SHIVAJI UNIVERSITY, KOLHAPUR
FINAL YEAR B.TECH
Chemical Technology
Curriculum Structure

Semester – VII

Sr.No.	Subject Code	Subject Title	Contact hours			Credits
			L	T	P	
1	CH411	Advanced Separation Techniques	04	-	-	04
2	CH412	Elective –I	04	-	-	04
3	CH413	Process Economics and Project Engineering	03	-	-	03
4	CH414	Reaction Engineering – II	03	01	-	04
5	CH415	Special Chemical Technologies-I	04	-	-	04
6	CH411 L	Advanced Separation Techniques Laboratory	-	-	02	01
7	CH414L	Reaction Engineering – II Laboratory	-	-	02	01
8	CH416L	Plant Design and Case studies		-	02	01
9	CH417L	Major Project(Phase I)	-	-	02	01
10	CH418	Report of Industrial Training	-	-	-	01
11	HS411	Audit Course V Professional Ethics	02	-	-	-
		Total	**20**	**01**	**08**	**24**
Total Contact hours per week = **29**						

Note: Tutorials and practical shall be conducted in batches with batch strength not exceeding 15 students.

List of Subjects as Elective-I:

CH412.1 Petroleum Refinery Engineering , CH412.2 Biochemical Engineering , CH412.3 Polymer Chemistry,, CH412.4 Introduction to Food Process Engineering , CH412.5 Surface Chemistry , CH412.6 Environmental Science and Microbiology, CH412.7 Drugs and Pharmaceutical Technology.

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Semester – VIII

Sr. No.	Subject Code	Subject Title	Contact Hours			Credits
			L	T	P	
1.	CH421	Energy Conservation in Chemical Industries	04	-	-	04
2.	CH422	Elective-II	04	-	-	04
3.	CH423	Process Modeling and Simulation	04	-	-	04
4.	CH424	Special Chemical Technologies-II	04	-	-	04
5.	CH425	Transport Phenomena	04	-	-	04
6.	HS421T	Industrial Safety and Hazard Management	-	01	-	01
7.	CH423L	Process Modeling and Simulation Laboratory	-	-	02	01
8.	CH426L	Major Project(Phase II)	-	01	03	02
9.	HS422	Audit Course VI Introduction to Constitution of India	02	-	-	-
		Total	**22**	**02**	**05**	**24**
Total Contact hours per week = **29**						

List of Subjects as Elective-II:

CH422.1 Petrochemical Technology, CH422.2. Industrial Biotechnology, CH422.3. Polymer Technology, CH422.4 Food Process Technology, CH422.5 Catalysis, CH422.6 Environmental Chemistry and Biochemistry CH422.7 Open Elective (to be chosen from any of the specialized program available on the campus)

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Final Year B. Tech (Chemical Technology) (Semester VII)

CH411 ADVANCED SEPARATION TECHNIQUES

Teaching Scheme: L: 4 hours/week **Credits: 4**

UNIT I Introduction to the subject (04Hours)

UNIT II (10Hours)

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 III (10Hours)

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 IV (08Hours)

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 V **(10Hours)**

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 VI **(08Hours)**

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.

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

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CH412 ELECTIVE-I

CH412.1 PETROLEUM REFINERY ENGINEERING

Teaching Scheme: L: 4 hours/week **Credits: 4**

UNIT I Introduction (08Hours)
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 Refining of petroleum (08Hours)
Atmospheric and vacuum distillation. Pretreatment of crude oil and transportation.

UNIT III Cracking processes (08Hours)
Thermal cracking, Vis-breaking, Coking. Catalytic cracking (FCC), Hydro cracking, Rebuilding processes, bitumen blowing.

UNIT IV Treatment techniques (10Hours)
Study of 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 Cracking and Reforming (10Hours)
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.

UNIT VI Threats and Challenges before Petroleum Industries (08Hours)

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.

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CH412 ELECTIVE-I

CH412.2 BIOCHEMICAL ENGINEERING

Teaching Scheme: L: 4 hours/week **Credits: 4**

UNIT I Introduction (08Hours)

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 organization, Principles of genetic Engineering, Recombinant DNA technology, mutation.

UNIT II Kinetics of enzyme catalyzed reactions (10Hours)

The enzyme substrate complex and enzyme action, simple enzyme kinetics with one and two substrates, determination of elementary step rate constants. Isolation and utilization 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 Metabolic pathways and energetics of the cell (10Hours)

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 Typical growth characteristics of microbial cells (10Hours)

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 AND VI Introduction to bio reactors and Future Trends (14Hours)

Types of bio reactors, 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.

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CH412 ELECTIVE-I

CH412.3 POLYMER CHEMISTRY

Teaching Scheme: L: 4 hours/week **Credits: 4**

UNIT I Scope of Polymer Chemistry (08Hours)
Definition of monomers, homopolymers and copolymers, Chemistry of important monomers, Thermosets, Thermoplastic, Elastomers (f) Tg, Tm, and solution properties of polymers

UNIT II Condensation polymerization (10Hours)
Mechanism, kinetic and molecular weight build up , Bulk, Solution, Emulsion and suspension polymerization, comparison of condensation and addition polymerization

UNIT III Addition polymerization (10Hours)
Type of addition polymerization, Radical, cationic and anionic polymerization, Mechanism and kinetics of polymerization, Copolymerization, Stereo-Regular polymerization, Block and Graft polymerization

UNIT IV Characterization of molecular weight polymers (10Hours)
End-Group analysis method, Viscosity of measurement method, G.P.C. Techniques for measurement

UNIT V AND VI Application of polymers present and future (12Hours)
Fiber forming synthetic polymer, Properties of fiber forming synthetic polymer , future trends in plastic fibre and elastomers

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",

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CH412 ELECTIVE-I

CH412.4 INTRODUCTION TO FOOD PROCESS ENGINEERING

Teaching Scheme: L: 4 hours/week **Credits: 4**

UNIT I Food chemistry **(08Hours)**

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.

UNIT II Transport Phenomena in food processing **(10Hours)**

Non Newtonian flow heat transfer simultaneous heat and momentum transfer thermal time distribution mixing Unit operations in food systems, evaporation.

UNIT III Preservation techniques **(10Hours)**

Study of different preservation techniques like: Thermal, Dehydration, microwave irradiation cold fermentation and by chemicals.

UNIT IV Packaging and storage **(10Hours)**

Principles, shelf life, canning, modified atmosphere packaging, refrigeration.

UNIT V Post Harvesting Techniques **(07Hours)**

Grain drying and storage fruit and vegetable processing seafood and meat processing

UNIT VI Supercritical extraction **(07Hours)**

Study of basic concepts of supercritical fluid extraction. Flavours, spices and essence extraction using SFE technique.

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.

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CH412 ELECTIVE-I

CH412.5 SURFACE CHEMISTRY

Teaching Scheme: L: 4 hours/week **Credits: 4**

UNIT I
Adsorption and Surface Phenomenon (12Hours)

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

UNIT II
Micelle (12Hours)

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.

UNIT III
Emulsion (12Hours)

Types of emulsion, theories of emulsion and emulsion stability, identification of emulsion types, inversion emulsion, micro emulsion: theory and application.

UNIT IV
Liquid gas and liquid interfaces (12Hours)

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.

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.

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CH412 ELECTIVE-I

CH412.6 ENVIRONMENTAL SCIENCE AND MICROBIOLOGY

Teaching Scheme: L: 4 hours/week **Credits: 4**

UNIT I

Environmental segments **(12Hours)**

Lithosphere, Hydrosphere, Biosphere, Composition of Atmosphere, Troposphere, Stratosphere, Mesosphere. Thermosphere, Chemical species and particulars in atmosphere, ions radicals particles Reactions in atmosphere.

UNIT II

Principle of Ecology **(12Hours)**

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)

UNIT III

Water chemistry **(12Hours)**

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.

UNIT IV

Environmental Microbiology **(12Hours)**

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)

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

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CH412 ELECTIVE-I

CH412.7 DRUGS AND PHARMACEUTICAL TECHNOLOGY

Teaching Scheme: L: 4 hours/week **Credits: 4**

UNIT- I
Development of drugs and pharmaceutical industry (10Hours)
Organic therapeutic agents uses and economics. Drug metabolism physio chemical principles – radio activitypharma kinetics –action of drugs of human bodies.

UNIT- II
Chemical conversion processes (10Hours)
Alkylation – carboxylation – condensation and cyclisation –dehydration, Esterification (alcohoysis) halogenation – oxidation sulforation – complex chemical conversion – fermentation.

UNIT-III (10Hours)
Compressed tablets
Wet granulation – dry granulation – direct compression – tablet presses formulation – coating – pills – capsules sustained action dosage forms – parenter solutions –oral liquids – injections – cirtmerts – standard of
hygienes and good manufacturing practice.

UNIT- IV
Vitamins (10Hours)
Cold remedies – laxatives – analgesic – non steroical contraceptives – external antiseptics – antacids and others.

UNIT- V
Antibiotics (10Hours)
Biologicals – harmones – vitamins – preservations – analytical methods or test for various drugs and pharmaceuticals packing – packing techniques – quality control.

Text Books:
1. E.A. Rawlines Bertleys,"Text books of pharmaceuticals" III Edition, billlieere Tincall, London, 1977.

Reference Books:
1. S.H. Yalkorsky and J. Swarbrick, "Drug and pharmaceutical Science" Volume I, II, III, IV, V, VI, and VII Marcel Dekar Inc. New York 1975.
2. Remingtons," Pharmaceutical Science", Mack Publishing Co, 1975.

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CH413 PROCESS ECONOMICS AND PROJECT ENGINEERING

Teaching Scheme: L: 3 hours/week **Credits: 3**

UNIT I (**07Hours)**

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.

UNIT II (**07Hours)**

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.

UNIT III (**07Hours)**

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.

UNIT IV (**07Hours)**

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

UNIT V (**08Hours)**

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

UNIT VI (**09Hours)**

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.

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

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CH414 REACTION ENGINEERING - II

Teaching Scheme: L: 3 hours/week **Credits: 4**
T: 1 hour/week

UNIT I **(04Hours)**

Review of Reaction Engineering Basics

UNIT II **(07Hours)**

Temperature effects in homogeneous reactions: Equilibrium Conversion, Optimum temperature progression, Adiabatic and non adiabatic operations, Rate, Temperature and conversion profiles for exothermic and endothermic reactions, Stable operating condition in reactors.

UNIT III **(09Hours)**

Non-Ideal flow : Residence time distribution in vessels: E, F and C curve and their relationship for closed vessels, conversion in reactors having non ideal flow; models for non-ideal flow: Dispersion model, Tank in Series model, Multi parameter model.

UNIT IV **(09Hours)**

Fluid-solid catalyzed reactions : Introduction, Rate equation, Film resistance controlling, surface flow controlling , Pure diffusion controlling, Heat effects during reaction, Experimental methods for finding rates, Product distribution in multiple reactions, Various types of catalytic reactors : Fixed bed reactor- construction, operation and design, Isothermal operation, Adiabatic operation, Fluidized bed reactor, Slurry reactor, Trickle bed reactor.

UNIT V **(09Hours)**

Reactor stability and scale up: Choice of reactor, Factors affecting choice of reactor, Optimum yield and conversion, Selectivity and reactivity.

UNIT VI **(07Hours)**

Modeling of reactors and numerical problems based on the reactor design

REFERENCES:

1. Octave Levenspeil, “Chemical Reaction Engineering”, 2nd Edition, John Wiley, London.
2. S. M. Walas, “Reaction Kinetics for Chemical Engineers”, McGraw Hill, New York
3. J. M. Smith, “Chemical Engineering Kinetics”, McGraw Hill, New York.
4. J. Rajaram and J. C. Kuriacose, “Kinetics and Mechanics of Chemical Transformation”, McMillan India Ltd., 1993.

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CH415 SPECIAL CHEMICAL TECHNOLOGIES-I

Teaching Scheme: L: 4 hours/week **Credits: 4**

UNIT I Wood and Wood Chemical industry: **(06 Hours)**

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 **(06 Hours)**

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

UNIT III Introduction to Biotechnology: **(13 Hours)**

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

UNIT IV Fermentation industries: **(09 Hours)**

Introduction to fermentation industry. Absolute Alcohol, Beer, wines & liquors, vinegar, citric acid and lactic acid.

UNIT V Agrochemical Industries: **(09 Hours)**

Insecticides, pesticides, Herbicides, plant growth, Nutrients and regulators, compound Fertilizers, Bio fertilizers, complex fertilizers, and various grades of N.P.K. fertilizer.

UNIT VI Surface Coating technology: **(13 Hours)**

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.

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CH411L ADVANCED SEPARATION TECHNIQUES Laboratory

Teaching Scheme: P: 2hours/week **Credit: 1**

LABORATORY PRACTICALS:

1. Study of membrane separation operations:
   - 1.1 Microfiltration 1.2 Ultrafiltration
   - 1.3 Nanofiltration 1.4 Reverse osmosis
   - 1.5 Pervaporation 1.6. Gas permeation

2. Demonstration Experiments:
   - 2.1 Chromatography experiments
   - 2.2 Ion Exchange.

3. Conceptual Experiments:
   - 3.1 Pressure swing Adsorption
   - 3.2 Supercritical Fluid extraction
   - 3.3 Electrostatic precipitator.

Note: Any 8 experiments to be performed from the above list.

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CH414L REACTION ENGINEERING - II Laboratory

Teaching Scheme: P: 2hours/week **Credit: 1**

LABORATORY PRACTICALS:

1. Study of Adiabatic continuous stirred tank reactor
2. Study of RTD in packed bed
3. Study of RTD studies in continuous stirred tank reactor
4. Study of non-catalytic homogeneous reaction in an isothermal tubular flow reactor
5. Study of non-catalytic homogeneous reaction in a batch reactor
6. Study of non-catalytic homogeneous reaction in continuous stirred tank reactor
7. Study of non-catalytic homogeneous reaction in plug flow reactor

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Final Year B. Tech (Chemical Technology) (Semester VIII)

CH 416L PLANT DESIGN AND CASE STUDIES

(Laboratory work: Design and Drawing to be taken adhering to the below mentioned theory topics unitized in 5 numbers)

Teaching Scheme: P: 2 hours/week **Credits: 1**

UNIT I **(02Hours)**

Introduction: The role of Chemical Engineer in Chemical Plant Design. Chemical Engineering Design, need for Plant Design.

UNIT II **(06Hours)**

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

UNIT III **(04Hours)**

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 **(06Hours)**

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

UNIT V **(08Hours)**

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.

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CH417L MAJOR PROJECT (Phase I)

Teaching Scheme: P: 2 hour/week **Credits: 01**

The project topic will 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 will be undertaken 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.

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CH418 REPORT OF INDUSTRIAL TRAINING

Credit: 1

The industrial training after semester VI 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. The evaluation of this particular activity is included in this Semester (VII).

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Audit Course V

HS411 PROFESSIONAL ETHICS

Teaching Scheme: L: 2 hours/week **No Credits**

The course auditor will conduct an examination of 50 marks so as to evaluate the students and these marks will be converted to grade as per standard guidelines.

UNIT I (**04 Hours)**

Engineering Ethics – Moral Issues, Ethical theories and their uses

UNIT II (**04 Hours)**

Engineering as Experimentation – Code of Ethics

UNIT III (**04 Hours)**

Engineer's Responsibility for Safety

UNIT IV (**04 Hours)**

Responsibilities in Rights

UNIT V (**04 Hours)**

Global issues of engineering ethics

UNIT VI (**08 Hours)**

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

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CH421 ENERGY CONSERVATION IN CHEMICAL INDUSTRIES

Teaching Scheme: L: 4 hours/week **Credits:4**

UNIT I Energy Outlook **(08Hours)**

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 Optimum performance of Existing Facilities (10Hours)

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 Detailed Thermodynamic Analysis of Common Unit Operations (10Hours)

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 Systematic Design Methods **(08Hours)**

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 Energy Conservation Measures **(07Hours)**

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

UNIT VI Heat and Power Recovery (07Hours)

Introduction, Heat Transfer Equipment, 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

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CH422 ELECTIVE-II

CH422.1 PETROCHEMICAL TECHNOLOGY

Teaching Scheme: L: 4 hours/week **Credits: 4**

UNIT I **(08Hours)**

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

UNIT II **(10Hours)**

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 **(10Hours)**

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 **(10Hours)**

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

UNIT V **(10Hours)**

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

UNIT VI **(04Hours)**

Threats and challenges before the petrochemical industry

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.

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CH422 ELECTIVE-II

CH422.2 INDUSTRIAL BIOTECHNOLOGY

Teaching Scheme: L: 4 hours/week **Credits: 4**

UNIT I **(10Hours)**

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 **(10Hours)**

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 **(10Hours)**

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 **(10Hours)**

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 **(10Hours)**

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.

UNIT VI **(04Hours)**

Future scope of Biotechnology

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.

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CH422 ELECTIVE-II

CH422.3 POLYMER TECHNOLOGY

Teaching Scheme: L: 4 hours/week **Credits: 4**

UNIT I **(12Hours)**

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 **(04Hours)**

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

UNIT III **(06Hours)**

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 **(10Hours)**

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 **(10Hours)**

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

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 VI **(10Hours)**

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

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"

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CH422 ELECTIVE-II

CH422.4 FOOD PROCESS TECHNOLOGY

Teaching Scheme: L: 4 hours/week **Credits: 4**

UNIT I **(06Hours)**

An overview: General aspects of food industry; world food needs and Indian situation.

UNIT II **(10Hours)**

Food constituents, quality and derivative factors: Constituents of food; quality and nutritive aspects; food additives; standards; deteriorative factors and their control

UNIT III

General engineering aspects and processing methods **(10Hours)**

Preliminary processing methods; conversion and preservation operations.

UNIT IV **(10Hours)**

Food preservation methods : Preservation by heat and cold; dehydration; concentration; drying irradiation; microwave heating; sterilization and pasteurization; fermentation and pickling; packing methods.

UNIT V

Production and utilization of food products **(10Hours)**

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.

UNIT VI **(04Hours)**

Threats and challenges before the Food Processing Industry

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.

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CH422 ELECTIVE-II

CH422.5 CATALYSIS

Teaching Scheme: L: 4 hours/week **Credits: 4**

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

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

UNIT III **(08Hours)**

Heterogeneous catalysis: reaction rates and selectivity, Fixed bed and fluidized bed catalytic reactors.

UNIT IV **(10Hours)**

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.

UNIT V **(08Hours)**

Role of diffusion in catalysis.

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

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.)

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CH422 ELECTIVE-II

CH422.6 ENVIRONMENTAL CHEMISTRY AND BIOCHEMISTRY

Teaching Scheme: L: 4 hours/week **Credits: 4**

UNIT I
Biochemistry **(10Hours)**

Structure of Cell, Structure and function of biologically important compounds such as carbohydrates protein, Lipids enzymes and Amino acids, Nucleic acids.

UNIT II **(08Hours)**
Environmental Chemistry Basics

UNIT III **(08Hours)**
Noise Pollution: Introduction, The describe scale, effects of noise – physiological and psychological effects, Measurement of noise levels, Noise control in industrial establishments.

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

UNIT V **(10Hours)**
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.

UNIT VI **(06Hours)**
Future of Environmental sciences

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 edition

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CH422 ELECTIVE-II

CH422.7 OPEN ELECTIVE

Teaching Scheme: L: 4 hours/week **Credits: 4**

The interested students have to choose the open elective from any of the specialized program available on the campus. The students have to contact the concerned subject teacher and attend the classes in the respective subject which will be taught by the concerned teacher.

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CH423 PROCESS MODELING AND SIMULATION

Teaching Scheme: L: 4 hours/week **Credits: 4**

Unit-I **(06Hours)**
Mathematical models for chemical engineering systems, fundamentals, introduction to fundamental laws

Unit -II **(10Hours)**
Examples of mathematical models of chemical engineering systems, constant volume CSTRS, two heated tanks, gas phase pressurized CSTR, non-isothermal CSTR. Examples of single component vaporizer, batch reactor, reactor with mass transfer, ideal binary distillation column, batch distillation with holdup.

Unit –III **(10Hours)**
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 –IV **(10Hours)**
Numerical integration by Trapezoidal and Simpson's rules, numerical solution of differential equations, Euler method, Runge-Kutta fourth order method. Interpolation, Lagrange interpolation, forward difference, backward difference and central difference interpolation methods, least square approximation of functions, linear regression, and polynomial regression.

Unit –V **(10Hours)**
Study of different simulation software, Computer simulation, examples, gravity flow tank, three CSTRs in series, binary distillation column, batch reactor

Unit –VI **(06Hours)**
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

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CH424 SPECIAL CHEMICAL TECHNOLOGIES-II

Teaching Scheme: L: 4 hours/week **Credits: 4**

UNIT I Green Technology: **(14 Hours)**

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.

UNIT II Sugar Technology: **(12 Hours)**

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.

UNIT III Textile wet processing technology (Textile Chemistry): **(14 Hours)**

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.

UNIT IV Nanotechnology: (14 Hours)

Introduction to Nanotechnology, Nanotechnology-Definition, Classification and Applications, 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. Special nanomaterials, characterization and Applications for Carbon nanotubes, nano composites, nano fluids-An overview over preparation, properties, applications. Nanoelectronics: Introduction – micro, nano fabrication: Optical lithography, Electron beam lithography, Atomic lithography, Molecular beam epitaxy, MEMS, NEMS –A

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.

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

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

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

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

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

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CH425 TRANSPORT PHENOMENA

Teaching Scheme: L: 4 hours/week **Credits: 4**

UNIT I (**10Hours)**

Equations of Change: 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 (**08Hours)**

Boundary Layer Theory and Turbulence : 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 **(08Hours)**

Mixing: 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 (**08Hours)**

Unsteady State Heat Transfer: 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.

UNIT V (**08Hours)**

Analogies between Heat, Momentum and Mass Transfer: 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 **(08Hours)**

Computational Fluid Dynamics and Two Phase Flow: 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.

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HS421T INDUSTRIAL SAFETY AND HAZARD MANAGEMENT

Teaching Scheme: T: 1 hours/week **Credits: 1**

During the tutorial, the subject in charge is required to impart the subject knowledge to the students. Also it is expected to encourage discussion in the class. It is desired to give the assignments to the students, ask them to prepare charts related to industrial safety so that they will also self study the subject content and they will be asked to deliver seminar on a topic relevant to the subject.

UNIT I (**03Hours)**

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

UNIT II (**02Hours)**

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

UNIT III (**02Hours)**

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

UNIT IV (**06Hours)**

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. **Hazard identification:** Various Techniques, HAZOP.

UNIT V (**05Hours)**

Consequence analysis: Flow of liquid/vapors through hole, flashing liquid, Pool evaporation. **Design to prevent fire & explosions:** Inerting, controlling static electricity, explosion proof equipments & instruments, ventilation, sprinkler systems.

UNIT VI (**06Hours)**

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

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CH423L PROCESS MODELING AND SIMULATION Laboratory

Teaching Scheme: P: 2hours/week **Credit: 1**

SIMULATION LABORATORY

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

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CH426L MAJOR PROJECT (PHASE II)

Teaching Scheme: P: 03 hours/week **Credits: 2**
T: 01 hours/week

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.

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Audit Course V
HS 422 INTRODUCTION TO CONSTITUTION OF INDIA

Teaching Scheme: P: 2hrs/week **No Credits**

UNIT I **(05 Hours)**

Preamble to the constitution of India. Fundamental rights under Part – III – details of Exercise of rights, Limitations & Important cases.

UNIT II **(05Hours)**

Relevance of Directive principles of State Policy under Part – IV. Fundamental duties & their significance.

UNIT III **(05 Hours)**

Union Executive – President, Prime Minister, Parliament & the Supreme Court of India.

UNIT IV **(04 Hours)**

State executive – Governors, Chief Minister, State Legislator and High Courts.

UNIT V **(05 Hours)**

Constitutional Provisions for Scheduled Castes & Tribes, Women & Children & Backward classes. Emergency Provisions.

UNIT VI **(04 Hours)**

Electoral process, Amendment procedure, 42nd, 44th, 74th, 76th, 86th and 91st Constitutional amendments.

Text Book:

1. Durga Das Basu: "Introduction to the Constitution of India"(Students Edn.) Prentice – Hall EEE, 19th/20th Edn., 2001.

2. R.C.Agarwal, "Indian Political System", (1997) S.Chand and Company, New Delhi.

Maciver and Page, "Society: An Introduction Analysis", Mac Milan India Ltd., New Delhi.

3. K.L.Sharma, "Social Stratification in India: Issues and Themes",(1997), Jawaharlal Nehru University, New Delhi.

Reference Book:

1. An Introduction to Constitution of India" by M.V.Pylee, Vikas Publishing, 2002.
   Sharma, Brij Kishore, "Introduction to the Constitution of India:, Prentice Hall of India, New Delhi.
2. U.R.Gahai, "(1998) Indian Political System ", New Academic Publishing House, Jalaendhar.
3. R.N. Sharma, "Indian Social Problems ", Media Promoters and Publishers Pvt. Ltd.
4. Yogendra Singh, "(1997) Social Stratification and Charge in India ", Manohar, New Delhi.

Equivalence of Final Year B.Tech (Chemical Technology) Semester VII and VIII

The above detailed syllabus is a revised version of the Final Year.BTech (Chemical Technology) course being conducted by the Shivaji University at the Technology Department of the University. This syllabus is to be implemented from June 2014. (Academic year 2014-15)

The Equivalence for the subjects of Chemical Technology at Final Year B Tech Semester VII and VIII pre-revised course under the faculty of Engineering and Technology is as follows.

Final Year.B Tech Semester VII (Chemical Technology)

Sr.No	Final Year. BTech(Chemical) Semester VII Pre-revised syllabus	Final Year.BTech(Chemical) Semester VII Revised syllabus	Remark
1.	Advanced Separation Techniques	Advanced Separation Techniques	No change. Only it is converted to credits
2.	Special Chemical Technologies-I	Special Chemical Technologies-I	Minor changes (avoiding repetition of chapters and adding 'biotechnology introduction' as one more chapter) in the subject content have been made
3.	----------	Reaction Engineering – II	Introduced by split up of Chemical Reaction Engineering subject from semester VI into two parts
4.	Elective –I	Elective –I	No change. Only it is converted to credits and one subject is added in the list and it is converted to credits
5.	Process Modeling and Simulation	----------	No change. Only it is converted to credits. And Shifted to VIII Semester
6.	----------	Process Economics and Project Engineering	Shifted from VIII Sem
7.	Transport Phenomena	----------	No change. Only it is converted to credits. Shifted to VIII Semester
8.	Major Project(Phase I)	Major Project(Phase I)	No change. Only it is converted to credits
9.	Professional Ethics	Professional Ethics	No change. Only it is included as Audit Course V. Evaluation to be done at the institute level. It has no credits.
10.	Report of Industrial Training	Report of Industrial Training	No change. Only it is converted to credits

The examination pattern is changed from percent marks into credit system and the contents in all the subjects have been unitized into mostly 6 numbers.

The students from the pre-revised syllabus need not complete the course work of any newly added subject.

Audit course is added which is not a part of credits. It is evaluated by AWARD of grade which is based on conversion of marks obtained out of 50. (Obtaining passing grade is essential)

Final Year.B Tech Semester VIII (Chemical Technology)

Sr.No.	Final Year. BTech(Chemical) Semester VIII Pre-revised syllabus	Final Year.BTech(Chemical) Semester VIII Revised syllabus	Remark
1.	Energy Conservation in Chemical Industries	Energy Conservation in Chemical Industries	No change. Only it is converted to credits
2.	Elective-II	Elective-II	No change. Only it is converted to credits
3.	Nanotechnology	----------	The subject contents are merged into SCT-II
4.	Process Economics and Project Engineering	----------	No change. Only it is converted to credits and it is shifted to Sem VII
5.	----------	Process Modeling and Simulation	Shifted from Sem VII
6.	Special Chemical Technologies-II	Special Chemical Technologies-II	Has been little modified with a space for a chapter on nanotechnology. And it is converted to credits.
7.	----------	Transport Phenomena	Only shifted from Sem VII to Sem VIII and converted to credits.
8.	Industrial Safety and Hazard Management	Industrial Safety and Hazard Management	No change. Only it is converted to credits
9.	Plant Design and Case studies	Plant Design and Case studies	No change. Only it is converted to credits
10.	Major Project(Phase II)	Major Project(Phase II)	No change. Only it is converted to credits
11.	----------	Introduction to Constitution of India	Introduced Constitution of India subject as the Audit Course-VI

The examination pattern is changed from percent marks into credit system and the contents in all the subjects have been unitized into mostly 6 numbers. (Chapters)

The students from the pre-revised syllabus need not complete the course work of any newly added subject i.e. Introduction to Constitution of India.

Audit course is added which is not a part of credits. It is evaluated by AWARD of grade which is based on conversion of marks obtained out of 50. (Obtaining passing grade is essential)