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DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY, AURANGABAD.

Revised Syllabus of

B.E.

Final Year

[Chemical Engineering]

[Effective from 2009-10 & onwards]

Dr. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY, AURANGABAD.

Proposed Scheme of Teaching and Examination for Fourth Year Engineering (Chemical Engineering) to be effective from the academic year 2009-2010.

Semester - I

Sr. No.	Subject No.	Subject	Teaching Scheme (Hours/ week)			Examination Scheme (Max. Marks)				Duration of Theory Paper (Hours)	Duration of Practical Examination. (Hours)
			Theory	Practical	Total	Theory	Practical	Term Work	Total		
1	4901	Chemica. Reaction Engineering-II.	04	02	06	100	50	--	150	03	04
2	4902	Transport Phenomena.	04	02	06	100	50	--	150	03	04
3	4903	Biochemical Engineering.	04	--	04	100	--	--	100	03	--
4	4904	Elective-I.	04	--	04	100	--	--	100	03	--
5	4905	Elective-II.	04	--	04	100	--	--	100	03	--
6	4906	In-plant Training Seminar.	--	--	--	--	--	50	50	--	--
7	4907	Seminar-I.	--	02	02	--	--	50	50	--	--
8	4908	Project Work-I.	--	02	02	--	--	50	50	--	--
		Total	20	08	28	500	100	150	750	--	--

Semester - II

Sr. No.	Subject No.	Subject	Teaching Scheme (Hours/ week)			Examination Scheme (Max. Marks)				Duration of Theory Paper (Hours)	Duration of Practical Examination. (Hours)
			Theory	Practical	Total	Theory	Practical	Term Work	Total		
1	4909	Process Modeling and Simulation.	04	02	06	100	50	--	150	03	02
2	4910	Industrial Pollution and Control.	04	02	06	100	50	--	150	03	04
3	4911	Industrial Safety.	04	--	04	100	--	--	100	03	--
4	4912	Elective-III.	04	--	04	100	--	--	100	03	--
5	4913	Project Work-II	--	04	04	--	100	50	150	--	--
		Total	16	08	24	400	200	50	650	--	--

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B.E. Chemical Revised Syllabus to be effective from the academic year 2009-2010.

The students are required to opt for any one of the following elective subjects during their course work.

List of elective subjects.

Semester – I :

Elective – I.

1. Industrial Piping.
2. Food Technology.
3. Energy Engineering.

Elective – II.

1. Petrochemical Engineering.
2. Polymer Science and Engineering.
3. Computer Aided Design.

Semester – II :

Elective – III.

1. Optimization in Chemical Engineering.
2. Catalysis.
3. Advanced Separation Process.

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4901. Chemical Reaction Engineering – II.

One Theory Paper : 100 marks. Duration : 03 Hours.

Practical Examination : 50 marks. Duration : 04 Hours.

Note :

The approximate number of teaching hours required to cover the syllabus on the topics given below is given at the end of the topic. Numerical be worked out as per the requirement of the topic.

Unit 1:

Temperature and Pressure effects : Single reaction and multiple reactions. Optimum temperature progression. Adiabatic and non-adiabatic operations. Non-ideal flow : RTD, models for non-ideal flow and applications to reactor design. Mixing of fluids : Self mixing of a single fluid and mixing of two miscible fluids. (12Hrs)

Unit 2 :

Rate equation for heterogeneous systems. Contacting Pattern for Two-Phase Systems, Fluid Particle Reactions. Progressive Conversion Model, Unreacted Core Model for Spherical Particle of Unchanging Size, Rate of Reaction for Shrinking Spherical Particles, Determination of Rate Controlling Steps, Mathematics of Progressive Conversion Model Reactors for Fluid-Particle non catalytic reactions. (06Hrs)

Unit 3:

Introduction to Fluid-Fluid System (without catalyst), Rate Equation for Instantaneous, Fast, Intermediate, Slow, Reaction and Infinitely Slow Reaction, Film Conversion Parameter, Slurry Reaction Kinetics. Applications to design - Tower for Fast and Slow Reaction, Mass Transfer with Chemical Reaction. Reactive Distillation and Aerobic fermentation. (06Hrs)

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Unit 4 :

Catalysts: Classification, Characteristics, Preparation and Deactivation of Catalyst. Promoters and Inhibitors. Determination of surface Area, Pore Volume etc of Catalyst. Selection & preparation catalysts for industrial reactions like NH_3, H_2SO_4, Water gas shift reaction, etc. Adsorption Process and its classifications. Types of Adsorption Isotherm. (04Hrs)

Unit 5 :

Solid Catalyzed Reactions. The Rate equation, Various resistances in catalyst pellets. Effectiveness Factor. Heat effects during reaction, Resistances for isothermal particles. Staged Adiabatic Packed Bed Reactors. Fluidized Bed Reactors. (06Hrs)

Unit 6 :

Introduction to Heterogeneous Catalytic Reactors. Design, Mechanism, Construction and applications of : Moving Bed Reactors like Slurry Bed Reactors, Trickle Bed Reactors. Isothermal and Adiabatic Fixed Bed Reactors. (06Hrs)

Practical Work

Minimum eight experiments, based on the syllabus, should be conducted during the course and record (Journal) for the same shall be submitted.

The practical examination shall consist of performing an experiment based on the practical work done during the course, the record of the experiments submitted by the candidate and viva-voce based on the syllabus.

Suggested List of Experiments: The experiment be based on

1. The kinetics of liquid phase reversible reaction with homogenous catalyst in a batch reactor.
2. The kinetics of liquid phase reaction by dilatometer method (Decomposition of diacetone alcohol)
3. The temperature dependency of liquid phase irreversible reaction.
4. Mass transfer with chemical reaction.
5. RTD in CSTR.
6. RTD in PFR.
7. RTD in packed bed reactor.
8. Characterization of catalysts.
9. CSTRs in series.
10. Heterogeneous catalytic reaction.

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Reference Books:

1. Chemical Reaction Engineering, O. Levenspiel, Wiley Eastern Ltd
2. Elements of Chemical Reaction Engineering, H. S. Fogler, Prentice- Hall of India Pvt Ltd.
3. The Engineering of Chemical Reactions, L.D.Schmidt, Oxford University Press.
4. Chemical Engineering Kinetics, J.M. Smith, McGraw Hill Book Co.
5. Principles of Reaction Engineering, S.D. Dawande, Central Techno Publications.

Note: For paper setter(s) for setting of question paper(s) for the theory examination to be conducted by University:

1. Weightage to the question to be asked be based on number of teaching hours allotted to each topic / unit.
2. Total of 05 (five) questions maximum, be asked per section of the paper, out of which students are expected to answer / solve any three questions.
3. Questions be of a maximum 16 / 18 marks each, to add up to maximum 50 marks per section.
4. Questions of maximum 16 / 18 marks are expected for teaching of @ 04 hrs of a topic. The question be a full question of 16/18 marks or have sub-questions to make a full question of 16/18 marks.
5. There be a minimum of one and a maximum of two question on each topic / unit.
6. @40% of the questions to be set be based on the theory, @40% be based on numerical solving and @20% be based on derivation(s).

4902. Transport Phenomena.

One Theory Paper : 100 marks. Duration : 03 Hours.

Practical Examination : 50 marks. Duration : 04 Hours.

Note :

The approximate number of teaching hours required to cover the syllabus on the topics given below is given at the end of the topic. Numerical be worked out as per the requirement of the topic.

Unit 1: Momentum Transport.

Viscosity & the mechanisms of momentum transport: Introduction of viscosity and mechanism of momentum transport. Newton's law of viscosity. Newtonian & non-Newtonian fluids. Pressure & temperature dependency of viscosity. Molecular theory of viscosity of gases & of liquids.

Shell momentum balances and velocity distributions : Shell momentum balances & boundary conditions, flow of a falling film, flow through a circular tube and an annulus, flow of two adjacent immiscible fluids, creeping flow around a sphere.

The equations of change for isothermal systems : The equation of (i) continuity, (ii) motion, (iii) mechanical energy, (iv) angular motion. Use of the equations of change to solve flow problems. Dimensional analysis of the equation of change.

Velocity distributions : Time dependent flow of Newtonian fluids. Comparison of laminar & turbulent flows. Time smoothed equations of change for compressible fluids, time smoothed velocity profile near a wall. Empirical expressions for turbulent momentum flux, turbulent flow in ducts & jets.

Interphase transport in isothermal systems : Friction factors for flow in tubes, around spheres, packed columns.

Macroscopic balances for isothermal flow systems : The macroscopic mass, momentum, angular momentum, mechanical energy balance. Estimation of viscous loss. Use of the macroscopic balances for steady – state & unsteady – state problems. (18 Hrs)

Unit 2 : Energy Transport.

Thermal conductivity and mechanism of energy transport : Fourier's law. Temperature & pressure dependence of heat conductivity. Thermal conductivity of – gases, liquids & solids. Effective thermal conductivity of composite solids. Convective transport of energy.

Shell energy balances and temperature distributions in solids & laminar flow : Shell energy balances – boundary conditions. Heat conduction with heat sources like, electrical, nuclear, viscous, and chemical. Heat conduction through a composite wall, in a cooling fin.

Temperature distributions : Unsteady heat conduction in solids. Steady heat conduction in laminar, incompressible flow. Boundary layer theory of non isothermal flow. Time smoothed equations for incompressible non isothermal flow. Time smoothed temperature profile near a wall. Empirical expressions for heat flux, temperature distribution for turbulent flow in tubes & jets. Fourier analysis of energy transport. Analogy of interphase transport with momentum transport. (12 Hrs)

Unit 3 :

Diffusivity and the mechanism of mass transport : Definitions of concentrations, velocities, mass flow. Fick's law. Temperature & pressure dependence of diffusivities. Diffusion in gases at low density, in binary liquids, & in colloidal suspensions. Mass & molar transport by convection. The Maxwell – Stefan equations.

Concentration distribution in solids & in laminar flow : Shell mass balances. Boundary conditions, diffusion through a stagnant film, with a homogenous and a heterogeneous chemical reaction. Diffusion into a falling liquid film – gas absorption & solid distribution (diffusion & chemical reaction inside a porous catalyst).

Concentration distribution : Time dependent diffusion, steady – state transport in binary boundary layers. Steady – state boundary layer theory for flow around objects, concentration fluctuations & the time smoothed concentration. Time – smoothing of the equation of continuity. Semi – empirical expressions for the turbulent mass flux. Enhancement of mass transfer by a 1^{st} order reaction. Analogy of interphase transport with momentum and energy transport. (12 Hrs)

Practical Work

Minimum eight experiments, based on the syllabus, should be conducted during the course and record (Journal) for the same shall be submitted. At least four experiments be based on the topic of momentum transport, at least two experiments be based on the topic of energy transport and at least two experiments be based on the topic of mass transport.

The practical examination shall consist of performing an experiment based on the practical work done during the course, the record of the experiments submitted by the candidate and viva-voce based on the syllabus.

Suggested List of Experiments: The experiment be based on

1. Newton's law of viscosity. 2. Shell momentum balances on flow through circular pipes.
3. Shell momentum balances on flow through annular pipes. 4. The equations of change for isothermal systems. 5. Time dependent flow of Newtonian fluids. 6. Interphase transport in isothermal systems. 7. Estimation of viscous loss.
8. Temperature and pressure dependence of heat conductivity. 9. Shell energy balances in solids.
10. Shell energy balances in laminar flow. 11. Unsteady heat conduction in solids.
12. Fick's law. 13. Diffusion into a stagnant liquid film. 14. Diffusion in a falling liquid film.
15. Enhancement of mass transfer.

Reference Books:

1. Transport Phenomena, R.B. Bird, W.E. Stewart, E.N. Lightfoot, John Wiley & Sons Inc.
2. Analysis of Transport Phenomena, W.M. Deen, Oxford University Press.
3. Momentum, Heat and Mass Transport, C.O. Benett, J.E. Mayers, McGraw Hill Publication.

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3. Questions be of a maximum 16 / 18 marks each, to add up to maximum 50 marks per section.
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5. There be a minimum of one and a maximum of two question on each topic / unit.
6. @40% of the questions to be set be based on the theory, @40% be based on numerical solving and @20% be based on derivation(s).

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4903. Biochemical Engineering.

One Theory Paper : 100 marks. Duration : 03 Hours.

Note :

The approximate number of teaching hours required to cover the syllabus on the topics given below is given at the end of the topic. Numerical be worked out as per the requirement of the topic.

Unit 1 :

Introduction to Biochemical Engineering, structure of cells important cell types, RNA and DNA, the building blocks, proteins from amino acids. (06Hrs)

Unit 2 :

Kinetics of Enzyme Catalyzed Reactions. The enzyme substrate complex and enzyme action, Michaelis Menten Kinetics, simple enzyme kinetics with one and two substrates, determination of elementary step rate constants, substrate activation and inhibition, multiple substrate modulation reactions, modulation and regulation of enzyme activity, effect of temperature and pH on enzyme activity, enzyme deactivation. (10Hrs)

Unit 3 :

Immobilized Enzyme Technology. Enzyme immobilization, immobilization of enzyme in industrial processes, utilization and regeneration of cofactors, immobilized enzyme kinetics.
Enzyme Metabolism. Carbon catabolism, the TCA cycle. Biosynthesis, transport across cell membranes, passive and facilitated diffusion, active transport, metabolic organization & regulation. End products of metabolism. Formulation, applications & characterization of immobilized cell biocatalysts. (10Hrs)

Unit 4 :

Ideal Reactors for Kinetic Measurements, ideal batch reactor, ideal continuous flow stirred tank reactor, Monod growth kinetics, growth cycle phase for batch cultivation. (004Hrs)

Unit 5 :

Design and Analysis of Biological Reactors, batch reactors, enzyme catalyzed reactions in CSTR, CSTR reactors with recycle and wall growth, the ideal plug flow tubular reactor. Sterilization reactors, batch & continuous sterilization. (04Hrs)

Unit 6 :

Fermentation Technology, Medium formulation, aseptic and aerobic fermentation process, alternate bioreactor configurations, product recovery trains, commercial enzymes, antibiotics, single cell protein in fermentation industries. (06Hrs)

Reference Books :

1. Biochemical Engineering Fundamentals, J. F. Bailey and D. F. Ollis, McGraw-Hill Bk Co.
2. Biochemical Engineering, Shuichi Aiba, E.H.Arthur & F.M.Nancy, University of Tokyo Press.
3. Principles of Fermentation Technology P.F.Stnbury, A. Whitakar & S. J. Hall, Aditya Books(P)Ltd, New Delhi.

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4. Questions of maximum 16 / 18 marks are expected for teaching of @ 04 hrs of a topic. The question be a full question of 16/18 marks or have sub-questions to make a full question of 16/18 marks.
5. There be a minimum of one and a maximum of two question on each topic / unit.

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4904. Elective I : Industrial Piping.

One Theory Paper : 100 marks. Duration : 03 Hours.

Note :

The approximate number of teaching hours required to cover the syllabus on the topics given below is given at the end of the topic. Numerical be worked out as per the requirement of the topic.

Unit 1 :

Importance of piping in chemical industry, Pipes & Tubing, Classification of pipes, Pipe codes and specification. Pipe sizing, Schedule numbers, BWG, NPS. Desirable properties of piping materials, materials for low, normal & high temperature services, materials for corrosion resistance. Basic energy equation for flow, calculation of frictional losses, pressure drop for Newtonian & Non-Newtonian fluids. Calculation of pipe diameter, thickness, equivalent lengths, etc, single liquid lines, single gas & vapor lines, NPSH. (08Hrs)

Unit 2 :

Pipe fittings their advantages & disadvantages. Criteria for selection of pipe joints, pipe joints for similar and dissimilar material, valves expansion effects and methods for reducing them. Safety valves & other pressure relieving devices. Calculation of frictional losses, pressure drop for Newtonian & Non-Newtonian fluids. (06 Hrs)

Unit 3 :

Piping layout piping diagrams, standard symbols & notations, types & design of pipe support, erection and maintenance of supporting, restraining and bracing systems. Fundamental considerations in pipe vibrations, types of vibrations, their prevention and control. Protection of pipe system such as cathode protection, painting, etc. (06 Hrs)

Unit 4:

Pipeline design on fluid dynamics. Complex pipelines in series and parallel. Pipeline storage capacity. Piping design for two phase flow, dispersed flow. Slurry pipeline – design parameters, slurry rheology for homogeneous & heterogeneous slurries. Piping & components as gas expands – isothermal flow, adiabatic flow. (08 Hrs)

Unit 5 :

Design of pipeline for transportation of crude oil & for natural gas. Design of pipes in sea water. Empirical correlations for flow of oil, gasoline, hydrocarbons. Piping for cryogenic materials. Piping arrangements and factors considered in heat exchanger piping, reactor piping, process & storage vessel piping, reboiler piping, piping for compressor & pumps, utility piping.(08 Hrs)

Unit 6 :

Insulation for piping systems. Purpose of insulation. Insulation materials, their selection criteria, their important properties. Principles of heat transfer to the extent of application to heat loss/gain through bare pipe surfaces. Critical thickness of insulation, estimating thickness of insulation, optimum thickness of insulation. (06 Hrs)

Reference Books :

1. Piping Design for process plants by H. F. Rase, John Wiley.
2. Process piping systems, ed" D. J.Deutsch, Chemical Engineering Magazine. McGraw Hill.
3. Industrial Piping by Littleton C.T., McGraw Hill.
4. Process Design of Equipments, Dr. S.D. Dawande, Central Techno Publications.
5. Handbook of Piping Design, G.K. Sahu, New Age International Publisher.
6. Process Piping Design Vol. 1 and 2, R. Weaver, Gulf Publishing.

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4. Questions of maximum 16 / 18 marks are expected for teaching of @ 04 hrs of a topic. The question be a full question of 16/18 marks or have sub-questions to make a full question of 16/18 marks.
5. There be a minimum of one and a maximum of two question on each topic / unit.
6. @40% of the questions to be set be based on the theory, @40% be based on numerical solving and @20% be based on derivation(s).

4904. Elective I : FOOD TECHNOLOGY.

One Theory Paper : 100 marks. Duration : 03 Hours.

Note :

The approximate number of teaching hours required to cover the syllabus on the topics given below is given at the end of the topic. Numerical be worked out as per the requirement of the topic.

Unit 1 :

Introduction & general aspects of food industry, World food needs and Indian situation. Current status of various food products like food grains, cereals, dairy, edible oil, fruits, vegetables and beverages. Current status of the Indian agriculture, food and food processing industry. Market opportunities for the Indian processed food industry. Food constituents, quality and deteriorative factors. Constituents of foods, quality and nutritive aspects, food additives; standards, deteriorative factors and their Control. Physical, chemical, biological, nutritional, sensory characteristics of food. (08 Hrs)

Unit 2 :

Post harvesting operations and storage. Storage of solid foods. Cleaning (wet & dry), sorting by shape, size, color, weight, grading and peeling. Equipment for storage of solid foods. Controlled atmospheric storage of food grains, vegetables and fruits. (06 Hrs)

Unit 3 :

Processing of food products/grains like cereal grains, pulses, vegetables, fruits, spices, fats & oils, bakery, confectionary, & chocolate products. Theory of size reduction equipments & effect of size reduction on foods. Evaporation, extrusion, hot air dehydration, baking, roasting and hot oil frying. Theory, equipments, applications and effects on food materials for freezing, freeze drying and freeze concentration. (08 Hrs)

Unit 4 :

Processing of fruits for manufacture of jams, jellies, pickles, squashes, etc. Processing of soft & alcoholic beverages, dairy products, meat, poultry and fish products. Preservatives used in food processing. (06 Hrs)

Unit 5 :

Food Preservation methods. Conversion and preservation operations. Preservation by heat and cold, dehydration, concentration, frying, irradiation, microwave heating, sterilization & pasteurization, fermentation & pickling. (06 Hrs)

Unit 6 :

Post processing operations. Coating & enrobing operations, equipments and applications. Packing methods. Theory of food packaging, types of packing materials. Packaging operations, filing & sealing of rigid and semi-rigid containers. Materials for handling food items. Pollution and it's control in food industries. (06 Hrs)

Reference Books :

1. Fundamentals of Food Processing Operations, J. L. Hied and M. A. Joslyn. AVI Publishing Co.
2. Food Science, N.N. Potter, J.H. Hotchkiss, CBS Publishers & Distributors, N. Delhi.
3. Food Processing Engineering, D R. Heldman, AVI Publishing Co.
4. The Fundamentals of Food Engineering, S. E. Charm, AVI Publishing Co.
5. K. Sharma, et al, Food Process Engineering, Theory and Laboratory Experiments, John Wiley & Sons.
6. G. Subbulaxmi & S.A Udipi, food Processing & Preservation, New Age International Pvt. Ltd.

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3. Questions be of a maximum 16 / 18 marks each, to add up to maximum 50 marks per section.
4. Questions of maximum 16 / 18 marks are expected for teaching of @ 04 hrs of a topic. The question be a full question of 16/18 marks or have sub-questions to make a full question of 16/18 marks.
5. There be a minimum of one and a maximum of two question on each topic / unit.

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4904. Elective I : Energy Engineering.

One Theory Paper : 100 marks. Duration : 03 Hours.

Note :

The approximate number of teaching hours required to cover the syllabus on the topics given below is given at the end of the topic. Numerical be worked out as per the requirement of the topic.

Unit 1 :

Energy resources of India and its current status. Conventional Vs Non-Conventional (Renewable) energy sources. Availability and utilization of energy resources, viz firewood, coal, petroleum, gaseous fuels, hydel, nuclear fuel, solar etc. Concept of energy conversion. Energy conservation act of India (2001). Co-generation concept and scope. Strategy for energy development in India, problems and prospects of centralized and decentralized patterns. Environmental effects of energy use. Thermodynamic concepts : Energy efficiency indices. Bureau (06 Hrs)

Unit 2 :

Solar energy storage and utilization. Thermodynamic and heat transfer aspect of solar energy collection. Solar collectors & concentrators their heat transfer analysis and performance. Solar devices like water heaters, stills, dryers, stills, photo-voltaic cells, etc.

Wind energy & its historical importance. Wind energy for water pumping. Scope of wind power generation in India. Design of wind machines. (08 Hrs)

Unit 3 :

Biomass utilization & conversion. Scope of biogas as a large scale energy source. Socio- economic importance of biogas production & utilization. Principles of biogas production, biological mechanism, effect of temperature, gas composition, product purification. Storage and use if biogas. Residue composition & utilization. Design & construction of biogas plants. (04 Hrs)

Tidal & wave energy its scope. Tidal phenomenon & generation of power from the ocean. (02 Hrs)

Basics of Geothermal energy, Nuclear energy, Hydrogen power, Biodiesel, and other renewable sources of energy. (02 Hrs)

Unit 4 :

Analysis of energy recovery systems. Study of energy recovery systems like recuperator, regenerator, thermal wheels, heat pipes, heat pumps, heat exchangers, waste heat boilers, absorbers, coolers, etc.

Co-generation of energy. Advantages of co-generation. Different types of co-generation power plants. Co-generation in typical chemical industries like sugar, pulp & paper, etc. (06)

Unit 5 :

Efficient steam generation, fluidized bed boilers. Efficient use of steam condensate, steam & gas co-generation. Heat exchanger network synthesis. Process heat recovery. Energy performance assessment of heat exchanger, water pumps, etc. Energy conservation in energy intensive chemical & process industries like pulp & paper, sugar, cement, fertilizer, etc. (08 Hrs)

Unit 6 :

Introduction to energy audit. Definition, need, types of energy audit. Methodology & steps taken, energy performance. Matching energy use to requirement, target setting, reduction in losses, improvements in operations. Optimizing the input energy requirement. Energy efficient process technologies. Investments for resources development cost and efficiencies. Concept of comprehensive energy conservation and planning. (08 Hrs)

Reference Books :

1. Energy Conservation Handbook, P.L. Diwakar Rao, Utility Publications Ltd.
2. Energy Technology Handbook, C. Douglas, McGraw Hill Publication.
3. Solar Energy, S.P Sukhatme, Tata McGraw Hill Publication.
4. Wind energy Conservation Systems, L.L. Freris, Prentice Hall publication.
5. Wind Power, D M Simmons, Noyes Data Corporation
6. Solar Energy, Principles of Thermal Collection and Storage, S P Sukhatme, Tata McGraw Hill
7. Nuclear Power, J J Duderstadt
8. Water Power Plants, E Mosinye,

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3. Questions be of a maximum 16 / 18 marks each, to add up to maximum 50 marks per section.
4. Questions of maximum 16 / 18 marks are expected for teaching of @ 04 hrs of a topic. The question be a full question of 16/18 marks or have sub-questions to make a full question of 16/18 marks.
5. There be a minimum of one and a maximum of two question on each topic / unit.
6. The questions to be set be based on the theory, on numerical solving & on derivation(s).

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4905. Elective II : Petrochemical Engineering.

One Theory Paper : 100 marks. Duration : 03 Hours.

Note :

The approximate number of teaching hours required to cover the syllabus on the topics given below is given at the end of the topic. Numerical be worked out as per the requirement of the topic.

Unit 1 :

Origin, formation, and composition of petroleum & natural gas. Reserves & deposits of the world and in India. Types of crude & Indian crude types. Introduction to petrochemicals & petrochemical industry in India. Basic raw material for petrochemical synthesis and their sources. Preparation of feedstock for petrochemical production, main building blocks of petrochemical industry. (06 Hrs)

Unit 2 :

Characteristics of petrochemical manufacture & techniques involved. Naphtha cracking, alkylation's, isomerisation and polymerization to produce petrochemicals. Petrochemicals and their applications. Classification of petrochemicals according to source : Ethylene derivatives, Propylene derivatives, Derivatives of C_4 hydrocarbons, Derivatives of higher paraffin's, Polymers of Olefins & Plastics, Petroleum aromatics. Economic aspects of petrochemical industry in India. (06 Hrs)

Unit 3 :

Chemicals from methanol & synthesis gas like formaldehyde, carbon-di-sulfide, hydrogen cyanide, etc. Chemicals from ethane, ethylene& acetylene like synthetic ethanol, glycols, acids, acetates, ketones, amines, etc. Chemicals from propane & propylene like isopropanol, acetone, glycerol, glycols, etc. Chemicals from butanes, pentanes like butadiene, butanol amines, butyl acetate, methyl ethyl ketone, etc. (08 Hrs)

Unit 4 :

Chemicals from aromatics like mono-chloro & di-chloro benzene, BHC, nitrobenzene, nitrotoulene, pthalic anhydride, terepthalic acid & dimethyl teraphthalate, adipic acid, hexamethylene diamine, maleic anhydride, etc. (08 Hrs)

Unit 5 :

Polymers : Different types of polymerization techniques like bulk, emulsion, suspension, engineering and special types of polymers etc. At least two different types of polymeric products & their manufacture from each of the different types of polymerization techniques. (06 Hrs)

nit 6 :

Future of petrochemicals. Natural gas as a petrochemical feed stock, Integrated petrochemical complex, with power generation, pollution control – norms and methods of elimination, brief description on safety considerations. Energy crisis and petrochemical industry. Trends in petrochemical industry. (06 Hrs)

Reference Books :

1. Petroleum Refining Engineering, W. L. Nelson, McGraw Hill Book Co.
2. Petroleum Refining and Petrochemicals, N.K. Sinha, Umesh Publications, Delhi.
3. The Petroleum Chemicals Industry, R. F. Goldstein. (E & FN London, 1967).
4. Chemical Technology of Petroleum, W. S. Gruese and Dr. Stevens, McGraw Hill, 1960.
5. Chemicals From Petroleum, A. I. Waddams, Chemical Publishing Co.
6. Petroleum Processing Hand Book, W. F. Bland and R. L. Davidson.
7. Petroleum Processing Part-2, A. Chauvee and G. Lefebure, Gulf Publishing Company, 1986.
8. Modern Petroleum Refining Processes, B. K. Bhaskara Rao, Khanna Publishers, N. Delhi.
9. A Text on Petrochemicals, B. K. Bhaskara Rao, Khanna Publishers, New Delhi.
10. Dryden's Outlines of Chemical Technology, M. Gopal Rao, M. Sittig, East-West Press Pvt. Ltd.
11. Shreve's chemical Process Industries, G.T. Austin, McGraw Hill Bok Co.

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3. Questions be of a maximum 16 / 18 marks each, to add up to maximum 50 marks per section.
4. Questions of maximum 16 / 18 marks are expected for teaching of @ 04 hrs of a topic. The question be a full question of 16/18 marks or have sub-questions to make a full question of 16/18 marks.
5. There be a minimum of one and a maximum of two question on each topic / unit.

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4905. Elective II : Polymer Science and Engineering.

One Theory Paper : 100 marks. Duration : 03 Hours.

Note :

The approximate number of teaching hours required to cover the syllabus on the topics given below is given at the end of the topic. Numerical be worked out as per the requirement of the topic.

Unit 1 :

Introduction to polymers. Basic concepts of polymer chemistry and mechanism of polymer formation. Classification of polymers. Functionality, chemical bonding in polymers, types of polymerization, structure of polymers. Linear, branch, and cross linked polymers. Thermosets & thermoplastics. Stereoisomerisms. (06 Hrs)

Unit 2 ;

Properties of Polymers, molecular weight, weight average, number average, etc. Polydispersity index, methods of determination. Factors influencing polymer properties. Effect of molecular weight on engineering properties of polymers. Crystallinity in polymers, transition in polymers, rheology in polymers, analysis & testing of polymers, polymer solubility parameter, polymer degradation. (08 Hrs)

Unit 3 :

Mechanism of polymerization. Addition & condensation. Free radical . Homogenous. Ionic and coordination. Copolymerisation. Bulk, Solution, Suspension, Emulsion, Interfacial types of polymerization their design criteria & comparison. (06 Hrs)

Unit 4 :

Kinetics of free radical polymerization. Chain transfer agents. Kinetics of step growth polymerization. Kinetics of copolymersation & coordination polymerization. Polymer reactions. (06 Hrs)

Unit 5 :

Processing of polymers. Different molding methods - Injection molding, Blow molding, Compression molding, Extrusion molding, Slush molding. Casting, Spinning, Coating and Compounding. (08 Hrs)

Unit 6 :

Brief description of individual polymers, their manufacture & production processes. Polyethylene, Polypropylene, Vinyls, Nylons, ABC polymers, Acrylics and Fluoro carbon polymers, Polyethers, Polyamides, Aldehydes. Condensation polymers, Polymers based on isocyanate reactions and Silicones. Thermoset polymers. (08 Hrs)

Reference Books :

1. Text Book of Polymer Science, F.W. Billmeyer Jr, John Wiley & Sons.
2. Principles of Polymer System, F. Rodrigues, Tata McGraw Hill Publishing Co. Ltd.
3. Fundamental Principles of Polymers Materials, S.L. Rosen, Wiley Interscience Publications.
4. Polymer Science, V.R. Gowarikar, N.V. Visvanathan, J. Sridhar New Age International (P) Ltd.
5. Introduction to Polymer Science and Technology, Dr. S.D. Dawande, Denett & Co.
6. Polymer Science & Technology, J.R. Fried, Prentice Hall of India.

Note: For paper setter(s) for setting of question paper(s) for the theory examination to be conducted by University:

1. Weightage to the question to be asked be based on number of teaching hours allotted to each topic / unit.
2. Total of 05 (five) questions maximum, be asked per section of the paper, out of which students are expected to answer / solve any three questions.
3. Questions be of a maximum 16 / 18 marks each, to add up to maximum 50 marks per section.
4. Questions of maximum 16 / 18 marks are expected for teaching of @ 04 hrs of a topic. The question be a full question of 16/18 marks or have sub-questions to make a full question of 16/18 marks.
5. There be a minimum of one and a maximum of two question on each topic / unit.
6. The questions to be set be based on the theory and on numerical solving.

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4905. Elective II : Computer Aided Design.

One Theory Paper : 100 marks. Duration : 03 Hours.

Note :

The approximate number of teaching hours required to cover the syllabus on the topics given below is given at the end of the topic. Numerical be worked out as per the requirement of the topic.

Unit 1 :

Introduction and basics of computer aided design (CAD). Physical properties of compounds. Thermodynamic properties of gases and binary mixtures. Viscosity, vapor pressure, latent heat, bubble point and dew point calculations. Phase equilibria, vapor liquid equilibria. (10 Hrs)

Unit 2 :

Computer aided design of reactors, evaporators, absorption columns, distillation columns, heat exchangers, furnaces and other chemical engineering equipments. (10 hrs)

Unit 3 :

Process flow sheet simulation. Process and information matrix. Recycle calculation sequence. Material and energy balance computation using modular approach. Process analysis. Process variables their selection. Equipment selection. (10 Hrs)

Unit 4 :

Introduction to simulation packages. Dynamic simulation of reactors, evaporators, absorption columns, distillation columns, heat exchangers, furnaces and other chemical engineering equipments. (10 Hrs)

Reference Books :

1. Computer Aided Design and Manufacturing, M.P. Groover, E.W. Timmers, Prentice Hall of India Ltd.
2. Material and Energy Balance Computations, E.J. Henley, F.M. Rusen, John Wiley.
3. Fundamentals and Modeling of Separation Processes, C.D. Holland, Prentice Hall.
4. Design of Equilibrium Stage Processes, B.D. Smith, McGraw Hill Book Co.

5. Process Flow Sheeting, A.W Wester Berg, Cambridge University Press.
6. Chemical Process Simulation, A. Chussain, Wiley Eastern.

Note: For paper setter(s) for setting of question paper(s) for the theory examination to be conducted by University:

1. Weightage to the question to be asked be based on number of teaching hours allotted to each topic / unit.
2. Total of 05 (five) questions maximum, be asked per section of the paper, out of which students are expected to answer / solve any three questions.
3. Questions be of a maximum 16 / 18 marks each, to add up to maximum 50 marks per section.
4. Questions of maximum 16 / 18 marks are expected for teaching of @ 04 hrs of a topic. The question be a full question of 16/18 marks or have sub-questions to make a full question of 16/18 marks.
5. There be a minimum of one and a maximum of two question on each topic / unit.
6. The questions to be set be based on the theory, on numerical solving and on derivation(s).

4806. In-plant Training Seminar.

Term Work : 50 marks.

The students are required to submit a typed report and present a seminar on the industrial in-plant training (duration 4 to 6 weeks), they have undertaken at the end of 2nd semester of third year in the presence of students and staff members. The term work will be assessed by two university approved internal examiners appointed by the Principal of the college.

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4807. Seminar.

Term Work : 50 marks.

The student will be assigned a topic in the field of chemical engineering or allied fields. The students are expected to search, collect and compile information (literature) on the topic assigned to them. One staff member will supervise the work of the student. Term work shall consist of a typed record, to be submitted by the student, of the work done during the term. The student will have to present a seminar on the topic in the presence of staff members and students.

The term work will be assessed by the two university approved internal examiners appointed by the Principal of the college one of whom will be his/her supervisor & the other a staff member of the concerned branch.

4808. Project Part – I.

Term Work : 50 marks.

The project work is training in chemical engineering practice. The knowledge gained by studying various subjects separately is utilized for a single task. The project trains to co-ordinate the knowledge of chemical engineering principles assimilated over the period of course study and about forty subjects. This is an exercise in literature survey, report writing and team work. The project report reflects on the devotion of students towards work and single mindedness of approach.

A group of 2-3 students will have to work on a topic assigned to them. The topic could be on Plant Design, Design of specific equipment, Process Development etc related to chemical engineering. One staff member will supervise the work of the students. The project work may involve experimental/ theoretical/computational work.

A preliminary report is to be submitted containing the details of literature survey, data collected, outlines of design and drawing, equipments, fabrication, cost estimation & project feasibility.

The term work will be assessed by two university approved internal examiners appointed by the Principal of the college, one of whom will be his guide & the other a staff member of the concerned branch.

4909. Process Modeling and Simulation.

One Theory Paper : 100 marks. Duration : 03 Hours.

Practical Examination : 50 marks. Duration : 04 Hours.

Note :

The approximate number of teaching hours required to cover the syllabus on the topics given below is given at the end of the topic. Numerical be worked out as per the requirement of the topic.

Unit 1 :

Introduction to Modeling & Simulation, Definitions, different types of models, applications of modeling, scope of coverage. Approaches to simulation, design problems Vs simulation problems, information flow diagram in modeling, CAD package in Chemical Engg – Thermodynamic & physical properties package, module library, numerical routines library, costing, etc. (04Hrs)

Unit 2 :

Mathematical Models their classification (deterministic Vs stochastic, linear Vs nonlinear, lumped Vs distributed parameter, dynamic Vs steady state etc with examples), Model building and procedure for steady state & unsteady state models in mass transfer operations, heat transfer operations, fluid flow operations, reaction engineering. (06Hrs)

Unit 3 :

Fundamental laws and their applications – Equation of continuity, equation of motion, equation of energy, equation of state, equation of transport, phase & chemical equilibrium, chemical kinetics, etc. (04Hrs)

Solutions to systems of non-linear algebraic equations, Newton's & successive substitution, Euler & Runge-Kutta method, Models of difference. Applications in chemical engg operations. (06Hrs)

Unit 4 :

Modeling and simulation of heat transfer & other equipments like DPHE, S&THE, evaporators, agitated vessels, mixing processes, fluid-solid operations, pressure change equipments etc. (06Hrs)

Unit 5 :

Modeling and simulation of mass transfer equipments used in flash distillation, continuous binary distillation, tray & packed column, vaporizers, single & multi phase separation, drying, adsorption, absorption & stripping. (08Hrs)

Unit 6 :

Modeling and simulation of reaction equipments like batch reactor, mixed flow reactor, plug flow reactor, trickle bed reactor, bubble column reactor, packed column reactor, fluid bed reactor, bioreactor, etc. (06Hrs)

Introduction to commercially available simulation package. Hysis, Hysis-Aspen, Simulink, Simusolve ect.

Practical Work :

The practical work shall consist of at least 08 modeling / simulation problems based on the syllabus.

The practical examination shall consist of an viva-voce based on the syllabus and the term work.

Reference Books :

1. Process Modeling, Simulation, and Control for Chemical Engineers, W. L. Luyben, McGraw Hill Pub. Co.
2. Process Plant Simulation, B.V. Babu, Oxford University Press.
3. Process Modeling & Simulation, R.W. Gaikwad, Dr. Dhirendra, Denett & Co.
4. Fundamentals & Modeling of Separation Processes, C D. Holland, Prentice Hall Inc., New Jersey.
5. Chemical Plant Simulation, Crowe, Heimlich, Hoffman, Johnson, S Hannou and Woods, McMaster University Publication.
6. Separation Process Principles, J D Seder and Henley

Note: For paper setter(s) for setting of question paper(s) for the theory examination to be conducted by University:

1. Weightage to the question to be asked be based on number of teaching hours allotted to each topic / unit.

2. Total of 05 (five) questions maximum, be asked per section of the paper, out of which students are expected to answer / solve any three questions.
3. Questions be of a maximum 16 / 18 marks each, to add up to maximum 50 marks per section.
4. Questions of maximum 16 / 18 marks are expected for teaching of @ 04 hrs of a topic. The question be a full question of 16/18 marks or have sub-questions to make a full question of 16/18 marks.
5. There be a minimum of one and a maximum of two question on each topic / unit.
6. The questions to be set be based on the theory, on numerical solving and on derivation(s).

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4910. Industrial Pollution and Control.

One Theory Paper : 100 marks. Duration : 03 Hours.

Practical Examination : 50 marks. Duration : 04 Hours.

Note :

The approximate number of teaching hours required to cover the syllabus on the topics given below is given at the end of the topic. Numerical be worked out as per the requirement of the topic.

Unit 1.

Introduction : Definition of pollution, importance of environmental pollution, it's causes & it's control. Types of Pollution. Concept of ecological balance. Role of hydrological and nutrient cycles of environment. Pollution control aspects, Environmental legislation & regulations - Water Act (1974) , Air Act (1981), Environmental Act (1986). Industrial emissions their sources and Indian standards. Waste characterization & pollution parameters. Pollution control aspects in chemical industries. (06 Hrs)

Unit 2.

Air pollutants : Definition of air pollutants, types of air pollutants. Classification, sources, & methods of identifying air pollutants. Their effects on humans & the environment, their threshold limits. Acid rain, greenhouse effect, ozone depletion, global warming. Meteorological factors influencing air pollution, plume behavior & dilution, estimation of plume rise, dispersion equations, stack height calculations. Gaussian plume model. Air pollution sampling & measurement – Ambient air, stack sampling. (08 Hrs)

Unit 3.

Air pollution control : Air pollution control methodology. Types & reasons for using Air pollution control equipments, their advantages, disadvantages & their applications. Equipments like gravity settlers, inertial separators, cyclones, bag filters, electrostatic precipitators, scrubbers, etc. methods of control for gaseous pollutants like SO_2, NO_x, HCN, Organic vapors, automobile exhausts, etc. Choice of equipment. (08 Hrs)

Unit 4.

Water pollution : Classification, sources. Effects of water pollution on humans & the environment. Eutrophication. Sampling, measurements, & standards of water quality. Hardness, Alkalinity, Turbidity, Suspended solids, MLSS, MLVSS, SVI, Dissolved oxygen, BOD, COD, TOC, etc. Dissolved oxygen depletion, Natural aeration. (04 Hrs)

Unit 5.

Effluent water treatment : Pretreatment, Screening, Sedimentation, Settling, Grit chambers, Lagoons & Stabilization ponds. Floatation, Flocculation, Chemical coagulation.

Primary treatment – Equalization, neutralization, settling tanks & their sizing. Secondary treatment – Theory of aeration, oxidation ditch, trickling filters, mechanical aerators, rotating biological contactors, fluid bed contactors, activated sludge process, aeration tanks. Tertiary treatment – Advanced methods for suspended solids & dissolved salts (Reverse osmosis, Electro dialysis, etc.), chemical oxidation methods, chlorination. Methods of recovery of value from effluent treatment, sludge handling & disposal. Effluent (waste) water reclamation & reuse. (08 Hrs)

Unit 6.

Noise pollution : It's effect on humans & environment. Measurements & control in general surroundings & in industries. (01 Hrs)

Solids refuse (waste) like plastics, nuclear & hazardous materials their management. (01 Hrs)

Pollution & it's control in chemical industries like pulp & paper, fertilizer plants, alcohol, petroleum refineries, petrochemical units, etc. Methods of removal of phenols, mercury, chromium, ammonia, etc. (06 Hrs)

Practical Work :

Minimum eight experiments, based on the syllabus, should be conducted during the course and record (Journal) for the same shall be submitted.

The practical examination shall consist of performing an experiment based on the practical work done during the course, the record of the experiments submitted by the candidate and viva-voce based on the syllabus.

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Suggested List of Experiments: The experiment be based on

Measurement of pH, Volatile matter, Total solids, Hardness, Alkalinity, Dissolved oxygen, BOD, COD, Chlorides, Turbidity.

Reference Books:

1.Air pollution control -P. Pratap Mouli & N. Venkata Subbaya, Divya Jyoti Prakashan, Jodhpur .

2. Air Pollution, M.N. Rao, H.V.N. Rao, Tata McGraw – Hill Publishing Co.

3. Fundamentals of air pollution control -Stern. Academic Press.

4. Industrial Water Pollution Control, W.W.Eckenfelder,Jr., McGraw – Hill Book Co.

5. Waste Water Treatment, M. N. Rao & A. K Datta, IBH Pub., New Delhi.

6. Pollution control in Process Industries, S.P. Mahajan. Tata McGraw-Hill Pub. Co. Ltd, N.Delhi.

7. Introduction to waste water treatment -R. S. Ramhalho, Academic Press, New York.

8. Waste Water Engineering: Treatment Disposal Reuse, Metcalf & Eddy, Inc, Tata McGraw Hill.

9. Environmental Pollution Control Engineering, C.S. rao, New Age International (P) Publishers.

10. Sewage Disposal & Air pollution Engineering, S.K. Garg, R. Garg, Khanna Publishers,N.Delhi

Note: For paper setter(s) for setting of question paper(s) for the theory examination to be conducted by University:

1. Weightage to the question to be asked be based on number of teaching hours allotted to each topic / unit.
2. Total of 05 (five) questions maximum, be asked per section of the paper, out of which students are expected to answer / solve any three questions.
3. Questions be of a maximum 16 / 18 marks each, to add up to maximum 50 marks per section.
4. Questions of maximum 16 / 18 marks are expected for teaching of @ 04 hrs of a topic. The question be a full question of 16/18 marks or have sub-questions to make a full question of 16/18 marks.
5. There be a minimum of one and a maximum of two question on each topic / unit.
6. @40% of the questions to be set be based on the theory, @40% be based on numerical solving and @20% be based on derivation(s).

4911. Industrial Safety.

One Theory Paper : 100 marks. Duration : 03 Hours.

Note :

The approximate number of teaching hours required to cover the syllabus on the topics given below is given at the end of the topic. Numerical be worked out as per the requirement of the topic.

Unit 1 :

Safety management : Principles & practices, need for safety, definitions. Types of accidents & damages. Role of safety considerations in chemical plant design & operations. Role of government, safety organization, management and trade unions in promoting industrial safety. Safety education and training. (06 Hrs)

Unit 2 :

Safety and law : The Factories Act 1948 & Factories Rule 1963. safety related provisions. ESI & Workmen Compensation Act and rules. Indian Boiler Act & regulations. Explosive Act, Petroleum Act, Gas Cylinder Rules, SMPV Rules. MSIHC Rules. Safety, and maintenance. (08 Hrs)

Unit 3 :

Toxicology & Industrial Hygiene : Industrial health hazards. Chemical hazards, dangerous properties of chemical dust, gases, fumes, mist, vapors & smoke their threshold limit value (TLV). Typical toxins and their biological effects. Route of ingestion to and elimination from biological systems. Toxicology parameters, their definitions & outline of the measurement methods.
Industrial hygiene – government regulations, control methods, substitution, isolation wet method, etc. local exhaust ventilation, personal hygiene. Evaluation of exposure to toxicants & its impact. Risk assessment & analysis. Minimization of hazards. Personal Protective Equipment (PPE). Need for PPE, selection, standard, supply, use, care & maintenance of respiratory & non respiratory PPE. (08 Hrs)

Unit 4 :

Machine safeguarding, principles, ergonomics, types of guards. Manual handling & storage of materials. Mechanical handling of materials. Hand tools & portable tools. Safety at work station &

plant layout. Safety & house keeping. Industrial lighting. Ventilation & heat control. Noise & vibration. Quality control in safety. (08 Hrs)

Unit 5 :

Fires and explosion. The fire triangle. Distinction between fire & explosion, factors contributing to fire & explosion. Concept of ignition, ignition energy, auto ignition, fire point and flammability limits etc. explosions – various types & conditions for their occurrence. Minimum oxygen concentration. Prevention of fires & explosions : inerting, control of static electricity, sprinkler systems, ventilation, fire fighting systems etc. Storage and handling of flammable & toxic materials. Relief types & locations. Relief systems – various options & their applications. (08 Hrs)

Unit 6 :

Hazards identification. Process hazards checklists, hazards survey. Hazards and Operability Studies (HAZOP), HAZAN, Safety reviews etc. Risk assessment. Review of probability theory, revealed & unrevealed failure, probability of coincidence, event trees & fault trees. Tackling disasters, plan for emergency, emergency shutdown systems. Learning from accidents. Methods of investigating & diagnosing. Case study of well known accidents like Bhopal gas tragedy, Chernobyl nuclear disaster etc. (08 Hrs)

Reference Books:

1. Loss Prevention in Process Industries, Vol. 1 & 2, F. Lees, Butterworth.
2. Chemical Hazards and Safety, Dr. S.D. Dawande, Denett & Co.
3. Chem Tech – I, D. Venkateshwarlu, S.Chand & Co Ltd.
4. Factories Act 1948.
5. Handbook of Fire Technology, R.S. Gupta, Orient Longman.
6. Chemical Process Safety Fundamentals with Applications, D.Y. Crowl, J.F. Louvar, Prentice Hall .
7. Industrial Safety/Safety Management, K.G. Mistry
8. Industrial Hazards & Safety Handbook, R.W. King, J. Magid, Butterworth.
9. Explosion Hazards and Evaluation, W.E. Baker, Elsevier, Amsterdam.
10. Workman Compensation Act 1923.

Note: For paper setter(s) for setting of question paper(s) for the theory examination to be

conducted by University:

1. Weightage to the question to be asked be based on number of teaching hours allotted to each topic / unit.
2. Total of 05 (five) questions maximum, be asked per section of the paper, out of which students are expected to answer / solve any three questions.
3. Questions be of a maximum 16 / 18 marks each, to add up to maximum 50 marks per section.
4. Questions of maximum 16 / 18 marks are expected for teaching of @ 04 hrs of a topic. The question be a full question of 16/18 marks or have sub-questions to make a full question of 16/18 marks.
5. There be a minimum of one and a maximum of two question on each topic / unit.

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4912. Elective III : Optimization in Chemical Engineering.

One Theory Paper : 100 marks. Duration : 03 Hours.

Note :

The approximate number of teaching hours required to cover the syllabus on the topics given below is given at the end of the topic. Numerical be worked out as per the requirement of the topic.

It is expected that the case studies of problems in chemical engineering should be emphasized.

Unit 1 :

Introduction, scope, and concept of optimization. The nature and organization of optimization problems, formulation of objective functions in chemical engineering. Optimization problems in fluid flow, heat exchangers, reactors, separation chains, inventory control etc. (04 Hrs)

Unit 2 :

Analytical methods for unconstrained single variable operation. Methods of optimum point search and applications. Numerical methods - Newton's, Quasi – Newton, Secant, Region elimination, etc. Application of these methods to chemical engineering operation like fluid flow, heat exchange, mass transfer, reactors, processes etc. (08 Hrs)

Unit 3 :

Analytical methods for unconstrained multi variable optimization. Numerical methods – Direct (Univariate search, Conjugate directions search) & indirect methods (Gradient, Conjugate gradient, Newton etc). Application to chemical engineering operations. Constrained optima. Equality constraints. Inequality constraints. (08 Hrs)

Unit 4 :

Linear programming and applications. Graphical solution, Simplex method, Duality & duel simplex, Integer programming. Non-Linear programming, Geometric programming. (08 Hrs)

Unit 5 :

Dynamic programming. Discrete & continuous dynamic programming and its applications. Calculus method of solution, Tabulation method of solution. Variational methods. Multi stage optimization. (04 Hrs)

Unit 6 :

Applications to inventory control, extraction & solvent recovery systems, condenser design, distillation, complex chemical equilibria, transportation problems, assignment problems and areas of chemical engineering operation. (08 Hrs)

Reference Books:

1. Optimization Theory and Practice, G.S.G. Beveridge, R.S. Schechter, McGraw Hill Book Co.
2. Optimization of Chemical Processes, T.F. Edgar, D.M. Himmelblau, McGraw Hill Book Co.
3. Optimization – Theory and its Application, S.R.Rao.
4. Formulation and Optimization of mathematical model, C.L. Smith et al Futernational Text Book
5. Theory and Problems of Operations Research, R. Bronson, Schaums outline Series.

Note: For paper setter(s) for setting of question paper(s) for the theory examination to be conducted by University:

1. Weightage to the question to be asked be based on number of teaching hours allotted to each topic / unit.
2. Total of 05 (five) questions maximum, be asked per section of the paper, out of which students are expected to answer / solve any three questions.
3. Questions be of a maximum 16 / 18 marks each, to add up to maximum 50 marks per section.
4. Questions of maximum 16 / 18 marks are expected for teaching of @ 04 hrs of a topic. The question be a full question of 16/18 marks or have sub-questions to make a full question of 16/18 marks.
5. There be a minimum of one and a maximum of two question on each topic / unit.
6. @40% of the questions to be set be based on the theory, @40% be based on numerical solving and @20% be based on derivation(s).

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4912. Elective III : Catalysis.

One Theory Paper : 100 marks. Duration : 03 Hours.

Note :

The approximate number of teaching hours required to cover the syllabus on the topics given below is given at the end of the topic. Numerical be worked out as per the requirement of the topic.

Unit 1 :

Introduction to catalysis. Homogeneous catalysis and heterogeneous catalysis. Phase transfer and tri – phase catalysis. Liquid – liquid and solid – liquid catalysis, mechanism, engineering problems, mass transfer considerations and reactor types. (08 Hrs)

Unit 2 :

Gas – solid catalytic reactions. Adsorption theories and concept of active site. Adsorption isotherm and Langmuir – Hinselwood approach. Diffusion effect. (06 Hrs)

Unit 3 :

Applications to industrial processes – one example each from inorganic, organic, fine organic chemical, petroleum refining, petrochemical and biochemical industries. (06 IIrs)

Unit 4 :

Preparation of catalysts. Major steps involved in the preparation of catalysts and their formation. physical methods of catalyst characterization for determination of surface area, pore volume and average pore size. The BET equation. Supported metal and metal oxide catalyst. (06 Hrs)

Unit 5 :

Zeolites – Structural considerations. Templeted molecular sieves, size and shape. Selectivity and modification of zeolites. Industrial applications of zeolites (at least 6). (06 Hrs)

Unit 6:

Biocatalysts – enzymes, lipases and microbes as catalyst. Mechanism of participation of enzymes in typical reactions. Michaelis – Menten kinetics, inhibition. Reactions and denaturizing of two biopolymers, proteins and nucleic acids. Some industrial reactions. (08 Hrs)

Reference Books:

1. Chemical Engineering Kinetics, J.M. Smith, McGraw Hill Publications.
2. Biochemical Engineering Fundamentals, J.E. Bailey, D.F. Ollis McGraw Hill Publications.
3. Heterogeneous Catalysis on Industrial Practices, C.N. Satterfield, McGraw Hill Publications.
4. Chemical and Catalytic Reaction Engineering, J.J. Caeberry, McGraw Hill Publications.
5. Enzyme Engineering, L.B. Wingard, Fr. InterScience.

Note: For paper setter(s) for setting of question paper(s) for the theory examination to be conducted by University:

1. Weightage to the question to be asked be based on number of teaching hours allotted to each topic / unit.
2. Total of 05 (five) questions maximum, be asked per section of the paper, out of which students are expected to answer / solve any three questions.
3. Questions be of a maximum 16 / 18 marks each, to add up to maximum 50 marks per section.
4. Questions of maximum 16 / 18 marks are expected for teaching of @ 04 hrs of a topic. The question be a full question of 16/18 marks or have sub-questions to make a full question of 16/18 marks.
5. There be a minimum of one and a maximum of two question on each topic / unit.
6. @40% of the questions to be set be based on the theory, @40% be based on numerical solving and @20% be based on derivation(s).

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4912. Elective III : Advanced Separation Process.

One Theory Paper : 100 marks. Duration : 03 Hours.

Note :

The approximate number of teaching hours required to cover the syllabus on the topics given below is given at the end of the topic. Numerical be worked out as per the requirement of the topic.

Unit 1:

Characteristics of separation processes. General principles involved. Temperature swing adsorption (TSA), pressure swing adsorption (PSA). Liquid chromatography process – basic concepts, phenomena and their characterization. Chromatography options, separation systems. Characteristics of solids and their selection for various applications. Column design & filling. Applications of chromatography. (08 Hrs)

Unit 2 :

Membrane separation processes. Principle, classification, types of membranes, their characteristic and properties. Concentration polarization and fouling. Membrane transport models. Membrane processes like reverse osmosis, ultra-filtration, micro-filtration, dialysis, electro-dialysis etc. Applications of membrane processes. (08 Hrs)

Unit 3 :

Reactive separations. Separation based on reversible chemical complex formation. Ion exchange. Reactive distillation, reactive extraction, reactive crystallization. (06 Hrs)

Unit 4 :

Bubble and foam separation. Foam formation, collapse and drainage. Adsorption properties of foams, modes of operation of foam. Equipments for foam separation. Principle of froth floatation, properties of foam related to floatation operation. Design and development of floatation equipment. Applications of foam separation process. (08 Hrs)

Unit 5 :

Zone electrophoresis. Zone refining. Molecular sieves. Adductive crystallization. Applications of these processes. (06 Hrs)

Unit 6 :

Ultra centrifugation. Electric field and magnetic field separations. Recoil methods. Exchange reactions. Nanotechnology for separations. Applications of these processes. (06 Hrs)

Reference Books :

1. Separation Processes, C.J. King, Tata –McGraw Hill Publishing Co.
2. Separation Techniques for Chemical Engineers, Schweitzer, McGraw Hill Publishing Co.
3. Reverse Osmosis, S. Souri Rajan, Logos Press Ltd.
4. Membrane Hand Book, K. Sirkar, H.O. Winston, Van Nostrand Reinhold.
5. Separation Methods, M.N. Sasteri, Himalaya Publishing House.
6. Mass Transfer Operations, R.E.Treybal, McGraw Hill Publishing Co.
7. Chemical Engineers Hand Book, R.H. Perry, C.H. Chilton, McGraw Hill Publishing Co.

Note: For paper setter(s) for setting of question paper(s) for the theory examination to be conducted by University:

1. Weightage to the question to be asked be based on number of teaching hours allotted to each topic / unit.
2. Total of 05 (five) questions maximum, be asked per section of the paper, out of which students are expected to answer / solve any three questions.
3. Questions be of a maximum 16 / 18 marks each, to add up to maximum 50 marks per section.
4. Questions of maximum 16 / 18 marks are expected for teaching of @ 04 hrs of a topic. The question be a full question of 16/18 marks or have sub-questions to make a full question of 16/18 marks.
5. There be a minimum of one and a maximum of two question on each topic / unit.
6. The questions to be set be based on the theory, on numerical solving and on derivation(s).

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4913. Project – II.

Term Work : 50 marks. **Practical Examination : 100 marks.**

A group of 2-3 students who have been assigned a topic in Project -I will complete the details of the calculations, design & drawing of equipments, fabrication details, cost estimation & project feasibility etc.

The group will have to submit a detailed typed & bound report of the work done, in Project -I and Project II, combined together.

The Practical examination shall consist of a viva-voce based on the project work completed in Part-I and Part-II by the candidate.