DEPARTMENT OF TECHNOLOGY

FINAL YEAR B.TECH

Scheme of Teaching and Examination

Semester – VII (Chemical Technology)

Subject Code	Subject	Teaching Scheme (Hours / Week)				Examination Scheme (Marks)					
						Theory			Practical		
		L	T	P	Total	Scheme	Max. marks	Min. Passing	Scheme	Max. marks	Min. Passing
CH411	Process Modeling and Simulation	04	-	-	04	CIE	50	20	--------	-------	--------
						SEE	50	20	--------	-------	--------
CH412	Advanced Separation Techniques	04	-	-	04	CIE	50	20	--------	-------	--------
						SEE	50	20	--------	-------	--------
CH413	Elective –I	04	-	-	04	CIE	50	20	--------	-------	--------
						SEE	50	20	--------	-------	--------
CH414	Special Chemical Technologies –I	04	-	-	04	CIE	50	20	--------	-------	--------
						SEE	50	20	--------	-------	--------
CH415	Transport Phenomena	04	-	-	04	CIE	50	20	--------	-------	--------
						SEE	50	20	--------	-------	---------
CH411L	Process Modeling and Simulation Laboratory	- -	- -	02	02	--------	-------	--------	IPE	50	20
						--------	-------	--------	EOE	25	10
CH412L	Advanced Separation Techniques Laboratory	- -	- -	02	02	--------	-------	--------	IPE	50	20
						--------	-------	--------	EOE	25	10
CH416L	Major Project(Phase I)	-	-	02	02	--------	-------	--------	IOE	50	20
HS411	Professional Ethics	02	-	-	02	--------	-------	--------	IOE (Seminar)	50	20
CH417	Report of Industrial Training	-	-	-	-	--------	-------	--------	IOE	50	20
	Total	**22**	**00**	**06**	**28**	--------	**500**	--------	--------	**300**	--------

CIE – Continuous Internal Evaluation, SEE – Semester End Examination,
IPE – Internal Practical Evaluation, EPE–External Practical Examination,
IOE– Internal Oral Evaluation, EOE–External Oral Examination

List of Subjects as Elective-I:

CH413.1 Petroleum Refinery Engineering. CH413.2 Biochemical Engineering

CH413.3 Polymer Chemistry CH413.4 Introduction to Food Process Engineering

CH413.5 Surface Chemistry CH413.6 Environmental Science and Microbiology

DEPARTMENT OF TECHNOLOGY
FINAL YEAR B.TECH
Scheme of Teaching and Examination
Semester – VIII (Chemical Technology)

Subject Code	Subject	Teaching Scheme (Hours / Week)				Examination Scheme (Marks)					
						Theory			Practical		
		L	T	P	Total	Scheme	Max. marks	Min. Passing	Scheme	Max. marks	Min. Passing
CH421	Energy Conservation in Chemical Industries	04	-	-	04	CIE	50	20	--------	-------	--------
						SEE	50	20	--------	-------	--------
CH422	Nanotechnology	03	-	-	03	CIE	50	20	--------	-------	--------
						SEE	50	20	--------	-------	--------
CH423	Elective-II	04	-	-	04	CIE	50	20	--------	-------	--------
						SEE	50	20	--------	-------	--------
CH424	Process Economics and Project Engineering	04	-	-	04	CIE	50	20	--------	-------	--------
						SEE	50	20	--------	-------	--------
CH425	Special Chemical Technologies-II	04	-	-	04	CIE	50	20	--------	-------	--------
						SEE	50	20	--------	-------	---------
HS421	Industrial Safety and Hazard Management	02	-	-	02	--------	-------	--------	IOE (Seminar & Assignments)	50	20
CH426	Plant Design and Case studies	01	01	-	02	--------	-------	--------	IOE	25	10
						--------	-------	--------	EOE	25	10
CH427L	Major Project(Phase II)	-	01	04	05	--------	-------	--------	IPE	100	40
						--------	-------	--------	EPE	100	40
	Total	**22**	**02**	**04**	**28**	--------	**500**	--------	--------	**300**	--------

CIE – Continuous Internal Evaluation, SEE – Semester End Examination,
IPE – Internal Practical Evaluation (Based on Project Work) EPE–External Practical Examination (Based on Project Work)
IOE– Internal Oral Evaluation, EOE–External Oral Examination

List of Subjects as Open Elective-II:

CH423.1 Petrochemical Technology CH423.2. Industrial Biotechnology

CH423.3. Polymer Technology CH423.4 Food Process Technology

CH423.5 Catalysis CH423.6 Environmental Chemistry and Biochemistry

Detailed Examination Scheme

1. Out of total 100 theory marks, 50 marks are assigned for Continuous Internal Evaluation (CIE). In each subject, in CIE, minimum 20 marks are required to become eligible for Semester End Examination (SEE) of that particular subject. In a semester, a student will be given an additional attempt to acquire passing marks in CIE. Upon failing to clear the CIE in the additional attempt, he/she will be allowed to appear for the Continuous Internal Evaluation scheme of the respective subject in the next semester. The tests will be conducted by the subject teacher. Only after passing the CIE, the particular student will become eligible for the Semester End Examination.

2. CIE (50 marks) includes:

    - Surprise Test – I of 10 marks in 4^{th} week
    - Mid Semester Test of 30 marks in 8^{th} week
    - Surprise Test - II of 10 marks in 12^{th} week

3. For the Semester End Examination (SEE), 100 marks (3 hrs.) paper will be set and finally it will be converted to 50 marks, in which student must secure minimum 40% i.e. 20 marks as university examination passing head.

4. Final theory marks (out of 100) will be the addition of CIE (out of 50 marks) and SEE (out of 50 marks).

5. IPE means Internal Practical Evaluation in which students have to demonstrate the practical work of his Project Topic as an internal examination at the term end.

6. IOE means Internal Oral Evaluation in which students have to face an internal oral examination at the term end. This examination is based on the practical work carried out by them throughout the year

7. EPE means External Practical Examination in which students have to demonstrate the practical work of his Project Topic as an external examination at the term end. It is as university passing head.

8. EOE means External Oral Examination in which students have to face an external oral examination at the term end. It is as university passing head.

Final Year U.G. Program
Semester VII
(Department: Chemical Technology)

PROCESS MODELING AND SIMULATION (CH411)

Teaching Scheme	**Examination Scheme**
Lectures: 4 hours/week	Theory: CIE (50) +SEE (50) =100 marks
Practical: 2 hours/week	EOE: 25 marks IPE: 50 marks

UNIT-I (5 Hrs)

Mathematical models for chemical engineering systems, fundamentals, introduction to fundamental laws

UNIT -II (6 Hrs)

Examples of mathematical models of chemical engineering systems, constant volume CSTRS, two heated tanks, gas phase pressurized CSTR, non-isothermal CSTR.

UNIT –III (6 Hrs)

Examples of single component vaporizer, batch reactor, reactor with mass transfer, ideal binary distillation column, batch distillation with holdup.

UNIT –IV (8 Hrs)

Iterative methods, bisection, false position, Newton –Raphson, successive approximation methods, comparison of iterative methods, solution of linear simultaneous algebraic equations, Computation of Eigen values and Eigen vectors, Gauss elimination method, Gauss-Jordan and Gauss-Seidel's method.

UNIT –V (5 Hrs)

Numerical integration by Trapezoidal and Simpson's rules, numerical solution of differential equations, Euler method, Runge-Kutta fourth order method

UNIT –VI (6 Hrs)

Interpolation, Lagrange interpolation, forward difference, backward difference and central difference interpolation methods, least square approximation of functions, linear regression, and polynomial regression.

UNIT –VII (6 Hrs)

Computer simulation, examples, gravity flow tank, three CSTRs in series, binary distillation column, batch reactor

UNIT –VIII (6 Hrs)

Simulation of Non-isothermal CSTR, VLE dew point, bubble point calculations, countercurrent heat exchanger

TEXTBOOKS:

1. W. L. Luyben, Process modeling simulation and control for chemical engineers McGraw Hill, 2nd Ed.
2. S.K. Gupta, Numerical methods in engineering, Tata McGraw Hill.

REFERENCE BOOKS:

1. B. S. Grewal, Engineering Mathematics
2. K.Balu and K.Padmanabhan, Modeling and analysis of Chemical Engineering processes, International private limited, 2007

SIMULATION LAB

The following experiments have to be conducted using C/C++/Simulink using MATLAB

1. Gravity Flow tank.
2. Three CSTR's in series – open loop
3. Three CSTR's in series – Closed loop
4. Non isothermal CSTR
5. Binary Distillation column
6. Batch Reactor isothermal; Batch reactor non isothermal – closed loop
7. Isothermal batch reactor – open loop
8. Heat Exchanger
9. Interacting System- two tank liquid level
10. Non interacting system-two tank liquid level
11. Plug flow reactor
12. Bubble point calculations
13. Dew point calculations

Major requirements are Personnel Computer and MATLAB Software

ADVANCE SEPARATION TECHNIQUES (CH412)

Teaching Scheme	**Examination Scheme**
Lectures: 4 hours/week	Theory: CIE (50) +SEE (50) =100 marks
Practical: 2 hours/week	EOE : 25 marks IPE : 50 marks

UNIT I (10 Hrs)

Separation Processes: Industrial Chemical Processes, Mechanism of Separation by phase addition or creation. Separation by barrier, Separation by solid agent, Separation by external field or gradient. Component Recoveries and product purities, Separation power. Selection of feasible separation processes. Crystallization from the melt: Introduction. Progressive freezing: component Separation by progressive freezing, Pertinent variables in progressive freezing. Applications. Zone melting: component separation by zone melting, pertinent variables in zone melting, Application. Melt crystallization from the bulk: Investigations, commercial equipment and application. Falling-film crystallization: Principles of operation, commercial equipment and applications.

UNIT II (10 Hrs)

Enhanced distillation: Introduction. Azeotropism.Azeotropic distillation: Introduction, exploitation of homogeneous azeotropes, exploitation of pressure sensitivity, exploitation of boundary curvature, Exploitation of azeotropy and liquid Extractive distillation: Introduction, solvent effect in extractive distillation, extractive distillation design and optimization, solvent screening and selection extractive distillation by salt effects. Reactive distillation: Introduction, simulation, modeling and design feasibility, Mechanical design and implementation issues, process applications.

UNIT III (10 Hrs)

Supercritical fluid separation processes: Introduction. Physical properties of pure supercritical fluids; thermodynamic properties and transport properties. Process concept in super critical fluid extraction. Phase equilibria: Liquid- Fluid equilibria, Solid- Fluid equilibria, Polymer- Fluid equilibria and the Glass Transition, Co solvents and surfactants, phase equilibria models. Mass Transfer. Applications: Food and Pharmaceutical applications, Temperature controlled residuum Oil super critical extraction [ROSE], Extraction from aqueous solution, Adsorption and desorption, Polymer de volatilization and fractionation, Drying and Aero gel formation, Clearing, Crystallization, Reactive separations.

UNIT IV (10 Hrs)

Membrane separation processes: Introduction. Advantages of membrane separations, Basic equations, Basic concept, Membrane types, Economics. Electro dialysis: Process description, examples, membranes, membrane efficiency, process description and configuration, Energy requirements, Equipment and economics. Reverse osmosis and Nano filtration: Processes description, examples Basic principles of operations, RO and NF membranes, process limitations and configuration. Economics. Ultra filtration: Process description, UF membranes, membrane characterization, process limitations, process configurations, Energy requirements, Design and economics. Micro filtration: process description, Examples, MF membranes, membrane characterization, process limitations, Equipments configurations, process Applications and Economics. Gas- Separations membranes: Process descriptions, examples, Basic principles of operations, selectivity and permeability, Gas- Separation membranes, membrane system design features, energy requirements and economics. Per vaporization: Process description, definition, operational factors, vapor feed, examples, per evaporation membranes, modules.

UNIT V (10 Hrs)

Biochemical separation processes: Introduction. Initial product harvest and concentration: centrifugation, Filtration, Selection of cell separation Unit operation, Cell disruption, protein refolding. Initial purification: Precipitation, Extraction, Adsorption, Membrane processes. Final Purification and product formulation, Chromatography, Lyophilization and drying. Integration of fermentation and downstream processing operations.

List of practicals:

1. Study of membrane separation operations.
    - 1.1 Microfiltration 1.2 Ultrafiltration
    - 1.3 Nanofiltration 1.4 Reverse osmosis
2. Pressure swing Adsorption.
3. Electrostatic precipitator.
4. Gas Chromatography.
5. Ion Exchange.

REFERENCE BOOKS:

1. Perry Robert H. and Green Don W., "Perry's chemical Engineers Handbook" 7th edition. McGraw Hill Publication, New York.

2. Seader J. D. and Henley Ernest J, "Separation Process Principles", John Wiley and Sons, Inc, New York

3. Ladisch Michael R., "Bioseparations Engineering, Principles, Practice and Economics", Wiley Interscience, John Wiley and Sons, Inc. Publications New York

4. Long Robert B. "Separation Process in Waste Minimization", Marcel Dekker, Inc, New York

ELECTIVE-I (CH413)

PETROLEUM REFINERY ENGINEERING (CH413.1)

Teaching Scheme	**Examination Scheme**
Lectures: 4 hours/week	Theory: CIE (50) +SEE (50) =100 marks

UNIT- I: (10 Hrs)

Introduction: genesis, occurrence, exploration, drilling of crude oil. Composition and Evaluation of crude oil and testing of petroleum products. Refining of petroleum – Atmospheric and vacuum distillation.

UNIT- II: (10 Hrs)

Refining of petroleum: Atmospheric and vacuum distillation. Pretreatment of crude oil and transportation.

UNIT- III: (10 Hrs)

Cracking processes: Thermal cracking, Vis-breaking, Coking. Catalytic cracking (FCC), Hydro cracking, Rebuilding processes, bitumen blowing.

UNIT- IV: (10 Hrs)

Treatment techniques for removal of sulphur compounds to improve performance, Storage and stability. Product treatment processes - various solvent treatment processes, Dewaxing, Clay treatment and Hydro fining.

UNIT- V: (10 Hrs)

Cracking of naphtha and gas for the production of ethylene, propylene isobutylene and butadiene. Production of acetylene from methane Catalytic Reforming of petroleum feed stocks. Extraction of Aromatics.

TEXT BOOKS:

1 B.K.Bhaskara Rao, "Modern Petroleum Refining Processes", 2nd Edition. Oxford

and IBH Publishing Company, New Delhi, 1990.

REFERENCE BOOKS:

1 W.L.Nelson, “Petroleum Refinery Engineering”, 4th Edition. McGraw Hill, New York, 1985

2. Robert. A. Meyers, “Handbook of Petroleum Refining Processes”, McGraw Hill, 1986.

3. G.D.Hobson and W.Phol, “Modern Petroleum Technology”, Applied science Publishers, IV Edition, 1975.

ELECTIVE-I (CH413)

BIOCHEMICAL ENGINEERING (CH413.2)

Teaching Scheme
Lectures: 4 hours/week

Examination Scheme
Theory: CIE (50) +SEE (50) =100 marks

UNIT I (10 Hrs)

Introduction: principles of microbiology, structure of cells, microbes, bacteria, fungi, algae, chemicals of life - lipids, sugars and polysaccharides, amino acids, proteins, nucleotides, RNA and DNA, hierarchy of cellular organisation, , Principles of genetic Engineering, Recombinant DNA technology, mutation.

UNIT II (10 Hrs)

The kinetics of enzyme catalyzed reactions: the enzyme substrate complex and enzyme action, simple enzyme kinetics with one and two substrates, determination of elementary step rate constants. Isolation and utilisation of Enzymes -production of crude enzyme extracts, enzyme purification, applications of hydrolytic enzymes, other enzyme applications, Enzyme production – intercellular and extra cellular enzymes.

UNIT III (10 Hrs)

Metabolic pathways and energetics of the cell: concept of energy coupling, ATP and NAD, Photosynthesis, Carbon metabolism, EMP pathway, Tricabocyclic cycle and electron transport chain, aerobic and anaerobic metabolic pathways, transport across cell membranes, Synthesis and regulation of biomolecules.

UNIT IV (10 Hrs)

Typical growth characteristics of microbial cells: Factors affecting growth, Batch and Continuous cell growth , nutrient media, enrichment culture, culture production and preservation, Immobilization Technology – Techniques of immobilization, Characteristics and applications, Reactors for immobilized enzyme systems

UNIT V (10 Hrs)

Introduction to bio reactors: types, Continuously Stirred aerated tank bioreactors, Determination of volumetric mass transfer rate of oxygen from air bubbles and effect of mechanical mixing and aeration on oxygen transfer rate, heat transfer and power consumption, Fermentation-methods and applications, Downstream processing and product recovery in bio processes

TEXT BOOKS:

1. M.L.Shuler and F.Kargi, "Bioprocess Engineering: Basic concepts", 1st Edition, Prentice Hall, New Jersey, 1992

2. Mukesh Doble, Sathyanarayana N, "Biochemical Engineering", Gummai, Prentice Hall, 2007.

REFERENCE BOOKS:

1. Trevan, Boffey, Goulding and Stanbury, "Biotechnology", Tata McGraw Hill Publishing Co., NewDelhi, 1987

2. S.Aaiba, "Biochemical Engineering", Academic Press, 1965.

3. D.G. Rao, "Introduction to Biochemical Engineering", Tata McGraw Hill, 2005.

4. J.E.Bailey and D.F.Ollis, "Biochemical Engineering Fundamentals", McGraw Hill, 1986.

ELECTIVE-I (CH413)

POLYMER CHEMISTRY (CH413.3)

Teaching Scheme
Lectures: 4 hours/week

Examination Scheme
Theory: CIE (50) +SEE (50) =100 marks

UNIT I (8 Hrs)

Scope of Polymer Chemistry: definition of monomers, homopolymers and copolymers, Chemistry of important monomers, Thermosets, Thermoplastic, Elastomers (f) Tg, Tm, and solution properties of polymers

UNIT II (8 Hrs)

Condensation polymerization: Mechanism, kinetic and molecular weight build up , Bulk, Solution, Emulsion and suspension polymerization ,comparison of condensation and addition polymerization

UNIT III (8 Hrs)

Addition polymerization: Type of addition polymerization, Radical, cationic and anionic polymerization, Mechanism and kinetics of polymerization, Copolymerization, Stereo-Regular polymerization, Block and Graft polymerization

UNIT IV (8 Hrs)

Characterization of molecular weight polymers: End-Group analysis method, Viscosity of measurement method, G.P.C. Techniques for measurement

UNIT V (8 Hrs)

Application of polymers: to textiles, Fiber forming synthetic polymer, Properties of fiber forming synthetic polymer

TEXT BOOKS:

1. F.W. Billmeyer, “Text Book of Polymer science”
2. M.S. Bhatnagar, “Text Book of polymer”
3. Gawaskar, Vishwanathan, Sreedhar and Jaydev, “Polymer science”
4. B.K. Sharma, “Polymer chemistry”,

ELECTIVE-I (CH413)

INTRODUCTION TO FOOD PROCESS ENGINEERING (CH413.4)

Teaching Scheme	Examination Scheme
Lectures: 4 hours/week	Theory: CIE (50) + SEE (50) =100 marks

UNIT I

Food chemistry: Lipids, proteins, carbohydrates, composition of foods nutrition. Food Microbiology: Introduction growth factors, degradation and spoilage of foods epidemiology of food borne diseases, food infections.

Food Biotechnology: Fermentation and enzymatic processes.

Aseptic Techniques: Food handling, food sterilization sterilization of food processing equipments. (10 Hrs)

UNIT II

Transport Phenomena in food processing: Non Newtonian flow heat transfer simultaneous heat and momentum transfer thermal time distribution mixing unit operations in food systems, evaporation. (10 Hrs)

UNIT III

Preservation techniques: Thermal, Dehydration, microwave irradiation cold fermentation and by chemicals. (08 Hrs)

UNIT IV

Packaging and storage: Principles, shelf life, canning, modified atmosphere packaging, refrigeration. (08 Hrs)

UNIT V

Post Harvesting Techniques: Grain drying and storage fruit and vegetable processing seafood and meat processing (08 Hrs)

UNIT VI

Supercritical extraction: Flavours, spices, and essence. (06 Hrs)

REFERENCE BOOKS:

1. R. Paul Singh and Demis R. Heldman, Introduction to Food Engineering, 2nd ed, Academic Press, 1993.
2. Ernest L. Watson and John C Harper, Elements of Food Engineering, 2nd ed. Von Nostrand Reinhold Co., 1987.
3. R. Macral, R. K. Robinson, and M. J. Sadler, Encyclopedia of Food Science, Food Technology and Nutrition, Vol. 8, Academic Press 1993.

ELECTIVE-I (CH413)

SURFACE CHEMISTRY (CH413.5)

Teaching Scheme
Lectures: 4 hours/week

Examination Scheme
Theory: CIE (50) + SEE (50) =100 marks

UNIT I

Adsorption and Surface Phenomenon: Physisorption and chemisorption, adsorption isotherms, Langmuir and B. E. T .equation and significance in surface area determination, surface films, states of insoluble films, L. B. films and their application, adsorption from solution, adsorption types, surface excess concentration, Gibb's adsorption equation: derivation, significance and experimental verification (12 Hrs)

UNIT II

Micelle: Surface activity, surface active agents and their classification, micellisation, critical micelle concentration (cmc) thermodynamics of micellisation , factors affecting cmc, methods of determination of cmc, reverse micelle, solublisation of water insoluble organic substances, use of surfactants in oil recovery. (11 Hrs)

UNIT III

Emulsion: Types of emulsion, theories of emulsion and emulsion stability, identification of emulsion types, inversion emulsion, micro emulsion: theory and application. (10 Hrs)

UNIT IV

Liquid gas and liquid interfaces: Surface tension, capillary action, methods of determination of surface tension, surface tension across curved surfaces, vapour pressure of droplet (Kelvin equation), surface spreading, spreading coefficient, cohesion and adhesion energy, contact angle, constant angle hysteresis, wetting and detergency. (12 Hrs)

REFFERNCE BOOKS

1. Physical chemistry of surfaces: A. W. Adamson.
2. Theory of adsorption and catalysis by Alfred Clark ,
3. Chemisorption by B. M. W. Trapnell and H.O. Hayward.
4. Introduction to colloide and surface chemistry by D. J. Shaw.
5. Surface chemistry by J. J. Bikermann
6. Adsorption and Catalysis by Solids by D. K. Chakrabarty, Wiley Eastern Ltd., 1991.

ELECTIVE-I (CH413)

ENVIRONMENTAL SCIENCE AND MICROBIOLOGY (CH413.6)

Teaching Scheme
Lectures: 4 hours/week

Examination Scheme
Theory: CIE (50) + SEE (50) =100 marks

UNIT I

Environmental segments: Lithosphere, Hydrosphere, Biosphere, Composition of Atmosphere, Troposphere, Stratosphere, Mesosphere. Thermosphere, Chemical species and particulars in atmosphere, ions radicals particles Reactions in atmosphere. (10 Hrs)

UNIT II

Principle of Ecology, Definition of Ecology and environment, kind of ecology, environmental and eco-factors, climate factor, medium factor, biotic factor, Ecosystem and its components, Nutrient cycle in ecosystem, carbon nitrogen, sulphur and phosphorous cycle (brief details) (12 Hrs)

UNIT III

Water chemistry:

Hydraulic cycle, specification of water, physical and chemical properties of water, chemistry of pollution due to detergents, pesticides, polymers trace organic metals, petroleum and radioactive components. (12 Hrs)

UNIT IV

Environmental Microbiology. Basic principle of microbial transformation of organic matter. Biodegradation acclimatization of waster and microbial inhibition. Species of algae and their significance in water engineering. Eutrophication. Water borne diseases and their control. Role of microorganism in water and waste water engineering, Role of microorganism in air pollution control (Bio filters and bio scrubbers) (12 Hrs)

TEXT BOOKS:

1. A. K. Datta, “Introduction to Environmental Science & Engineering”, Oxford & IBH,New Delhi
2. Subramaniam, “Text book of Environmental Science”, Narosa

REFERENCE BOOKS:

1. Purohit & Purohit, “Text book of Microbiology”, Agro Publication
2. Subramaniam & Sambamurty, “Ecology”, Narosa
3. Davis & Cornwell, “Introduction to Environmental Science & Environmental Engineering”, Mcgraw Hill Inst.
4. Botkin Keller, “Environmental Science”, Wiley & Son, New York

SPECIAL CHEMICAL TECHNOLOGIES-I (CH414)

Teaching Scheme
Lectures: 4 hours/week

Examination Scheme
Theory: CIE (50) +SEE (50) =100 marks

UNIT I Wood and Wood Chemical industry (08 Hrs)

Composite wood, plywood etc.; Manufacture of oleoresin, turpentine, methanol, rosin, and tall oil; Ethanol production; Essential oils, perfumes, flavours and cosmetics.

UNIT II Leather industry (08 Hrs)

Skin and hides; Tanning processes; Leather making; Embossing; Leather chemicals.

UNIT III Pulp and paper industry (08 Hrs)

Different pulping process; Recovery of chemicals from cooking liquors; Paper making; Role of additives.

UNIT IV Agrochemical Industries (12 Hrs)
Insecticides, pesticides, Herbicides, plant growth, Nutrients and regulators, compound Fertilizers, Bio fertilizers, complex fertilizers, and various grades of N.P.K. fertilizer.

UNIT V Surface Coating technology (12 Hrs)

Classification of paints, water soluble paints and their manufacturing processes; Natural and Synthetic resins; solvents and plasticizers.

Definition and classification of varnish; Oleoresinious and spirit varnishes; Manufacture of different types of varnishes. Ceramic coating; Electroplating; Galvanizing; Tinning, Polymer coating; Protective and decorative coatings. Powder coating.

TEXT BOOK:

1. George T. Austin, “Shreve's Chemical Process Industries”, 5th edition. McGraw Hill Book Company, 1985.

REFERENCE BOOKS:

1. S.D. Shukla, G.N. Pandey. “A Text book of Chemical Technology”, 3rd Edition.
2. C.E. Dryden, “Outlines of Chemical Technology”, Affiliated East-West Press, 1973.
3. D. Venkteshwaralu, “Chemical Technology”, I & III manuals of Chemical Technology Chemical Engineering. Ed. Dev. III Madras, 1977.
4. Faith, “Industrial Chemicals”
5. Rogers, “Industrial Chemistry

TRANSPORT PHENOMENA (CH415)

Teaching Scheme
Lectures: 4 hours/week

Examination Scheme
Theory: CIE (50) +SEE (50) =100 marks

UNIT I Equations of Change (10 Hrs)

Differential equations of continuity and motion. Representation using tensor notation. Navier-Stokes equations. Meaning and examples of constitutive equations. Application of N-E equation to flow in specific geometries such as laminar flow through pipe, Tangential annular flow, Radial flow between parallel disks / concentric spheres / concentric cylinders, Falling film. Models of Non-Newtonian flow. Non-Newtonian laminar flow through pipe. Flow of two adjacent immiscible fluids through pipe. Solution of at least three of the above stated or analogous cases using shell balance approach. Comparison of approaches.

UNIT II Boundary Layer Theory and Turbulence (08 Hrs)

Prandtl's equations. Steady flow laminar boundary layer on a flat plate parallel to the flow. Blasius solution. Boundary layer thickness. Displacement thickness. Momentum thickness. Boundary layer drag.
Turbulence. Importance in heat and mass transfer applications. Decay and production of turbulence. Kinetic energy of turbulence. Scale of turbulence. Reynolds's stresses. Eddy viscosity.

UNIT III Mixing **(**8 Hrs)

Types of mixing problems usually encountered in process industries. Mixing in stirred tanks. Power number-Reynolds number correlation. Power input and mixing time calculations. Zwietering correlation for suspension of solid particles. Agitation equipment. Standard turbine design. Scale up of agitator design. Motionless mixers.

UNIT IV Unsteady State Heat Transfer (08 Hrs)

Calculation of heating and cooling time for agitated liquid batch in coil-in-tank or jacketed vessel and also in a vessel with external heat exchanger.

UNITV Analogies between Heat, Momentum and Mass Transfer (08 Hrs)

Extension of Blasius solution for the laminar boundary layer on a flat plate to include (a) convective heat transfer and (b) convective mass transfer problems for the same geometry and laminar flow. Mass, energy and momentum transfer analogies.

UNIT VI Computational Fluid Dynamics and Two Phase Flow (08 Hrs)

Introduction to the process of discretization and use of grids. Solution of unsteady state one dimensional laminar flow equation using CFD approach. Extension to analogous problems in heat and mass transfer. Issue of numerical stability.
Two phase flow in horizontal and vertical pipes. Different flow regimes. Pressure drop and void fraction calculations.

REFERENCE BOOKS:

1. Noel de Nevers, "Fluid Mechanics for Chemical Engineers", Third Edition; McGraw Hill, 2005.
2. Geankoplis C. J, "Transport Processes and Separation Process Principles", Fourth Edition; Prentice Hall India, 2003.
3. Bird R. W. Stewart and E. Lightfoot, "Transport Phenomena", Second Edition; John Wiley and Sons Inc., 2002.
4. Kern D. Q., "Process Heat Transfer", McGraw Hill, 1965.

PROFESSIONAL ETHICS (HS411)

Teaching Scheme	**Examination Scheme**
Lectures: 2 hours/week	Internal Oral Examination: 50 marks

UNIT I (3 Hrs)

Engineering Ethics – Moral Issues, Ethical theories and their uses

UNIT II (3 Hrs)

Engineering as Experimentation – Code of Ethics

UNIT III (3 Hrs)

Engineer's Responsibility for Safety

UNIT IV (3 Hrs)

Responsibilities in Rights

UNIT V (3 Hrs)

Global issues of engineering ethics

UNIT VI (3 Hrs)

Introduction to Entrepreneurship awareness and Development: Functions -why men become economic innovators –Various Assistance Programmes for Small Scale and large Scale Industries through agencies, like IDBI, IFC, ICICI, NSIC, SFC, SIDCO and DIC.

REFERENCE BOOKS:

1. Charles D.Fleddermann, "Engineering Ethics", Prentice Hall, New Mexico, 1999.

2. Seth, M. L., "Principles of Economics", Lakshmi Narain Agarwal, Agra.

3. Agarwal, A. N., "Indian Economy", Vikas Publishing House Pvt. Ltd., New Delhi.

4. Datta R. and Sundharam, "Indian Economy", K. P. M., S. Chand & Co. Ltd., New Delhi

MAJOR PROJECT (Phase I) (CH416L)

Teaching Scheme	**Examination Scheme**
Practical: 2 hours/week	IOE = 50 marks

The project topic shall consists of either some investigation work or design problem or experimental set up of some development work or prototype equipment or dissertation related to field of chemical engineering.

Project shall be taken in the beginning of the seventh term in consultation with concerned guide and must be completed in eighth term. The project proposal must be submitted in the beginning of the seventh term by every student or a group of students (not more than five students in a group).

The students shall submit the report to the corresponding guide, present their work in due time based on following points,

- Introduction.
- Literature survey.
- Physical / chemical properties etc.
- Experimental setup and procedure.
- Extent of project completed.

Presentation can be performed with OHP slides / LCD.

The progress of the project shall be evaluated by a committee of internal teachers which shall include concerned guide also and shall award the term work marks.
The oral examination of the project shall be conducted by concerned guide.

REPORT OF INDUSTRIAL TRAINING (CH417)

Examination Scheme **Teaching Scheme**

I.O.E. = 50 marks

There will be an industrial training for 21 days after semester VI. This will cover the study of a reputed chemical industry from standpoint of chemical engineering principles. The report of the training is required to be submitted by the students. This particular activity is for 25 marks as an Internal Oral Evaluation (IOE) which is included in this Semester (VII).

Final Year U.G. Program
Semester VIII
(Department: Chemical Technology)

ENERGY CONSERVATION IN CHEMICAL PROCESS INDUSTRIES

(CH421)

Teaching Scheme	**Examination Scheme**
Lectures: 4 hours/week	Theory: CIE (50) + SEE (50) =100 marks

UNIT I (10 Hrs)

Energy Outlook: Introduction, Scope of the Problem. Thermodynamic Efficiencies. The Fundamental Strategy. The Second Law of Thermodynamics Revisited: Difference between Laws, Definitions Available Energy. Availability, and Energy, Available Energy and Fuel. Characterizing Energy Use: Understanding Energy use, Missing Data. An illustrative Onsite Audit, An illustrative Steam Power Balance

UNIT II (10 Hrs)

Optimum performance of Existing Facilities: Principle I Minimize Waste ,Combustion Principles, Illustrative Problems — Combustion Efficiency, Steam Trap Principles, Principle 2 Manage Energy Use Effectively, Facilities Improvement - An Overall Site Approach, Utilizing the Energy Audit, Overall Site Interactions, Cogeneration, Total Site Cogeneration Potential, II illustrative Problem: Maximum Potential Fuel Utilization, The Linear Programming Approach Methodology of Thermodynamic Analysis: General Considerations, Introduction, Sign Conventions, Detailed Procedures, Illustrative Examples.

UNIT III (10 Hrs)

Detailed Thermodynamic Analysis of Common Unit Operations: Introduction, Heat Exchange, Expansion – Pressure Letdown Mixing, Distillation — A Combination of Simple Processes Combustion Air Preheating. Use of thermodynamic Analysis to Improve Energy Efficiency: Introduction, Overall Strategy, Reducing available Energy (Work) Losses, Accepting 1nevitahle" Inefficiencies, Optimization through Lost Work Analysis. Research Guidance and Economics: Capital— Cost Relationships, Background Information, The Entire Plant Energy System Is Pertinent, Investment Optimization, Defining the limits of Current Technology, Fundamental Process Improvements

UNIT IV (10 Hrs)

Systematic Design Methods: Introduction, Process Synthesis, Applications to Cogeneration Systems, Thermo economics, Systematic Option station. Guidelines and Recommendations for improving process conditions: Introduction, Chemical Reactions, Separations, Heat Transfer, Process Machinery, System Interactions and Economics, A Check list of Energy Conservation Items, Shortcomings of Guidelines

UNIT V (10 Hrs)

Energy Conservation Measures: Introduction, Management Systems for Energy Conservation, Energy Audits and Energy Monitoring, Combined heat and power generation: introduction, Technology of CHP Systems, Balancing Heat and Power Loads, Economic Incentives for Further CHP systems, Technical Potential for Further CHP systems. Good Housekeeping (Minor) Conservation Measures Heat Recovery: Introduction, Heat Transfer Equipment, I—feat Exchanger Networks. Heat Recovery from Waste Fuels, Heat Exchanger Fouling, Fleet Pumps. Power recovery: Power recovery from pressure reduction of process fluids. Power recovery from low grade waste heat

TEXT BOOKS:

1. Murphy W.R. and McKay G., "Energy Management (BH)",
2. Hinrich & Klein Bach, "Energy: its use and the environment",
3. Boyle, "Renewable Energy: Power for a sustainable future"
4.Rao S. & Parulekar B.B., "Energy technology", Khhanna publisher
5. Capenart & Turner, "Guide to energy management", 6 ed. Kennedy Fairmont press

NANOTECHNOLOGY (CH422)

Teaching Scheme
Lectures: 3 hours/week

Examination Scheme
Theory: CIE (50) + SEE (50) =100 marks

UNIT I Introduction (9 Hrs)

Evolution of science and technology, Introduction to Nanotechnology, Nanotechnology-Definition, Difference between Nanoscience and Nanotechnology, Feynman predictions on Nanotechnology, Moore's law, Bottom up and top down approaches, challenges in Nanotechnology .

UNIT II Nano materials, Synthesis and processing of nano materials (10 Hrs)

History of materials, Nanomaterials-Definition, Classification of Nanostructured materials, causes of interest in nanomaterials, some present and future applications of nanomaterials. Processes for producing ultrafine powders-mechanical grinding, wet chemical synthesis of nanomaterials. Gas phase synthesis of nano materials, gas condensation processes, chemical vapour condensation, laser ablation.

UNIT III Special nanomaterials, characterization and tools (10 Hrs)

Carbon nanotubes, nano composites, nano fluids-An overview over preparation, properties, applications. Electron Microscopy Techniques: Scanning Electron Microscopy, Transmission Electron Microscopy, Scanning Tunneling Microscopy, Atomic Force Microscopy, Scanning Probe Microscopy– X ray methods – Fluorescence

UNIT IV Nanoelectronics (9Hrs)

Introduction – micro, nano fabrication: Optical lithography, Electron beam lithography, Atomic lithography, Molecular beam epitaxy, MEMS, NEMS –An introduction.

REFERENCE BOOKS:

1. J.Dutta & H.Hofman, "Nano materials",

2. Guozhong cao, "Nano structures & Nano materials", Imperial college press.

3. N.P.Mahalik., "Micro manufacturing and Nano Technology"

4. Mark Ratner & Denier Ratner, "Nano Technology", Prentice Hall

5. A S Edelstein& R C Cammarata, "Nano materials", Institute of physics publishing, Bristol and Philadelphia.

ELECTIVE-II (CH423)

PETROCHEMICAL TECHNOLOGY (CH423.1)

Teaching Scheme
Lectures: 4 hours/week

Examination Scheme
Theory: CIE (50) +SEE (50) =100 marks

UNIT I (5 Hrs)

General Introduction - History, economics and future of petrochemicals, energy crisis and petrochemical industry, sources and classification of petrochemicals.

UNIT II (12 Hrs)

First generation petrochemicals - alkanes - C1, C2, C3, C4 petrochemicals, alkenes -C2,C3,C4 petrochemicals, alkynes - C2,C3,C4 petrochemicals, B-T-X aromatics, diene based petrochemicals.

UNIT III (10 Hrs)

Second generation petrochemicals - synthesis gas, methanol, formaldehyde chloromethanes, ethanol, acetaldehyde, acetic acid, acetic anhydride, isopropyl alcohol, ethylene oxide, propylene oxide, acetone, vinyl chloride, phenol, aniline and styrene.

UNIT IV (10 Hrs)

Third generation petrochemicals - plastics, rubbers and fibres, olefinic polymers, polyethylene, polypropylene, polyisobutylene, diene polymers - polybutadiene, neoprene, polyisoprene, SBR, synthetic fibres.

UNIT V (10 Hrs)

Miscellaneous petrochemicals - petroleum proteins, synthetic detergents, resin and rubber chemicals, explosives - TNT and RDX.

TEXT BOOKS:

1.S.Maiti, “Introduction to petrochemicals”, Oxford and IBH publishing Co., 1992.

REFERENCE BOOKS:

1. H.Steines, Pergamon, “Introduction to petrochemical Industry”, 1961.

2. G.D.Hobson and W.Pohl, “Modern Petroleum Technology”, Applied Science

Publishers, IV Edition, 1975.

3. Richard frank Goldstein and A. Lawrence Waddams, “The Petroleum Chemical Industry”, E&FN Spon Ltd., 1967.

4. G.T.Austin, “Shreve’s Chemical Process Industries”, McGraw Hill, V Edition, 1986.

ELECTIVE-II (CH423)

INDUSTRIAL BIOTECHNOLOGY (CH423.2)

Teaching Scheme
Lectures: 4 hours/week

Examination Scheme
Theory: CIE (50) +SEE (50) =100 marks

UNIT I (10 Hrs)

Introduction: Basic concepts in biotechnology and historical development, Biotechnology an interdisciplinary pursuit – public perception of biotechnology – Biotechnology and developing world – Ethics of biotechnology – future and scope of biotechnology.

UNIT II (10 Hrs)

General requirements of Fermentation Process: An overview of aerobic and anaerobic fermentation processes and their application in industry; basic design and construction of fermentor and its auxiliaries, sensors and monitoring instruments, media design and sterilization for fermentation processes.

UNIT III (10 Hrs)

Solid and liquid substrate fermentation: cheese production – single cell protein (SCP) – mushroom production – soya sauce production – leaching of metals – vitamin C and vitamin B12 production – sewage treatment – biogas production – ethanol from molasses.

UNIT IV (10 Hrs)

Genetics and biotechnology: The role of genes within cells, elucidation of the genetic code, genetic elements that control gene expression, methods of creating recombinantDNA molecules, safety guidelines of recombinantDNA research, plasmid and phage vectors.

UNIT V (10 Hrs)

Food and Medicine biotechnology: Biotechnology in relation to the food industry, types of micro-organisms brewing and alcoholic brewerages – wine production –beer production. Antibiotics – penicillin production, vaccines and monoclonal antibodies, human insulin production.

TEXT BOOK:

1. John E.Smith, "Biotechnology", 3rd edition, Cambridge University Press.

REFERENCE BOOKS:

1. Atkinson.B and Mavituna.F, "Biochemical Engineering and Biotechnology Handbook", McGraw HillMillan, 1993.

2. J.E.Bailey and D.F.Ollis, "Biochemical Engineering Fundamentals", McGraw Hill, 1986.

ELECTIVE-II (CH423)

POLYMER TECHNOLOGY (CH423.3)

Teaching Scheme
Lectures: 4 hours/week

Examination Scheme
Theory: CIE (50) + SEE (50) =100 marks

UNIT I (8 Hrs)

Introduction: definitions: polymer& macro molecule, monomer, functionality, average functionality, co-polymer, polymer Blend, plastic and resin. Classification of polymers: based on source, structure, applications, thermal behavior, and mode of polymerization. Concept of average molecular weight of polymers, molecular weight distribution, poly disparity index. Determination of average molecular weights: End group analysis, osmometry, light scattering techniques, viscometer, and Gel permeation chromatography.

UNIT II (4 Hrs)

Natural polymers: brief study of i) Natural rubber ii) shellac iii) rosin iv) cellulose v) proteins.

UNIT III (5 Hrs)

Mechanism and kinetics: Addition or chain polymerization
a) Free radical addition polymerization b) Ionic addition polymerizations
c) Coordination polymerization. d) Coordination or step growth or condensation polymerization.

UNIT IV (10 Hrs)

Methods of polymerization: mass or Bulk polymerization process, solution polymerization process, suspension polymerization process and emulsion polymerization method comparison of merits and demerits of these methods. Properties of polymers: crystalline and amorphous status, melting and glass transition temperatures and their determination, effect of polymer structure on mechanical, physical, chemical and thermal properties.

UNIT V (5 Hrs)

Degradation of polymers, Role of the following additives in the polymers: i) Fillers and reinforcing fillers ii) Plasticizers iii) Lubricants iv) Antioxidants and UV stabilizers v) Blowing agents vi) Coupling agents vii) Flame retardants viii) Inhibitors

UNIT VI (6 Hrs)

Brief description of manufacture, properties and uses: i) Polyethylene (HDPE&LDPE), ii) Poly propylene iii) Polyvinylchloride iv) Polystyrene v) Polytetra fluoroethylene vi) Polymethyl methacrylate vii) Polyvinyl acetate & Polyvinyl alcohol.

UNIT VII (6Hrs)

Brief description of manufacture, properties and uses: i) Polyesters (Polyethylene terephalate polycarbonate and unsaturated polyesters) ii) Nylon (Nylon 66) iii) Phenol- Formaldehyde resins iv) Epoxy resins v) Polyurethane vi) Silicones

UNIT VIII (6 Hrs)

Compounding of polymer resins, brief description: i) Compression and transfer moulding ii) Injection moulding iii) Extrusion iv) Blow moulding v) Calendaring vi) Laminating and pultrusion

TEXT BOOKS:

1. J.A. Brydson, Newnes-Butterwarths "Plastic materials", (London) 1989.
2. Bill Meyer, F.W.Jr., "Text book of polymer science", (3rd edition.) John Wiely&sons 1984

REFERENCE BOOKS:

1. J.H. Brison and C.C. Gosselin, "Introduction to plastics", Newnes, London 1968.
2. C.C.Winding and G.D.Hiatt, "Polymeric Materials", McGraw Hill Book Co. 1961
3. Gowarikar, "Polymer Science"

ELECTIVE-II (CH423)

FOOD PROCESS TECHNOLOGY (CH423.4)

Teaching Scheme
Lectures: 4 hours/week

Examination Scheme
Theory: CIE (50) + SEE (50) =100 marks

UNIT I
An overview: General aspects of food industry; world food needs and Indian situation. (10 Hrs)

UNIT II
Food constituents, quality and derivative factors: Constituents of food; quality and nutritive aspects; food additives; standards; deteriorative factors and their control (10 Hrs)

UNIT III
General engineering aspects and processing methods :
Preliminary processing methods; conversion and preservation operations. (10 Hrs)

UNIT IV
Food preservation methods : Preservation by heat and cold; dehydration; concentration; drying irradiation; microwave heating; sterilization and pasteurisation; fermentation and pickling; packing methods. (10 Hrs)

UNIT V
Production and utilisation of food products :
Cereal grains; pulses; vegetables; fruits; spices; fats and oils; bakery; confectionery and chocolate products; soft and alcoholic beverages; dairy products; meat; poultry and fish products. (10 Hrs)

REFERENCE BOOKS:

1. Heid, J.L; Joslyn, M.A., " Fundamentals of Food Processing Operation ", The AVI Publishing Co., Westport, 1967.
2. Potter, N.N.; " Food Science ", The AVI Publishings Co., Westport, 1963.
3. Heldman D.R.; " Food Process Engineering ", The AVI Publishing Co., Westport, 1975.
4. Charm, S.E.; " The Fundamentals of Food Engineering ", The AVI Publishing Co., Westport, 1963
5. R. Macral, R. K. Robinson, and M. J. Sadler, Encyclopedia of Food Science, Food Technology and Nutrition, Vol. 8, Academic Press 1993.

ELECTIVE-II (CH423)

CATALYSIS (CH423.5)

Teaching Scheme
Lectures: 4 hours/week

Examination Scheme
Theory: CIE (50) + SEE (50) =100 marks

UNIT I
Review of chemical kinetics, homogeneous catalysis, acid base catalysis (08 Hrs)

UNIT II
Enzymatic reaction kinetics and design for enzymatic reaction. (08 Hrs)

UNIT III
Heterogeneous catalysis: reaction rates and selectivity, Fixed bed and fluidized bed catalytic reactors. (08 Hrs)

UNIT IV
Catalyst deactivation with separable kinetics, Reactor Design with and without catalyst deactivation, temperature – time trajectories, effect of deactivation on selectivity, determination of order of deactivation by integral and differential methods. (10 Hrs)

UNIT V
Role of diffusion in catalysis. (07 Hrs)

UNIT VI
Selection, preparation, and evaluation of catalysts. (08 Hrs)

REFERENCE BOOKS:
1.H. S. Fogler., "Elements of Chemical Reaction Engineering", PHI, 3rd Ed. (2002).
2.O. Levenspiel, "Chemical Reaction Engineering", John Wiley, 3rd Ed. (1999).
3.J. M. Thomas and W. J. Thomas, "Introduction of the Principles of Heterogeneous Catalysis", Academic Press, (1967).
4.C. N. Satterfield and T.K. Sherwood, "The Role of Diffusion in Catalysis", Addison Wesley, (1963).
5.P. H. Emmett (Ed.), "Catalysis", Reinhold, (1954.)

ELECTIVE-II (CH423)

ENVIRONMENTAL CHEMISTRY AND BIOCHEMISTRY (CH423.6)

Teaching Scheme
Lectures: 4 hours/week

Examination Scheme
Theory: CIE (50) + SEE (50) =100 marks

UNIT I
Biochemistry:
Structure of Cell, Structure and function of biologically important compounds such as carbohydrates protein, Lipids enzymes and Amino acids, Nucleic acids. (10 Hrs)

UNIT II
Noise Pollution: Introduction, The describe scale, effects of noise – physiological and psychological effects, Measurement of noise levels, Noise control in industrial establishments. (12 Hrs)

UNIT III
Environmental Toxicology: Classification of toxic materials, toxicity testing, toxic effects of hydrocarbons, alcohols, aldehydes, ketones, amines.
(10 Hrs)

UNIT IV
Environmental Toxicology and control: toxic effects and control of metal pollutants like Hg, Col, Pb, V, Cr, Co, etc. Disease measurement and control of occupational diseases. (10 Hrs)

TEXT BOOKS:
1. S. M. Khopkar, “Environmental Pollution Monitoring & Control”, New Age
2. T. G. Spiro, W. M. Stigliani, “Chemistry of Environment”, PHI

REFERNECE BOOKS:
1. A. K. Das, “Textbook on Medical Aspects of Bioinorganic Chemistry”, CBS
2. Nelson Cox and Lehninger, “Biochemistry”
3. M. Ather & S. B. Vohra, “Heavy Metal & Environment”, New Age
4. S. S. Dara, “Environmental Chemistry » latest édition

PROCESS ECONOMICS AND PROJECT ENGINEERING (CH424)

Teaching Scheme
Lectures: 4 hours/week

Examination Scheme
Theory: CIE (50) + SEE (50) =100 marks

UNIT I

Introduction: Scales of Production, Selection of Plant Capacity, Plant Location. Availability of Raw Materials, Energy Gestation Period. Expansion, Diversification and Obsolescence. Scope for Standardization in Design and Production .Economics of Research and Development .Indian Chemical Industry, Current Status and Trends.

(8 Hrs)

UNIT II

Cost Estimation: Factors Affecting Investment and Production Cost .Capital Investment, Fixed Investment and Working Capital .Estimating Equipment Cost by 6 /10 Factor Rule Method of Estimating Capital Investment .Different Costs Involved in Total Product Cost .Computer Atomization in Costing.

(8 Hrs)

UNIT III

Interest and Investment Cost: Simple and Compound Interest, Nominal and Effective Rates of Interest, Continuous Interest, Ordinary Annuity, Perpetuities and Capital Costs Taxes and Insurances: Types of Taxes and Tax Returns. Types of Insurance and Legal Responsibility.

(8 Hrs)

UNIT IV

Depreciation: Types of Depreciation, Service Life, Salvage Value, Present Value. Methods of Determining Depreciation, Single Unit and Group Depreciation .Causes of Obsolescence and Inadequacy.

(8 Hrs)

UNIT V

Profitability, Alternative Investment and Replacement: Mathematical Methods of Profitability Evaluation, Cash Flow Diagram. Break Even Analyses, Balance Sheet, Pricing Issue Method and Income Statement.

(8 Hrs)

UNIT VI

Project conception, Planning, Engineering and Management: Project conception and definition, Selection of plant capacity, Causes for time and cost over runs of a Project, Process Optimization, and Selection of Alternative Processes Equipment
Project engineering: Management and Organization, Project Planning, Scheduling and Controlling, Use of BAR chart, CPM and PERT Techniques, General site considerations, Plant Location and Site Selection, Site Layout, Plant Layout, Battery Limits and Off Site Facilities. (8 Hrs)

REFERENCE BOOKS:

1. Peter M.S. Timmerhaus K.D., Plant Design and Economics for Chemical Engineers.
McGraw Hill.
2. Vilbrandt F.C. and C.E. Dryden, Chemical Plant Design. McGraw Hill
3. T.R. Banga and S.C.Sharma, Industrial Organization & Engineering Economics, Khanna Publications, New Delhi.
4. O.P.Khanna Industrial Engineering & Management, Dhanpat Rai Publications Pvt. Ltd. New Delhi.
5. Dewett & Varma, Elementary Economic Theory: S Chand & Company Ltd New Delhi

SPECIAL CHEMICAL TECHNOLOGIES-II (CH424)

Teaching Scheme
Lectures: 4 hours/week

Examination Scheme
Theory: CIE (50) +SEE (50) =100 marks

UNIT I

Green Technology:

Green Chemistry: An Overview Introduction, underlying philosophy and focus, Twelve principles of green chemistry, Ecological Threats & Green Chemistry, The Greenhouse Effect, Climate Change, photochemical smog, Pragmatic Green, Chemistry Challenges, Old Technology vis-à-vis Green Technology : Suitable examples, to understand comparative advantage of Green Technology over Old one, Renewable, resources, Process intensification , Carbon credits .
Green Chemistry & Nonconventional Fuels, Green chemistry in batteries, production and recycling, Fuel cell and electric vehicles, Solar energy and hydrogen production,biodiesel, bio-hydrogen, Green Chemistry & Sustainable development, Esterification: transesterification, autogeneous pressure of methanol, transesterification under supercritical conditions Optimisation: catalyst concentration, methanol to oil ratio, reaction temperature, reaction time (12 Hrs)

UNIT II Sugar Technology:

Sugar Industry in India: Chemical and physical properties of sucrose and reducing sugars. Sources for sucrose. Formation of sucrose plants. Non-sugar compounds of sugarcane. Inorganic constituents of sugar cane juices and sugars analytical methods used in sugar industry. Purification: Chemical technology of the purification process. Fundamental reactions and physical chemistry aspects of clarification, liming, sulphitation and carbonation process. Filtration of sugar juice. Evaporation: Evaporation of sugar juice. Heat transfer in evaporations. Evaporation equipment and auxiliaries. Evaporation: Methods of obtaining steam, and quality of steam. Steam economy. Chemistry of the evaporation process. Crystallography: Solubility of sucrose. Nucleation in super saturated solutions – kinetics and growth of crystallization. Chemistry of crystallization. Crystallography: Control methods and equipment in sugar crystallization, technology of sugar crystallization. Evaporation and circulation in vacuum pans. Centrifugation: Theory of the centrifugal process, centrifugal operation. Centrifugation: Engineering principles of sugar centrifugals and the centrifugal equipment and auxiliaries. Production of final molasses and molasses's utilization. Grading of sugar. (18 Hrs)

UNIT III Fermentation industries: Introduction to fermentation industry. Absolute Alcohol, Beer, wines & liquors, vinegar, citric acid and lactic acid. (08 Hrs)

UNIT IV Textile wet processing technology (Textile Chemistry):

Brief introduction to textile industry. Study of various steps involved in the chemical processing of textiles (pretreatments and after treatments like dyeing, printing and finishing.) Chemistry and processes for desizing, scouring, bleaching and mercerization. Study of applications of reactive, vat and other classes of dyestuff on various textiles. Study of all the above treatments in chemical processing of textiles from stand point of unit operations of chemical engineering. (14 Hrs)

TEXT BOOKS:

1.Principles of Sugar Technology - Honing P. Vol. I to III, Elsevier Publishing Company, 1953.

2.Jenkinos.G.H Elsevier, 1966. Introduction to Cane Sugar Technology .

3.Paul T. Anastaj; “Green Chemistry – Theory and Practice”

4.Albert S. Matlack; “Introduction to Green Chemistry”

5. George T. Austin, “Shreve's Chemical Process Industries”, 5th edition. McGraw Hill Book Company, 1985.

REFERENCE BOOKS:

1. Handbook of Cane Sugar Technology - Mathur R.B.L 2nd Edition, Oxford and I.B.H. Publishing Co., 1997.

2. Jink. R.W. and Pan Cost H.M, Handbook of Sugars, Avi Publishing Co., 1974.

3. Anastas, P.; Zimmerman, J. “Design through the Twelve Principles of Green Engineering,” Environmental Science and Technology, 37, 94A – 101A, 2003.

4.Tyron. L. Vigo, Textile Processing and properties, 1994 Elsevier.

5. S. Kawabek, Objective Parameters of fabric, 1999, Textile Machinery Society Kyoto.

INDUSTRIAL SAFETY AND HAZARD MANAGEMENT (CH425)

Teaching Scheme
Lectures: 2 hours/week

Examination Scheme
I.O.E. : 50 marks

UNIT I (3 Hrs)

Introduction: Types of Ecosystems, Factors responsible for the distribution on Hydrologic cycles, Nutrient cycles (carbon, nitrogen, phosphorous, sulfur).

UNIT II (2 Hrs)

Introduction to ISO standards: ISO standards (ISO 14001) with reference to chemical industry.

UNIT III (2 Hrs)

Industrial hygiene and safety aspects related to toxicity, noise, radiation: identification, Evaluation, Control

UNIT IV (4 Hrs)

Fires and Explosions: Flammability Characteristics of liquids & vapors, minimum oxygen concentration (MOC), Ignition Energy, Ignition sources, Explosions: Detonation & Deflagration, combined explosions, BLEVE, Blast Damage due to overpressure.

UNIT V (2 Hrs)

Hazard identification: Various Techniques, HAZOP.

UNIT VI (3 Hrs)

Consequence analysis: Flow of liquid/vapors through hole, flashing liquid, Pool evaporation.

UNIT VII (3 Hrs)

Design to prevent fire & explosions: Inerting, controlling static electricity, explosion proof equipments & instruments, ventilation, sprinkler systems.

UNIT VIII (3 Hrs)

Hazards / Risk Assessment: Event trees, fault trees, reliability, probability, Emergency planning: Elements of emergency planning, on-site/ off-site emergency, plans.

UNIT IX (3 Hrs)

Case studies: Bhopal Tragedy, Flixborough Disaster, Mexico Disaster

REFERENCES BOOKS:

1. "Chemical Process Safety Fundamentals with Applications", Daniel A Crowl, Joseph

F.Lovvar, Prentice Hall Inc, U.S.A

2. "Safety in Process Plant Design", Wells, G.L. Godwin, London (1980)

3. "Loss Prevention in Process Industries", Lees, F.P. Butterworth, Oxford

4. "Environmental Protection", Chanlett, E.T. McGraw Hill

5. "Strategy of Pollution Control", Berthouex, P.M., and Rudd, D.F. Wiley (1977)

6. "Safety for Chemical Engineers", A.I.Ch.E. Publications (1976-77).

PLANT DESIGN AND CASE STUDIES (CH426)

Teaching Scheme	**Examination Scheme**
Lectures: 1 hour/week	I.O.E.: 25 marks
Tutorial: 1 hours/week	E.O.E.: 25 marks

UNIT I

Introduction: The role of Chemical Engineer in Chemical Plant Design. Chemical Engineering Design, need for Plant Design. (2 Hrs)

UNIT II (2 Hrs)

Plant location and layout: Start-up and shut-down; Cost estimation, capital investment, and profitability; Construction of P&I diagram.

UNIT III (2 Hrs)

Principles of scale-up : Principles of scale-up for fluid mechanical, heat transfer, mass transfer equipment and homogeneous and heterogeneous chemical reactors; Selection and specifications of process equipment and utilities

UNIT IV (2 Hrs)

Heat exchange networks: Mass exchange network; Distillation sequencing; Reaction-separation system; Heat integration of reactors, distillation columns, evaporators.

UNIT V (2 Hrs)

Process Auxiliaries : Introduction, Piping, Explanation of CODES, Selection of Piping, Pipe strength, Wall thickness, Nominal Pipe Size (NPS), Criteria for Selection of Materials, Pipe sizing by ID, Choosing the final pipe size, Process steam piping, piping layout, piping insulation, methods of providing flexibility for piping.

REFERENCE BOOKS:

1. Rudd, D.F. and Watson, C.C., "Strategy of Process Engineering", John Wiley & Sons, Inc.
2. Smith, R., "Chemical Process Design", McGraw-Hill Co. Inc.
3. Sieder, W.D., Seader, J.D. and Lewin, D.R., "Product & Process Design Principles", John Wiley & Sons, Inc.
4. Douglas J.M., "Conceptual Design of Chemical Processes", McGraw-Hill, Inc.
5. Peters, M.S. and Timmerhaus, K.D., "Plant Design and Economics for Chemical Engineers", McGraw-Hill, Inc.

MAJOR PROJECT (PHASE II) (CH427L)

Teaching Scheme	**Examination Scheme**
Tutorial: 1 hour/week	I.P.E.: 100 marks
Practical: 4 hours/week	E.P.E.: 100 marks

The students are required to carry out one of the following projects.

1. Process based Project: Manufacture of product.
2. Equipment based Project: Detailed design and fabrication of the equipment for a given capacity.
3. Experimental based Project: Experimental investigation of basic or applied research problem.
4. Industrial Problems: Any problem or project directly related to existing plants for modification of process or equipment or regarding pollution control and energy conservation under the guidance of a staff member and /or staff members and submit a typed report in duplicate.

The Project Work consists of collection of literature, study of the various processes selection of the process, computation of material and energy balances, process design of important equipments, detailed design of one of the main equipment, plant location and layout, cost Estimation, economic analysis, details of experimental set up, analysis of data, pollution control, safety, marketing, conclusions and recommendations, bibliography, etc., as applicable to the individual problem.
The object of the project is to make use of the knowledge gained by the student at various stages of the degree course. This helps to judge the level of proficiency, originality and capacity for application of the knowledge attained by the student at the end of the course.

Each group should consist of maximum 5 students. For term-work (Internal) of 100 marks, the assessment should be by conducting frequent written tests, seminars during the year and an oral examination at the end of the year conducted by all the staff members of the department. The Head of the Department should see that the assessment procedure should be the same for all the students of the class.
For external 100 marks, the project work shall be assessed by an oral examination by at least two examiners, one internal and one must by external at the end of the year.

The object of the VIVA VOCE examination (Internal and External Orals) is to determine whether the objectives of the project work have been met by the student as well as to assess the originality and initiative of the student as demonstrated in the project work.