Structure and Syllabus

TE (Petrochemical Engineering)
University of Pune

(With effect from 2014-15)

T.E. (Petrochemical Engineering)-2012 Course
(w.e.f. Academic Year 2014-15)

T. E. (Petrochemical Engineering) Semester – I

Code	Subject	Teaching Scheme (Weekly Load in hrs)			Examination Scheme (Marks)					
		Lect.	Tut	Pract.	Theory		TW	PR	OR	Total
					In Sem.	End Sem.				
312401	Numerical and Statistical Methods	4	1	--	30	70	25	--	--	**125**
312402	Applied Hydrocarbon Thermodynamics	4	--	2	30	70	25	--	--	**125**
312403	Mass Transfer –I	4	--	2	30	70	--	--	50	**150**
312404	Petrochemical Processes	3	--	2	30	70	--	50	--	**150**
312405	Process Instrumentation and Instrumental Analysis	3	--	2	30	70	--	--	50	**150**
312406	Skill Development	--	--	2	--	--	50	--	--	**50**
Total of Semester – I		**18**	**1**	**10**	**150**	**350**	**100**	**50**	**100**	**750**

T. E. (Petrochemical Engineering) Semester – II

Code	Subject	Teaching Scheme (Weekly Load in hrs)			Examination Scheme (Marks)					
		Lect.	Tut	Pract.	Theory		TW	PR	OR	Total
					In Sem.	End Sem.				
312407	Transport Phenomena	4	--	2	30	70	25	--	--	**125**
312408	Mass Transfer-II	4	--	2	30	70	--	--	50	**150**
312409	Reaction Engineering- I	4	--	2	30	70	25	--	--	**125**
312410	Refining Operations	3	--	2	30	70	--	50	--	**150**
312411	Process Equipment Design	3	--	2	30	70	--	--	50	**150**
312412	Seminar	--	--	2			50	--	--	**50**
Total of Semester – II		**18**	**--**	**12**	**150**	**350**	**100**	**50**	**100**	**750**

Important Notes

1. ***In-Semester Theory examination will be conducted, approximately one and half month after the commencement of each semester.***
2. ***In-Semester Theory examination will be based on first three units from Syllabus and will be conducted by the University of Pune.***
3. ***Total time allotted for In-Semester Theory examination will be 1 hr 30 min.***
4. ***Total time allotted for End- Semester Theory examination will be 2 hrs 30 min.***

T.E. (Petrochemical Engineering) - 2012 Course

Numerical and Statistical Methods [312401]

Code	Subject	Teaching Scheme (Weekly Load in hrs)			Examination Scheme (Marks)					
		Lect.	Tut	Pract.	Theory		TW	PR	OR	Total
					In Sem.	End Sem.				
312401	Numerical and Statistical Methods	4	1	--	30	70	25	--	--	**125**

COURSE OBJECTIVES

1. To learn various numerical techniques to solve engineering problems.
2. To get acquainted with operations research tools and statistical techniques required in Petrochemical engineering practice.
3. To understand curvilinear coordinates used in Petrochemical engineering.

COURSE OUTCOMES:

1. To apply finite difference techniques, interpolation, numerical integration in various Petrochemical engineering problems.
2. To solve system of equations arising in solutions of heat and wave equations.
3. To solve initial and boundary value problems which do not have closed form solutions using numerical methods.
4. To apply the optimization techniques in planning and allocation of available resources.
5. To use statistical methods and regression analysis in analyzing and interpreting experimental data.
6. To apply the knowledge of tensor analysis in fluid mechanics.

Unit- I Numerical Analysis (08 hrs)

Calculus of Finite difference, Finite difference Operators, Newton's, Lagrange's and Stirling's interpolation formulae, Lagrange's method for interpolation.
Numerical differentiation and numerical Integration, Trapezoidal rule, Simpson's 1/3rd and 3/8th rules, Weddle's rule, Error analysis.

Unit – II Solutions of Equations (08 hrs)

Solution of Algebraic and transcendental equations, Method of false position, Newton- Raphson method, Method of successive approximation, Convergence and stability criteria, Solution of System of simultaneous linear equations, Gauss elimination method, Gauss-Seidel method, Method of least square for curve fitting.

Unit – III Ordinary and Partial Differential Equations (08 hrs)

Solution of ordinary differential equations, Euler's method, modified Euler's method, Runge-Kutta method.
Solution of partial differential equations using finite difference technique, Explicit and implicit methods. Solution of one dimensional unsteady state problem in heat and mass transfer.

Unit – IV Optimisation Techniques ***(08 hrs)***

Linear programming, Formulation and solution, Simplex method, Duality, Transportation problem, Vogel's approximation method for initial basic feasible solution, Introduction to unconstrained optimization, Applications of Linear programming in Petrochemical engineering.

Unit – V* Statistics *and Probability ***(08 hrs)***

Correlation and Regression of data, Probability, Probability distributions, Binominal, Normal and Poisson distribution, Testing of hypothesis, χ^2 distribution .

Unit – VI Tensors ***(08 hrs)***

General curvilinear Co-ordinate systems, Contravarient, Covariant and mixed tensors, Metric tensor, Christoffel Symbols, Covariant derivative, Divergence, Laplacian and curl, Applications of tensors.

Term-Work

Term work shall consist of *six assignments* (one per each unit) based on performance and continuous assessment.

Text Books:

1. Chapra S. C. and Canale R. D., 'Numerical Methods for Engineers', WCB/McGraw-Hill Publications, 2001
2. Freund John, 'Probability and Statistics for Engineers', Prentice-Hall of India Pvt. Ltd., 2004
3. Kreyszig E.,' Engineering Mathematics', Wiley Eastern Ltd., 2006

Reference Books

1. M.E. Davis, 'Numerical Methods and Modeling for Chemical Engineers', Wiley, 1984.
2. Taha H. A., 'Operations Research-An Introduction', Seventh Edition, Prentice-Hall, 2002
3. Gupta Santosh K., 'Numerical methods for Engineers', New Age International Publishers
4. Ltd., Wiley Eastern Ltd, 1999
5. Aris R., 'Vectors, tensors and the basic equations of fluid mechanics', Dover Publication Inc., 1962

T.E. (Petrochemical Engineering) - 2012 Course

Applied Hydrocarbon Thermodynamics [312402]

Code	Subject	Teaching Scheme (Weekly Load in hrs)			Examination Scheme (Marks)					
		Lect.	Tut	Pract.	Theory		TW	PR	OR	Total
					In Sem.	End Sem.				
312402	Applied Hydrocarbon Thermodynamics	4	--	2	30	70	25	--	--	**125**

COURSE OBJECTIVES

1. To be able to calculate heat and work effects associated with a process.
2. To learn to predict and correlate important thermodynamic properties.
3. To gain insight into phase equilibria and chemical equilibria.

COURSE OUTCOMES:

1. Understand and apply the laws of thermodynamics to various devices and systems used in petrochemical engineering applications.
2. Select the appropriate equation of state for representing the PVT behavior of fluids.
3. Calculate the various thermodynamic properties using appropriate relations in the absence of experimental data.
4. Distinguish between ideal and non-ideal solutions and predict the properties of the same.
5. Apply the criteria of phase equilibrium to solve problems of multicomponent and complex hydrocarbon systems under different thermodynamic conditions.
6. Determine temperature and pressure conditions for a particular reaction system or process for obtaining optimum yield.

Unit – I: Applications of Laws of Thermodynamics (08 hrs)

Revision of laws of thermodynamics, applications of laws of thermodynamics to flow processes: flow through pipes, nozzles, ejectors, compressors, throttling process, refrigeration, heat pumps, IC Engines.

Unit – II: PVT Behavior of Fluids (08 hrs)

Phase Change processes for pure substances, property diagrams and property tables, concept of ideal gas, processes involving ideal gases, equations of state for real gases, compressibility factor and compressibility charts.

Unit – III: Thermodynamic Properties of Fluids (08 hrs)

Classification of thermodynamic properties, work function, Gibbs free energy, Maxwell's equations, Clapeyron equation, Gibbs-Helmholtz Equation, concept of fugacity, methods for determination of fugacity.

Unit – IV: Properties of Solutions (08 hrs)

Partial molar properties, chemical potential, ideal and non-ideal solutions, Lewis-Randall rule, Raoult's law, Henry's law, Activity and activity coefficients, Gibbs-Duhem equations.

Unit – V: Phase Equilibria ***(08 hrs)***

Criteria of phase equilibrium, phase rule for non-reacting systems, phase diagrams for binary systems, vapor-liquid equilibria for ideal and non-ideal solutions, azeotropes, activity coefficient Equations, multicomponent VLE.

Unit – VI: Chemical Reaction Equilibria ***(08 hrs)***

Reaction stoichiometry, equilibrium constant and standard free energy change, effect of the following on equilibrium constant: temperature, pressure, inert materials, excess reactants, products, heterogeneous reaction equilibria, phase rule for reacting systems.

Term-Work

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

Practical Exercises on the following topics will be based on ***physical experimentation*** or ***simulation*** on commercial simulation software.

1. Experimentation based on energy conversion for different thermodynamic systems
2. Determination of Joule Thomson coefficient
3. Determination of COP for refrigeration
4. Determination of compressor efficiency
5. Determination of change in entropy
6. Guidelines for selection of proper thermodynamic package for commercial simulation software
7. Generating Thermodynamic Property Diagrams for hydrocarbons in commercial simulation software
8. Experimental determination of VLE for binary mixtures
9. Determination of dew point and Bubble Point for a multicomponent hydrocarbon mixture
10. Multicomponent Flash Calculations

Text Books:

1. Narayanan, K.V., ‘A Textbook on Chemical Engineering Thermodynamics’, Prentice Hall of India Ltd, 2013
2. Rao, Y.V.C., ‘An Introduction to Thermodynamics’, University Press (India) Pvt. Ltd., 2004
3. Cengel, Y.A. and Boles, M.A., ‘Thermodynamics: An Engineering Approach. Seventh Edition’, Tata McGraw Hill Education Pvt. Ltd., 2011

Reference Books:

1. Kyle B. G.,’ Chemical and Process Thermodynamics’, Third Edition, Prentice Hall, 1999.
2. Smith, J. M. and Van Ness H. C.., ‘Introduction to Chemical Engineering Thermodynamics’, McGraw-Hill, 1996.
3. Vidal Jean, ‘Thermodynamics: Applications in Chemical Engineering and Petroleum Industry’, Editions Technip, 2003.
4. NPTEL courses available at http://nptel.ac.in/courses/Webcourse-contents/IIT- KANPUR/Basic_Thermodynamics/ui/TOC.htm

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Mass Transfer -I [312403]

Code	Subject	Teaching Scheme (Weekly Load in hrs)			Examination Scheme (Marks)					
		Lect.	Tut	Pract.	Theory		TW	PR	OR	Total
					In Sem.	End Sem.				
312403	Mass Transfer-I	4	--	2	30	70	--	--	50	**150**

COURSE OBJECTIVES

1. To learn the fundamental concepts of mass transfer principles and to apply those concepts to real engineering problems.
2. To be familiar with equations describing molecular diffusion through gases, liquids, and solids.
3. To be familiar with techniques used to estimate mass transfer coefficients in laminar and turbulent flows.
4. To get acquainted with the general approach for the design of continuous contact and stage wise operations.

COURSE OUTCOMES:

1. Develop familiarity with major chemical process separations units.
2. Ability to estimate mass transfer rates using Fick’s Law
3. Ability to do basic calculations involving mass transfer
4. Ability to determine convective mass transfer coefficients
5. Analyze and design constant rate drying systems
6. Ability to design cooling towers

Unit – I Introduction to Mass Transfer and Molecular Diffusion (08 hrs)

Introduction to mass transfer operations, Classification of mass-transfer operations, Choice of separation method, Methods of conducting the mass-transfer-operations, Design principles, Molecular diffusion in gases and liquids, diffusivities of gases and liquids, types of diffusion, Fick’s and Maxwell law of diffusion, diffusion in solids, unsteady state mass transfer, Multicomponent diffusion.

Unit – II Interphase Mass Transfer (08 hrs)

Equilibrium, Diffusion between phases, Local and average phase /overall mass transfer coefficients, Material balances for steady-state co current and countercurrent processes, Stage wise and differential contact, Theoretical stages, NTU, Stage, local and overall efficiency.

Unit – III Mass Transfer Coefficients (08 hrs)

Mass transfer coefficients in laminar and turbulent flow, Theories for mass transfer: Film Theory, Penetration theory, Surface renewal theory, Convective mass transfer, Dimensionless group of mass transfer and its applications, Analogies and correlations between heat, mass, and momentum transfer, Mass transfer data for simple situations.

Unit – IV Equipment for Gas-Liquid Operation (08 hrs)

Gas dispersed: Sparged vessel/Bubble column, mechanically agitated vessels for gas liquid contact, Tray towers, Type of trays, flow arrangements on tray, Tray efficiency, Sparged vessels, Gas hold up – concept of sleep velocity.

Liquid dispersed: Ventury Scrubber, Wetted wall tower, Spray tower, Spray chamber, Packed tower, Mass Transfer coefficients for packed tower, Types of packings, End effects and axial mixing, Tray tower Verses packed tower, Liquid hold up – determination of interfacial area based on hold up and mass transfer coefficients, Co-current flow of gas and liquid, hydrodynamic behavior of packed and tray towers

Unit – V Humidification and Dehumidification Operations (08 hrs)

Concept of humidity and definitions, vapor-liquid equilibria, enthalpy of pure substances, wet bulb temperature relation, psychrometric chart, Lewis relation, methods of humidification and dehumidification, Humidification and dehumidification operations, Humidifier height calculations, cooling tower principle and operation, types of equipment, design calculation, HTU, NTU concept

Unit – VI Drying Operations (08 hrs)

Principles, equilibrium in drying, type of moisture content, mechanism of batch drying, continuous drying, time required for drying, mechanism of moisture movement in solid, Classification and selection of industrial dryers, design principles of tray dryer, rotary dryer, spray dryer, fluidized bed and spouted bed dryer, pneumatic dryer and vacuum dryer.

Term-Work

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

List of Experiments:

1. To determine diffusivity of acetone in air.
2. To determine mass transfer behavior of packed bed.
3. To determine mass transfer behavior of plate column.
4. To determine mass transfer behavior of wetted wall tower.
5. To determine mass transfer behavior of spray chamber.
6. To determine mass transfer behavior of a sparged vessel.
7. To determine mass transfer coefficient for surface evaporation.
8. To determine liquid hold up in packed tower.
9. To evaluate performance of humidification/ de-humidification column.
10. To study cooling tower
11. To determine drying characteristics of a wet solid material using tray dryer
12. Study of tray towers and packed towers

Text Books:

1. Treybal, R.E., ‘Mass Transfer Operations’, 3rd edition, McGraw Hill, 1980.
2. Geankoplis, C.J, ‘Transport Processes and Unit Operations’, PHI, 3rd Edition, 1993
3. Coulson, J. M.; Richardson, J. F., ‘Chemical Engineering – Vol. I & II’, 6th edition, Butherworth-Heinemann, 1999.

Reference Books:

1. Cussler E.L., ‘Diffusion: Mass transfer in fluid Systems’; 2nd Edition, Cambridge University Press, 1998.
2. Thomas-K-Sherwood, Robert L. Pigford, Chorles R. Wilke, ‘Mass transfer’ International Student Edition, McGraw Hill, Kogakusha Ltd., 1975.
3. Hines A. L., R. N. Maddox, ‘Mass Transfer Operations: Fundamentals and Applications’, Prentice-Hall, Inc, Englewood Cliffs, New Jersey, 1985.

T.E. (Petrochemical Engineering) - 2012 Course

Petrochemical Processes [312404]

Code	Subject	Teaching Scheme (Weekly Load in hrs)			Examination Scheme (Marks)					
		Lect.	Tut	Pract.	Theory		TW	PR	OR	Total
					In Sem.	End Sem.				
312404	Petrochemical Processes	3	--	2	30	70	--	50	--	**150**

COURSE OBJECTIVES

1. To learn scientific and technological principles of organic synthesis and related unit processes.
2. To understand the role of Petrochemical engineer in unit processes used for organic synthesis and polymerization processes

COURSE OUTCOMES:

1. Ability to understand the unit processes in organic synthesis
2. Develop familiarity with major polymerization processes on industrial scale
3. Ability to understand variety of petrochemical feedstocks and products
4. Ability to understand process technologies for Fibers, Elastomers and resins

Unit – I Nitration, Halogenation and Oxidation (06 hrs)

Overview of organic chemical process industry and petrochemical industry, Size and scope of the industry, Overview of unit processes with applications, Nitration- nitrobenzene, nitrotoluenes, Halogenation- DCM, MCA, VCM, chlorobenzene, Oxidation- formaldehyde, acetic acid, ethylene oxide.

Unit – II Esterfication, Alkylation and Amination (06 hrs)

Overview of following unit processes with applications: Alkylation and acylation- Cumene, Dodedecyl benzene, Acetophenone, Esterification- C_1 to C_4 alcohols.

Unit – III Polymerization Processes (06 hrs)

Monomers and polymers, classification, types, properties and applications of polymers, polymerization processes, addition and condensation polymerization with examples.

Unit – IV Petrochemical Products and Feedstocks (06 hrs)

Petrochemical product profile, Feedstock selection for petrochemicals, petrochemical base intermediates, aromatic separation, aromatic conversion processes, steam cracking process technology for olefins.

Unit – V Polymers, Elastomers and Resins (06 hrs)

Polymerization reactors, process technologies for Polyethylene, Polypropopylene, Polyvinyl chloride, Polystyrene and Formaldehyde resins.

Unit – VI Fibers (06 hrs)

Process technologies for Caprolactum, Adipic acid, Terephthalic acid, Dimethyl terephthalate, Polyethylene terephthalate, Nylon 6, Nylon 66, SBR, Polyester filament yarn

Practical:

Every student should carry out minimum *eight experiments* from the following list and submit the journal.

List of Experiments:

At least eight experiments from the following list should be performed

1. Conversion of Phenol to Anisole (O-Alkylation).
2. Conversion of Benzene to Nitrobenzene (Nitration).
3. Conversion of Nitrobenzene to Aniline (Amination by Reduction).
4. Conversion of Aniline to 2, 4, 6-Tribromoaniline (Halogention).
5. Conversion of Aldehyde to Carboxylic Acid (Oxidation).
6. Conversion of Carboxylic Acid to Ester (Esterification).
7. Conversion of 2-Naphthol to Nerolene (O-Alkylation).
8. Conversion of Aldehyde of Alcohol (Reduction).
9. Oxidation of side chain of an aromatic substrate (Oxidation).
10. Experiment involving C – Alkylation.
11. Experiment involving N – Alkylation.
12. Experiment involving a Photochemical Conversion.

Text Books:

1. Groggins P H, 'Unit Processes in Organic Synthesis', Tata McGraw Hill, 5th Edition, 1995.
2. Chauvel A and Lefebvre G.,'Petrochemical Processes - I' Gulf Publication; 1st Edition, 1989
3. Mall I.D., 'Petrochemical Process Technology', Macmillan India Ltd, 2007

Reference Books:

1. Rao M Gopala, Marshall Sittig, 'Dryden's Outlines of Chemical Technology', East West Press; Third edition, 1997.
2. Wittcoff H. A. and Reuben B. G., 'Industrial Organic Chemicals,' Wiley Interscience Publication; 5th Edition, 1996.
3. Wiseman P., 'Petrochemicals,'Ellis Horwood Ltd., 1986

T.E. (Petrochemical Engineering) - 2012 Course

Process Instrumentation and Instrumental Analysis [312405]

Code	Subject	Teaching Scheme (Weekly Load in hrs)			Examination Scheme (Marks)					
		Lect.	Tut	Pract.	Theory		TW	PR	OR	Total
					In Sem.	End Sem.				
312405	Process Instrumentation and Instrumental Analysis	3	--	2	30	70	--	--	50	**150**

COURSE OBJECTIVES

1. To understand the fundamentals of process instrumentation and instrumental analysis
2. To understand the working and interpret the results of various analytical techniques.
3. To use Statistics in data analysis and reporting
4. To understand the working of instruments, its codes, standards and calibration
5. To get familiar with recent advances in instrumentation and analytical techniques

COURSE OUTCOMES: At the end of the course the student should

1. Be able to measure, calibrate and select appropriate measuring instrument based on the process dynamics and requirement
2. Be able to analyze the given sample using appropriate analytical technique, interprete the results and report
3. Be able to report the data using statistical analysis
4. Be able to understand the elements of process control operation
5. Be able to understand various Codes, Standards and Norms associated with Instrumentation and Analytical techniques

Unit – I Introduction to Process Instrumentation and Elements of Process Control (06 hrs)

Introduction to instruments, elements, classification, codes and standards, calibration, static and dynamic characteristics of instruments.
Statistical techniques in data analysis and interpretation, reporting of results in graphical and tabular forms.
Classification and transient response of a first and second order system, introduction to feedback control loop and its elements, basic control scheme for processes involving temperature, pressure, level and flow.

Unit – II Temperature, Pressure and Level Measurements (06 hrs)

Temperature measurement: Temperature scales, non electrical methods, electrical methods, Radiation methods, recent advances in Temperature measurements
Pressure measurement: Moderate pressure measurement, high pressure measurement, vacuum measurement, recent advances in pressure measurements
Level measurement: Measurement techniques for liquids and slurries, Recent advances in level measurements

Unit – III Flow Measurements and Study of Valves, Codes, Sizing and Selection (06 hrs)

Flow measurement: Review of venturimeter, Orifice meters, Rotameters, Pitot tube, working of Turbine, Vortex shedding, Electromagnetic flow meters.

Introduction to Advanced flow measurement techniques: Hot Wire Anemometer, Laser Doppler Anemometer, Ultrasound, Particle Image Velocimetry

Study of Valves: Types of valves, Actuators, Positioners, Valve codes and standards, Valve characteristics, Controllability and rangeability, Cavitation, Flashing, choking, Valve sizing, Valve selection criteria.

Unit – IV Introduction to Analytical Techniques (06 hrs)

Need for chemical analysis in process industry. Crude assay, Standard test methods, introduction to principles of analytical techniques: Spectroscopic techniques and chromatographic techniques, Crystallography, Electrophoresis, Hybrid techniques.

Unit – V Spectroscopic and Chromatographic Techniques (06 hrs)

Spectroscopic techniques: X-ray, Inductively Coupled Argon Plasma (ICAP), Ultraviolet – Visible (UV-VIS), Fluorescence, Infrared (IR), Raman Spectroscopy, Mass Spectrometry (MS), Nuclear Magnetic Resonance (NMR)

Chromatographic Techniques: Overview of Gas Chromatography (GC) and Thin Layer Chromatography (TLC), High Pressure Liquid Chromatography (HPLC), Gel Permeation Chromatography (GPC), Super Critical Fluid Chromatography (SFC)
Classification of Spectroscopic and Chromatographic techniques for analysis of fuels.

Unit – VI Lubricant Analysis and Miscellaneous Measurements (06 hrs)

Lubricant Analysis: constituents of lubricants, characterization of lubricants by analytical techniques, importance of elemental analysis in lubricants.

Miscellaneous measurements and analysis: Refractormeter, pH and redox potential measurements, Thermal conductivity gas analyzers, Oxygen determination, and Orsat analysis.

Term-Work

Term work shall consist of

Performance of *11 practicals, 3 tutorial assignments* and a *presentation on case study* using statistical techniques for data interpretation and analysis will qualify for the term work evaluation.

List of Experiments:

To Study working, characteristics and applications of following instruments and analyzers

1. Temperature Measurements, Calibration. Statistical Report Using MS-Excel
2. Pressure Measurements, Calibration. Statistical Report Using MS-Excel
3. Flow Measurements, Calibration. Statistical Report Using MS-Excel
4. Level Measurements, Calibration. Statistical Report Using MS-Excel
5. Types of Valves and Valve Characteristics
6. First and Second order system transient response and characteristics
7. Analysis of Samples Using Gas Chromatography
8. Analysis of samples using UV Spectrophotometer
9. Analysis of samples by Refractometer
10. Interpretation of trends of HPLC, GPC, SFC, IR, NMR, MS
11. Working of Relays, Switches and Contactors
12. Study of Instrumentation Standards, Codes & Symbols *(Assignment)*
13. Study of Instrumentation Specification data sheet for T, P, L, F and Valves *(Assignment)*
14. Study of P& ID Diagram for simple process control loops *(Assignment)*
15. Case Study of Statistical Techniques in Data Analysis and Interpretation *(Presentation)*

Text Books:

1. Nakra, B. C.; Chaudhary K. K.; 'Instrumentation Measurement and Analysis'; 3rd Edition, Tata McGraw Hill, New Delhi, (2009)
2. Patranabis, D.; 'Principles of Industrial Instrumentation'; 3rd Edition Tata McGraw Hill, New Delhi, (2010)
3. S.K.Singh; 'Industrial Instrumentation and Control'; Third Edition, Tata McGraw Hill, New Delhi, (2012)
4. Bela G. Liptak ; 'Instrument Engineers' Handbook'; 4th Volume, CRC Press, 2003

Reference Books:

1. Bela G. Liptak ; 'Instrument Engineers' Handbook'; 4th Volume, CRC Press, 2003
2. Pradyot Patnaik: Dean's Analytical Chemistry Handbook', McGraw Hill Professional, 2004
3. Douglas A. Skoog, Donald M. West, F.James Holler, Timothy A. Nieman , 'Principles of Instrumental Analysis', 6th Edition, Thomson Brooks/Cole, 2007

T.E. (Petrochemical Engineering) - 2012 Course

Skill Development [312406]

Code	Subject	Teaching Scheme (Weekly Load in hrs)			Examination Scheme (Marks)					
		Lect.	Tut	Pract.	Theory		TW	PR	OR	Total
					In Sem.	End Sem.				
312406	Skill Development	--	--	2	--	--	50	--	--	**50**

COURSE OBJECTIVES

1. To get an integrated view of fundamental subjects
2. To formulate the solution to open ended problems of the industry
3. To use the computational tools effectively
4. Prepare the students to lead high-performing, successful professional career in the future

COURSE OUTCOMES:

1. Ability to have an integrated approach of the fundamental engineering subjects
2. Ability to tackle the open ended problems from Petrochemical engineering
3. Ability to structure, write, present and defend the technical report
4. Ability to use computational tools and its interface with professional software

(1) Computing in MS Excel: *Any Two* from the following list:

(i) To perform mass and energy balance over entire plant for a given process

(ii) To perform process simulation

(iii) To perform different operation on Matrix

(iv) Solving three different numerical methods

(2) Heat exchanger simulation using typical software used in industry like HTRI: *Any one* from the following list:

(i) To use HTRI software to design heat exchangers.

(ii) To learn to use TEMA codes for design of heat exchangers.

(3) Process simulation using plant design software like Aspen Plus/ Hysys: *Any one* from the following list:

(i) Simulation of Binary and Multicomponent systems.

(ii) Simulation of three phase separators

(iii) Design of rotary equipments

(4) Exercise on design of a piping network system for a given process as per required norms and codes

(5) Exercise on balance sheet and profit and loss account statement for a company.

(6) Exercise on cost estimation of a process and calculation of its pay back period

(7) Exercise on evaluation of a process design from Safety, Health and Environment (SHE) aspects

(8) Case studies based on real world logistics and service operations decisions.

(9) Case Study on making decisions across the functional areas of the business: marketing, research and development, production, distribution, and finance.

(10) Case study on Negotiation skills for Engineers

Term-Work

Every student shall perform minimum *six* exercises from the above list and submit a journal which will form the term work.

Term work and theory are considered to be integral part of the course. The Term work will include the evaluation of above exercises and a solution of a given problem using appropriate software tools and its report. Term work shall consist of a journal consisting of regular assignments and presentations completed in the practical class. Evaluation will be based on practical batchwise oral presentation and group discussions based on the exercises performed during the semester.

T.E. (Petrochemical Engineering) - 2012 Course

Transport Phenomena [312407]

Code	Subject	Teaching Scheme (Weekly Load in hrs)			Examination Scheme (Marks)					
		Lect.	Tut	Pract.	Theory		TW	PR	OR	Total
					In Sem.	End Sem.				
312407	Transport Phenomena	4	--	2	30	70	25	--	--	**125**

COURSE OBJECTIVES

1. To introduce and develop the main approaches and techniques that constitutes the basis of numerical fluid mechanics for engineers and applied scientists.
2. To familiarize students with the numerical implementation of numerical schemes for practical implementation.
3. Develop an understanding of conservation laws that govern mass, momentum and heat transfer.

COURSE OUTCOMES:

1. Understand the similarity between heat, mass and momentum transport and their analogy.
2. Develop the ability to formulate and solve mathematical models for physical situations.
3. Understand the science of turbulence, its prediction through various models and their utility.
4. Mathematical formulation of heat transfer problem and it numerical solution.
5. Analysis of mass transfer problem, its mathematical formulation and the numerical simulation.
6. Introduction to CFD, meshing, discretization and analysis.

Unit – I Introduction to Transport Phenomena (08 hrs)

Transport phenomena and unit operations, Role of intermolecular forces. Analogous forms of heat, mass Transfer and momentum transfer equations, Heat, mass and momentum diffusivities, estimation of transport properties, Reynolds analogy, and Chilton-Colburn analogy.

Unit – II Molecular Transport and the General Property Balance (08 hrs)

Conservation of mass and energy, Coordinate systems Balance equation in differential form, one directional balance equation including molecular and convective transport.
Three dimensional balance equations, continuity equation, Navier Stokes equations.

Unit – III Turbulence and Related Topics (08 hrs)

Laminar and turbulent flows, fully developed turbulent flow, equations for transport under turbulent conditions: Reynolds rules of averaging, Reynolds equation for incompressible turbulent flow, Reynolds stresses, turbulent flow through pipe, Prandtl mixing length.

Unit – IV Numerical Heat Transfer (08 hrs)

Derivation of basic equation, Unsteady state heat conduction, Numerical finite difference methods for unsteady state conduction, Differential equation for energy change, Boundary layer flow and turbulence in heat transfer, Dimensional analysis in heat transfer.

Unit – V Numerical Mass Transfer (08 hrs)

Review of Mass transfer and diffusion in gases, liquids and solids, unsteady state diffusion, convective mass transfer coefficients, molecular diffusion Plus convection and chemical reaction, Numerical methods for unsteady state molecular diffusion, Dimensional analysis in mass transfer, Boundary layer flow and turbulence in mass transfer.

Unit – VI Introduction to CFD (08 hrs)

Basics of CFD, CFD code, Meshing, Problem solving with CFD, Finite volume method analysis, Finite volume method for one dimensional steady state diffusion, Finite volume for two dimensional diffusion problems, Solution of discretized equation, TDMA, Closure methods.

Term-Work

Every student shall perform minimum *eight* experiments from the following list and submit a journal which will form the term work.

1. Simulation of one dimensional heat conduction
2. Diffusive Mass Transfer Simulation.
3. Experimentation on Turbulence and observing the underlying phenomena.
4. Experimentation on Solid dispersion and the effect of agitator and observing the flow pattern.
5. Modeling and Simulation of velocity profile through a pipe.
6. Modeling and Simulation of phase change using commercial software.
7. Velocity Profile of two immiscible fluid flowing through a pipe
8. Heat Transfer Simulation
9. To simulate diffusion of a spherical ball
10. Heat transfer through wall for a flowing fluid and effect of variation of linear velocity.

Text Books:

1. Geankoplis C. J.; ‘Transport Processes and Separation Process Principles’, Fourth Edition; Prentice Hall India, 2003.
2. Bird R. W. Stewart and E. Lightfoot; ‘Transport Phenomena’, Second Edition; John Wiley and Sons Inc., 2002.
3. Noel de Nevers; ‘Fluid Mechanics for Chemical Engineers’, Third Edition; McGraw Hill, 2005.

Reference Books:

1. Brodkey, Robert S; ‘Transport Phenomena: A Unified Approach’, McGraw Hill,1988
2. Kern D. Q.; ‘Process Heat Transfer’; McGraw Hill, 1965.
3. Tosun Ismail; ‘Modeling in Transport Phenomena: A Conceptual Approach’, Elsevier Science B. V., Amsterdam, Netherlands, 2002.
4. Versteeg H.K, Malalasekara W; ‘An Introduction to Computational Fluid Dynamics: The Finite Volume Method’, 2nd Edition, Pearson Education, 2007.

T.E. (Petrochemical Engineering) - 2012 Course

Mass Transfer-II [312408]

Code	Subject	Teaching Scheme (Weekly Load in hrs)			Examination Scheme (Marks)					
		Lect.	Tut	Pract.	Theory		TW	PR	OR	Total
					In Sem.	End Sem.				
312408	Mass Transfer-II	4	--	2	30	70	--	--	50	**150**

COURSE OBJECTIVES

1. Be familiar with principles underlying and the derivation of the design equations for basic mass transfer operations.
2. To learn basic design principles and applications relevant to stage-wise operations.
3. To be able to perform design calculations for equilibrium staged separation processes.
4. To provide an understanding of the general principles of separation processes to allow students to make sensible options given a separation task.
5. To use a simulation package (Aspen Plus/Hysys) for processes involving multiple equilibrium-stage and rate-based unit operations.

COURSE OUTCOMES:

1. Ability to calculate material balances and minimum solvent rates of single component absorption operations.
2. Ability to apply mass transfer principles to various phase equilibrium based separation processes viz. perform graphical calculations for binary distillation.
3. Ability to construct and analyze the simultaneous phase equilibrium and mass balances in continuous separation processes (absorbers, strippers, and distillation columns).
4. Ability to develops understanding of implications of factors affecting column operation, and design: effect of reflux ratio, feed conditions.
5. Ability to understand principles of various membrane separation processes

Unit – I Gas Absorption (08 hrs)

Mechanism of gas absorption, equilibrium in gas absorption, Choice of solvent, Equilibrium and operating line concept in absorption calculations, application of mass transfer theories to absorption, absorption in wetted wall columns, packed tower and spray tower, calculation of HETP, HTU, NTU, calculation of height of packed and spray tower. Absorption in tray towers, absorption and stripping factors, tray efficiencies, calculation of number of trays for absorption, absorption with chemical reaction.

Unit – II Distillation -I (08 hrs)

Vapor-liquid equilibria, Relative volatility, Ideal Solutions, Relative volatility, Azeotropic mixtures, Raoult’s law and deviations from ideality, methods of distillation; fractionation of binary and multicomponent system, Principle of distillation - flash distillation, differential or simple distillation, steam distillation, multistage continuous rectification, Total reflux, minimum reflux ratio, optimum reflux ratio.

Unit – III Distillation –II ***(08 hrs)***

Design calculations by McCabe-Thiele and Ponchon-Savarit methods; continuous contact distillation tower (packed tower) design; extractive and azeotropic distillation, low-pressure distillation; steam distillation, reactive distillation, membrane distillation, effect of operating conditions on the number of ideal stages, Murphree stage and overall efficiency, calculation of actual number of stages, batch distillation with reflux, packed bed distillation, NTU and HTU calculations, Introduction to Multicomponent distillation

Unit – IV Liquid-Liquid Extraction and Leaching Operations ***(08 hrs)***

Liquid-Liquid equilibrium, ternary diagrams, solvent characteristics, Stage wise contact, Single stage extraction, Multistage crosscurrent and countercurrent extraction with and without reflux, Different types of extractors: Selection construction, sizing and operation, Solid-liquid extraction (Leaching), various types with application, method of calculations, leaching equipment.

Unit – V Adsorption and Ion Exchange ***(08 hrs)***

Adsorption – Types of adsorption, nature of adsorbents, adsorption equilibria, Adsorption isotherms, effect of pressure and temperature on adsorption isotherms, Freundlich equation, Langmuir equation, BET equation, break through curve, adsorption equipment for batch and continuous operation.

Ion exchange – Principle of Ion exchange, techniques and applications, industrial equipment.

Unit – VI Membrane Separation Processes ***(08 hrs)***

Principles, classification of membrane separation processes, solid and liquid membranes, Ultra, Nano and Micro filtration, concept of osmosis, reverse osmosis, Electrodialysis, their applications, thermal and sweep diffusion process.

Term work

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

List of Experiments:

1. To determine the mass transfer coefficient and number of plate in a sieve plate absorption column
2. To carry out gas liquid absorption of CO_2 in aqueous NaOH solution in packed bed column and to determine mass transfer coefficient
3. To generate VLE data for Methanol-Water system in the laboratory
4. To carry out simple distillation for a binary system and verify Rayleigh equation
5. To carry out batch distillation in packed column under variable reflux packed column distillation.
6. To carry out Liquid –Liquid Extraction in a packed column.
7. To carry out cross current leaching.
8. To carry out counter current leaching.
9. To carry out and compare single stage and multistage extraction.
10. To study adsorption in packed bed for a solid-liquid system and plot breakthrough curve.
11. To carry out solute-solvent separation using membrane (RO, MF and NF)
12. To study Batch Reactive Distillation operations in Laboratory.

Text Books:

1. Treybal, R.E., ‘Mass Transfer Operations’, 3rd edition, McGraw Hill, 1980.
2. Coulson, J. M.; Richardson, J. F., ‘Chemical Engineering – Vol. I & II’, 6th edition, Butherworth-Heinemann, 1999.
3. Philip Wankat, ‘Equilibrium staged Operations’, McGraw Hill; NJ, 1988

Reference Books:

1. Seader J.D., Henley E.J, ‘Separation Process Principles’, John Wiley and sons, 1998.
2. King, C. J., ‘Separation processes’, second edition. McGraw-Hill, 1980.
3. Kister, Henry Z., ‘Distillation Operation’, 1st edition, McGraw-Hill, 1996.
4. Kister, Henry Z., ‘Distillation Design’, 1st Edition, McGraw-Hill, 1992

T.E. (Petrochemical Engineering) - 2012 Course

Reaction Engineering-I [312409]

Code	Subject	Teaching Scheme (Weekly Load in hrs)			Examination Scheme (Marks)					
		Lect.	Tut	Pract.	Theory		TW	PR	OR	Total
					In Sem.	End Sem.				
213409	Reaction Engineering-I	4	-	2	30	70	25	--	--	**125**

COURSE OBJECTIVES

1. Write a rate law and define reaction order and activation energy.
2. Demonstrate the ability to quantitatively predict the performance of common chemical reactors using simplified engineering models.
3. Demonstrate the ability to regress the experimental reaction kinetics data.
4. Choose the appropriate sequence of reactors for a given reaction rate expression and collection of reactors.

COURSE OUTCOMES:

1. Ability to develop stoichiometric tables for batch, semi-continuous and flow reactors
2. Ability to derive design equations for different types of reactors based on mole and energy balance.
3. Ability to analyze multiple reactions carried out both isothermally and non-isothermally in batch and flow reactors.
4. Ability to apply energy balance equation for a reacting system to describe equilibrium conversions
5. Ability to understand the temperature and pressure effects on the reaction rate and on specific reaction rates.
6. Ability to apply the concept of residence time distribution in laminar and non-ideal flow reactors

Unit – I Introduction to Kinetics and Reaction Engineering (08 hrs)

Chemical kinetics and thermodynamics of reaction; General mole balance equation, Homogeneous and Heterogeneous Reaction rates, rate constants, stoichiometry, and reactor mass balance, Kinetics of homogeneous reaction, Temperature dependency of rate constant – Arrhenius law, Transition state theory and collision theory, Search for a reaction mechanism.

Unit – II Interpretation of Batch Reactor Data (08 hrs)

Batch reactor concept, Constant volume Batch reactor system; Design equation for zero, first, Second and third order irreversible and reversible reactions, Differential and integral methods for rate analysis, Regression analysis in fitting rate models, Variable volume Batch reactors. Design equation for zero, first and second order irreversible and reversible reactions.

Unit – III Ideal Flow Reactors (08 hrs)

Concept of ideality, Types of flow reactors and their differences, Space-time and Space velocity, Design equation for plug flow reactor and CSTR; Design equations for first and second order reversible and irreversible constant volume and variable volume reactor, Graphical interpretation of these equations; Mean holding time; Development of rate expression for mean holding time for a plug flow reactor.

Unit – IV Single and Multiple Reactor System (08 hrs)

Size comparison of single reactors; Optimum size determination; Staging of reactors, Reactors in series and parallel; Performance of infinite number of back mix reactors in series, Back mix and plug flow reactors of different sizes in series and their optimum way of staging; Recycle reactors, Optimum recycle ratio for auto –catalytic (recycle) reactors; Yield and selectivity, Parallel reactions requirements for high yield. Best operating condition for mixed and plug flow reactors.

Unit – V Temperature Effects in Homogeneous Reactions (08 hrs)

Heat generation and removal, Energy balance in CSTR and PFR, Heat removal or addition to maintain reactor isothermal, exothermic and endothermic reactions. Non-isothermal reactions, Design rate equation as a function of temperature, material and energy balance for reactor design, Equilibrium conversion as function of temperature and pressure, Optimum temperature progression, Adiabatic and nonisothermal operations, Optimum operation of reactors.

Unit – VI Basics of Non-ideal Flow (08 hrs)

Basic concept: conversion in reactors having non ideal flow; Causes of non-ideal behavior in process vessels, Residence Time Distribution, RTD of ideal reactors, Determining RTD from experimental tracer curves , Analysis of RTD from Pulse Input and step input , Earliness of mixing, Segregation and RTD, Conversion in non-ideal flow reactors, Models for predicting conversion from RTD data

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. Verification of Arrhenius law
2. Determine activation energy of acid catalyzed hydrolysis of methyl acetate.
3. To study effect of concentration of reactant and temperature on the rate of reaction.
4. Determination of specific reaction rate of acid catalyzed hydrolysis of ethyl acetate
5. Determination of specific reaction rate of acid catalyzed hydrolysis of ethyl acetate by sodium hydroxide at 298 K

6. To calculate value of rate constant “K” for the saponification of ethyl acetate with

NaOH in batch reactor-I (where M=1)

7. To calculate value of rate constant “K” for the saponification of ethyl acetate with NaOH in mixed flow reactors
8. To calculate value of rate constant ‘k’ for the saponificaton of ethyl acetate with NaOH in CSTR and PFR
9. To study the reaction between potassium persulphate and iodide
10. Kinetics of hydrolysis of methyl acetate by strong acid.
11. Autoclave reactor: Reaction CO_2 Carbonization in the reactor
12. RTD Studies on packed bed reactor.

Textbooks:

1. Levenspeil, O., ‘Chemical Reaction Engineering’, 3rd. edition, John Wiley & Sons, 2001.
2. Fogler, H. S., ‘Elements of Chemical Reaction Engineering’, 3rd edition, PHI, 2002.

Reference Books:

1. Walas, S. M., ‘Reaction Kinetics for Chemical Engineers’, McGraw Hill, 1959
2. Davis, Mark, ‘Fundamentals of Chemical Reaction Engineering’, McGraw Hill, 2003
3. Schmidt, L., ‘The Engineering of Chemical Reactions’, Oxford University Press, 1998
4. Smith, J.M., ‘Chemical Engineering Kinetics’, 3rd edition, McGraw Hill, 1987.

T.E. (Petrochemical Engineering) - 2012 Course
Refining Operations [312410]

Code	Subject	Teaching Scheme (Weekly Load in hrs)			Examination Scheme (Marks)					
		Lect.	Tut	Pract.	Theory		TW	PR	OR	Total
					In Sem.	End Sem.				
312410	Refining Operations	4	-	2	30	70	-	50	-	**150**

COURSE OBJECTIVES

1. To understand the importance of crude oil as source of fuel and the size of refining industry
2. Get acquainted with the various refinery processes and the products along with their specifications
3. Be aware of the challenges involved in refining from viewpoint of product specifications, economic considerations and environmental regulations

COURSE OUTCOMES:

1. Know the composition of crude oil and its products, along with its properties and characterization methods
2. Get conversant the basic separation and conversion processes used in refining crude oil
3. Apply chemical engineering principles to the analysis of safe and efficient refinery operations
4. Identify the specifications required for good quality petroleum product
5. Understand the process of purification and fractionation of crude oil
6. Decide the proper conversion route to upgrade the products from ATU and VDU
7. Understand in detail the manufacturing process of lube oil.

Unit – I: Overview of Production and Refining of Crude Oil (08 hrs)

Origin, formation, exploration and production of crude oil, Reserves and deposits in the world, Petroleum industry in India, Overall Refinery flow, Petroleum Products, Nelson complexity factor

Unit – II: Composition and evaluation of Crude oil and its Products (08 hrs)

Classification of crude oil, Composition of crude oil, Crude Assay, ASTM/TBP/EFV curves, Specifications and Test methods for: LPG, Naphtha, Gasoline, Kerosene, Diesel, Lube oil, Waxes, Bitumen and Coke.

Unit – III: Crude Oil Distillation ***(08 hrs)***

Desalting of Crude, Preheating Train, Atmospheric distillation of Crude oil, Vacuum distillation

Unit – IV: Conversion Processes ***(08 hrs)***

Catalytic cracking, Catalytic reforming, Hydrocracking, Alkylation, Isomerization, Coking, Bitumen Blowing

Unit – V: Lube Oil Manufacturing ***(08 hrs)***

Lube oil processing, Propane deasphalting, Solvent extraction, Dewaxing, finishing Processes, Lube oil additives

Unit – VI: Supporting Processes and Pollution Control in Refineries ***(08 hrs)***

Product blending, Hydrogen production, Sulphur Recovery, Control of air and water pollution, solid waste management

Term-Work

Every student should carry out minimum ten experiments from the following list and submit the journal which will form the term work

List of Practicals:

1. To study ASTM Distillation of Petroleum Products
2. To characterize a given crude oil sample for water content
3. To characterize a given crude oil sample for Viscosity Gravity Constant
4. To determine the Conradson carbon residue for crude oil sample
5. To determine the softening point of bituminous material
6. To determine the melting point of petroleum wax
7. To determine the smoke point of given fuel sample
8. To determine the flash point of a given fuel sample
9. To aniline point and diesel index of diesel
10. To determine the cloud point and pour point of a given fuel sample
11. To determine the Reid Vapor Pressure of a gasoline sample
12. To determine the calorific value of a petroleum product using bomb calorimeter
13. To determine the oxidation stability of gasoline

Text Books

1. Bhaskararao, B.K, ‘Modern Petroleum Refining Processes’, Fifth Edition, Oxford and IBH Publishing Co. Pvt. Ltd, 2007
2. Gary, J.H and Handework, G.E., ‘Petroleum Refining Technology and Economics’, Fourth Edition, Marcel Dekker, Inc. , 2001
3. Ram Prasad, ‘Petroleum Refining Technology’, First Edition, Khanna Publishers, 2013

Reference Books

1. Fahim, M.A., Alsahhaf, T.A. and Elkilani, A., ‘Fundamentals of Petroleum Refining’, Elsevier, 2010
2. Nelson, N.L. , ‘Petroleum Refinery Engineering’, McGraw Hill Book Co., 1985
3. Speight, J.G., ‘ Handbook of Petroleum Product Analysis’, Wiley Interscience, 2002
4. Myers, R.A.,Ed., ‘Handbook of Petroleum Refining Processes’, Third Edition, McGraw Hill Book Co., 2004
5. Ottinger, G., ‘Refining Expertise: How Responsible Engineers Subvert Environmental Justice Challenges’ 1st Edition. New York University Press, 2013
6. NPTEL Courses on Refining available at
   http://nptel.ac.in/courses/103103029/pdf/mod2.pdf

T.E. (Petrochemical Engineering) - 2012 Course

Process Equipment Design [312411]

Code	Subject	Teaching Scheme (Weekly Load in hrs)			Examination Scheme (Marks)					
		Lect.	Tut	Pract.	Theory		TW	PR	OR	Total
					In Sem.	End Sem.				
312411	Process Equipment Design	3	--	2	30	70	--	--	50	150

COURSE OBJECTIVES

1. To learn about the design procedures of process equipments used in chemical process plants
2. To be familiar with process and mechanical aspects of equipment design.
3. To be exposed to various design codes and standards used in mechanical design of equipment.
4. To learn to draw various process equipments and mechanical components as per calculated design.

COURSE OUTCOMES:

1. Understand the role of design engineer in designing procedure and knowledge of basics of process equipment design
2. Understand the design of important components like flange coupling and belt drive
3. Understand key criteria involved in the design of internal pressure vessels as per IS Code.
4. Able to design heat transfer equipments, understand heat exchanger sizing and develop a heat exchanger data sheet.
5. Ability to design storage vessels and various parts of vessels (e.g. heads, bottom plate)
6. Understand the relationship between process design, safety and environment.

Unit – I Introduction to Design (06 hrs)

General Design procedure, Design methodology, steps in design activity, creative design, process design and mechanical design, mechanical properties of material, stress concentration, factor of safety, material of construction, Selection, Equipment fabrication methods and testing, Codes and standards, IS, ASME and TEMA codes in design and their significance. Use of computer in design activity. Economic & Environmental considerations in the design process.

Unit – II Design of Mechanical Components (06 hrs)

Theories of failure, Design of mechanical components such as protected and unprotected types of flange couplings, Types of drive systems, Design of belt drives, Selection of bearings.

Unit – III Design of Pressure Vessel (06 hrs)

A brief overview of process design aspects of pressure vessel (as a reactor for example), Codes and standards for pressure vessels design (IS: 2825: 1969) for unfired pressure vessel shell, head (Flat, hemispherical, torrispherical, elliptical & conical), flange joint, nozzle and supports. Selection of corrosion allowance and weld joint efficiency, Design of heating and cooling arrangement (jackets and coil) for reaction vessel.
Over pressure protection devices such as blow down, Pressure relief valves, rupture disc, steam trap etc.

Unit – IV Design of Heat Exchanger (06 hrs)

Types of Heat Exchangers, brief overview of process design aspects of heat exchanger. Codes and standards for heat exchangers, Design of heat exchanger (U tube and fixed tube) i.e. shell, head, channel, channel cover, flanged joints, tubes, tube sheet, tie rods & baffles as per IS:4503 and TEMA standards. Complete fabrication drawing for designed Heat exchanger to a recommended scale, Design consideration of condensers and evaporators.

Unit – V Design of Storage Vessel (06 hrs)

Storage of volatile and non-volatile fluid, types of losses, Types of floating roofs, Design of fixed roof cylindrical storage tank. Pipeline design consideration, stress analysis, nozzle compensation.

Unit – VI Design of Piping System, Agitator and Reaction Vessels (06 hrs)

Piping: Pipe line color codes, Codes and standards, Wall thickness, Pipe supports, Pipe fittings, Pipe stressing, Pipe size selection, economic pipe diameter, Pipe support, Design of piping for natural gas, crude oil, sea water pipe line.

Agitator: Study of various types of agitators, their selection, applications, baffling, design of blades.

Reaction Vessel: classification, heating systems, design of vessels, study and design of various types of jackets.

Oral:

Oral examination will be based on above syllabus and the design assignments carried out during semester.

List of Design Assignments:

Minimum *three* design assignments and respective drawings should be drawn (By hand or through AutoCAD) on full empirical drawing sheet from the following list.

1. Design of mechanical component such as protected / unprotected flange couplings.
2. Design of pressure / reaction vessel including shell, heads, supports, nozzles etc.
3. Design of storage tank including design of each course at different heights, rooftop, bottoms, vents etc.
4. Design of shell and tube heat exchanger including channels, baffles, tube sheets, and tie rods supports etc.
5. Design of distillation / absorption tower, including tall tower considerations, eccentrically loaded joints, supports, manholes reinforcement rings etc.
6. Optimum design of pressure vessel using design software such as Designer Desktop and IS Code 2825.

Text Books

1. Joshi M. V., Mahajani V. V., ‘Process Equipment Design’, Macmillan, 2010.
2. Bhattacharya B. C., ‘Introduction to Chemical Equipment Design Mechanical Aspects’, CBS Publishers, Delhi, 1991.
3. E. Brownell and Edwin, H. Young, ‘Process Equipment Design– Vessel Design ’, John Wiley, New York 1963.

Reference Books

1. J.M. Coulson, J.F. Richardson and R.K. Sinott, ‘Chemical Engineering Vol.6’, Pergamon Press, 2004
2. Walas S.,’ Chemical Equipment Design’, Butterworth-Heinemann, 1988.
3. Spolts M. F., ‘Mechanical Design Analysis;’, Prentice Hall, 1964
4. Moss Dennis R., ‘Pressure Vessel Design Manual’ 3rd Edition; Gulf Professional Publishing, 2003.
5. Indian Standards Institution, ‘code for unfired pressure vessels’, IS – 2825, 1969

T.E. (Petrochemical Engineering) - 2012 Course

Seminar [312412]

Code	Subject	Teaching Scheme (Weekly Load in hrs)			Examination Scheme (Marks)					
		Lect.	Tut	Pract.	Theory		TW	PR	OR	Total
					In Sem.	End Sem.				
312412	Seminar	--	--	2	--	--	50	--	--	**50**

COURSE OBJECTIVES

1. Investigate some of the current Scientific and Technological issues facing society
2. Develop learning tools that will help student be life-long learners
3. To improve skills in writing, oral presentation
4. To work on a chosen topic, create a technical report and present it
5. Develop of intellectual and professional competence

COURSE OUTCOMES:

1. Ability to conduct literature review relevant to an advanced topic
2. Ability to present the work in a variety of formats (written, oral, formal presentation) in front of an audience and to explore topics of their own choosing in detail
3. Ability to evaluate the reliability of sources of information
4. Be prepared for rapidly changing technological environments with the core knowledge central to multidisciplinary development
5. Ability to understand professional ethics by acknowledging original resource material

Contents:

Seminar should be based on a detailed study of any topic related to Petrochemical Engineering (preferably the advanced areas / application) and the topic should preferably be relevant to the curriculum. Students may undertake studies in research survey, literature review and analysis, synthesis, design and development, generation of new ideas and concept, modification in the existing process/system, development of computer programs, solutions, modeling and simulation related to the subject. Topics of interdisciplinary nature may also be taken up. A detailed literature survey is expected to be carried out as a part of the work. A technical report is required to be submitted at the end of the term and a presentation made based on the same. Modern audio-visual techniques may be used at the time of presentation

It is expected that the student collect information from reference books, standard journals. The report submitted should reveal the student's internalization of the collected information. Mere compilation from the net and other resources is discouraged.

Format of the Seminar report should be as follows:

1. The report should be neatly written or typed on white paper. The typing shall be with normal spacing and on one side of the paper (A-4 size).
2. The report should be submitted with front and back cover of card paper neatly cut and bound or spirally together with the text.

3. Front cover: This shall have the following details:

   a) Title of the seminar report.
   b) The name of the candidate with roll number examination seat number at the middle.
   c) Name of the guide below the candidate's details.
   d) The name of the institute and year of submission on separate lines at the bottom.
   e) Seminar approval sheet.

Format of the text of the seminar reports:

The report shall be presented in the form of a technical paper. The introduction should be followed by literature survey. The report of analytical or experimental work done, if any, should then follow. The discussion and conclusions shall form the last part of the text. They should be followed by nomenclature and symbols used followed by acknowledge the bibliography should be at the end. References should be written in the standard format. The total number of typed pages, excluding cover shall be about 25 to 30 only. All the pages should be numbered. This includes figures and diagrams.

Two copies of the seminar report shall be submitted to the college. The candidate shall present the seminar before the examiners. The total duration of presentation and after-discussion should be about 20 minutes. (15 min + 5 min. Audience can ask questions only if the examiner permits. Such questions will not have any bearing on marks).

The assessment for the subject shall be based on

1. Report submitted.
2. Presentation.
3. Discussion.

Seminar – Conduct, Evaluation:

1. Review – I: during month of February (Compulsory) as per the Academic Calendar.
2. Review – II : The last week of March (Optional)
3. Seminar is an individual activity with separate topic and presentation.
4. Duration of presentation – 15 minutes
5. Question and answer session – 5 minutes

Seminar Evaluation Scheme: based on rubrics developed on following lines**:**

1. Attendance during Semester
2. Attendance during Seminar presentation self and peer
3. Relevance of Seminar topic
4. Timely Abstract submission
5. Literature review
6. Technical contents
7. Presentation
8. Question and answer Session