BRANCH-CHEMICAL ENGINEERING

Specialization: **Chemical Engineering**

Second Semester							
	Theory				**Practical**		
Course Name	**Hours/ Week L/T**	**Credit Theory**	**University Marks**	**Internal Evaluation**	**Hours/ Week L/T**	**Credit Practical**	**Marks**
Specialization Core-1 Petroleum Refinery Engineering	4-0	4	100	50	-	-	-
Specialization Core-2 Advanced Separation Techniques	4-0	4	100	50	-	-	-
Elective I(Specialization related) 1. Advanced Fluid Dynamics 2. Mineral Beneficiation 3. Advance Process Control 4.Advance Chemical Reaction Engineering & Reactor Design	4-0	4	100	50	-	-	-
Elective II (Departmental related) 1. Multiphase Flow 2. Bioprocess Engineering 3. Advances in Bio-Chemical Engineering 4. Process Plant Simulation	4-0	4	100	50	-	-	-
Elective III (from any department) 1. Air Pollution Control Equipment Design 2. Thermodynamics in Process Design 3. Non-conventional Energy 4. Industrial Pollution Control	4-0	4	100	50	-	-	-
Lab-2 (Specialization lab to be decided by the department)					4	4	150
Seminar/Project					4	4	150
Total							
Total Marks: 1050							
Total Credits: 28							

PETROLEUM REFINERY ENGINEERING

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, Feedstocks and product yields and qualities, Catalysts and operating parameters. Hydrocracking, principles, process requirements, product yields and qualities, Residcracking – implications and technology.

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 PetroleumU.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, McGraw – Hill Publishing Company, NY, 1990.
5. Watkins, R.N “Petroleum Refinery Distillation”, 2nd Edition, Gulf Publishing Company, Texas, 1981.

ADVANCED SEPARATION TECHNIQUES

MOUDLE –1

General Review: Mechanisms, separation factors and its dependence on process variables, classification and characterization, kinetics and mass transport, theory of cascades and its application in single stage operation for binary separations.

Separation by sorption techniques: Types and choice of adsorbents, reaction theory mechanism, design controlling factors in ion exchange chromatography equipments .

MOUDLE – II

Membrane Separations: Types and choice of membranes, their merits, commercial, pilot plant polarization of membrane processes and laboratory membrane permeators, dialysis, reverse osmosis, ultra titration, concentration and economics of membrane operations, design controlling factors.

MOUDLE – III

Thermal Separation: Thermal Diffusion, basic rate law, phenomenological theories of thermal diffusion for gas and liquid mixtures, equilibrium diagrams, controlling factors.

MOUDLE – IV

Other Techniques: Adductive crystallization, economics and commercial processes, foam separation, nature foams, controlling factors, superficial fluid extraction.

***Text and Reference Books*:**

1. H.M. Schoen, ***New Chemical Engg. Separation Techniques***, *Wiley, NY, 1972.*
2. C.J. King, ***Separation Processes***, *TMH, New Delhi, 1982.*
3. R.W.Roussel, ***Hand Book of Separation Process Technology***, *John Wiley, NY, 1987.*

ADVANCED FLUID DYNAMICS

(Will be uploaded soon)

MINERAL BENEFICIATION

MOUDLE –I

Exploitable characteristics of minerals. Economics of mineral beneficiation. Power laws. Principles of crushing and grinding. Grindability. Evalution of Prticle size. Size distribution curves and significance. Mechanism of breakage of material.

MOUDLE – II

Classification, design and application of crushers and grinders. Industrial screening, classification and performance of screens. Dry and wet classifiers. Thickeners, hydrocyclones, filtration, tabling, jigging, magnetic and electrostatic separation.

MOUDLE – III

Surface behavior and flotation principles. Flotation machines, differential flotation and flotation circuit design. Elements of hydrometallurgy. Important beneficiation circuits of minerals like chalcopyrites, galena, bauxite, and hematite.

***Text and Reference Books*:**

1. A.M. Gaudin, ***Principles of Mineral Dressing***, Tata McGraw Hill, New Delhi
2. B. A. Wills and T. Naperir, ***Mineral Processing Technology***, Elsevier.

ADVANCED PROCESS CONTROL

Module I

Review of Systems: Review of first and higher order systems, closed and open loop response. Response to step, impulse and sinusoidal disturbances. Transient response. Block diagrams.

Module II

Stability Analysis: Frequency response, design of control system, controller tuning and process identification. Zigler-Nichols and Cohen-Coon tuning methods, Bode and Nyquist stability criterion. Process identification.

Special Control Techniques: Advanced control techniques, cascade, ratio, feed forward, adaptive control, Smith predictor, internal model control.

Module III

Multivariable Control Analysis: Introduction to state-space methods, , Control degrees of freedom analysis and analysis, Interaction, Bristol arrays, Niederlinski index - design of controllers, Tuning of multivariable controllers.

Module IV

Sample Data Controllers: Basic review of Z transforms, Response of discrete systems to various inputs. Open and closed loop response to step, impulse and sinusoidal inputs, closed loop response of discrete systems. Design of digital controllers. Introduction to PLC and DCS.

TEXT BOOKS:

1. D.R. Coughanour, 'Process Systems analysis and Control', McGraw-Hill, 2nd Edition, 1991.
2. D.E. Seborg, T.F. Edger, and D.A. Millichamp, 'Process Dynamics and Control', John Wiley and Sons, 2nd Edition, 2004.

REFERENCES:

1 B.A.Ogunnaike and W.H.Ray, "Process Dynamics, Modelling and Control", Oxford Press, 1994.
2 W.L.Luyben, 'Process Modelling Simulation and Control for Chemical Engineers', McGraw Hill, 2nd Edition, 1990.
3 B.W. Bequette, 'Process Control: Modeling, Design and Simulation', PHI, 2006.
4 S. Bhanot, 'Process Control: Principles and Applications', Oxford University Press, 2008.

ADVANCED CHEMICAL REACTION ENGINEERING AND REACTOR DESIGN

Module I

BASICS OF REACTOR DESIGN Kinetics of homogeneous reactions: concentration-dependent term of a rate equation, temperature-dependent term of a rate equation, predictability of reaction rate from theory. Interpretation of batch reactor data: constant-volume batch reactor, varying-volume batch reactor, temperature and reaction rate, search for a rate equation.

Module II

IDEAL REACTORS Introduction to reactor design. Ideal reactors for a single reaction: ideal batch reactors, steadystate mixed flow reactors, steady-state plug flow reactors.

Module III

SINGLE AND MULTIPLE REACTIONS Design for single reactions: size comparison of single reactors, multiple-reactor systems, recycle reactor. Design for parallel reactions. Irreversible first-order reactions in series temperature and pressure effects

Module IV

NON-IDEAL FLOW Basics of non-ideal flow: E-age distribution of fluid-RTD, conversion in non-ideal flow reactors. Dispersion model: axial dispersion, chemical reaction and dispersion. Tanks-in-series model: pulse response experiments and the RTD, chemical conversion. Rate equation for surface kinetics, pore diffusion resistance combined with surface kinetics, performance equations for reactors containing porous catalyst particles, experimental methods for finding rates.

TEXT BOOK

1. Octave Levenspiel, “Chemical Reaction Engineering”, 3rd edition, John Wiley & Sons India edition, 2011.
2. Scott Fogler. H., “Elements of Chemical Reaction Engineering”, 3rd edition, Prentice Hall of India, New Delhi, 2006.

REFERENCE BOOKS:

1. Smith. J.M., “Chemical Engineering Kinetics”, 3rd edition, McGraw Hill International Editions, New Delhi, 1981.
2. Ronald. W.Missen, Charles. A.Mions, Bradley. A.Saville, “Introduction to Chemical Reaction Operation and Kinetics”, John Wiley and Sons,

MULTIPHASE FLOW

Module I

Two phase flow: Gas/Liquid and Liquid/liquid systems: Flow patterns in pipes, analysis of two phase flow situations,

Prediction of holdup and pressure drop or volume fraction, Bubble size in pipe flow, Lockchart-Martinelli parameters, Bubble column and its design aspects, Minimum carryover velocity. holdup ratios, pressure drop and transport velocities and their prediction.

Module II

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

Module III

Introduction to three phase flow, Dynamics of gas-solid liquid contactors (agitated vessels, packed bed, fluidized bed, pneumatic conveying, bubble column, trickle beds), Flow regimes, pressure drop, holdup, distributions, mass and heat transfer, reactions, Applications of these contactors

Module IV

Measurement techniques in multiphase flow: Conventional and novel measurement techniques for multiphase systems (Laser Doppler anemometry, Particle Image Velocimetry)

TEXT BOOKS/REFERENCES:

1. Clift, R., Weber, M.E. and Grace, J.R., Bubbles, Drops, and Particles, Academic Press, New York, 1978.
2. Y. T. Shah, Gas-Liquid-Solid reactors design, McGraw Hill Inc, 1979
3. Fan, L. S. and Zhu, C., Principles of Gas-solid Flows, Cambridge University Press, 1998
4. Govier, G. W. and Aziz. K., "The Flow of Complex Mixture in Pipes", Van Nostrand Reinhold, New York, 1972.
5. Wallis, G.B., "One Dimensional Two Phase Flow", McGraw Hill Book Co., New York, 1969.
6. Crowe, C. T., Sommerfeld, M. and Tsuji, Y., Multiphase Flows with Droplets and Particles, CRC Press, 1998
7. Kleinstreuer, C., Two-phase Flow: Theory and Applications, Taylor & Francis, 2003 Rhodes, M., Introduction to Particle Technology, John Wiley & Sons, New York. 1998.

BIOPROCESS ENGINEERING

Module I

Introduction: Fermentation Processes General requirements of fermentation processes- An overview of aerobic and anaerobic fermentation processes and their application in industry - Medium requirements for fermentation processes - examples of simple and complex media Design and usage of commercial media for industrial fermentation. Sterilization: Thermal death kinetics of microorganisms - Batch and Continuous Heat-Sterilization of liquid Media- Filter Sterilization of Liquid Media and Air.

Module II

Enzyme Technology, Microbial Metabolism : Enzymes: Classification and properties-Applied enzyme catalysis - Kinetics of enzyme catalytic reactions Metabolic pathways - Protein synthesis in cells.

Stoichiometry And Kinetics Of Substrate Utilization And Biomass And Product Formation: Stoichiometry of microbial growth, Substrate utilization and product formation-Batch and Continuous culture, Fed batch culture .

Module III

Bioreactor And Product Recovery Operations: Operating considerations for bioreactors for suspension and immobilised cultures, Selection, scale-up, operation of bioreactors-Mass Transfer in heterogeneous biochemical reaction systems; Oxygen transfer in submerged fermentation processes; oxygen uptake rates and determination of oxygen transfer rates and coefficients; role of aeration and agitation in oxygen transfer. Heat transfer processes in Biological systems. Recovery and purification of products.

Module IV

Introduction To Instrumentation And Process Control In Bioprocesses: Measurement of physical and chemical parameters in bioreactors- Monitoring and control of dissolved oxygen, pH, impeller speed and temperature in a stirred tank fermenter.

TEXT BOOKS:

1. M.L. Shuler and F. Kargi, "Bio-process Engineering", 2nd Edition, Prentice Hall of India, New Delhi. 2002.

2 J.E. Bailey and D.F. Ollis," Biochemical Engineering Fundamentals", 2nd Edn., McGraw Hill, Publishing Co. New York., 1985.

REFERENCE:

1. P.Stanbury, A. Whitakar and S.J.Hall, "Principles of Fermentation Technology" 2nd Edn., Elsevier-Pergamon Press, 1995.

ADVANCES IN BIO-CHEMICAL ENGINEERING

(Will be uploaded soon)

PROCESS PLANT SIMULATION

(Will be uploaded soon)

AIR POLLUTION CONTROL EQUIPMENT DESIGN

Module I

Air Pollutant Sources, Effects and Clean Air Acts: Pollution of air: Sources and effects of air pollutants on physical environment and living systems, Monitoring air pollution, Air pollution Laws and Minimum national standards.

Module II

Air Pollutant Formation, Dipersion, Analysis: Formation of pollutants through large-scale combustion of fossil fuels, mineral processing, automobiles in urban areas and at source minimisation of release - Meteorological aspects of air pollutant dispersion. Chemical reactions in a contaminated atmosphere, urban air pollution, acid rain Air sampling and measurement, Analysis of air pollutants

Module III

Air Pollution Control Methods for Particulates Removal: Control Methods - Source Correction methods - Particulate emission control: Dry techniques industrial dust collectors, cyclone and multiclone separators, bag filters, electrostatic precipitators, relative merits and demerits, choice of equipments, design aspects economics. Wet techniques wet dust collection, wet cyclone, empty scrubber, column (packed) scrubber, ventury scrubber, suitability, merits and demerits, design aspects and economics.

Module IV

Control of Specific Gaseous Pollutants: Cleaning of Gaseous effluents - Control of sulphur dioxide emission by various methods - Control of nitrogen oxides in combustion products - Control of release of carbon monoxide and hydrocarbons to the atmosphere. Noise Pollution and Control: Sound pressure, Power and Intensity - Measures of Noise- Outdoor noise propagation- Indoor Noise propagation- Noise Control

TEXT BOOKS:

1. Y.B.G. Verma, H. Brauer," Air Pollution Control Equipments", Springer, Verlag Berlin, 1981.

2. M.N. Rao and H.V.N. Rao, "Air Pollution", Tata McGraw Hill, New Delhi, 1993.

REFERENCES:

1. Rao C.S. "Environmental Pollution Control Engineering," 2nd Edition, New Age International Publishers, 2006.

2. A. P. Sincero and G.A. Sincero Environmental Engineering: A Design Approach, Prentice Hall of India pvt Ltd, N.Delhi.1996

THERMODYNAMICS IN PROCESS DESIGN

(Will be uploaded soon)

NON-CONVENTIONAL ENERGY

Module I

Introduction various non-conventional energy resources- Introduction, availability, classification, relative merits and demerits. 3 Solar Cells: Theory of solar cells. Solar cell materials, solar cell array, solar cell power plant, limitations.

Module II

Solar Thermal Energy: Solar radiation, flat plate collectors and their materials, applications and performance, focussing of collectors and their materials, applications and performance; solar thermal power plants, thermal energy storage for solar heating and cooling, limitations.

Module III

Geothermal Energy: Resources of geothermal energy, thermodynamics of geo-thermal energy conversion-electrical conversion, non-electrical conversion, environmental considerations. 4 Magneto-hydrodynamics (MHD): Principle of working of MHD Power plant, performance and limitations. 2 Fuel Cells: Principle of working of various types of fuel cells and their working, performance and limitations.

Module IV

Thermo-electrical and thermionic Conversions: Principle of working, performance and limitations. 2 Wind Energy: Wind power and its sources, site selection, criterion, momentum theory, classification of rotors, concentrations and augments, wind characteristics. Performance and limitations of energy conversion systems.

Bio-mass: Availability of bio-mass and its conversion theory. 2 Ocean Thermal Energy Conversion (OTEC): Availability, theory and working principle, performance and limitations. Wave and Tidal Wave: Principle of working, performance and limitations. Waste Recycling Plants.

References Books:

1. Raja etal, “Introduction to Non-Conventional Energy Resources” Scitech Publications.
2. John Twideu and Tony Weir, “Renewal Energy Resources” BSP Publications, 2006.
3. M.V.R. Koteswara Rao, “ Energy Resources: Conventional & Non-Conventional “ BSP Publications,2006.
4. D.S. Chauhan,”Non-conventional Energy Resources” New Age International. 5.
C.S. Solanki, “Renewal Energy Technologies: A Practical Guide for Beginners” PHI Learning.

INDUSTRIAL POLLUTION CONTROL

MODULE-1

Definition and classification of pollutants, Environmental protection Acts, Conceptual aspects of EIA (Environmental Impact Assessment), ES (Environmental standards), EMP (Environmental Management plans), Hazardous wastes.

MODULE-2

Water pollution: physical, chemical and biological characteristics of waste water, measurement of water pollutants (BOD, COD, suspended particles etc.), physical unit operation, chemical and biological unit processes used in waste water treatment and their design.

MODULE-3

Air pollution: Sources and effects, temperature lapse rate and stability, tropo-graphical effects, plume behavior, effective stack height, air pollution control equipments and their design like settling chamber, cyclone separator, fabric filters, electrostatic precipitator, venturi scrubber.

MODULE-4

Noise pollution : Defination, causes and effects, control measures. Solid waste: classification, collection and disposal management.

TEXT BOOKS:

1. Rao, C. S., 1991, Environmental Pollution Control Engineering, Wiley Eastern Limited, New Delhi.
2. Tchobanoglous, G., Burton, F. L., Waste Water Engineering (Metcalf and Eddy), Tata McGraw –Hill Publishing Company Limited, New Delhi.
3. Kiely, G., 2006, Environmental Engineering, Tata McGraw –Hill Publishing Company Limited, New Delhi.