COURSE STRUCTURE FOR B.TECH. THIRD YEAR

SEMESTER VI		B.TECH. Third YEAR										
Course Code	Course Name	Teaching Scheme					Exam Scheme					
							Theory			Practical		Total
		L	T	P	C	Hrs/wk	MS	ES	IA	LW	LE/Viva	Marks
PE-308	Polymer Sciences and Technology	3	1	0	7	4	30	60	10	--	--	100
PE- 322	Contracts in Hydrocarbon Industry	2	0	0	4	2	30	60	10	--	--	100
PE- 310	Petrochemical Engineering - I	3	1	0	7	4	30	60	10	--	--	100
PE-311	Petroleum Refinery Engineering	3	1	0	7	4	30	60	10	--	--	100
PE-350	Design of Hydrocarbon Processes Equipment	3	1	0	7	4	30	60	10	--	--	100
PE-312P	Petroleum Product Testing Lab	0	0	2	1	2	--	--	--	25	25	50
MA- 301T	Advanced Numerical Methods	3	1	0	7	4	30	60	10	--	--	100
PE-313	Seminar	0	0	4	2	4	--	--	--	80	20	100
PE-323	Introduction to Research methodology	2	0	0	4	2	30	60	10	--	--	100
	Total	**19**	**5**	**6**	**46**	**30**						**850**

MS = Mid Semester, ES = End Semester; IA = Internal assessment (like quiz, assignments etc)

LW = Laboratory work; LE = Laboratory Exam

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	6	3	30	60	10	--	--	100

Unit 1: **12 Hrs**

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 2: **10 Hrs**

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 3: **10 Hrs**

Polymer Technology & Rheology: Polymer compounding-need and significance, different compounding ingredients for rubber and plastics, crosslinking 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. viscoelasticity-creep and stress relaxations, mechanical models, control of rheological characteristics through compounding, rubber curing in parallel plate viscometer, ODR and MDR.

Unit 4: **10 Hrs**

Polymer processing and testing: Compression molding, transfer molding, injection molding, blow molding, reaction injection molding, extrusion, pultrusion, calendaring, rotational molding, 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

Text Book

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 322 Contracts in hydrocarbon industry										
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	1	0	7	4	30	60	10	--	--	100

UNIT-I **5 HRS**

Historical background of the Oil and Gas trading, , Geopolitical history of Hydrocarbon exploration and trading, Life cycle of Petroleum Project, Fiscal System in hydrocarbon industry, Basic elements of Contracts, Basic terminologies of contract and legal. Basics of Upstream and Downstream regulatory Laws and Policies.

UNIT-II **12 Hrs**

Contracts in E & P Industry, Classification of contracts, Concession style, Sharing contracts- Production Sharing Contract, Terminologies, Attributes of PSC, Different PSC Models (Indonesian, Indian, Nigerian, Chinese, Equatorial New Guinea, etc). Risk Sharing Contracts, Joint Operating Agreements, JOA attributes, JOA Models, Farmout Agreements, Rig procurement contracts-Design and Fabrication aspects

UNIT-III **5 Hrs**

Elements of Transportation, Hydrocarbons transport, Contracts related to bougers, ship and pipeline, Tarrif mechanism- national and International, LNG contracts, LNG taxation and charges. Oil Tanker

UNIT- IV **6 Hrs**

Hydrocarbon trading-Oil trading, Physical and Paper; Crude oil Markets- Spot, Barter, Future and forward. Oil Pricing mechanism, short term and long term, Level playing and swaping. Hydrocarbon Strategic storage, Contract Arbitration and dispute settlement.

Total Hours: 42

1. Shippey, K. C. (2009) A short course on international Contracts, 4th Ed. World Trace press.
2. Tordo, S (2007) Fiscal System in Hydrocarbons: design issues. The World Bank
3. Ministry of P & G (Goverment of India) Model Production Sharing Contracts,
4. Johnston, D (1994) International petroleum fiscal system and Production sharing contracts, Penn Well books.

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	6	3	30	60	10			100

Unit 1:- **Hours: 12**

Introduction- Application of various components of Hydro Carbon, Major Industrial Application- Fertilizer, Power generation, Petrochemicals, Sponge iron, glass Industry, Ceramic Industry

Unit 2:- **Hours: 10**

Gas Foe Fertilizer Plant- use of Methane ($_{C1H4}$) ; Reforming of Methane; shift Conversion of Synthesis gas; Air Separation (Making Oxygen and Nitrogen); Ammonia Synthesis.

Unit 3:- **Hours: 10**

Urea Reaction in presence of Catalyst; G as for Petrochemicals- Use of Ethane($C_2 H_6$) ; Cracking of Ethane to Ethylene;

Unit 4:- **Hours: 10**

Polymerization; Product Slate(MDPE, LDPE,LLDPE,HDPE); Propane cracking; Market for polymers and application of polymer

Text Book **Total Hours: 42**

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

PE 323 Introduction to Research Methodology										
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	4	2	30	60	10	--	--	100

Unit – 1: Background **Hours: 7**

Motivation for research, building a background, role of a supervisor, time and energy management, solving a problem, writing a paper, publishing and reviewing a paper

Unit – 2: Quantitative Methods **Hours: 7**

Introduction to quantitative methods, statistics and research design, implementation of various statistical technique, research literacy, data gathering technique

Unit – 3: Critique **Hours: 7**

Finding a problem, solving a problem, writing a paper, publishing and reviewing of paper, scientific ethics, collaborative work, presentation skill.

Unit 4:- **Hours: 7**

Bibliometrics, Recognition, awards and prizes, research funding, Intellectual Property Right, Politics in Research environment.

Total Hours: 28

Texts and References:

1. Research Methodology: A step by step guide for beginners, SAGE publication.
2. Wayne C Both and Gregory G Colomb , The craft of research.
3. Robert K Yin, The Case Study Research : Design and Methods.

PE 311 Petroleum Refinery Engineering										
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	6	3	30	60	10	--	--	100

Unit – 1: Origin, Formation and Composition of Petroleum **Hours: 12**

Origin and Formation of Petroleum, Production Statistics, Reserves and Raw Materials, Composition of Petroleum

Unit- 2: Properties of Petroleum Fractions **Hours: 10**

Evaluation of Petroleum, Thermal Properties of Petroleum Fractions, Important products- Properties and Test Methods

Unit – 3: Fractionation of Petroleum **Hours: 10**

Dehydration and Desalting of Crudes, Distillation of Petroleum

Unit – 4: Treatment Techniques **Hours: 10**

Fractions- Impurities, Gasoline Treatment, Treatment of Kerosene, Treatment of Lubes
Wax and Purification Catalytic Cracking, Catalytic Reforming, Coking, Alkylation, Isomerisation Processes Air Blowing of Bitumen

Total Hours: 42

Texts and References:

1. Dr. B.K. Bhaskara Rao , Modern Petroleum refining Processes (5th Edition) .
2. Dr. B.K. Bhaskara Rao, A Text Book on Petro-Chemicals.
3. Marshall Sittig, Drden'S Outlines of Chemical Technology.
4. George T. Austin, Shrieve's Chemical Process Industries.

PE 312P Petroleum Product Testing Lab										
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2				25	25	50

Laboratory Courses: Practical classes shall be based on theory course content of the corresponding courses.

Aim: Theory courses which are taught will be practiced in the laboratory.

PE 313 Seminar							
Teaching Scheme					Examination Scheme		
L	T	P	C	Hrs/Week	Report writing	V/V	Total
0	0	2	2	2	80	20	100

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

PE 350 Design of Hydrocarbon process Equipments										
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	1	0	7	4	30	60	10			100

Unit 1: **10 Hrs**

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; pressure relief devices for pressure vessel; computer aided design of pressure vessels.

Unit 2: **8 Hrs**

Non-pressure storage tanks- type and design; design of tall vertical vessels; vessels supports type, selection and design.

Unit 3: **6 Hrs**

High-pressure vessels- theories of elastic failure, mono-block and multi-layer construction, materials of construction, enclosures for high-pressure vessels.

Unit 4: **18 Hrs**

Introduction to Flanges and gaskets-types, selection and design; nozzles and nozzle compensation
Process Design of Distillation Column
Process Design of Shell & Tube Heat Exchangers
Process Design of Gas-Liquid Separators (Vertical/Horizontal Separators)
Introduction to Pumps – Pump Characteristic Curves, NPSH

Total 42 Hrs

Reference Books:

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	7	4	30	60	10			100

UNIT 1 **10 Hours**

Numerical solution of Algebraic & Transcendental equations: 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 2 **10 Hours**

Finite Differences: 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 3 **15 Hours**

Numerical Differentiation: 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 4 **7 Hours**

Introduction to Finite Elements Methods: 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 42 Hours

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, 5th 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, 3rd edition, Narosa .
6. Numerical Methods for Engineers by S C Chapra , Raymond P. Canale, Tata McGraw Hill Pub. Co. Ltd.