UNIVERSITY DEPARTMENTS

ANNA UNIVERSITY CHENNAI : : CHENNAI 600 025

REGULATIONS - 2009

CURRICULUM I TO IV SEMESTERS (FULL TIME)

M.TECH. PETROLEUM REFINING AND PETROCHEMICALS

SEMESTER I

SL. NO	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	MA9120	Advanced Numerical Methods	3	1	0	4
2.	CL9111	Advanced Reaction Engineering	3	0	0	3
3.	CL9112	Advanced Transport Phenomena	3	0	0	3
4.	CL9113	Advanced Thermodynamics	3	0	0	3
5.	PP9111	Petroleum Refinery Engineering	3	0	0	3
6.	E1	Elective I	3	0	0	3
PRACTICAL						
7.	CL9116	Instrumental Methods of Analysis Lab	0	0	2	1
		TOTAL CREDITS	**18**	**1**	**2**	**20**

SEMESTER II

SL. NO	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	CL9121	Advanced Separation Processes	3	0	0	3
2.	CL9122	Advanced Process Control	3	0	0	3
3.	PP9121	Natural Gas Engineering	3	0	0	3
4.	PP9122	Petrochemicals	3	0	0	3
5.	E2	Elective II	3	0	0	3
6.	E3	Elective III	3	0	0	3
PRACTICAL						
7.	PP9125	Petroleum Testing Lab	0	0	2	1
		TOTAL CREDITS	**18**	**0**	**2**	**19**

SEMESTER III

SL. NO	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	CL9131	Process Modeling and Simulation	3	0	0	3
2.	PP9131	Catalyst Design & Application	3	0	0	3
3.	E4	Elective IV	3	0	0	3
PRACTICAL						
4.	PP9133	Project Work (Phase I)	0	0	12	6
		TOTALCREDITS	**9**	**0**	**12**	**15**

SEMESTER IV

SL. NO	COURSE CODE	COURSE TITLE	L	T	P	C
PRACTICAL						
1.	PP9141	Project Work (Phase II)	0	0	24	12
		TOTAL	**0**	**0**	**24**	**12**

TOTAL CREDITS TO BE EARNED FOR THE AWARD THE DEGREE = 66

LIST OF ELECTIVES

SL. NO	COURSE CODE	COURSE TITLE	L	T	P	C
1.	PP9151	Solvent Extraction	3	0	0	3
2.	PP9152	Environmental Engineering	3	0	0	3
3.	PP9153	Safety and Hazard Control	3	0	0	3
4.	PP9154	Energy Management	3	0	0	3
5.	PP9155	Polymer Technology	3	0	0	3
6.	PP9156	Industrial Instrumentation	3	0	0	3
7.	PP9157	Gas Transportation	3	0	0	3
8.	PP9158	Petroleum Economics	3	0	0	3

MA9120 ADVANCED NUMERICAL METHODS 3 1 0 4

UNIT I ALGEBRAIC EQUATIONS 6

Systems of linear equations – Jacobi, Gauss Seidel, SOR methods, Thomas algorithm for tridiagonal systems; Systems of nonlinear equations - successive approximation method, methods for improved convergence, Newton Method and its variants, continuation methods for multiple solutions.

UNIT II ORDINARY DIFFERENTIAL EQUATIONS – IVPs 6

Runge Kutta Methods, step size control and estimates of error, numerical stability, solution of stiff ODEs, ODE-IVPs coupled with algebraic equations;

UNIT III ORDINARY DIFFERENTIAL EQUATIONS – BVPs 12

Finite difference method, orthogonal collocation method, orthogonal collocation with finite element method, Galerkin finite element method, shooting technique.

UNIT I V PARTIAL DIFFERENTIAL EQUATIONS – FINITE DIFFERENCE METHOD 12

Parabolic equations – Different explicit and implicit methods, alternating direction explicit and implicit methods; Elliptic equations – Point iterative methods, line iterative methods, ADI methods; First order hyperbolic equations – method of characteristics, different explicit and implicit methods; numerical stability analysis, method of lines.

UNIT V PARTIAL DIFFERENTIAL EQUATIONS – FINITE ELEMENT METHOD 9

Partial differential equations – Finite element method - orthogonal collocation method, orthogonal collocation with finite element method, Galerkin finite element method.

TOTAL NUMBER OF PERIODS: 60

REFERENCE:

1. Gupta, S.K., Numerical Methods for Engineers, New Age Publishers, 1995
2. Jain, M. K., S. R. Iyengar, M. B. Kanchi, R. K. Jain, Computational Methods for Partial Differential Equations, New Age Publishers, 1993.

Curriculum

CL9111 ADVANCED REACTION ENGINEERING 3 0 0 3

UNIT I KINETICS OF HETEROGENEOUS REACTIONS 10

Catalytic reactions, rate controlling steps, Langmuir-Hinshelwood model, Rideal-Eiley mechanism, steady state approximation, noncatalytic fluid-solid reactions, shrinking and unreacted core model.

UNIT II EXTERNAL DIFFUSION EFFECTS IN HETEROGENEOUS REACTIONS 10

Mass and heat transfer coefficients in packed beds, quantitative treatment of external transport effects, modeling diffusion with and without reaction.

UNIT III INTERNAL TRANSPORT PROCESSES IN POROUS CATALYSTS 10

Interpellet mass and heat transfer, evaluation of effectiveness factor, mass and heat transfer with reaction.

UNIT IV ANALYSIS AND DESIGN OF HETEROGENEOUS REACTORS 15

Isothermal and adiabatic fixed bed reactors, non-isothermal and non-adiabatic fixed bed reactors. Two-phase fluidized bed model, slurry reactor model, trickle bed reactor model. Experimental determination and evaluation of reaction kinetics for heterogeneous systems

TOTAL NUMBER OF PERIODS: 45

REFERENCE:

1. Carberry, J. J., “Chemical and Catalytic Reaction Engineering”, Dover Publications, 2001.
2. Froment, G. F. and Bischoff, K. B., “Chemical Reactor Design and Analysis”, 2nd Edition, John Wiley & Sons, New York, 1997.

Curriculum

CL 9112 ADVANCED TRANSPORT PHENOMENA 3 0 0 3

UNIT I BASIC CONCEPTS 6

Phenomenological Equations and Transport properties, Rheological behaviour of fluids, Balance Equations – Differential and Integral equations.

UNIT II APPLICATIONS OF DIFFERENTIAL EQUATIONS OF CHANGE 6

Applications in laminar and Turbulent transport in compressible and incompressible fluids. Boundary layer theory.

UNIT III APPLICATIONS OF INTEGRAL EQUATIONS OF CHANGE 8

Macroscopic balance for isothemal and nonisothermal systems and their applications in Momentum, Heat and Mass transport problems.

UNIT IV INTERPHASE AND MULTIPHASE MOMENTUM TRANSFER 10

Friction factor, Fluid –Fluid systems, Flow patterns in vertical and horizontal pipes, Formulation of bubbles and drops and their size distribution, Solid – fluid systems, Forces acting on stagnant and moving solids, Flow through porous medium, Capillary tube model and its applications.

UNIT V INTERPHASE TRANSPORT IN NON-ISOTHERMAL 8

Heat Transfer coefficient, Forced convection in tubes, around submerged objects, Heat Transfer by free convection, film type and dropwise condensation and equations for heat transfer, Heat transfer in boiling liquids.

UNIT VI INTERPHASE MASS TRANSFER AND MACROSCOPIC BALANCES FOR MULTICOMPONENT SYSTEM 7

Mass Transfer co-efficient in single and multiple phases at low and high mass transfer rates, Film theory, Penetration theory, Boundary layer theory, Macroscopic balance to solve steady and Unsteady state problems.

TOTAL NUMBER OF PERIODS: 45

REFERENCES

1. Bird R.B., Stewart, W. E. and Lightfoot, E. N., “Transport Phenomena”, 2nd Edn., John Wiley and Sons, 2002.
2. Welty, J.R., Wicks, C. E. and Wilson, R. E., “Fundamentals of Momentum, Heat Mass Transfer”, 5th Edn., John Wiley and Sons, 2007.
3. Brodkey, R. S. and Hershey, H. C., “Transport Phenomena – A Unified Approach”, Brodkey Publishing, 2003.

Curriculum

CL 9113 ADVANCED THERMODYNAMICS 3 0 0 3

UNIT I BASIC CONCEPTS 9

Energy and first Law; Reversibility and second Law; Review of Basic Postulates, equilibrium criteria, Legendre Transformation and Maxwell's relations

UNIT II STABILITY AND PHASE TRANSITION 9

Stability of thermodynamic systems, first order phase transitions and critical phenomenon, phase rule, single component phase diagrams, thermodynamic properties from volumetric and thermal data

UNIT III MULTICOMPONENT MIXTURES 9

Partial molar properties, fugacities in gas and liquid mixtures, activity coefficients, Ideal and Non-ideal solutions, Gibbs-Duhem equation, Wilson, NRTL, and UNIQUAC equations, UNIFAC method,

UNIT IV PHASE EQUILIBRIUM 9

VLE - Equations of state, corresponding states, Henry's Law, lattice theory, criticality, high pressure VLE. Other phase equilibriums- SLE/LLE/VLLE

UNIT V CHEMICAL EQUILIBRIUM 9

Homogeneous gas and liquid phase reactions, heterogeneous reactions – phase and chemical equilibrium

TOTAL NUMBER OF PERIODS: 45

REFERENCES

1. Rao., Y.V.C., Chemical Engineering Thermodynamics, University Press, Hyderabad, 2005
2. Tester, J. W. and M. Modell, Thermodynamics and Its Applications. 3rd Edn. Prentice Hall, New Jersey, 1997.
3. Prausnitz, J.M., Lichtenthaler R.M. and Azevedo, E.G., Molecular thermodynamics of fluid-phase Equilibria, 3rd Edn, Prentice Hall Inc., New Jersey, 1999

Curriculum

PP9111 PETROLEUM REFINERY ENGINEERING 3 0 0 3

Unit I **9**

Origin, Exploration and production of petroleum, Types of crudes, Composition, characteristics, products pattern and characteristics, indigenous and imported crudes, Availability Vs Demands, Future outlook.

Unit II **9**

Engineering aspects of refining, Reaction stoichiometry; Chemical kinetics; Thermochemistry and chemical equilibrium; Mixuing in flow systems; Reactor design. Crude heating, Primary distillation, principles, Separation of cuts, Gaps/ overlaps, Stripping, Desalting, heat balance in distillation, Energy input and recovery, Vacuum distillation, Types of trays, Draw offs, intermediate product quality control.

Unit III **9**

Lube oil and wax processing, Solvent extraction, Dewaxing, Deciling, Deasphalting, Clay contacting, principles, technologies, operating parameters, Feed and product qualities and yields. Asphalt Manufacture, product qualities, Air blowing technology, Tankage operations, Storage and handling of crude products.

Unit IV **9**

Fluid catalytic cracking, principles, recent developments, Feedstocks and product yields and qualities, Catalysts and operating parameters.
Hydrocracking, principles, process requirements, product yields and qualities, Residcracking – implications and technology.

Unit V **9**

Catalytic reforming and Isomerisation, Reforming, Principles, developments in technology, Catalyst types and their performance, Effects of operating parameters, Feed quality, Product improvement; Sulphur removal, Aromatics removal, Hydrofinishing, Catalyst regeneration, Catalytic dewaxing. Environmental aspects of refining.

Total number of periods: 45

References

1. Nelson, W.L “Petroleum Refinery Engineering” McGraw Hill Publishing Company Limited, 1985.
2. Hobson, G.D. – Modern petroleum Refining Technology, 4th Edition, Institute of Petroleum U.K. 1973.
3. Smalheer, C.V and R.Kennedy Smith Lubricant Additives. The Lezius – Hill Company, Cleveland, Ohio. USA, 1987
4. Donald L.Katz and Robert L.Lee, Natural Gas Engineering, Mc Graw – Hill Publishing Company, NY, 1990.
5. Watkins, R.N “Petroleum Refinery Distillation”, 2nd Edition, Gulf Publishing Company, Texas, 1981.

Curriculum

CL9116 INSTRUMENTAL METHODS OF ANALYSIS LAB 0 0 2 1

LIST OF EXPERIMENTS

1. UV-Visible spectrophotometer
2. Infrared spectrophotometer
3. Gas chromatograph.
4. High performance liquid chromatograph
5. Atomic absorption spectrophotometer.
6. Flame photometer
7. Thermo gravimetric analyzer
8. Differential scanning calorimeter
9. Differential thermal analyzer

Total number of periods: 30

Curriculum

SEMESTER II

CL9121 ADVANCED SEPARATION PROCESSES 3 0 0 3

1. General 12

Review of conventional processes, recent advances in separation techniques based on size, surface properties, ionic properties and other special characteristics of substances. process concept, theory and equipment used in cross flow filtration, cross flow electrofiltration, dual functional filter, surface based solid-liquid separations involving a second liquid, sirofloc filter.

2. Membrane Separations 8

Types and choice of membranes, plate and frame, tubular, spiral wound and hollow fibre membrane reactors and their relative merits, commercial, pilot plant and laboratory membrane pemeators involving dialysis, reverse osmosis, nanofiltration, ultrafiltration, microfiltration and Donnan dialysis, economics of membrane operations, ceramic membranes.

3. Separation by Adsorption Techniques 8

Mechanism, types and choice of adsorbents, normal adsorption techniques, affinity chromatography and immuno chromatography, types of equipment and commercial processes, recent advances and process economics

4. Ionic Separations 8

Controlling factors, Applications, Types of equipment employed for electrophoresis, dielectrophoresis, Ion Exchange chromatography and electrodialysis, Commercial processes

5. Other Techniques 9

Separations involving lyophilization, pervaporation and permeation techniques for solids, liquids and gases, industrial viability and examples, zone melting, addiuctive crystallization, other separation processes, supercritical fluid extraction, oil spill management, industrial effluent treatment by modern techniques.

Total number of periods: 45

References

1. King, C. J., “Separation Processes”, Tata McGraw Hill Co., Ltd., 1982.
2. Nakagawal, O. V., “Membrane Science and Technology”, Marcel Dekker, 1992.
3. Rousseau, R. W., “Handbook of Separation Process Technology”, John Wiley, New York, 1987.
4. Humphrey, J and G. Keller, Separation Process Technology, McGraw-Hill, 1997

Curriculum

CL9122 ADVANCED PROCESS CONTROL 3 0 0 3

1. Advanced Control Strategies 9

Feed forward, cascade, dead time compensation, split range, selective and override control; automatic tuning and gain scheduling

2. Internal Model Control 9

Model based control – IMC structure – development and design; IMC based PID control

3. Multivariable Control 9

Control loop interaction – general pairing problem, relative gain array and application, sensitivity. Multivariable control – zeros and performance limitations, directional sensitivity and operability, decoupling

4. Discrete Systems 9

Z – Transform and inverse Z – transform properties, Discrete – Time Response of dynamic system, Pulse Transfer Function, Closed Loop System Stability.

5. Digital Feedback Controllers 9

Design of digital feedback controllers, digital approximation of classical, effect of sampling, Dahlin's algorithms, Dead – beat algorithm, ringing, IMC algorithm, simplified model predictive algorithm.

Total number of periods: 45

References

1. Bequette, B. W., Process Control: Modeling, Design, and Simulation, Prentice Hall, 2003
2. Stephanopolous, G., "Chemical Process Control", Prentice Hall of India, New Delhi, 1985.

Curriculum

PP9121 NATURAL GAS ENGINEERING 3 0 0 3

Unit I **9**

Availability of natural gas, Properties and composition, Exploration and control of gas, output, Estimation of availability quantity.

Unit II **9**

Natural gas application in Chemical Process and transportation industry LNG technology, Natural gas storage and transport, Economics of natural gas utilization.

Unit III **9**

General Hydrodynamic equations for flow of fluids through porous media, two dimensional flow problems and potential theory methods, gravity flow systems, systems of non uniform permeability, multiple well systems using computerized streamline tracking methods.

Unit IV **9**

Use of multiphase flow correlations to determine flow ratio and pressure traverse in flowing oil wells, gas condensate wells, gathering systems and pipe lines, application of correlations to the design of gas system

Unit V **9**

Reservoir fluid properties – PVT properties for oil gas systems, phase Behavior of complex hydrocarbon mixtures at high temperature and pressure - thermodynamic property evaluation, packages used in petroleum industry.

Total Number of periods: 45

References

1. Donald L.Katz and Robert L.Lee, Natural Gas Engineering, Mc Graw – Hill Publishing Company, NY, 1990.
2. Speight, J.G Fuel Science and Technology Handbook, Marcel Decker Inc. 1990.
3. Guide to Natural Gas Utilization Technologies, Fairmount Press Inc. 1987.
4. Lom. W.L and A.F. Williams, Substitute Natural Gas, Kalstod Willey, New York, 1976.
5. Dermott, M.C. Liquified Natural Gas Technology, Neysos Park Ridge, N.J. 1973.
6. M.J. Econonides A.Daniel “Petroleum Production Systems”, Prentice Hall Petroleum Engineering series 1999.
7. Michael J.Economides, A.Daniel Hill and Christine Ehlig – Economides, Petroleum Production Systems, PTR Prontice Hall, NJ, 1993.
8. Dring, M.M – The Natural Gas Industry – A review of World Resources and Industrial Applications, Butterworth, London, 1974.

Curriculum

PP 9122 **PETROCHEMICALS** **3 0 0 3**

Unit I **9**

Overview of petrochemical industrial Growth in India, Economics, Feedstock Selection for Petrochemicals

Unit II **9**

Steam reforming, Hydrogen, Synthesis gas, cracking of gaseous and liquid for stocks, Olefins, Diolifins, Acetylene and Aromatics and their separation.

Unit III **9**

Alkylation, Oxidation, Dehydrogenation, Nitration, Chlorination, Sulphonation and Isomerization

Unit IV **9**

Chemicals from synthesis gas, Olefins, Diolefins, Acetylene and Aromatics.

Unit V **9**

Modes and techniques, Production of Polyethylene, PVC, Polypropylene, SAN, ABS, SBR, Polyacrylonitrile, Polycarbonates, Polyurethane, Nylon, PET.

Total number of periods: 45

References

1. Brownstein A.M. Trends in Petrochemical Technology, Petroleum Publishing Company, 1976.
2. Sitting M., Aromatics Hydrocarbons, Manufacture and Technology, Noyes Data Corporation, 1976.
3. Stevens P.M. Polymer Chemistry, Addison Wesley Publishing Company, 1975.
4. Hatch F. and Sami Mater, “From Hydrocarbon to Petrochemicals”, Gulf Publishing Company, Texas 1998.
5. Petrochemical Hand book Hydrocarbon Processing 1988, 1989.

Curriculum

PP9125 **PETROLEUM TESTING LAB** **0 0 3 1**

LIST OF EXPERIMENTS

1. Determination of flash point
2. Viscosity Determination
3. Aniline point determination
4. API gravity determination
5. Determination of aromatic content
6. Hydrogen sulphide content determination
7. Sulphur content determination
8. Determination of calorific value
9. Bitumen testing
10. Carbon residue determination (Conradson apparatus)
11. Cloud point and pour point estimation
12. Cgealing point of wax
13. Foaming characteristics of lube oil
14. Smoke point estimation
15. Corrosion testing of petroleum oil
16. API distillation apparatus
17. Moisture determination other than Karl-Fischer method

Minimum of 10 experiments

Curriculum

SEMESTER III

CL 9131 PROCESS MODELLING AND SIMULATION 3 0 0 3

1. Introduction 3

Introduction to modeling and simulation, classification of mathematical models, conservation equations and auxiliary relations.

2. Steady State Lumped Systems 9

Degree of freedom analysis, single and network of process units, systems yielding linear and non-linear algebraic equations, flowsheeting – sequential modular and equation oriented approach, tearing, partitioning and precedence ordering, solution of linear and non-linear algebraic equations.

3. Unsteady State Lumped Systems 9

Analysis of liquid level tank, gravity flow tank, jacketed stirred tank heater, reactors, flash and distillation column, solution of ODE initial value problems, matrix differential equations, simulation of closed loop systems.

4. Steady State Distributed System 7

Analysis of compressible flow, heat exchanger, packed columns, plug flow reactor, solution of ODE boundary value problems.

5. Unsteady State Distributed System 11

Analysis laminar flow in pipe, sedimentation, boundary layer flow, conduction, heat exchanger, heat transfer in packed bed, diffusion, packed bed adsorption, plug flow reactor, hierarchy in model development, classification and solution of partial differential equations.

6. Other Modelling Approaches 6

Empirical modeling, parameter estimation, population balance and stochastic modeling.

Total number of periods: 45

References

1. Ramirez, W., "Computational Methods in Process Simulation", 2nd Edn., Butterworths, New York, 2000.
2. Luyben, W.L., "Process Modelling Simulation and Control", McGraw-Hill Book Co., 1973.
3. Felder, R. M. and Rousseau, R. W., “Elementary Principles of Chemical Processes“, John Wiley, 2000.
4. Franks, R. G. E., “Mathematical Modelling in Chemical Engineering“, John Wiley, 1967.

Curriculum

PP9131 CATALYST DESIGN AND APPLICATION 3 0 0 3

1. Catalysis and catalytic Kinetics 9

General definition of catalysts, illustration of a catalytic a process, Design for catalysts – Primary constitutents, secondary constituents; Catalyst supports-choice of support material, texture and strength of support materials; Chemical interaction, Deactivation steps involved in global catalytic rate.

2. Adsorption-Diffusion and Heterogeneous Catalysis 9

Adsorption and Heterogeneous Catalysis – the geometrical factor in Catalysis; Electron structure of catalysts; Chemical properties of surfaces; Theories and Adsorption; Semiconduction and catalysts; Defect structure in crystal lattices, Thermodynamics abasics of catalysis; Adsorption studies – Fischer – Tropsh catalysts, synthetic ammonia catalysts, methanol synthesis catalyst. Diffusion and Heterogeneous Catalysis

3. Production of some catalysts: 9

Precipitation method – Alumino silicate catalyst, Barium alumino vanadium contact mass, production of tabletted chromium catalysts for the conversion of CO., Production of Cadmium – Calcium Phosphate catalysts for the synthesis of acetaldehyde from acetylene. Mechanical mixing method. Fused-skeleton contact masses – Platinum network catalysts of Ammonia oxidation, iron catalysts of Ammonia synthesis, fused vanadium pentoxide, catalysts of natural clays, zeolites and iron exchange resins, natural catalysts and their activation, zeolite catalysts.

4. Methods of studying catalysts 9

Methods of determining catalysts activity – static methods, flow (dynamic) method; Study of structure – adsorption for determining catalsyst surface and pore radii; Mercury porosimetry, determination of true and apparent densities of catalysts; Structural study of electron microscopy, determination of mechanical strength of catalysts-static methods, dynamic methods; Methods of thermal analysis.

5. Analysis and Design of Heterogeneous Catalytic Reactors 9

Fixed bed reaction, continuity equations, reactor parameters. Reaction significance of dimensionless parameters, Chemical dimensionless parameters, physical diemensionless parameters, radial peclet number for heat and mass transfer, Biot numbers. Adiabatic fixed bed reactor .Reactor yield, non isothermal, non adiabatic fixed bed. Fluidixed bed catalytic reactor; slurry reactors – Analysis of first order slurry reaction systems; Selectivity in slurry reactors; catalytic – gaue reactor, trickle bed reactors, batch fluid bed reactor, moving bed continuous fluid bed reactor.

Total Number of Periods : 45

References:

1. Carbery – J.J. Chemical and Catalytic, Reaction Engineering, McGraw – Hill Book Co., NY, 1986.
2. Muchlyonor I, Dobkina E.,.Deryozhkina V,.and Sorco V., Catalyst Technology – Catalyst Technology MIR Publication, Moscow, 1982.
3. Trimm D.L., Design of Industrial catalsysts, Elsevier Scientific Publishing Company, Amsterdam – Oxford – New York, 1986.

4. Fremont G.F. and Bischoff K.B. Chemical Reactor Analysis and Design – John-Wiley and Sons NY, 1990.
5. Webterp K.R. Vanswaaij and Beenackers ACM, Chemical Reactor Design and Operations, Wiley, NY 1987.
6. Fogler S. Elements of Chemical Reaction Engineering" Prentice – Hall NJ, 1992.
7. Chemical and Catalytic Reaction Engineering – Vol.1 & Vol.2 Edited by L.K.Duraiswamy & R.A. Mashlekar, National Chemical Laboratories, Pune, Wiley Eastern Limited, New Delhi, 1987.
8. Chen N.H. Process Reactor Design, Allyn & Bacon, Boston, 1983.

Curriculum

PP9133 PROJECT WORK (PHASE I) 0 0 12 6

Students have to do a research-based project in the department or in an industry and submit a report at the end of Phase I

Curriculum

SEMESTER IV

PP9141 PROJECT WORK (PHASE II) 0 0 24 12

Phase II of Project Work is a continuation of Phase I of Project. Students submit a report at the end of Phase II.

Curriculum

ELECTIVES

PP9151 SOLVENT EXTRACTION 3 0 0 3

1. Equilibrium In Liquid-Liquid System 12

Binary and ternary liquid equilibria, Tie-lines, Critical solution temperature, Tie line correlations ,Contour/prism diagrams, Binary / Ternary prediction methods of activity coefficient, Theory and Prediction of diffusivity in liquids, Theory of interphase mass transport, Estimation and prediction of mass transport coefficients

2. Differential / Stage-Wise Equilibrium Contact Operations 9

Equilibrium stage-wise contact, Single and multiple contacts with co-current and counter current flow of phases for immiscible and partially miscible solvent phases , Calculation methods, Fractional extraction with reflux of raffinate and extract. Differential contact, HETS, NETS, HTU, NTU concepts and Estimation of these parameters, Mass transfer efficiency, Axial mixing and Residence time distribution in extractors and their estimation.

3. Dispersion and Coalescence in Extractors 12

Characteristics of dispersion involving single and multiple nozzle distributors, Drop size and formation and coalescence, Mean drop size at dispersion and their settling velocities/relative characteristics velocities. Effect of drop oscillation ,wobbling and Internal circulation, Effect of surface active agents, Prediction of drop size and characteristics velocity in spray , packed and mechanically agitated contactors as in RDC, pulsed columns, solute transfer effects on drop dynamics.

4. Design Of Liquid Extraction Columns 12

Design of extractor height and diameter, Prediction of flow capacities in terms of flooding rates, Regime of operating envelops, Hydrodynamic design variables such as hold up, characteristic velocities, pressure drop, Effect of direction of solute transfer on these variables and their prediction methods, Correction of mass transfer data, Axial mixing correction for column height, Interfacial area estimations, using slow, fast and instantaneous reactions and their application with models for mass transfer coefficients.

Total number of periods: 45

References:

1. Laddha, G. S. and Degaleesan, T. E., ”Transport Phenomena in Liquid Extraction”, Tata McGraw Hill, New Delhi, 1976.
2. Hanson, C., Baird, M. H. I. and Lo, T. C., “Hand Book of Solvent Extraction”, Wiley – International, New York, 1983.
3. Hanson, C., “Recent Advances in Liquid Extraction”, Pergamon Press, London, 1972.
4. Treybal, R. E., “Liquid Extraction”, McGraw Hill, New York, 1963.

Curriculum

PP9152 ENVIRONMENTAL ENGINEERING 3 0 0 3

1. Environment awareness 9

Environment – friendly chemical Process; Hazard and risk analysis; Environmental Audit,

2. Chemical Engineering Processes 9

Unit Operations – application of - Abatement of water pollution; Current strategies to control air pollution; Disposal of solid wastes

3. Recycling Methodology 9

Economic recovery and recycling of waste; Transport fuel- Bio-diesel for a cleaner environment.

4. Clean Technology 9

Towards Eco- friendly products of chemical industry; Pesticides –Their transfer and Transformation in the environment, Biological and electrochemical technology for effluent treatments

5. Pollution Prevention 9

Mass exchange network synthesis for pollution control and minimization Implications of environmental constraints for process design, policies for regulation of environmental impacts, Concept of common effluent treatment; Environmental legislations, Role of Government and Industries

Total Number of periods : 45

References

1. Rao, C.S Environmental Pollution control Engineering, Wiley- Eastern Ltd. 1991.
2. Peavy H.S. Rowe D.R., and George Technologious, Environmental Engineering, Mc Graw Hill Book Company, Ny, 1985.
3. Rao M.N and H.V.N. Rao. "Air pollution" ,Tata McGraw Hill Publishing Co. Ltd.1989.
4. Theodore L and Buomlore A.J Air pollution control equipments. Prentice Hall Inc, NY. 1982.
5. Coulson, J.M. Richardson, J.F and R.K Sinnott, Chemical Engineering Vol. 6, Pergomon Press, 1989.
6. Gilbert M.Mastrs, Introduction to Environmental Engineering and Science, Prentice- Hall of India, New Delhi, 1994.
7. Wahi S.K., Agnihotri A.K and Sharmma J.S (Editors) Environmental Management in Petroleum Industry, Wiley Eastern Ltd., New Delhi 1996.
8. Smith, R., "Chemical Process Design", McGraw Hill, New York, 1995.

Curriculum

PP9153 SAFETY AND HAZARD CONTROL 3 0 0 3

Unit I **9**

Conventional and modern concepts of safety, Basic Principles and concepts in hazard identification, Chemical hazards, Process and operation hazard, Hazards from utilities like air, water, steam etc., Occupational health hazards, Hazard and operability Studies, Safety Audits.

Unit II **9**

Past Accident Analysis, Consequence Analysis of fire, gas/vapour, Dispersions and explosion, Vulnerability models, Fault and Event Tree Analysis.

Unit III **9**

Safety in plant design and layout. Risk Assessment

Unit IV **9**

Safety measures in handling and storage of chemicals, Process plant, personnel Protection, First Aid.

Unit V **9**

Disaster mitigation, Emergency Preparedness plans.

Total Number of periods: 45

References

1. Well, G.S Safety Process Plants Design, George Godwin Ltd., London, John Wilelys and Sons, New York, 1980.
2. Safety in Chemical and Petrochemical Industries, Report of the Inter Ministry Group, Dept. of Chemicals and Petrochemicals, Govt.of India, ICMA Publications. 1986.
3. Major Hazard Control, Manual by International Labour Organization, Geneva, 1990.
4. Frank P.Less, Loss Prevention in Process Industries, Vol. I and Vol II Butterworth, London, 1980.
5. Marshal, V.C Major Chemical Hazards, Ellis Harwood Ltd. Chichester, U.K. 1987.
6. Guidelines for Chemical Process Quantitative Risk Analysis, Published by Centre for Chemical Process Safety of the AICh.E., New York, USA. 1989.
7. Raghavan, K.V and A.A Khan, Methodologies in Hazard Identification and Risk Assessment, Manual by CLRI., Dec, 1990.
8. R.K.Sinnott, Coulson & Richardson's Chemical Engineering, Vol.6 Butlerworth – Heinmann. Oxford, 1996.
9. Coulson J.M and Richardson J.F., Chemical Engineering, Vol. 1 (Chaper 4) Asian Book House Pvt. Ltd., New Delhi. 1998.

Curriculum

PP9154 ENERGY MANAGEMENT 3 0 0 3

Unit I **9**

Energy Resources – Conventional – Non conventional, Energy Reserves and Depletion, Non renewable energy sources.

Unit II **9**

Power generation by steam, Hydroelectric, Diesel oil, Nuclear fission and Natural gas, Co-generation of power. Selection of power generation process, Economical and technical efficiency of power generation, Socio economic factor affecting consumption of power by various methods, Design and safety equipments

Unit III **9**

Renewable sources of energy, Thermal and power generation using water, wind, seawave, Solar energy, Geothermal and biomass utilization.

Unit IV **9**

Energy consumption, Demand pattern, energy planning – Short term and long term, Energy conservation – need for, Energy recovery, various types of Energy audit – advantages

Unit V **9**

Recovery of waste heat, optimum shell and tube heat exchanger, heat exchanger network, evaporator systems, boiler, turbo generator system

Total Number of periods : 45

References:

1. Francis, W. and M.C. Peter – Fuels and fuel technology, Pergamon Press, 1980.
2. Nagpal, G.R – Power Plant Engineering, Khanna Publishers, 1973.
3. Loftiness, R.L. – Energy Hand Book, Van Nostrand Reinhold Company, New York, 1978.
4. Edgar R.F. and Himmelblau, Optimization of Chemical Process, McGraw Hill Book Co., NY, 1989.

Curriculum

PP9155 POLYMER TECHNOLOGY 3 0 0 3

Unit I **9**

Introduction to various Polymer Processing methods & Machinery Morphology and structure of Polymers

Unit II **9**

Screw Extrusion – Geometry of screw – Simplified Flat plate Model; rectangular channel model; cylindrical Channel Model; Helical Channel Model; Newtonian and Non-Newtonian flows; isothermal, non-isothermal and adiabatic Models

Unit III **9**

Injection Moulding Various parts of the moulds; Analysis of flow through mould Cavity; various Models; Balancing of runners

Unit IV **9**

Newtonian and non-Newtonian models; Calendar fed with finite sheet; normal stress and viscosity effects, coating – Mixing operations

Unit V **9**

Knowledge based expert systems for modeling of polymer processing

Total Number of periods : 45

References

1. Agassant, J.F. Avenas, P, Sergant, J,Ph., and Correon, P.J. “Polymer Porcessing” – Carl Hamsen Verlag Munich, 1991.
2. Tucker C.L, “Fundamentals of Computer Modelling for Polymer Processing”, Carl Hamsen Verlag, Munich, 1989.

Curriculum

PP9156 INDUSTRIAL INSTRUMENTATION 3 0 0 3

Unit I **5**

Introduction – Variables, Units & standards of measurement, Measurement terms – characteristic. Data Analysis.

Unit II **12**

Process Variables Measurement–Temperature systems– Thermocouples, Thermo resistive system, Filled-system thermometers, Radiation thermometry, Location of temperature measuring devices in equipments, Pressure system – Mechanical pressure elements Pressure Transducers and Transmitters, Vacuum measurement, Resonant wire pressure Transducer, Flow system – Differential producers, Variable area flow meters, Velocity, vortex, mass, ultrasonic & other flow meters, positive displacement flow meters, Open – channel flow measurements, Force systems, Strain gauges Humidity Moisture system, Humidity Measurement, Moisture measurement system, Rheological system, Viscosity measurement, Radiation system, Nuclear radiation instrumentation.

Unit III **12**

Analytical instrumentation – Analysis instruments, Sample conditioning for process analyzers, X-ray Analytical methods, Quadrupole mass spectrometry, Ultra violet Absorption Analysis, Infra red process analyzers, Photometric reaction product analysers Oxygen analyzers, Oxidation – reduction potential measurements, pH measuring systems, Electrical conductivity and Resistivity measurements, Thermal conductivity, gas analysis, Combustible, Total hydro carbon, and CO analyzer, Chromatography.

Unit IV **9**

Fundamentals of Automatic process control – Control algorithms-Automatic controllers – Electronic controllers -Electric controllers (Traditional) - Hydraulic controllers – Fluidics - Programmable controllers.

Unit V **7**

Sensors, Transmitters and control valves - Pressure, Flow, Level, Temperature and Composition sensors, Transmitters, Pneumatic and electronic control valves, Types, Actuator, accessories, Instrumentation symbols and Labels.

Total Number of periods : 45

References:

1. Fribance "Industrial Instrumentation Fundamentals" ,Mc Graw Hill Co. Inc. New York 1985
2. Eckman D.P. "Industrial Instrumentation", Wiley Eastern Ltd., 1989.
3. Considine D M and Considine G D "Process Instruments Controls" Handbook 3rd Edition , McGraw – Hill Book Co., NY, 1990.
4. Scborg D E,.Edgar T.F and Mellichamp D.A, "Process Dynamics and Control" John Wiley 1989.
5. Ernest Doebelin, Measurement systems, McGraw – Hill Book, Co., NY, 1975.
6. Astrom K.J., Bjon wittenmark, Computer controlled systems, Prentice- Hall of India, New Delhi 1994.
7. Cartis Johnson, Process Control Instrumentation Technology, Prentice-Hall of India, New Delhi 1993.

Curriculum

PP9157 **GAS TRANSPORTATION** **3 0 0 3**

UNIT I

Introduction, widespread use, the various types, the advantages and the special features of pipelines.

UNIT II

The fluid mechanics of various types of pipe flow including incompressible and compressible flows of Newtonian fluids, non-Newtonian fluids, flow of solid/liquid mixture (slurry), flow of solid/air mixture (pneumatic transport), and flow of capsules (capsule pipelines).

UNIT III

Various types of pipes (steel, concrete, PE, PVC, etc.), valves (gate, globe, ball, butterfly, etc.) and pressure regulators in pipelines. Blowers and compressors (for gases). Various kinds of flowmeters, sensors, pigs (scrapers) and automatic control systems used in pipelines.

UNIT IV

Various means to protect pipelines against freezing, abrasion and corrosion, such as cathodic protection, Planning, construction and operation of pipelines, including modern use of advanced technologies such as global positioning systems (GPS), directional drillings, automatic control using computers, and pipeline integrity monitoring such as leak detection.

UNIT V

Structural design of pipelines —load considerations and pipe deformation and failure. Economics of pipelines including life-cycle, Cost analysis and comparison of the cost-effectiveness of pipelines with alternative modes of transport such as truck or railroad. Legal, safety and environmental issues about pipelines.

References

1. Liu, H., R. L. Gandhi, M. R. Carstens and G. Klinzing, "Freight pipelines: current status and anticipated use,"(Report of American Society of Civil Engineers (ASCE) Task Committee on freight Pipelines), ASCE J. of Transportation Engr., **vol. 124**, no. 4, pp.300-310, Jul/Aug 1998.

2. Liu, H and T. Marrero, "Pipeline engineering research and education at universities in the United States," C.D. Proc. of Intl. Conf. on Engr. Education (ICEE-98), Rio de Janeiro Brazil, 15 pages, August 17-20, 1998.

Curriculum

PP9158 **PETROLEUM ECONOMICS** **3 0 0 3**

UNIT I

Introduction to upstream economics analysis, energy overview of India – Time value of money, cash flow analysis, capital budgeting techniques, general probability, elements of oil and gas project cash flows.

UNIT II

Reserves classification methods, quantification, assessment of geoscience and reservoir engineering uncertainties – Assessment of reserves, production and demand in international market.

UNIT III

Inflation and cost escalation, oil market and OPEC, share of non OPEC countries in oil production – International oil and gas pricing mechanism – Geopolitics.

UNIT IV

Petroleum Fiscal system, classification and analysis – Reserves Auditing – Accounting systems for oil and gas.

UNIT V

Project Economic Evaluation and petroleum economic models – Decision analysis – Valuation of petroleum properties.

References

1. Abdel-Aal, H. K. Bakr, A. B. Al-Sahlawi. A : Petroleum Economics and Engineering, Dekrer Publication, 1992
2. Cronquist, C., Estimation and classification of Reserves of Crude oil, Natural Gas, and Condensate, SPE (2001)
3. Johnston, D, “International Exploration Economics, Risk, and Contract Analysis”, Pennwell Books, 2003.
4. Seba R. D., “Economics of Worldwide Petroleum Production”, OGCL Publications, USA, 1998.
5. Thompson R. S. and Wright J. D., “Oil Property Evaluation”, 2nd Edition, Thompson-Wright Associates, 1985.

Curriculum