BE VII SEMESTER CHEMICAL ENGG.							
COURSE CONTENTS (UEC SCHEME)							
CM-7001	Transport Phenomenon	**L**	**T**	**P**	**C**	**Max. Marks**	**Min. Marks**
Duration	3 Hours	3	1	0	4	70	22

Unit- I

Transport Properties:

Continuum fluids, Newton's law of viscosity, Introduction to non-Newtonian fluids, pressure and temperature dependency of viscosity, Viscosity of gases at low density, Laminar flow, shell momentum balance, boundary conditions, selected applications.

Unit- II

Momentum Transport:

Equations of change for isothermal systems – Navier-Stokes equation, use of equations of change to set up steady state flow problems with Newtonian fluids, Microscopic mass, momentum and energy balance for isothermal systems, Bernoulli's equation, compressible flow, pipe flow. Introduction to Macroscopic momentum balances.

Unit- III

Energy Transport:

Shell energy balances, Fourier's Law of heat conduction, boundary conditions. Application to steady and unsteady problems, convective heat transfer, heat transfer coefficients for forced convection around submerged objects, for free convection for condensation of pure vapors on solid surface. Introduction to Macroscopic energy balances.

Unit- IV

Mass Transport:

Fick's Law of diffusion, analogy with heat transfer, shell mass balances, boundary conditions, applications, species continuity equation, conductive mass transfer, mass transfer coefficients, applications, correlations. Introduction to Macroscopic Mass Balances.

Suggested Readings:

1. Bird, R. B., Stewart, W. E. and Lightfoot, E. N., "Transport Phenomena," John Wiley, 1960.
2. Thomson, W. J., "Introduction to Transport Phenomena," Pearson Education Asia, 2000.
3. Brodkey, R. S. and Hershey, H. C., "Transport Phenomena: A Unified Approach," McGraw-Hill, NY, 1988.

BE VII SEMESTER CHEMICAL ENGG.							
COURSE CONTENTS (UEC SCHEME)							
CM-7002	Modeling & Simulation	**L**	**T**	**P**	**C**	**Max. Marks**	**Min. Marks**
Duration	3 Hours	3	1	2	6	70	22

Unit I

Role of Analysis:

Chemical Engineering Problems, basic concepts of analysis: The analysis process, A simple example of estimating an order. Source of the model equations: conservation equations, constitutive equations, control volumes, Dimensional analysis, System of units, Dimensional consistency in mathematical descriptions, Dimensional analysis and constitutive relationships, Final observations.

Unit II

Non-Reacting Liquid Systems:

Introduction, equation of continuity, simple mass balance, application of the model equations, component mass balances. Model behavior: Steady state behavior, Unsteady state behavior, density assumption. Numerical integration methods of ordinary differential equation.

Reacting Liquid Systems: Introduction, basic model equations for a Tank-Type reactor, The reaction rate, The batch reactor, Pseudo First-order reactions, Reversible reactions, multiple reactions: consecutive reactions, parallel reactions, complex reactions, constant density assumption, order and stoichiometry.

Unit III

Treatment of Experimental Data:

Introduction, criteria for Best Fit, Best Slope-I, Best Slope-II, Best straight line, Physical property correlations, Fitting a quadratic. Simulation examples of gravity fluid flow, heat and mass transfer, monte-carto simulation.

Unit IV

Dynamic Modeling:

Dynamic modeling of simple processes, sequential, simultaneous modular and equation oriented approaches, partitioning and tearing.

Unit V

Iterative Convergence:

Computer programming of various iterative convergence methods such as Newton-Raphson, False position, wegstein, Muller methods.

List of Experiments:

1. Process dynamics experiments like flow of incompressible fluids at a variable flow rate.
2. Dynamics of a tank draining through an orifice in the bottom. Differential equation formulation and verification with the experimental data.
3. Mass balance in a tank filling at certain rate and emptying at another rate. Rectangular and wedge-shaped tank and incompressible fluid.
4. Modeling a batch reactor-verification of 151 and 2nd order rate kinetics.
5. Counter current double pipe heat exchanger modeling-data analysis by iterative methods.
6. Simulation of a distillation column-binary systems, equimolal overflow, constant relative, volatility.
7. Input-Output response study in non-ideal flow reactors.
8. Simulation of a perfectly mixed reactor with heat transfer. Derivation of a mathematical model and solving for study state heat transfer.

Note: ***Each student should perform at least six experiments out of the above list.***

Suggested Readings:

1. Russell T. W.F. - INTRODUCTION TO CHEMICAL ENGINEERING ANAL YSIS - John Wiley & Sons New-York.
2. Luyben W.L. - PROCESS MODELLING, SIMULATION AND CONTROL FOR CHEMICAL ENGINEERS - II Ed. Mc. Graw Hill Publishing Co. New York - 1990.

BE VII SEMESTER CHEMICAL ENGG.							
COURSE CONTENTS (UEC SCHEME)							
CM-7003	Process Plant Design and Economics	**L**	**T**	**P**	**C**	**Max. Marks**	**Min. Marks**
Duration	3 Hours	3	1	2	6	70	22

Unit-I

Process Design and Development:

General design considerations; the hierarchy of chemical process design, the nature of process synthesis and analysis; developing a conceptual design and finding the best flow sheet: input information and batch versus continuous,

Unit- II

Plant Design:

Input/output structure of the flow sheet; Recycle structure of the flow sheet; Separation system; Heat Exchanger Networks. Process design development and general design considerations.

Unit-III

Process Economics:

Economic feasibility of project using order-of magnitude cost estimates, plant and equipment cost estimation,

Unit-IV

Product Cost Analysis:

Product cost estimation. Cash Flows: Time value of money, investment, costs, sales, profits, taxes, depreciation.

Unit-V

Profitability Analysis:

Rate of return, payback period, discount rate of return, net present worth, internal rate of return, comparing investment alternatives.

Suggested Readings:

1. Douglas, J. M., "Conceptual Design of Chemical Processes," McGraw-Hill, 1989.
2. Peters, M. S. and Timmerhaus, K. D., "Plant Design and Economics for Chemical Engineers," 4th ed., McGraw-Hill, 1991.
3. Biegler, L., Grossmann, I. E. and Westerberg, A. W., "Systematic Methods of Chemical Engineering and Process Design," Prentice Hall, 1997.

BE VII SEMESTER CHEMICAL ENGG.							
COURSE CONTENTS (UEC SCHEME)							
CM-7021	Petroleum Processing Technology	**L**	**T**	**P**	**C**	**Max. Marks**	**Min. Marks**
Duration	3 Hours	3	1	0	4	70	22

Unit-I

Origin of Petroleum:

Origin and occurrence of petroleum crude, status of petroleum refining in India. Composition of petroleum, classification and physical properties of petroleum. Evaluation of crude oil and petroleum products, future refining trends.

Unit –II

Distillation of Crude

Crude oil Distillation Process, Pretreatment of crude, atmospheric and vacuum distillation process. Secondary conversion processes: Catalytic reforming, catalytic cracking and deep catalytic cracking.

Unit - III

Heavy Residue Up gradation:

Hydro cracking, Hydro treating, visbreaking and delayed coking alkylation, isomerisation, dehydrogenation processes, polymerization.

Unit - IV

Lubricating Oil, Grease and Bitumen:

Dewaxing and deoiling, deasphalting, lube hydro-finishing, bitumen air blowing, Sweetening and Desulphurization. Hydro-desulphurisation of petroleum products.

Unit - V

Solvent Extraction:

Solvent furfural process, refinery gas utilization: LPG, propylene and hydrogen recovery, Reformulated Gasoline: Present and future requirements.

Suggested Readings:

1. Nelson W.L. - PETROLEUM REFINERY ENGINEERING - 4th ed. McGraw Hill . (1987)
2. Hobson G.D. et al. - MODERN PETROLEUM TECHNOLOGY - Part I & II 9th ed. 1986. John Willy & Sons.

BE VII SEMESTER CHEMICAL ENGG.							
COURSE CONTENTS (UEC SCHEME)							
CM-7022	Bio Process Technology	**L**	**T**	**P**	**C**	**Max. Marks**	**Min. Marks**
Duration	3 Hours	3	1	0	4	70	22

Unit I

Introduction to Bio-Processes:

Aspects of microbiology, cell theory structure of microbial cells, classification of microorganism, Essential chemicals of life lipids, Sugars and Polysaccharides, RNA and DNA, Amino acids and proteins.

Unit II

Bio-Processes Mechanism:

Metabolic mechanism of the cells. Biochemical Kinetics, Simple enzyme kinetics with one or two substrates, Modulation and regulation of enzymatic activity, immobilized enzyme, enzyme reactions in heterogeneous systems. sterilization, filtration

Unit III

Growth & Cultivation:

Growth cycle, phases for Batch cultivation, mathematical modeling of batch growth, products synthesis Kinetics, overall kinetics and thermal death kinetics of cells and spores.

Unit IV

Genetic Engineering:

Application of genetic engineering, agitation and aeration, Determination of oxygen transfer rate, determination of K_{ga} and K_{La} scaling of mass transfer equipment

Unit V

Design of Bioreactors:

Classification and characterization of different bioreactors. Batch and continuous reactors, tubular, CSTR and tower reactors. Aerobic and anaerobic fermentation - process, design and operation of typical aerobic and anaerobic fermentation processes, Manufacture of microbial products e.g. antibiotics alcohol/wine etc. and whole cells for industrial processes.

List of Experiments:

1. To carry out the isolation and identification of microorganism from a soil sample.
2. To examine and study the effectiveness of various techniques used for the preservation of microorganisms.
3. To study the kinetics of ethanol fermentation.
4. To determine the kinetic constants l.1max and Km for the growth of microorganisms.
5. To identify bacterial species using Gram staining tests.
6. To determine the biochemical oxygen demand of the given wastewater sample.
7. To determine the chemical oxygen demand of the given wastewater sample.
8. To study the BOD kinetics of the given wastewater sample and to determine the kinetic constant.
9. To determine the dissolved oxygen content of the given sample by Winkler method.
10. To determine the reducing sugar in the given fermentation medium.
11. To determine the protein in the given fermentation medium.
12. To determine the total sugar content in the given fermentation medium.
13. To study the kinetics of methane fermentation.
14. To study the kinetics of an enzyme catalyzed reaction.
15. To study the activity of enzymes in free and immobilized States.
16. To study the activity of whole cell enzymes in free and immobilized States.

Note: Each student should perform at least eight experiments out of the above list.

Suggested Readings:

1. Baily, J .E. and Ollis D.F. - BIOCHEMICAL ENGINEERING FUNDAMENTALS - II edition McGraw Hill (1986).
2. Coulson and Richardson - CHEMICAL ENGINEERS - Ed. III

BE VII SEMESTER CHEMICAL ENGG.							
COURSE CONTENTS (UEC SCHEME)							
CM-7023	Fertilizer Technology	**L**	**T**	**P**	**C**	**Max. Marks**	**Min. Marks**
Duration	3 Hours	3	1	0	4	70	22

Unit- I
Introduction:
Plant nutrients, different types of fertilizers and their production in India. Different feed stocks. Synthesis gas production by steam-naphtha reforming and gas purification. Ammonia synthesis.

Unit- II
Nitrogenous Fertilizers:
Urea manufacturing processes. Manufacture of sulphuric acid and ammonium sulphate. Nitric acid and ammonium nitrate manufacture.

Unit – III
Phosphatic Fertilizers:
Availability and grinding of rock phosphate, manufacturing processes for single and triple super-phosphate and phosphoric acid.

Unit- IV
Mixed Fertilizers:
Availability and manufacture of muriate of potash.
Mixed Fertilizers: Mono and di-ammonium phosphate, urea ammonium phosphates, NPK complex fertilizers, granulation techniques.

Unit-V
Major Engineering Problems:
Fertilizers storage and handling. Corrosion problems in fertilizers industries. Fertilizer plant effluent treatment and disposal.

Suggested Readings:

1. Slack A.V. “Chemistry and Technology of Fertilizers”, Wiley linterscience Publishers.
2. Waggaman W.H., “ Phosphoric Acid, Phosphates and Phosphatic Ferilizers”, Hafner Pub.
3. Austin G.T., “Shreve’s Chemical Processes Industires”, 5th Ed. McGraw Hill.
4. Rao M.G. and Sittig M., “ Dryden’s Outlines of Chemical Technology”, Affiliated East West Press, Delhi.

BE VII SEMESTER CHEMICAL ENGG.							
COURSE CONTENTS (UEC SCHEME)							
CM-7031	Energy Management	**L**	**T**	**P**	**C**	**Max. Marks**	**Min. Marks**
Duration	3 Hours	3	1	0	4	70	22

Unit- I

Introduction to Energy Management:

Definition, need and types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel & energy substitution, Energy audit instruments.

Unit – II

Energy and Environment Monitoring:

Defining monitoring & targeting, elements of monitoring & targeting, data and information-analysis, techniques - energy consumption, production, cumulative sum of differences CUSUM).

Global environmental concerns: United Nations Framework Convention on Climate Change (UNFCC), sustainable development, Kyoto Protocol, Conference of Parties (COP), Clean Development Mechanism (CDM), Prototype Carbon fund (PCF).

Unit – III

Energy Efficiency:

Steam System: Properties of steam, assessment of steam distribution losses, steam leakages, steam trapping, condensate and flash steam recovery system, identifying opportunities for energy savings.

Energy efficiency in Electrical Utilities: Electrical system, Electric motors, HVAC and Refrigeration System, Fans and blowers, Pumps and Pumping System, Cooling Tower, Lighting System.

Unit – IV

Waste Heat Recovery and Insulation:

Classification, advantages and applications, commercially viable waste heat recovery devices, saving potential. Insulation-types and application, economic thickness of insulation, heat savings & application criteria, Refractory-types, selection and application of refractories, heat loss.

Unit- V

Heat Exchanger Networks and Pinch Technology:

Energy targeting, area targeting, number of units targeting, shell targeting, cost targeting Pinch design methods, Grid diagram, composite curve, problem table algorithm, grand composite curve.

Suggested Readings:

1. Goodall P. M., “The Efficient Use of Steam”, Editor: Westbury House
2. Mannan S., “Lee’s Loss Prevention in the Process Industries”, Vol. I, Vol. II 2nd Ed., Butterworth Heinemann.
3. Kafarov V. V., “Wasteless Chemical Processes”, Mir.
4. Shenoy U. V., “Heat Exchanger Network Synthesis”, Gulf Publishing Company.
5. Kemp I. C., “Pinch Analysis and Process Integration: A user Guide on Process Integration for the Efficient Use of Energy”, 2nd Ed., Butterworth-Heinemann.
6. Henderson S. M., Perry R. L., and Young J. H., “Principles of Process Engineering”, 4th Ed., Asae.
7. D.Reay, “Industrial Energy Conservation”.

BE VII SEMESTER CHEMICAL ENGG.							
COURSE CONTENTS (UEC SCHEME)							
CM-7032	Non Conventional Energy Sources	**L**	**T**	**P**	**C**	**Max. Marks**	**Min. Marks**
Duration	3 Hours	3	1	0	4	70	22

Unit- I
Introduction:
Energy scenario of supply and demand in India and the world, energy consumption in various sectors, potential of non-conventional energy resources.

Unit- II
Solar Energy:
Solar radiation and its measurement, limitations in the applications of Solar Energy, Solar collectors – types, and constructional details. Solar water heating, applications of Solar Energy for heating, drying, space cooling, water desalination, solar concentrators, photovoltaic power generation using silicon cells.

Unit- III
Wind Power:
Principle of energy from wind, windmill construction and operational details and electricity generation and mechanical power production.
Tidal Power: Its meaning, causes of tides and their energy potential, enhancement of tides, power generation from tides and problems. Principles of ocean thermal energy conversion (OTEC) analysis and sizing of heat exchangers for OTEC.

Unit- IV
Geothermal Energy:
Geo technical wells and other resources dry rock and hot aquifer analysis , harnessing geothermal energy resources.

Unit- V
Energy Storage and Distribution:
Importance, biochemical, chemical, thermal, electric storage. Fuel cells, distribution of energy.

Suggested Readings:

1. Rai, G.D., “Non-Conventional Energy Sources,” Khanna Publishers, New Delhi, 2001.
2. Twiddle, J. Weir, T. “Renewable Energy Resources,” Cambridge University Press, 1986.
3. Kreith, F. and Kreider, J. F., “Principles of Solar Engineering,” McGraw Hill, 1978.
4. Duffie, J. A., Beckman, W. A., “Solar Engineering of Thermal Processes,” John Wiley, 1980.
5. Veziroglu, N., “Alternative Energy Sources,” Volume 5 & 6, McGraw-Hill, 1978.
6. Sarkar, S., “Fuels and Combustion,” 2nd ed., Orient Longman, 1989.
7. Sukhatme, S. P., “Solar Energy: Principles of Thermal Collection and Storage,” 2nd ed., Tata McGraw-Hill, 2001.
8. Garg, H.P. and Prakash, J., “Solar Energy: Fundamentals and Applications,” Tata McGraw-Hill, 2001.

BE VII SEMESTER CHEMICAL ENGG.							
COURSE CONTENTS (UEC SCHEME)							
CM-7033	Pulp and Paper Technology	**L**	**T**	**P**	**C**	**Max. Marks**	**Min. Marks**
Duration	3 Hours	3	1	0	4	70	22

Unit- I
Introduction:
Present status of pulp and paper industries; Fibrous raw materials; Fiber chemistry.
Raw Material Preparation: Debarking, chipping, chip screening, storage. Pulping: Chemical, semi chemical, mechanical, chemi-mechanical and non-conventional. Secondary fiber pulping. Advances and recent trends in pulping.

Unit- II
Bleaching:
Objectives of bleaching bleach ability measurement, bioleaching. Chemical Recovery: Composition and properties of black liquor, oxidation and desilication, concentration of black liquor & its incineration caustic zing and clarification, sludge washing and burning.

Unit- III
Pulp Manufacture:
Stock preparation, beating and refining, functional and control additives for papermaking, wet-end chemistry, polymer chemistry, retention sizing.

Unit- IV
Paper Manufacture:
Approach flow system, wire part, sheet forming process, sheet transfer mechanism, press part, theory of pressing, dryer part, paper drying process, calendaring, cylinder mould machine, finishing, fiber recovery systems, recent developments in paper making. Coating and lamination.

Unit- V
Paper Properties:
Physical (optical, strength and resistance), chemical and electrical properties, paper defects. Paper Grades: Types, composition, manufacturing techniques, properties and uses.

Suggested Readings:

1. Britt, K. W. (Ed.), "Handbook of Pulp and Paper Technology," 2nd ed., CBS Publishers & Distributors, Delhi, 1984.
2. Casey, J. P., "Pulp and Paper Chemistry and Chemical Technology," Vol. 1, 3rd ed., Wiley Interscience.
3. Rydholm, S. A., "Pulping Processes," Wiley Interscience.
4. Libby, C. E., "Pulp and Paper Science and Technology," Vol. 1, McGraw-Hill.
5. Clark, J. D. A., "Pulp Technology and Treatment for Paper," 2nd ed. Miller Freeman.
6. McDonald, R. G., "Pulp and Paper Manufacture," Vol. 1, 2nd ed., McGraw-Hill.
7. Biermann, C. J., "Essentials of Pulping and Paper Making," Academic Press.
8. Saltman, D., "Paper Basics," Van Nostrand, 1978.

BE VII SEMESTER CHEMICAL ENGG.							
COURSE CONTENTS (UEC SCHEME)							
CM-7006	Project Part-I	**L**	**T**	**P**	**C**	**Max. Marks**	**Min. Marks**
Duration	3 Hours	0	0	4	4	60	19

- All Experimental Projects should contain: Introduction, Literature Review, and Setup Preparation
- All Plant Design Projects should contain: Introduction, Literature Review, Process selection and Material and Energy Balances.