PE 308 Polymer Science and Technology

Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	30	60	10	--	--	100

Unit I **Hours:12**

Chemistry of high polymers & Characterization: Monomers, functionality, degree of polymerizations, classification of polymers, glass transition, melting transition, criteria for rubberiness, polymerization methods: addition and condensation; their kinetics, metallocene polymers and other newer techniques of polymerization, copolymerization, monomer reactivity ratios and its significance, kinetics, different copolymers, random, alternating, azeotropic copolymerization, block and graft copolymers, techniques for copolymerization-bulk, solution, suspension, emulsion. Solubility and swelling, concept of average molecular weight, determination of number average, weight average, viscosity average and Z-average molecular weights, polymer crystallinity, analysis of polymers using IR, XRD, thermal (DSC, DMTA, TGA), microscopic (optical and electronic) techniques.

Unit II **Hours: 10**

Polymer Synthesis, properties, blends and composites: Commodity and general purpose thermoplastics: PE, PP, PS, PVC, Polyesters, Acrylic, PU polymers. Engineering Plastics: Nylon, PC, PBT, PSU, PPO, ABS, Fluoropolymers Thermosetting polymers: PF, MF, UF, Epoxy, Unsaturated polyester, Alkyds. Natural and synthetic rubbers: Recovery of NR hydrocarbon from latex, SBR, Nitrile, CR, CSM, EPDM, IIR, BR, Silicone, TPE. Difference between blends and composites, their significance, choice of polymers for blending, blend miscibility-miscible and immiscible blends, thermodynamics, phase morphology, polymer alloys, polymer eutectics, plastic-plastic, rubber-plastic and rubber-rubber blends, FRP, particulate, long and short fibre reinforced composites.

Unit III : Polymer Technology & Rheology **Hours: 10**

Polymer compounding-need and significance, different compounding ingredients for rubber and plastics, cross linking and vulcanization, vulcanization kinetics. Flow of Newtonian and non-Newtonian fluids, different flow equations, dependence of shear modulus on temperature, molecular/segmental deformations at different zones and transitions. Measurements of rheological parameters by capillary rotating, parallel plate, cone-plate rheometer. Visco elasticity-creep and stress relaxations, mechanical models, control of rheological characteristics through compounding, rubber curing in parallel plate viscometer, ODR and MDR.

Unit IV : Polymer processing and testing **Hours: 10**

Compression moulding, transfer moulding, injection moulding, blow moulding, reaction injection moulding, extrusion, pultrusion, calendaring, rotational moulding, thermoforming, rubber processing in two-roll mill, internal mixer. Mechanical-static and dynamic tensile, flexural, compressive, abrasion, endurance, fatigue, hardness, tear, resilience, impact, toughness. Conductivity-thermal and electrical, dielectric constant, dissipation factor, power factor, electric resistance, surface resistivity, volume resistivity, swelling, ageing resistance, environmental stress cracking resistance.

Total Hours : 42

Texts and References:

1. Freid, J (2013) Polymer science and Technology, Prentice Hall
2. Billmeyer, F. W. (1994) Textbook of Polymer Science
3. Maiti, S (2003) Analysis and Characterization of polymer, polymer science

PE 374 Natural Gas Processing

Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	30	60	10	--		100

Unit I : Introduction **Hours: 12**

Composition, properties, fields & reserves in India and energy scenario; major NG producing industries of India and their contribution to Indian economy; techniques of utilization

Unit II : Gas Processing **Hours: 10**

Conventional and advanced separation techniques; sulphur recovery; LPG, LNG & CNG systems; specifications of NG for transportation in pipelines , NG Utilization: uses, underground storage, conservation & concept of peak shaving etc. CBM, NG hydrates & in-situ coal gasification, conversion of gas to liquid (GTL)

Unit III : Transportation of NG **Hours: 10**

Compression calculations; gas stations & transmission; city gas distribution system; gas flow measurement; compressor sizing

Unit IV: Marketing, Retailing and Gas Trading **Hours: 10**

CBM, NG hydrates & in-situ coal gasification, conversion of gas to liquid (GTL)

Total Hours: 42

Texts and References:

1. Bradley,H. B.(1987)Petroleum Production Handbook.SPE Publication.
2. Skimmer,D. R. (1982)Introduction to Petroleum Production Volume 1,2and 3, Gulf Publishing
3. Katz: D. L.and Lee, R. L.(1990), Natural Gas Engineering-Production and Storage, McGraw-Hill Publishing Company, New York.
4. Kumar,S (1987)Gas production Engineering., Gulf Publishing

PE 350 Design of Hydrocarbon Process Equipment

Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	1	0	4	4	30	60	10	--	--	100

Unit I **Hours: 10**

Various code and standards for pressure vessel; design considerations and factors influencing design of unfired pressure vessels; materials of construction, type and selection, fabrication of process equipment; unfired pressure vessels with internal pressure; unfired pressure vessels with external pressure; end closures -types, considerations for selection, design under internal pressure and external pressure; testing of pressure vessels

Unit II **Hours: 8**

Non-pressure storage tanks -type and design; design of tall vertical vessels; vessels supports type –selection, Introduction to flanges and gaskets –design of non-standard flanges.

Unit III **Hours: 6**

Process design of Separators (gas-liquid) –Vertical and Horizontal, selection of separator; Distillation Column basics, selection between tray column and packed column, sieve tray performance, factors affecting operation of tray column –entrainment, flooding, weeping, and dumping; sieve tray column sizing, tray hydraulic design, and tray pressure drop calculation.

Unit IV **Hours: 18**

Classification of Heat Exchanges, concept of LMTD, components of Shell and Tube Heat Exchangers (STHE), classification of STHE, TEMA types, fluid allocation, tube geometry, baffles types, cut, spacing; tinker flow model; Thermal design of STHE –duty, diameter, heat transfer coefficient, pressure drop calculation; Introduction to pumps, pump classification and applications, Basic concepts –head, Net Positive Suction Head, cavitations.

Total Hours : 42

Texts and References:

1. Brownell and Young Process Equipment Design: John Willey
2. Bhattacharya, B. C. Process Equipment Design: CBS Publications
3. Joshi, M. V. Process equipment design, Macmillan
4. Sinnot, R.K., Chemical Engineering Design, Coulson-Richardson, Vol 6

MA 301T Advanced Numerical Methods

Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	1	0	4	4	30	60	10			100

Unit I : Numerical solution of Algebraic & Transcendental equations **Hours:10**

Introduction, Descarte's Sign rule, Bisection Method, Method of false position, Secant method, Iteration method, Extended method of iteration, Newton-Raphson method, it's applications, Solution of nonlinear simultaneous equations, Newton-Raphson method for multiple roots, Horner's method, Lin-Bairstow's method or Method for Complex Root, Graeffe's root squaring method, Comparison of various methods.

Unit II : Finite Differences **Hours:10**

Introduction, Finite differences, Operators: Forward Difference, Backward Difference, Central Difference, Shift Operator, Averaging Operator. Relation between operators, Factorial Notation, Synthetic Division, and Missing term Technique. **Interpolation:** Newton Gregory Forward Interpolation Formula, Newton Gregory Backward Interpolation Formula, Gauss's Forward and Backward Interpolation Formula, Stirling's Central Difference Formula, Lagrange's Interpolation Formula for unevenly spaced Formula, Inverse Interpolation, Divided Differences, Properties of Divided Differences, Newton's Divided Difference Formula, Relation between Divided Differences and Ordinary Differences.

Unit III : Numerical Differentiation **Hours:15**

Introduction, Formulae for Derivatives; Numerical integration : Introduction, Newton-Cotes's Quadrature Formula, Trapezoidal rule, Simpson's one-third rule, Simpson's Three-Eighth rule, Weddle's rule, Romberg's method, Double Integration. Solution of Simultaneous Algebraic Equations: Direct methods, Iterative methods: Gauss-Jacobi's method, Gauss-Seidal method, Relaxation method. Numerical Solution of Ordinary Differential Equation: Taylor's method, Euler's method, Rung- Kutta method, Modified Euler's method, Predictor Corrector method: Adam's method & Milne's method. Numerical Solution of Partial Differential Equation: Difference Quotients, Graphical representation, Classification of PDE's of 2^{nd} order, Elliptic equations, Solutions of Laplace equation by Liebmann's iteration method, Poisson's equation, Parabolic equation(One dimension heat equation), Bender-Schmidt method Crank- Nicholson method.

Unit IV : Introduction to Finite Elements Methods **Hours: 7**

Introduction to Finite Element Methods, Functionals, Base Functions. Methods of Approximation: The Rayleigh-Ritz Method, The Galerkin Method. The FEM for one dimensional problems and applications to two dimensional problems.

Total Hours: 42

Texts and References:

1. Numerical Methods in Engineering and Science with Programs in C & C++ by B.S. Grewal, Khanna Publisher.
2. Introductory Methods for Numerical Analysis by S.S. Sastry, Fourth edition, Prentice Hall of India.
3. Numerical Methods for Scientific and Engineering Computation by M.K. Jain, S.R.K. Iyenger and R.K. Jain, 5^{th} edition, New Age International .
4. An introduction to Finite Element Method By J N Reddy, Mc Graw Hill.
5. Advanced Engineering Mathematics by R.K. Jain & S.R.K. Iyenger, 3^{rd} edition, Narosa .
6. Numerical Methods for Engineers by S C Chapra , Raymond P. Canale, Tata McGraw Hill Pub. Co. Ltd.

PE 310 Petrochemical Engineering - I

Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	30	60	10	--	--	100

Unit I **Hours: 10**

Definition of Petrochemicals – petrochemical industries and products – feed stock for petrochemicals – Separation of Aromatics: Azeotropic separation of Toluene, Separation of Styrene, Extraction process, Crystallisation process – Air separation (Making Oxygen and Nitrogen).

Unit II **Hours:12**

Production of methanol via synthesis gas – production of formaldehyde from methanol – production of methylamines - production of chloromethane – trichloroethylene – percholoroethylene – Ethylene dichloride production – Vinyl chloride via ethylene dichloride pyrolysis and acetylene HCl reaction. Ethylene Oxide by air oxidation of ethylene. Butadiene via dehydrogenation of butane – butadiene from butane by oxy-dehydrogenation process – butadiene from ethanol – hydro dealkylation process.

Unit III **Hours: 10**

Synthetic fibres, rubbers, plastics, resins: method, mechanism and types of polymerization , production of poly butadiene, polyesters, nylons, acrylic fibres, etc. production of phenol formaldehyde resin, epoxy resin, production principle of ABS plastic, polycarbonates, etc. manufacturing techniques of butyl rubber, SBR, isoprene rubber, etc.

Unit IV **Hours: 10**

Application of various components of Hydro carbon, Major industrial applications – Fertilizer, power generation, petrochemicals, sponge iron, glass industry, Ceramic Industry.

Total Hours: 42

Texts and References:

1. Maiti, S (1992) Introduction to petrochemical, Oxford & IBH Publishing Company.
2. Chaudhary, U. R. (2011) Fundamentals of petroleum and petrochemical engineering, CRC Press Mall, I. D (2007) Petrochemical processes technology, Macmillan India.
3. Rao, B. K. B (2009) Modern Petroleum refining processes 5th Ed, Oxford & IBH Publishing Company

PE 345 Prime Movers, Pumps and Compressors

Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	1	0	3	3	30	60	10	--	--	100

Unit I : Reciprocating Engines **Hours: 7**

Two & four stroke engines, engine cycles and their comparisons. Natural Aspirated and Supercharged engines. Carburetion and Fuel Injection systems including MPFI system Supercharging & Turbo Charging, Engine cooling and lubrication. Engine testing and performance Emission and control mechanism,

Unit II : Gas Turbine Engines **Hours: 7**

Fundamentals (Bayton cycle and Regeneration cycle) Combined cycle & waste heat recovery etc. Single and multi-shaft turbines Effects of intake compressor speed and air contamination

Unit III : Pumps **Hours: 7**

Pumps classification & types Advantages & disadvantages, Basic principles – head, HP, Net Positive Suction Head (NPSH), Selection criteria, Centrifugal multiple pump and stage installations and their characteristics. Pumping stations (series & parallel installations).Types of seal systems etc. Reciprocating pumps Pulsation dampening system, Various codes & standards

Unit IV : Compressors **Hours: 7**

Types, Advantages & disadvantages, Centrifugal Compressors, Specifying a compressor, Determination of HP & No of stages, Surge control & stonewalling, Reciprocating compressors, Components, Capacity control devices, Cooling & lubricating systems, API Specs; 11P & 618, Environmental Aspects:, Air pollution

Total Hours: 28

Texts and References:

1. Boyce, M. P. (2012) Gas turbine engineering Handbook, Elsevier
2. American Petroleum Institute (1995) Positive displacement pumps-resciprocating
3. Girdhar, P (2008) Performance evaluation of pumps and compressors, Lulu. com

PE 313 Seminar

Teaching Scheme					Examination Scheme		
L	T	P	C	Hrs/Week	Report writing	V/V	Total
0	0	4	2	4	80	20	100

Aim: To improve the presentation and inter-personal skill of the students