies Contingency plans, Marketing in a Technology Company, Developing successful products, Pricing your products, Marketing program, Marketing tactics

Unit: 4 Sales, Marketing and R&D (06 hrs)

Sales in a Technology Company, Goals and objectives, Sales Strategies, The states of innovation, Research and Development, Focus on the customer- Goals and objectives - Strategies and tactics, Draft of written hypothesis, Legal and Intellectual Property Issues, Intellectual property (IP), Permits and licenses, Agreements, Regulations and certification requirements, Covering your assets, tender process, bidding for a project.

Unit: 5 Organizational Chart (06 hrs)

Board of directors, Roles and responsibilities, Advisory committees, Consultants and other specialists, company laws, Hiring people, Management compensation and incentives, Corporate Social Responsibly (CSR), Corporate citizenship, Acquisition by another company, Hand down, Close up shop.

Unit: 6 Financial Controls (06 hrs)

Profit and Loss, Revenue, expense, earnings and cash budget, Income statement, understanding of balance sheet, Cash-flow projection, Sources of funds, Use of funds, Break-even analysis, Start-up costs, Guidelines for preparing financial projections, Building value and wealth, Types of funding, Equity financing, Debt financing, Grants - Capital expenditures, Working capital, Cash reserve, Small business investment companies.

Text Books:

1. Jeffrey A. Timmons and Stephen Spinelli, "New Venture Creation, Entrepreneurship for the 21st Century." Seventh Edition. Boston, MA: McGraw Hill/Irwin, 2007
2. Jeff Mauzy and Richard Harriman, "Creativity Inc., Building an Inventive Organization", Boston, MA: Harvard Business School, 2003
3. The Spirit of Entrepreneurship. New York, NY: Nyenrode Business University.
4. Daniel H. Pink, "A Whole New Mind: Why Right-Brainers Will Rule The Future", New York, NY: Riverhead Books, 2005

References Books:

1. Richard K. Lester and Michael J. Piore, "Innovation – The Missing Dimension", Cambridge, MA: Harvard University Press, 2004
2. Mervyn Kurlansky (Ed.), "Masters of the 20th Century", ICOGRADA Design Hall of Fame. New York, NY: Graphis, Inc. , 2001
3. National Collegiate Inventors and Innovation Alliance, "Getting Started as an Entrepreneur: A Guide for Students. Hadley, MA: NCIIA, 2002

B.E. (Petrochemical Engineering) - 2012 Course, Semester-II
ELECTIVE-IV

ARTIFICIAL INTELLIGENCE [412411-4D]
(OPEN ELECTIVE)

Code	Subject	Teaching Scheme (Weekly Load in hrs)			Examination Scheme (Marks)					
		Lect.	Tut	Pract.	Theory		TW	PR	OR	Total
					In Sem.	End Sem.				
412411 4D	Artificial Intelligence	3	-	-	30	70	-	--	-	**100**

COURSE OBJECTIVES

1. To understand the principle of artificial intelligence.
2. To understand the numerical techniques followed by various artificial intelligence based methods.
3. To get acquainted with the usefulness of AI tools and their usage in industrial operations.

COURSE OUTCOMES:

By the end of this course, the student should be able to:

1. understand the basic AI methodologies and learning rules.
2. identify the type of an AI problem (e.g., search) and formulate the problem as a particular type. (e.g., define a state space for a search problem.
3. develop knowledge of logical agents and knowledge of representation structures.
4. develop working knowledge of artificial neural network.
5. develop overview of various special networks.
6. develop knowledge on fuzzy sets and systems and their applications.

Unit – I : Introduction to Artificial Intelligence (06 hrs)

Basics of AI, Historical Development, Learning Rules, Intelligent Agents, Agents and Environments, Good Behavior: The Concept of Rationality, The Nature of Environments, The Structure of Agents, How the components of agent programs work

Unit – II : Searching Techniques (06 hrs)

Solving Problems by Searching, Study and analysis of various searching algorithms. Implementation of Depth, first search, Problem Solving Agents, Searching for Solutions, Uninformed Search Strategies: Breadth first search, Uniform cost search, Depth first search

Depth limited search, Iterative deepening depth first search, Bi directional search informed (Heuristic) Search Strategies: Greedy best first search.

Unit – III : Logical Agents ***(06 hrs)***

Knowledge representation structures: Frames, semantic net, Scripts, Logic: Prepositional Logic, Prepositional Theorem Proving, Inference and proofs, Proof by resolution, Conjunctive normal form, Horn clauses and definite clauses, Forward and backward chaining, A complete backtracking algorithm, Syntax and Semantics of First Order Logic, Symbols and interpretations, Knowledge Engineering in First Order Logic, Unification, Resolution, Introduction to logic programming (PROLOG)

Unit – IV : Artificial Neural Network ***(06 hrs)***

Biological neural network, Comparison between brain and computer, Network architechture, Setting of weights, Activation function, Bias, Threshold, Learning rules, Perceptron networks, Feedforward Networks, Back propagation strategy, Training algorithms, Application of back propagation network.

Unit – V : Special Networks ***(06 hrs)***

Radial basis function network: Architecture, Training, ApplicationsSelf organizing map: Kohonen SOM, Learning vector quantizationCounter propagation network: Full conter propagation, forward only counter propagation

Unit – VI: Fuzzy Logic ***(06 hrs)***

Development of fuzzy logic, Operations of fuzzy logic, Fuzzy sets and traditional sets, Membership functions, Fuzzy techniques, Applications of fuzzy systems in engineering industry.

Text Books:

1. Russell S. and Norvig P., “Artificial Intelligence: A Modern Approach” Third Edition, Cambridge University Press, London, 2004.
2. Winston, P. H. “Artificial Intelligence". 3rd Edition Addison Wesley, 1993.
3. Dean, T., Allen, J. and Aloimonos. Y. “Artificial Intelligence: Theory and Practice” The Benjamin/Cummings Publishing Company, Inc., New York, 1995.

Reference Books:

1. Tambe, S. S., Kulkarni B. D. and Deshpande, P. B. “Elements of Artificial Neural Networks with selected applications in Chemical Engineering, and Chemical & Biological Sciences”, Simulations & Advanced Controls, Louisville, KY, 1996.
2. Bulsari A. B. (Ed.), “Neural Networks for Chemical Engineers”, Elsevier, Amsterdam, 1995.
3. Bezdek, J. and Pal, S. K. “Fuzzy Models for Pattern Recognition”, IEEE Press, Piscataway, New York (1993).
4. Vapnik, V. “Statistical Learning Theory”, John Wiley, New York, 1998.
5. Mitchell, T. M. “Machine Learning”, McGraw-Hill, New York, 1997.

B.E. (Petrochemical Engineering) - 2012 Course, Semester-II

PETROCHEMICAL ENGINEERING PRACTICE [412412]

Code	Subject	Teaching Scheme (Weekly Load in hrs)			Examination Scheme (Marks)					
		Lect.	Tut	Pract.	Theory		TW	PR	OR	Total
					In Sem.	End Sem.				
412412	Petrochemical Engineering Practice	-	-	2	-	-	50	--	-	**50**

COURSE OBJECTIVES

Prime objective of this course is to understand and get acquainted with the standard practice followed by the professionals to make a successful career in engineering and management

COURSE OUTCOMES:

By the end of this course, the student should be able to:

1. comprehend importance of codes and standards in professional work
2. grasp importance of Intellectual Patent Rights and Copyrights
3. understand Global scenario of Petrochemical industry including demand and supply analysis
4. apply safety norms in personal and professional life
5. understand the importance of supply chain management
6. appreciate and follow the environmental practices

Every student should carry out minimum *Eight Assignments* from the following list and submit the journal, which will form the term work.

1. Rating and design calculations of a Pump/Compressors
2. Global analysis on Petrochemical Industry
3. Modeling and Simulation of a Petrochemical Processes using modern software tools
4. Generation of a design report for given process need
5. Feasibility study for incorporating advanced separation processes in an existing process
6. P & ID Analysis
7. HAZOP Analysis
8. Trouble shooting of a process equipment
9. Exercise in supply chain management
10. Scale-up of process equipment
11. IPR Analysis

B.E. (Petrochemical Engineering) - 2012 Course, Semester-II

PROJECT WORK [412407]

Code	Subject	Teaching Scheme (Weekly Load in hrs)			Examination Scheme (Marks)					
		Lect.	Tut	Pract.	Theory		TW	PR	OR	Total
					In Sem.	End Sem.				
412407	Project	-	6	-	-	-	50	--	100	**150**

COURSE OBJECTIVES:

1. To work in a team in a planned manner on a chosen engineering topic based on the knowledge gained throughout the program
2. To develop skills in the students whereby they apply the totality of knowledge and skills gained through the course in the solution of particular problem or undertaking a project.
3. To understand and get acquaint with the standard practice followed by the professionals to make a successful career in engineering and management.

COURSE OUTCOMES:

By the end of the course students should be able to

1. apply the engineering and allied skills acquired to the specific problem
2. identify and describe the problem, and relevance with industry
3. search the literature and develop an overview of the problem
4. apply systematic methodology by applying knowledge of science and engineering to develop solution for the problem.
5. apply design principles, and carry out experimental work to develop data
6. use modern engineering tools to analyse and interpret data
7. apply professional ethics by acknowledging the source of information.
8. synthesize data to derive meaningful conclusion and present the same in a systematic way
9. understand importance of teamwork
10. understand importance of lifelong learning skills
11. communicate the results effectively in written, oral and graphical form.

Contents:

Every student will be required to submit a project report in a typed form in standard format. Three identical copies should be bound and embossed according to University regulations. This project should be related to the curriculum, and should be either selected by the student or approved by the faculty member, who will guide the student, or assigned by the department.

The project work will consist of an investigation work, computer simulation, design problem or experimentation or set up of prototype equipment related to curriculum. Every student will be orally examined in the topic incorporated in the project and in the related area of specialization.

Students will be allotted project in a group. The project is to be completed in two parts: Project Phase-I in Semester I and Project Phase- II in Semester II. Each project will have one guide from the faculty. Students may be encouraged to choose a co guide from the industry, wherever possible.

Students are expected to carry out an in-depth literature survey based on chemical/engineering abstracts, national/international journals using online/print media. The project work shall be divided in to two parts spread over two terms of final year of engineering. Project stage I shall be inclusive of problem identification and relevant updated literature survey and methodology to evolve solution for the same.

A proper planning of the project work is expected. The project group should prepare activity chart and submit the same along with the reports for Phase- I and Phase- II. The group should also submit and present the work completed in semester I in an appropriate format. The actual contents of the project report may be decided in consultation with the project guide.

The students shall submit printed copy of project stage I and present the same in effectively. Assessment shall be based on quality and originality of work submitted and presented.

Format of report for the project work:

Formats of the report for the complete project to be submitted at the end of Phase -II (Semester II) are given below. The actual contents of the project report may be decided in consultation with the project guide.

(A) Plant Design Project:

In case of a Plant Design Project, the report should consist of the following heads:

(xi) Introduction (including market report)
(xii) Process Selection
(xiii) Material and Energy Balance
(xiv) Sizing and detailed design of major equipment/s
(xv) Thermodynamics and Kinetics
(xvi) Instrumentation & Process Control
(xvii) Plant Layout
(xviii) Waste Treatment & Safety Aspects
(xix) Cost Analysis
(xx) References

(B) Research / Experimental Project:

In case of a project involving research / experimental work, the report should consist of the following heads:

(xi) Abstract
(xii) Objectives
(xiii) Introduction/background
(xiv) Literature Review
(xv) Methodology
(xvi) Results
(xvii) Discussion
(xviii) Conclusion and recommendations
(xix) References
(xx) Appendices

(C) Modeling and Simulation Project:

In case of a project based on mathematical modeling and computer simulation the report may consist of the following heads:

(xi) Introduction
(xii) Literature Review
(xiii) Overview of the equipment / system to be modeled
(xiv) Modeling of the equipment / system
(xv) Simulation of the model
(xvi) Sensitivity Analysis
(xvii) Conclusion & recommendations
(xviii) Nomenclature
(xix) References
(xx) Appendices

Stage I: This stage will include a report consisting of synopsis, the plan for experimental/theoretical work and the summary of the literature survey carried out till this stage. This stage will include comprehensive report on literature survey, design and fabrication of experimental set up and/or development of model, relevant computer programs and the plan for stage II.

Stage II: This is the final stage in the Project work. This stage will include comprehensive report on the work carried out at this stage and relevant portions from stage I, including experimental studies, analysis and/or verification of theoretical model, conclusions.

SAVITRIBAI PHULE PUNE UNIVERSITY

Faculty of Engineering

Board of Studies in Petroleum Engineering

Subjects Equivalence of 2008 course with 2012 course

B.E. (Petrochemical Engineering)

TERM I

Code No	Name of subject, 2008 Structure	Code No.	Name of subject, 2012 Structure
412401	Reaction Engineering – II,TH		To be continued, TH: In-Sem.and End-Sem.
412402	Process Dynamics and Control, TH,TW, OR		To be continued, TH: In-Sem.and End-Sem.
412403	Environmental Engineering, TH, TW, PR	**412408**	Environmental Engineering, TH: In-Sem.and End-Sem.,TW, PR
412404	**Elective – I, TH, OR**		
(A)	Biochemical Engineering	**412405 (A)**	Bioprocess Engineering TH: In-Sem.and End-Sem
(B)	Novel Separation Processes	**412404 (A)**	To be continued, OR TH: In-Sem.and End-Sem
(C)	Elements of Fluidization Engineering	**412404 (B)**	Fluidization Engineering, OR TH: In-Sem.and End-Sem
(D)	Green Chemistry	**412404 (C)**	Green Technology, OR TH: In-Sem.and End-Sem
412405	**Elective – II, TH**		
(A)	Optimization Techniques for Process Industries	**412404(D)**	Flow Assurance TH: In-Sem.and End-Sem
(B)	Emerging feed stocks and Technologies for Petrochemicals	**412405 (B)**	Piping Engineering TH: In-Sem.and End-Sem
(C)	Natural Gas Technology	**412404(C)**	Natural Gas Engineering TH: In-Sem.and End-Sem
(D)	Health, Safety and Environment in Process Industry	**412411(C)**	Project Finance and Management TH: In-Sem.and End-Sem
412406	Professional Ethics, TW		To be continued, TW
412407	Project	**412407**	Project Stage-I, TW

TERM II

Code No	Name of subject, 2008 Structure	Code No.	Name of subject, 2012 Structure
412408	Refinery Process Design, TH,TW	**412403**	Refinery Process Design, PR TH: In-Sem.and End-Sem.
412409	Plant Design and Process Economics, TH, OR	**412409**	Plant Design and Economics, PR TH: In-Sem.and End-Sem
412410	**Elective – III,TH,PR**		
(A)	Process Modeling and Simulation	**412409(A)**	To be continued, OR TH: In-Sem.and End-Sem
(B)	Fine Chemical Industries	**412409(C)**	Process Development for Fine Chemicals, OR TH: In-Sem.and End-Sem
(C)	Colloidal and Interface Science	**412405(D)**	Colloidal and Interface Science, OR TH: In-Sem.and End-Sem
(D)	Renewable Energy Sources	**412410(B)**	Energy Engineering, OR TH: In-Sem.and End-Sem
412411	**Elective – IV, TH**		
(A)	Petroleum Exploration and Production Operations	**412411(A)**	Petroleum Engineering TH: In-Sem.and End-Sem
(B)	Catalyst Science and Technology	**412411(B)**	Catalysis Technology TH: In-Sem.and End-Sem
(C)	Polymer Reaction Engineering	**412410(D)**	To be continued TH: In-Sem.and End-Sem
(D)	Open Elective	**412411(D)**	To be continued TH: In-Sem.and End-Sem
412412	Chemical Engineering Laboratory II, TW	**412412**	Petrochemical Engineering Practice, TW
412407	Project Work, TW,OR		To be continued, TW, OR

Note: The practical / oral examination of the candidate will be conducted based on the assignments performed and submitted by the candidate in his / her journal and not as per assignments in 2008 revised syllabus. This has to be brought to the notice of the examiners by the concerned Institutes.