BHAGWANT UNIVERSITY
Sikar Road, Ajmer
Proposed Syllabus of M.Tech in Petro-Chemical Engineering

COURSE EDUCATIONAL OBJECTIVES (CEOs) :

1. To create mastery of the basic principles of engineering science that underlies modern chemical process principles used in petroleum industries.
2. To make employable process engineers in refinery fields and to work towards the development of sustainable technologies in petroleum and allied industries.
3. To function effectively in the complex modern work environment with the ability to assume professional leadership roles.
4. To exhibit professional, ethical codes of conduct, team work and continuous learning for catering the ever changing needs of the society.

COURSE OUTCOMES (COs)

On successful completion of this course, the students will have the

1. Ability to apply knowledge of mathematics, Science and Engineering.
2. Ability to design a system, component, or process to meet desired needs with realistic constraints such as economical, environmental, social, ethical, health, safety, manufacturability and sustainability
3. Ability to conduct experiments, analyze and interpret data.
4. Capacity to formulate and solve complex problems associated with refinery fields based on the realistic situation.
5. Ability to identify the impact of engineering solutions in a global, economic, and societal context.
6. Ability to communicate effectively by conveying technical material through bothformal written medium and also through oral presentations.
7. Ability to use the techniques, skills, and modern engineering tools necessary for engineering practices especially in petroleum and allied industries.
8. The competency in utilizing the available resources effectively and optimally.
9. Knowledge on the importance of professional and ethical responsibilities in an organization.
10. Inclination towards acquiring knowledge on the latest developments in the field of petroleum refining and petrochemicals**.**

Course Educational Objectives	Course Outcomes									
	CO1	CO2	CO3	CO4	CO5	CO6	CO7	CO8	CO9	CO10
I	√	√	√	√	√	√	√			
II		√	√	√		√				√
III		√	√	√	√	√		√		
IV		√			√	√			√	√

SEM	Name of Subject	CO1	CO2	CO3	CO4	CO5	CO6	CO7	CO8	CO9	CO10
I-Sem	i. Environmental Health And Safety In Industries	√	√	√		√			√		√
	ii. Advance Numerical Method Analysis	√		√							
	Petroleum Thermodynamics	√	√	√	√			√			
	Petroleum Refinery Engineering	√	√	√	√			√			
	Elective-I										
II-Sem	Advance Production Engineering	√	√	√	√			√	√		
	Petrochemical Engineering	√	√	√	√			√	√		
	Advance Mass Transfer Engineering	√	√	√	√						
	Elective-II										
III-Sem	Advance Chemical Reaction Engineering	√	√	√	√			√			
	Modeling And Simulation Of Industrial Process	√	√	√	√			√			
	Minor Project	√	√			√	√			√	√
	Dissertation stage-I	√	√			√	√			√	√
IV-Sem	Dissertation stage-II	√	√			√	√			√	√

BHAGWANT UNIVERSITY
Sikar Road, Ajmer

Proposed Syllabus of M.Tech in Petro-Chemical Engineering

SEMESTER I

Subject Code	Name of Subject	Teaching Period			Credit Points
		L	T	P	
01MPCE101	1. Environmental Health And Safety In Industries 2. Advance Numerical Method Analysis	4	1	0	5
01MPCE102	Petroleum Thermodynamics	4	1	0	5
01MPCE103	Petroleum Refinery Engineering	4	1	0	5
01MPCE104	Elective-I	4	1	0	5
01MPCE 201	Instrumental methods of analysis lab	0	0	5	3
01MPCE301	Discipline and Co Curricular activities	0	0	4	1
	Total	12	8	4	24

SEMESTER II

Subject Code	Name of Subject	Teaching Period			Credit Points
		L	T	P	
02MPCE101	Advance Production Engineering	4	1	0	5
02MPCE102	Petrochemical Engineering	4	1	0	5
02MPCE103	Advance Mass Transfer Engineering	4	1	0	5
02MPCE104	Elective-II	4	1	0	5
02MPCE 201	Petroleum Testing Lab	0	0	5	3
02MPCE301	Discipline and Co Curricular activities			4	1
	Total	12	8	4	24

SEMESTER III

Subject Code	Name of Subject	Teaching Period			Credit Points
		L	T	P	
03MPCE101	Advance Chemical Reaction Engineering	4	1	0	5
03MPCE102	Elective-III	4	1	0	5
03MPCE201	Minor Project	5	0	0	5
03MPCE202	Dissertation stage-I	0	0	5	5
03MPCE301	Discipline and Co Curricular activities	0	0	4	1
	Total	16	4	1	21

SEMESTER IV

Subject Code	Name of Subject	Teaching Period			Credit Points
		L	T	P	
04MPCE201	Dissertation satge-II a) Continuous Evaluation b) Project Report c) Voice-Viva	0	0	5 5 6	5 5 6
04MPCE301	Discipline and Co Curricular activities	0	0	4	1
	Total	16	0	1	17

CHOICE BASED CREDIT SYSTEM

Subject Code		Name of Subject	Teaching Period			Credit Points
			L	T	P	
Foundation Course (FC)						
01MPCE101		Environmental Health And Safety In Industries	4	1	0	5
01MPCE101		Advance Numerical Method Analysis	4	1	0	5
Professional Course (PC)						
01MPCE102		Petroleum Thermodynamics	4	1	0	5
01MPCE103		Petroleum Refinery Engineering	4	1	0	5
02MPCE101		Advance Production Engineering	4	1	0	5
02MPCE102		Petrochemical Engineering	4	1	0	5
02MPCE103		Advance Mass Transfer Engineering	4	1	0	5
03MPCE101		Advance Chemical Reaction Engineering	4	1	0	5
Professional Elective Course (PEC)						
Elective I	01MPCE104.1	Corrosion Engineering	4	1	0	5
	01MPCE104.2	Waste Management and Energy Recovery	4	1	0	5
	01MPCE104.3	Separation Process Techniques	4	1	0	5
	01MPCE104.4	Solvent Extraction	4	1	0	5
Elective II	02MPCE104.1	Multiphase Flow	4	1	0	5
	02MPCE104.2	Petroleum Economics	4	1	0	5
	02MPCE104.3	Process Optimization	4	1	0	5
	02MPCE104.4	Gas Transportation	4	1	0	5
Elective III	03MPCE102.1	Fluidization Engineering	4	1	0	5
	03MPCE102.2	Modeling And Simulation Of Industrial Process	4	1	0	5
Employability Enhancement Course (EEC)						
03MPCE201		Minor Project	5	0	0	5
03MPCE202		Dissertation stage-I	0	0	5	5
04MPCE201		Dissertation stage-II d) Continuous Evaluation e) Project Report f) Voice-Viva	0	0	5 5 6	5 5 6

SEMESTER-I

01MPCE 101.1 ENVIRONMENTAL HEALTH AND SAFETY IN INDUSTRIES

OBJECTIVE

To illuminate the importance of environmental health and safety in industries besides the necessity for education and training at work place.

UNIT I

INTRODUCTION

Need for developing Environment, Health and Safety systems in work places. Status and relationship of Acts, Regulations and Codes of Practice .Role of trade union safety representatives. International initiatives. Ergonomics and work place.

UNIT II

OCCUPATIONAL HEALTH AND HYGIENE

Definition of the term occupational health and hygiene. Categories of health hazards. Exposure pathways and human responses to hazardous and toxic substances. Advantages and limitations of environmental monitoring and occupational exposure limits. Hierarchy of control measures for occupational health risks. Role of personal protective equipment and the selection criteria. Effects on humans, control methods and reduction strategies for noise, radiation and excessive stress.

UNIT III

WORKPLACE SAFETY AND SAFETY SYSTEMS

Features of the satisfactory design of work premises HVAC, ventilation. Safe installation and use of electrical supplies. Fire safety and first aid provision. Significance of human factors in the establishment and effectiveness of safe systems. Safe systems of work for manual handling operations. Control methods to eliminate or reduce the risks arising from the use of work equipment. Requirements for the safe use of display screen equipment. Procedures and precautionary measures necessary when handling hazardous substances. Contingency arrangements for events of serious and imminent danger.

UNIT IV

TECHNIQUES OF ENVIRONMENTAL SAFETY

Elements of a health and safety policy and methods of its effective implementation and review. Functions and techniques of risk assessment, inspections and audits. Investigation of accidents- Principles of quality management systems in health and safety management. Relationship between quality manuals, safety policies and written risk assessments. Records and other documentation required by an organisation for health and safety. Industry specific EHS issues.

UNIT V

EDUCATION AND TRAINING

Requirements for and benefits of the provision of information, instruction, training and supervision. Factors to be considered in the development of effective training programmes. Principles and methods of effective training. Feedback and evaluation mechanism.

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REFERENCES

1. Environmental and Health and Safety Management by Nicholas P. Cheremisinoff and Madelyn L. Graffia, William Andrew Inc. NY, 1995

2. The Facility Manager's Guide to Environmental Health and Safety by Brian Gallant, Government Inst Publ., 2007.

3. Effective Environmental, Health, and Safety Management Using the Team Approach by

01MPCE 101.2 **ADVANCED NUMERICAL METHODS**

OBJECTIVE:

☐ The course objective is to impart knowledge on advanced numerical methods for solving differential equations in science and engineering.

☐ Analysis and application of advanced numerical methods for solving Partial Differential Equations (PDEs).

UNIT I

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

UNIT IV

PARTIAL DIFFERENTIAL EQUATIONS –
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 –
Partial differential equations – Finite element method - orthogonal collocation method, orthogonal collocation with finite element method, Galerkin finite element method. Function approximation.

OUTCOME:

☐ Be familiar with numerical solution of ODEs.

☐ Setup and solve partial differential equations numerically

REFERENCES

1. Gupta, S.K., Numerical Methods for Engineers, New Age Publishers, 2003
2. Jain, M. K., S. R. Iyengar, M. B. Kanchi, R. K. Jain, Computational Methods for Partial Differential Equations, New Age Publishers, 2007

01MPCE 102 **PETROLEUM THERMODYNAMICS**

OBJECTIVES

To present the application of thermodynamic principles in petroleum and allied processes from chemical engineering viewpoint.

UNIT I

Behavior of Gases and Liquids – Gas laws, Density, Mole percent, Weight percent, Volume percent, Specific gravity, Heat, Work Closed and Open Systems, First and Second Laws of thermodynamics, specific heats, Compressibility factor, PVT relationships, Vapour pressure, Claussius – Clayperson equation, heat of vaporization.

UNIT II

Free energy change, Heat of reaction, Entropy change, Heat capacity, Heat of formation, Fugacity, Pressure – Temperature diagram, Pressure – Volume diagram, Density –Temperature diagram for one and two component

system. Pressure – Composition diagram, Temperature – Composition diagram, Temperature – Composition diagram, for multi component system Gibbs phase rule

UNIT III

Calculation of liquid and vapour composition of Bubble point and Dew point pressure for multi component system. Equilibrium constant

UNIT IV

Gas formation volume factor, Gas solubility, Oil formation volume factor, Viscosity

UNIT V

Dalton Law Volumetric analysis of a gas mixture – apparent weight and gas constant – specific heats of a gas mixture – determination of calorific values of fuels – oil and fuel vapour mixtures – steam condenser.

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TEXT BOOK

1. Smith J.M., H.C. Van Ness, M.M. Abbott .Introduction to Chemical Engineering Thermodynamics. VI Edition, Tata M.Graw-Hill publishing Company Limited, New Delhi

REFERENCES

1. Jean vidal, Thermodynamics Application in chemical Engineering and the petroleum industry, Institute Francais bu petroleum publications, France 2003
2. Stanley.I.sandler,' Chemical and Engineering Thermodynamics' Wiley, 1988.
3. John J.McKetta Jr. ""Advances in Petroleum Chemistry and Refining"" – Volume 9 (Interscience Publications), NY, 1983.
4. Rao., Y.V.C., Chemical Engineering Thermodynamics, University Press, Hyderabad,2005
5. Tester, J. W. and M. Modell, Thermodynamics and Its Applications. 3rd Edn.Prentice Hall, New Jersey, 1997.
6. Prausnitz, J.M., Lichtenthaler R.M. and Azevedo, E.G., Molecular thermodynamics of fluid-phase Equilibria, 3rd Edn, Prentice Hall Inc., New Jersey, 1999

01MPC103 PETROLEUM REFINERY ENGINEERING

OBJECTIVES

To impart detailed knowledge on petroleum refining operations, this course being the last part in a three parts series.

UNIT I

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

Engineering aspects of refining, Reaction stoichiometry; Chemical kinetics; Thermochemistry and chemical equilibrium; Mixing 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

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

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

UNIT V

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.

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.

01MPCE104 ELECTIVE – I

01MPCE 201 INSTRUMENTAL METHODS OF ANALYSIS LAB

OBJECTIVES

To impart practical knowledge on various instruments used in petroleum industries.

LIST OF EXPERIMENTS

1. UV-Visible spectrophotometer
2. Laser particle size diffraction analyzer
3. Gas chromatography
4. High performance liquid chromatography
5. Atomic absorption spectrophotometer.
6. Halogen moisture analyzer
7. Thermo gravimetric analyzer
8. Automated capillary microflow porometer
9. Electrochemical workstation

SEMESTER-II

02MPCE 101 Advance Production Engineering

OBJECTIVES

To know the stages of production and processing of natural gas.

UNIT I

Availability of natural gas, Properties and composition, Exploration and control of gas, output, Estimation of availability quantity. Natural gas application in Chemical Process and transportation industry LNG technology, Natural gas storage and transport, Economics ofnatural gas utilization.

UNIT II

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 III

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 IV

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.

OUTCOMES

To learn origin, properties, treatment, transportation, storage and liquefaction of natural gas.

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. 2007.
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 2012.
7. Michael J.Economides, A.Daniel Hill and Christine Ehlig – Economides, Petroleum Production Systems, PTR Prontice Hall, NJ, 2012.
8. Dring, M.M – The Natural Gas Industry – A review of World Resources and Industrial Applications, Butterworth, London, 1974.

02MPCE 102 PETROCHEMICAL ENGINEERING

OBJECTIVES

To impart knowledge on petrochemicals used in refinery industries.

UNIT I

Petrochemical industries and their feed stocks survey of petrochemical industry. Resources and generation of different feed stocks-their purification, separation of individual components by adsorption, low temperature fractionation and crystallization.

UNIT II

Production and utilization of synthesis gas: generation of synthesis gas by steam reforming of naptha and natural gas, fuel oil partial oxidation. chemicals from synthesis gas, methanol via synthesis gas route, formaldehyde from methanol, chloromethane by direct chlorination of methane, trichloroethylene, perchloroethylene by pyrolysis of carbon tetra chloride. Fischer-Tropsch process

UNIT III

Petrochemical based on methane, ethylene, acetylene, propylene and butane: acetylene and methanol from methane , VCM, VAM, ethylene oxide and ethylene glycol, ethanol amides from ethylene. VCM, VAM, acrylonitrile etc. from acetylene. Isopropanol, Propylene oxide, Glycerine, acrylonitrile, Acrylic acid, etc. From propylene. Production of butadiene by dehydrogenation of butane, nitrogen.

UNIT IV

Separation and utilization of aromatics: catalytic reforming operation-seperation of BTX from Reformate .isolation of benzene, toluene, xylene. aromatics derived from thermal cracking of naptha, pyrolysis gasoline hydrogenation process. Alkylation of benzene. production of pthalic anhydride etc. synthetic detergents: classification of detergents production of KERYL Benzene Sulphonate etc., filter, binders, dyes, perfumes, etc. for detergents. Hard and soft detergents.

UNIT V

Synthetic fibres, rubbers, plastics, resins: method, mechanism and types of polymerization ,production of HDPE,LDPE, PP,PVC, polystyrene, poly butadiene, etc., manufacture of 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 .

OUTCOMES

To learn about resources,separation techniques in refining and concerned materials
obtained from refining.

REFERENCES

1. Brownstein A.M. Trends in Petrochemical Technology, Petroleum Publishing Company,1976.
2. B.K.B.Rao, A Text on Petrochemicals, Khanna publishers.
3. I D Mall, Petrochemical process technology, Macmillan, 2006.
4. Robert Meyers, Handbook of Petrochemicals production Processes(McGraw Hill Handbooks), 2004

02MPCE 103 ADVANCE MASS TRANSFER ENGINEERING

OBJECTIVES

To provide the knowledge on principles and operations of mass transfer.

UNIT I

Fundamental Thermodynamic principles involved in the calculation of vapor – liquid equilibria and enthalpies of multi component mixtures – Use of multiple equation of state for the calculation of K values – Estimation of the fugacity coefficients for the vapor phase of polar gas mixtures – calculation of liquid – phase activity coefficients.

UNIT II

Fundamental principles involved in the separation of multi component mixtures – Determination of bubble-point and Dew Point Temperatures for multi component mixtures – equilibrium flash distillation calculations for multi component mixtures – separation of multi component mixtures at total reflux.

UNIT III

General considerations in the design of columns – Column sequencing – Heuristics for column sequencing – Key components – Distributed components – Non-Distributed components – Adjacent keys. Definition of minimum reflux ratio – calculation of Rm for multi component distillation – Underwood method – Colburn method.

UNIT IV

Theta method of convergence – Kb method and the constant composition method – Application of the Theta method to complex columns and to system of columns – Lewis Matheson method – Stage and reflux requirements – Short cut methods and Simplified graphical procedures.

UNIT V

Design of sieve, bubble cap, valve trays and structured packing columns for multi component distillation – computation of plate efficiencies.

OUTCOMES

Students will be able to develop a sound knowledge on application of thermodynamic principles in MCD, design of MCD columns and types of MCD columns.

TEXT BOOKS

1. Holland, C.D., “Fundamentals of Multi Component Distillation”, McGraw Hill Book Company,1981
2. Van Winkle, “Distillation Operations”, McGraw Hill Publications, 1987.

02MPCE104 ELECTIVE - II

02MPCE 201 PETROLEUM TESTING LAB

OBJECTIVES

To impart practical knowledge on different petroleum testing methods.

LIST OF EXPERIMENTS

1. Determination of flash point and fire point
2. Viscosity Determination
3. Aniline point determination
4. API gravity determination
5. Hydrogen sulphide content determination
6. Determination of calorific value
7. Cloud point and pour point estimation
8. Congealing point of wax
9. Foaming characteristics of lube oil
10. Smoke point estimation
11. Corrosion testing of petroleum oil
12. Moisture content determination

Minimum of 10 experiments

OUTCOMES

Students learn petroleum testing, determination of aniline point, softening point, carbon residue, foaming characteristics, sulphur content etc.

SEMESTER-III

03MPCE 101 Advance Chemical Reaction Engineering

OBJECTIVES

To introduce the dynamics of heterogeneous reactions and design of chemical reactors.

UNIT I

Design Principles, Continuous Reaction Model, Intrinsic and Global Rate Concepts

UNIT II

Heterogeneous Catalysis, Chemical and Physical Characteristics of Solid Catalysts, Activity, Specific Activity, Selectivity. Kinetics of Heterogeneous Catalytic Reactions, Mechanisms and Kinetic Models, Experimental Reactors and Transport Criteria, Determination of Intrinsic Kinetics

UNIT III

External Transport Processes, Internal Transport Processes, Fluidized-Bed Reactors

UNIT IV

Reactor Types, Fixed-Bed Gas-Solid Catalytic Reactors, Pseudo-homogeneous Fixed-Bed Models, One-Dimensional Heterogeneous Fixed-Bed Models, Design by Scale-Up, Fluidized-Bed Catalytic Reactors

UNIT V

Engineered Catalysts, Micro-structured Catalytic Reactors - Monolith Reactors, Microreactors

OUTCOMES

Students will be able to study the behavior of catalytic heterogeneous reactors, gas-solid catalytic and non-catalytic reactors and gas-liquid reactors

TEXTBOOK

1. G.F. Froment, K.B, Bischoff, J. de Wilde, Chemical Reactor Analysis and Design, 3rded., Wiley & Sons, 2011.

REFERENCES

1. Carberry – J.J. Chemical and Catalytic, Reaction Engineering, McGraw – Hill Book Co.,NY, 2001.
2. Muchlyonor I, Dobkina E.,.Deryozhkina V,.and Sorco V., Catalyst Technology – Catalyst Technology MIR Publication, Moscow, 1982.
3. Webterp K.R. Vanswaaij and Beenackers ACM, Chemical Reactor Design and Operations, Wiley, NY 1991.
4. Fogler S. Elements of Chemical Reaction Engineering, 4th edn, Prentice – Hall NJ, 2006.
5. L.K.Duraiswamy & R.A. Mashlekar, Chemical and Catalytic Reaction Engineering – Vol.1 & Vol.2 Wiley Eastern Limited, New Delhi, 1987.
6. Chen N.H. Process Reactor Design, Allyn & Bacon, Boston, 1983.
7. D. Shekawat, J.J. Spivey, D.A. Berry (Eds.), Z.İ. Önsan, A.K. Avci, Reactor Design for Fuel Processing", n "Fuel Cells: Technologies for Fuel Processing", pp. 451-516.

03MPCE102 ELECTIVE - III

03MPCE-201 SEMINAR

OBJECTIVE The students are to select one technical topic related its branch for Seminar. The student is to submit the synopsis for assessment and approval. Progress for preparation of the seminar topic would be continuously assessed from time to time. Two periods per week are to be allotted and students are expected to present the seminar Progress. A faculty guide is to be allotted and he / she will guide and monitor the progress of the student and maintain the attendance. Students have to give a final presentation for 15 minutes on his topic. Students are encouraged to use various teaching aids such as over head projectors, power point presentation and demonstrative models. This will enable them to gain confidence in facing the placement interviews

03MPCE-202 DISSERTATION STAGE-I

OBJECTIVE The objective of the project work is to enable the students in convenient groups of not more than 3 members on a project involving theoretical and experimental studies related to the branch of study. Every project work shall have a guide who is the member of the faculty of the institution. The student should select any one of the topics offered from the department or select one on his own duly approved from the department. Candidate is required to submit the detailed synopsis of the work that he would complete in the part-II Each student shall

finally produce a comprehensive report covering back ground information, literature survey, problem statement, project work details and conclusion. This final report shall be typewritten form as specified in the guidelines.

SEMESTER-IV

04MPCE-201 DISSERTATION STAGE-II

The student will submit a synopsis at the beginning of the semester for the approval from the University project committee in a specified format. Synopsis must be submitted within a two weeks. The first defense, for the dissertation work, should be held within a one month. Dissertation Report must be submitted in a specified format to the University for evaluation purpose.

ELECTIVE COURSE

01MPCE104.1 CORROSION ENGINEERING

OBJECTIVES

To impart knowledge on corrosion in petroleum refining.

UNIT I

TYPES OF CORROSION AND TESTING METHODS

Basic principles of corrosion and its control – Forms of corrosion, uniform, Galvanic, Crevis, pitting, selective leaching, erosion, stress-corrosion, cracking – Capitation phenomena & their effects – Corrosion testing – Field testing – Electrochemical techniques for measurement of corrosion rates, corrosion detection and components examination – Accelerated salt-spray testing.

UNIT II

CORROSION PROTECTION METHODS

Corrosion inhibitors, electroplated coatings, conversion coatings, anodizing, hot dipping, spray metal coatings, zinc coating by alloying, electrophoteric coatings and electro painting, powder coating, electrical methods of corrosion protection, composite materials in corrosion minimization – Cathodic and Anodic protections.

UNIT III

CORROSION IN SPECIFIC ENVIRONMENTS

Corrosion damage to concrete in industrial and marine environments and its protection; biological corrosion, halogen corrosion of metals, environmental degradation of materials, corrosion and inspection managements in chemical processing and petrochemical industries.

UNIT IV

CORROSION IN SPECIFIC CASES AND CONTROL

Corrosion in structure – corrosion of stainless steels – corrosion in power equipments, corrosion in electrical and electronic industry – corrosion and selection of materials of pulp and paper plants – corrosion aspects in nuclear power plants – corrosion of surgical implants and prosthetic devices.

UNIT V

CORROSION AND COUNTRY'S ECONOMY

Corrosion protection management–process maintenance procedures under corrosion Environments

OUTCOMES

Students learn about the types of corrosion, protection methods, corrosion in specific environments, corrosion in specific cases and control.

TEXT BOOK

1. Fontana, M.G., "Corrosion Engineering", Edn 3, McGraw Hill, 1989

REFERENCE

1. Roberge, P.R., Handbook of Corrosion Engineering, McGraw-Hill,2000

01MPCE104.2 WASTE MANAGEMENT AND ENERGY RECOVERY

OBJECTIVE

To focus on characteristics of various industrial wastes, management and energy recovery.

UNIT I

SOLID WASTE – CHARACTERISTICS AND PERSPECTIVES

Definition - types – sources – generation and estimation. Properties: physical, chemical and biological – regulation

UNIT II

COLLECTION, TRANSPORTATION AND PROCESSING TECHNIQUES

Onsite handling, storage and processing – types of waste collection mechanisms – transfer Stations: types and location – manual component separation - volume reduction: mechanical, thermal – separation: mechanical, magnetic electro mechanical

UNIT III

ENERGY GENERATION TECHNIQUES

Basics, types, working and typical conversion efficiencies of composting – anaerobic digestion – RDF – combustion – incineration – gasification – pyrolysis

UNIT IV

HAZARDOUS WASTE MANAGEMENT

Hazardous waste – definition - potential sources - waste sources by industry – impacts –waste control methods – transportation regulations - risk assessment – remediation technologies – Private public paternership – Government initiatives.

UNIT V

ULTIMATE DISPOSAL 7

Landfill – classification – site selection parameters – design aspects – Leach ate control – environmental monitoring system for Land Fill Gases.

OUTCOMES

To make students understand about characteristics of various waste, their collection, transport and processing techniques,

TEXT BOOKS

1. Tchobanoglous, Theisen and Vigil, Integrated Solid Waste Management, 2d Ed. McGraw-Hill, New York, 1993.
2. Howard S. Peavyetal, Environmental Engineering, McGraw Hill International Edition,1985

REFERENCES

1. Lagrange, M., et al., Hazardous Waste Management, McGraw-Hill, c. 1200 pp., 2nd ed.,2001.
2. Stanley E. Manahan. Hazardous Waste Chemistry, Toxicology and Treatment, Lewis Publishers, Chelsea, Michigan, 1990
3. Parker, Colin and Roberts, Energy from Waste – An Evaluation of Conversion Technologies, Elsevier Applied Science, London, 1985.
4. Manoj Datta, Waste Disposal in Engineered Landfills, Narosa Publishing House, 1997.

01MPCE104.3 SEPARATION PROCESS TECHNIQUES

OBJECTIVE

To present recent advances in separation techniques from a chemical engineering view point

UNIT I

GENERAL

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.

UNIT II

MEMBRANE SEPARATIONS

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.

UNIT III

SEPARATION BY ADSORPTION TECHNIQUES

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

UNIT IV

IONIC SEPARATIONS

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

UNIT V

OTHER SEPARATION TECHNIQUES

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 ffluent treatment by modern techniques.

OUTCOMES

To learn Liquid-solid, Gas-Solid, Liquid-Gas separation process, membrane modules, separation techniques and membrane materials.

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, 2009.
4. Humphrey, J and G. Keller, Separation Process Technology, McGraw-Hill, 1997
5. Phillip C. Wankat , Separation Process Engineering (2nd Edition),Printice Hall,2007

01MPCE104.4 SOLVENT EXTRACTION

OBJECTIVES

To impart knowledge on principles of solvent extraction and the design of extractors.

UNIT I

EQUILIBRIUM IN LIQUID-LIQUID SYSTEM

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 inter phase mass transport, Estimation and prediction of mass transport coefficients.

UNIT II

DIFFERENTIAL / STAGE-WISE EQUILIBRIUM CONTACT OPERATIONS

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.

UNIT III

DISPERSION AND COALESCENCE IN EXTRACTORS

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.

UNIT IV

DESIGN OF LIQUID EXTRACTION COLUMNS

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.

OUTCOMES

Student will be able to develop a sound knowledge on equilibrium in liquid-liquid system,
HETS, NETS, HTU, NTU, dispersion and coalescence in extractors and design of extraction column.

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.

02MPCE104.1 MULTIPHASE FLOW

OBJECTIVE

To analyze, characterize the multiphase systems and appreciate the role of structure in multiphase flows. To understand the limitations of modeling in multiphase flows and to comprehend engineering problems involving multiphase flows

UNIT I

CHARACTERISTICS OF MULTIPHASE FLOWS

Significance of multiphase flows, important non-dimensional numbers, parameters of characterization, particle size measurement, size distribution and moments, size distribution models

UNIT II

PARTICLE FLUID INTERACTION

Equation of motion for a single particle, calculation of drag, motion of a particle in two dimensions, effects of unsteady and non-uniform flow fields, effect of acceleration, effect of coupling; Interaction between particles, mechanism of interaction, interparticle forces, hard sphere model, soft sphere model, discrete element modeling, semi-empirical methods, kinetic theory, force chains.

UNIT III

MODELING OF MULTIPHASE FLOWS

Flow patterns - identification and classification - flow pattern maps and transition - momentum and energy balance - homogeneous and separated flow models - correlations for use with homogeneous and separated flow models - void fraction and slip ratio correlations - influence of pressure gradient - empirical treatment of two phase flow - drift flux model - correlations for bubble, slug and annular flows

UNIT IV

CONSERVATION EQUATIONS

Averaging procedures - time, volume, and ensemble averaging, quasi-one-dimensional flow, two-fluid volume-averaged equations of motion, turbulence and two-way coupling.

UNIT V

MULTIPHASE SYSTEMS

Flow regime and hydrodynamic characteristics of packed bed, fluidized bed, pneumatic conveying, bubble column, trickle beds; Conventional and novel measurement techniques for multiphase systems including CARPT, Laser Doppler anemometry, Particle Image Velocimetry.

OUTCOMES

Students develop a sound knowledge on underlying concepts of multiphase flows and different approaches to model such flows under different conditions.

REFERENCES

1. Clift, R., Weber, M.E. and Grace, J.R., Bubbles, Drops, and Particles, Academic Press, New York, 2005.
2. Crowe, C. T., Somerfield, M. and Tsuji, Y., Multiphase Flows with Droplets and Particles, CRC Press, 2011
3. Fan, L. S. and Zhu, C., Principles of Gas-solid Flows, Cambridge University Press,2005
4. Govier, G. W. and Aziz. K., "The Flow of Complex Mixture in Pipes", Van Nostrand Reinhold, New York, 1972.
5. Kleinstreuer, C., Two-phase Flow: Theory and Applications, Taylor & Francis, 2003
6. Rhodes, M., Introduction to Particle Technology, John Wiley & Sons, New York.2008.
7. Wallis, G.B., "One Dimensional Two Phase Flow", McGraw Hill Book Co., New York,

02MPCE104.2 PETROLEUM ECONOMICS

OBJECTIVES

To introduce process economics and industrial management principles.

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.

OUTCOMES

Students will be able to make cost estimation, feasibility analysis,management, organization and quality control that will enable the students to perform as efficient managers.

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.

02MPCE104.3 PROCESS OPTIMIZATION

OBJECTIVE

To impart basic knowledge in process optimization.

UNIT I

INTRODUCTION

Problem formulation, degree of freedom analysis, objective functions, constraints and feasible region, Types of optimization problem.

UNIT II

LINEAR PROGRAMMING

Simplex method, Barrier method, sensitivity analysis, Examples.

UNIT III

NONLINEAR UNCONSTRAINED OPTIMIZATION

Convex and concave functions unconstrained NLP, Newton's method Quasi-Newton's method, Examples.

UNIT IV

CONSTRAINED OPTIMIZATION

Direct substitution, Quadratic programming, Penalty Barrier Augmented Lagrangian Methods.

UNIT V

MULTI OBJECTIVE OPTIMIZATION

Weighted Sum of Squares method, Epsilon constrain method, Goal attainment, Examples. Introduction to optimal control and dynamic optimization.

OUTCOMES

Students would be able to optimize the process for a given chemical industry at the end of the course.

REFERENCES

1. Edgar, T. F., Himmelblau, D. M. and Ladson, L. S., “Optimization of Chemical Processes”, 2nd Ed., McGraw Hill, New York, 2003.
2. Diwaker, U. W. “Introduction to Applied Optimization”, Kluwer, 2003.
3. Joshi, M. C. and Moudgalya, K. M., “Optimization, Theory and Practice”, Narosa, New Delhi, 2004.
4. Rao, S. S., Engineering Optimization: Theory and Practice, New Age Publishers, 2000 28

02MPCE104.4 GAS TRANSPORTATION

OBJECTIVES

To present various gas transportation methodologies.

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 flow meters, 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.

OUTCOMES

Students would gain knowledge on selection of right type of transport and various types of pipes, pipeline protection techniques and design of pipeline.

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.

03MPCE102.1 FLUIDIZATION ENGINEERING

OBJECTIVE

To encompass the new areas and introduce reactor models specifically for these contacting regimes.

UNIT I

INTRODUCTION

The Fluidized state, Nature of hydrodynamic suspension, particle forces, species of Fluidization, Regimization of the fluidized state, operating models for fluidization systems, Applications of fluidization systems.

UNIT II

HYDRODYNAMICS OF FLUIDIZATION SYSTEMS

General bed behavior, pressure drop, Flow regimes, Incipient Fluidization, Pressure fluctuations, Phase Holdups, Measurements Techniques, Empirical Correlations for Solids holdup, liquid holdup and gas holdup. Flow models – generalized wake model, structural wake model and other important models.

UNIT III

SOLID MIXING AND SEGREGATION

Phase juxtapositions operation shifts, Reversal points, Degree of segregation, Mixing Segregation equilibrium, Generalised fluidization of poly disperse systems, liquid phase Mixing and gas phase mixing.

UNIT IV

HEAT AND MASS TRANSFER IN FLUIDIZATION SYSTEMS

Mass transfer – Gas Liquid mass transfer, Liquid Solid mass transfer and wall to bed mass transfer, Heat transfer – column wall – to – bed heat transfer, Immersed vertical cylinder to bed heat transfer, Immersed horizontal cylinder to bed heat transfer.

UNIT V

MISCELLANEOUS SYSTEMS

Conical Fluidized bed, Moving bed, Slurry bubble columns, Turbulent bed contactor, Two phase and Three phase inverse fluidized bed, Draft tube systems, Semifluidized bed systems, Annular systems, Typical applications, Geldart's classification for power assessment, Powder characterization and modeling by bed collapsing.

OUTCOMES

Students would be able to determine the minimum fluidization velocity for the given bed of particles. To find the bed expansion with increasing gas velocity. To qualitatively observe the behavior of a gas fluidized bed with increasing gas velocity.

REFERENCES

1. Fan, L. S., "Gas- liquid Solid Fluidization Engineering", Butterworths, 1989,
2. Kwauk, M., "Fluidization - Idealized and Bubbleless, with applications", Science Press, 2009.
3. Kunii, D. and Levenspiel, O., "Fluidization Engineering", 2nd Edn., Butterworth.

03MPCE 102.2 MODELING AND SIMULATION OF INDUSTRIAL PROCESS

OBJECTIVES

To understand the principles and applications of modeling and simulation of industrial processes.

UNIT I

INTRODUCTION

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

UNIT II

STEADY STATE LUMPED SYSTEMS

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.

UNIT III

UNSTEADY STATE LUMPED SYSTEMS

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.

UNIT IV

STEADY STATE DISTRIBUTED SYSTEM

Analysis of compressible flow, heat exchanger, packed columns, plug flow reactor, solution of ODE boundary value problems.Empirical modeling, parameter estimation, population balance and stochastic modeling.

UNIT V

UNSTEADY STATE DISTRIBUTED SYSTEM

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.

OUTCOMES

To impart knowledge on modeling and simulation, classification of mathematical models,steady and unsteady state lumped and distributed systems and other modeling approaches

REFERENCES

1. Ramirez, W., "Computational Methods in Process Simulation", 2nd Edn., Butterworths, New York, 2000.
2. Luyben, W.L., "Process Modeling Simulation and Control", McGraw-Hill Book Co., 1990.
3. Felder, R. M. and Rousseau, R. W., “Elementary Principles of Chemical Processes“, John Wiley, 2005.
3. Franks, R. G. E., “Mathematical Modeling in Chemical Engineering“, John Wiley,1967.