SCHEME OF TEACHING AND EXAMINATION
B.E. CHEMICAL ENGINEERING

V SEMESTER

Sl. No.	Subject Code	Title of the Subject	Teaching Dept.	Teaching Hrs / Week		Examination			
				Theory	Practical	Duration (Hrs)	Marks		
							IA	Theory / Practical	Total
1	06AL51	Management & Entrepreneurship	@	04	--	03	25	100	125
2	06CH52	Chemical Technology – II	CH	04	--	03	25	100	125
3	06CH53	Chemical Reaction Engg. – I	CH	04	--	03	25	100	125
4	06CH54	Mass Transfer – I	CH	04	--	03	25	100	125
5	06CH55	Pollution Prevention & Control Engg.	CH	04	--	03	25	100	125
6	06CH56	Chemical Equipment Design	CH	04	--	03	25	100	125
7	06CHL57	Pollution Control & Instrumental Analysis Lab	CH	--	03	04	25	50	75
8	06CHL58	Heat Transfer Lab	CH	--	03	04	25	50	75
TOTAL				**24**	**06**	**26**	**200**	**700**	**900**

Note: @ indicates that teaching department can be any Engineering Department/Department of Management Studies

SCHEME OF TEACHING AND EXAMINATION
B.E. CHEMICAL ENGINEERING

VI SEMESTER

Sl. No.	Subject Code	Title of the Subject	Teaching Dept.	Teaching Hrs / Week		Examination			
				Theory	Practical	Duration (Hrs)	Marks		
							IA	Theory / Practical	Total
1	06CH61	Chemical Plant Utilities & Safety	CH	04	--	03	25	100	125
2	06CH62	Chemical Reaction Engg. – II	CH	04	--	03	25	100	125
3	06CH63	Mass Transfer – II	CH	04	--	03	25	100	125
4	06CH64	Energy Technology	CH	04	--	03	25	100	125
5	06CH65	Process Equipment Design & Drawing	CH	02	03	04	25	100	125
6	06CH66x	**Elective-I (Group A)**	CH	04	--	03	25	100	125
7	06CHL67	Chemical Reaction Engg. Lab	CH	--	03	04	25	50	75
8	06CHL68	Mass Transfer Lab	CH	--	03	04	25	50	75
TOTAL				**22**	**09**	**27**	**200**	**700**	**900**

Elective-I (Group A)

06CH661	Petroleum Refinery Engg.
06CH662	Pharmaceutical Technology
06CH663	Operations Research
06CH664	Programming in C++

SCHEME OF TEACHING AND EXAMINATION
B.E. CHEMICAL ENGINEERING

VII SEMESTER

Sl. No.	Subject Code	Title of the Subject	Teaching Dept.	Teaching Hrs / Week		Examination			
				Theory	Practical	Duration (Hrs)	Marks		
							IA	Theory / Practical	Total
1	06CH71	Chemical Process Integration	CH	04	--	03	25	100	125
2	06CH72	Instrumentation & Process Control	CH	04	--	03	25	100	125
3	06CH73	Computer Applications & Modeling	CH	04	--	03	25	100	125
4	06CH74	Biochemical Engineering	CH	04	--	03	25	100	125
5	06CH75x	**Elective-II (Group B)**	CH	04	--	03	25	100	125
6	06CH76x	**Elective-III (Group C)**	CH	04	--	03	25	100	125
7	06CHL77	Process Control Lab	CH	--	03	04	25	50	75
8	06CHL78	Computer Applications & Simulation Lab	CH	--	03	04	25	50	75
TOTAL				**24**	**06**	**26**	**200**	**700**	**900**

Elective-II (Group B)

06CH751 - Food Technology
06CH752 - Polymer Technology
06CH753 - Electrochemical Technology
06CH754 - Sugar Technology

Elective-III (Group C)

06CH761 - Applied Mathematics in Chemical Engineering
06CH762 - Oracle 9*i* (06CH664 is prerequisite)
06CH763 - Petrochemicals (06CH661 is prerequisite)
06CH764 - Oils and Fats

SCHEME OF TEACHING AND EXAMINATION
B.E. CHEMICAL ENGINEERING

VIII SEMESTER

Sl. No.	Subject Code	Title of the Subject	Teaching Dept.	Teaching Hrs / Week		Examination			
				Theory	Practical	Duration (Hrs)	Marks		
							IA	Theory / Practical	Total
1	06CH81	Process Engineering Economics	CH	04	--	03	25	100	125
2	06CH82	Transport Phenomena	CH	04	--	03	25	100	125
3	06CH83x	Elective - IV (Group D)	CH	04	--	03	25	100	125
4	06CH84x	Elective - V (Group E)	CH	04	--	03	25	100	125
5	06CH85	Project	CH	--	12	03	100	100	200
6	06CH86	Seminar on Project	CH	--	03	--	50	--	50
7	06CH87	In-plant Training/ Industrial Visit	--	--	--	--	50	--	50
TOTAL				**16**	**15**	**15**	**300**	**500**	**800**

Elective-IV (Group D)

06CH831 - Interfacial Phenomena & Surface Engineering
06CH832 - Advanced Bio Process Engineering
06CH833 - Novel Separation Techniques
06CH834 - Composite Materials

Elective – V (Group E)

06CH841 - Pilot Plant and Scale up Methods
06CH842 - Waste Management and Recycle
06CH843 - Multi-component Distillation
06CH844 - Pulp and Paper Technology

SCHEME OF TEACHING AND EXAMINATION
B.E. CHEMICAL ENGINEERING

V SEMESTER

Sl. No.	Subject Code	Title of the Subject	Teaching Dept.	Teaching Hrs / Week		Examination			
				Theory	Practical	Duration (Hrs)	Marks		
							IA	Theory / Practical	Total
1	06AL51	Management & Entrepreneurship	@	04	--	03	25	100	125
2	06CH52	Chemical Technology – II	CH	04	--	03	25	100	125
3	06CH53	Chemical Reaction Engg. – I	CH	04	--	03	25	100	125
4	06CH54	Mass Transfer – I	CH	04	--	03	25	100	125
5	06CH55	Pollution Prevention & Control Engg.	CH	04	--	03	25	100	125
6	06CH56	Chemical Equipment Design	CH	04	--	03	25	100	125
7	06CHL57	Pollution Control & Instrumental Analysis Lab	CH	--	03	04	25	50	75
8	06CHL58	Heat Transfer Lab	CH	--	03	04	25	50	75
Total				**24**	**06**	**26**	**200**	**700**	**900**

Note: @ indicates that teaching department can be any Engineering Department/Department of Management Studies

SCHEME OF TEACHING AND EXAMINATION
B.E. CHEMICAL ENGINEERING

VI SEMESTER

Sl. No.	Subject Code	Title of the Subject	Teaching Dept.	Teaching Hrs / Week		Examination			
				Theory	Practical	Duration (Hrs)	Marks		
							IA	Theory / Practical	Total
1	06CH61	Chemical Plant Utilities & Safety	CH	04	--	03	25	100	125
2	06CH62	Chemical Reaction Engg. – II	CH	04	--	03	25	100	125
3	06CH63	Mass Transfer – II	CH	04	--	03	25	100	125
4	06CH64	Energy Technology	CH	04	--	03	25	100	125
5	06CH65	Process Equipment Design & Drawing	CH	02	03	04	25	100	125
6	06CH66x	Elective – I (Group A)	CH	04	--	03	25	100	125
7	06CHL67	Chemical Reaction Engg. Lab	CH	--	03	04	25	50	75
8	06CHL68	Mass Transfer Lab	CH	--	03	04	25	50	75
Total				**22**	**09**	**27**	**200**	**700**	**900**

Elective – I (Group A)		
Sl. No.	**Subject Code**	**Title of the Subject**
1	06CH661	Petroleum Refinery Engg.
2	06CH662	Pharmaceutical Technology
3	06CH663	Operations Research
4	06CH664	Programming in C++

SCHEME OF TEACHING AND EXAMINATION
B.E. CHEMICAL ENGINEERING

VII SEMESTER

Sl. No.	Subject Code	Title of the Subject	Teaching Dept.	Teaching Hrs / Week		Examination			
				Theory	Practical	Duration (Hrs)	Marks		
							IA	Theory / Practical	Total
1	06CH71	Chemical Process Integration	CH	04	--	03	25	100	125
2	06CH72	Instrumentation & Process Control	CH	04	--	03	25	100	125
3	06CH73	Computer Applications & Modeling	CH	04	--	03	25	100	125
4	06CH74	Biochemical Engineering	CH	04	--	03	25	100	125
5	06CH75x	Elective – II (Group B)	CH	04	--	03	25	100	125
6	06CH76x	Elective – III (Group C)	CH	04	--	03	25	100	125
7	06CHL77	Process Control Lab	CH	--	03	04	25	50	75
8	06CHL78	Computer Applications & Simulation Lab	CH	--	03	04	25	50	75
Total				**24**	**06**	**26**	**200**	**700**	**900**

Elective – II (Group B)		
Sl. No.	**Subject Code**	**Title of the Subject**
1	06CH751	Food Technology
2	06CH752	Polymer Technology
3	06CH753	Electrochemical Technology
4	06CH754	Sugar Technology

Elective – III (Group C)		
Sl. No.	**Subject Code**	**Title of the Subject**
1	06CH761	Applied Mathematics in Chemical Engineering
2	06CH762	Oracle 9*i* (06CH664 is prerequisite)
3	06CH763	Petrochemicals (06CH661 is prerequisite)
4	06CH764	Oils and Fats

SCHEME OF TEACHING AND EXAMINATION
B.E. CHEMICAL ENGINEERING

VIII SEMESTER

Sl. No.	Subject Code	Title of the Subject	Teaching Dept.	Teaching Hrs / Week		Examination			
				Theory	Practical	Duration (Hrs)	Marks		
							IA	Theory / Practical	Total
1	06CH81	Process Engineering Economics	CH	04	--	03	25	100	125
2	06CH82	Transport Phenomena	CH	04	--	03	25	100	125
3	06CH83x	Elective - IV (Group D)	CH	04	--	03	25	100	125
4	06CH84x	Elective - V (Group E)	CH	04	--	03	25	100	125
5	06CH85	Project	CH	--	12	03	100	100	200
6	06CH86	Seminar on Project	CH	--	03	--	50	--	50
7	06CH87	In-plant Training/ Industrial Visit	--	--	--	--	50	--	50
Total				**16**	**15**	**15**	**300**	**500**	**800**

Elective – IV (Group D)		
Sl. No.	**Subject Code**	**Title of the Subject**
1	06CH831	Interfacial Phenomena & Surface Engineering.
2	06CH832	Advanced Bio Process Engineering
3	06CH833	Novel Separation Techniques
4	06CH834	Composite Materials

Elective – V (Group E)		
Sl. No.	**Subject Code**	**Title of the Subject**
1	06CH841	Pilot Plant and Scale up Methods
2	06CH842	Waste Management and Recycle
3	06CH843	Multi-component Distillation
4	06CH844	Pulp and Paper Technology

V SEMESTER

MANAGEMENT & ENTREPRENEURSHIP

Subject Code	: **06AL51**	IA Marks	: 25
No. of Lecture Hours/Week	: 04	Exam Hours	: 03
Total No. of Lecture Hours	: 52	Exam Marks	: 100

PART - A

MANAGEMENT

UNIT - 1

MANAGEMENT: Introduction: Meaning – nature and characteristics of Management, Scope and functional areas of management – Management as a science, art or profession – Management & Administration – Roles of Management, Levels of Management, Development of Management Thought – early management approaches – Modern management approaches.

7 Hours

UNIT - 2

PLANNING: Nature, importance and purpose of planning process – Objectives – Types of plans (Meaning only) – Decision making – Importance of planning – Stes in planning & planning premises – Hierarchy of plans.

6 Hours

UNIT - 3

ORGANISING AND STAFFING: Nature and purpose of organization – Principles of organization – Types of organization – Departmentation – Committees – Centralization Vs Decentralization of authority and responsibility – Span of control – MBO and MBE(Meaning only) Nature and importance of Staffing – Process of Selection & Recruitment (in brief).

7 Hours

UNIT - 4

DIRECTING & CONTROLLING: Meaning and nature of directing – Leadership styles, Motivation Theories, Communication – Meaning and importance – Coordination, meaning and importance and Techniques of Co – ordination. Meaning and steps in controlling – Essentials of a sound control system – Methods of establishing control (in brief).

6 Hours

PART - B

ENTREPRENEURSHIP

UNIT - 5

ENTREPRENEUR: Meaning of Entrepreneur; Evolution of the Concept, Functions of an Entrepreneur, types of Entrepreneur, intrapreneur – an

emerging emerging Class. Concept of Entrepreneurship – Evolution of Entrepreneurship, Development of Entrepreneurship

6 Hours

UNIT - 6

SMALL SCALE INDUSTRY: Definition; Characteristics; Need and rationale: Scope; role of SSI in Economic Development. Advantages of SSI. Steps to Start and SSI – Government policy towards SSI; Different Policies of S.S.I.; Government Support for S.S.I. during 5 year plans. Impact of Liberalization, Privatization, Globalization on S.S.I., Effect of WTO/GATT Supporting Agencies of Government for S.S.I., Meaning; Nature of Support; Objectives; Functions; Types of Help; Ancillary Industry and Tiny Industry (Definition only).

6 Hours

UNIT - 7

INSTITUTIONAL SUPPORT: Different Schemes; TECKSOK; KIADB; KSSICE; KSIMC; DIC Single Window Agency: SISI; NSIC; SIDBI; KSFC.

8 Hours

UNIT - 8

PREPARATION OF PROJECT: Meaning of Project; Project Identification; Project Selection; Project Report; Need and Significance of Report; Contents; formulation; Guidelines by Planning Commission Identification of Business Opportunities:

Market Feasibility Study; Technical Feasibility Study; Financial Feasibility Study & Social Feasibility Study.

6 Hours

TEXT BOOKS:

1. **Principles of Management –** P.C. Tripathi, P.N.Reddy; Tata McGraw Hill.
2. **Dynamics of Entrepreneurial Development & Management –** Vansant Desai – Himalaya Publishing House –
3. **Entrepreneurship Development** – Small Business Enterprises – Poornima M Charantimath – Person Education – 2006.
4. **Management and Entrepreneurship** –NVR Naidu and Krishna Rao- I K International –2008.

REFERENCE BOOKS:

1. **Management Fundamentals –** Concepts, Application, Skill Development – Robert Lusier – Thomson
2. **Entrepreneurship Development –** S S Khanka – S Chand & Co.
3. **Management –** Stephen Robbins – Pearson Education/PHI – 17th Edition, 2003.

CHEMICAL TECHNOLOGY – II

Subject Code	: **06CH52**	IA Marks	: 25
No. of Lecture Hours/Week	: 04	Exam Hours	: 03
Total No. of Lecture Hours	: 52	Exam Marks	: 100

PART - A

UNIT - 1

COAL: Classification of coals. Destructive distillation of coal. Coking of coal. Coal tar distillation and chemicals from coal.

6 Hours

UNIT - 2

OILS, FATS, WAXES & SOAPS: Vegetable and animal oils & fats. Extraction of vegetable oils. Refining of edible oils. Hydrogenation of oils, waxes and their applications. Soaps and detergents. Theory of detergency. Micelles concentrations. Manufacture of soaps and heavy duty detergents. Linear alkyl benzenes.

8 Hours

UNIT - 3

PULP AND PAPER: Raw materials, manufacture of pulp & paper and structural boards. Effluent treatment appropriate for pulp and paper industries.

6 Hours

UNIT - 4

SUGAR AND STARCH INDUSTRIES: Production of cane sugar. Chemistry of starch. Manufacturing of industrial starch and its applications.

6 Hours

PART - B

UNIT - 5

FERMENTATION INDUSTRIES: Production of alcohol. Manufacture of beer, wines and liquors, acetic acid and citric acid by fermentation.

6 Hours

UNIT - 6

PETROLEUM INDUSTRIES: Origin & classification. Petroleum refining and processing.

7 Hours

UNIT - 7

PETROCHEMICALS: LPG, CNG, LNG Technologies, Methane, Propylene, Benzene.

6 Hours

UNIT - 8

POLYMERS AND RUBBER: Macromolecules. Polymerization. PVC. LDPE. Polypropylene. Cross-linked polymers. UF and MF. Engineering therplastics. Natural rubber. Synthetic rubber and rubber compounding.

7 Hours

TEXT BOOKS:

1. **Chemical Process Industries** - George T. Austin, Shreve's, Mc Graw Hill International Ltd., 5th Edition, 1984.
2. **Outlines of Chemical Technology -** Gopal Rao M and Marshall Sittig Dryden's, 3rd Edition, East-West Press, 1997.

REFERENCE BOOKS:

1. **Text Book of Chemical Technology, Vol. 2** - Shukla S.D. and Pandey G.N, Vikas Publishing House Pvt. Ltd, New Delhi,1979.
2. **Chemtech-III,** Chemical Engineering Education Development Centre, IIT, Madras, 1977.
3. **Chemtech-IV**, Chemical Engineering Education Development Centre, IIT, Madras, 1979.

CHEMICAL REACTION ENGINEERING – I

Subject Code	: **06CH53**	IA Marks	: 25
No. of Lecture Hours/Week	: 04	Exam Hours	: 03
Total No. of Lecture Hours	: 52	Exam Marks	: 100

PART - A

UNIT - 1

INTRODUCTION: Scope of Chemical Reaction Engineering. Classification of reactions. Rate equation and rate of reaction. Factors affecting rate of reaction. Chemical kinetics and Thermodynamics Equilibrium. Temperature dependency of rate constant from Arrhenius, Collision and Transition state theories. Molecularity and order of reaction.

6 Hours

UNIT - 2

NON-ELEMENTARY REACTIONS: Difference between elementary and non-elementary reactions. Kinetic models and mechanisms for non-elementary reactions. Types of reactors.

6 Hours

UNIT - 3

HOMOGENEOUS REACTIONS: Interpretation of batch reactor data. Constant & Variable Volume batch reactor. Analysis : Differential method,

Integral method, half-life method. Method of excess and method of isolation (For Reverssible and Irriversibale reactions up to second order). Autocatalytic reactions.

7 Hours

UNIT - 4

DESIGN OF IDEAL REACTORS: Concept of ideality. Development of design equations for batch, tubular and stirred tank reactors for both constant and variable volume reactions. Evaluation of rate equations from data obtained in these reactors.

7 Hours

PART - B

UNIT - 5

COMPARISON OF IDEAL REACTORS: General graphical comparison.

MULTIPLE REACTOR SYSTEMS: Plug flow and/or Mixed flow reactors in Series, parallel and series parallel. Reactors of different types and sizes in series.

6 Hours

UNIT - 6

DESIGN OF REACTORS FOR MULTIPLE REACTIONS: Design of Batch reactor, Plug and Mixed flow reactors for Parallel, Series and Series-Parallel reactions (Only irreversible reactions must be considered).

7 Hours

UNIT - 7

NON-ISOTHERMAL REACTORS: Introduction, Material, Energy balances and conversions.

6 Hours

UNIT - 8

ANALYSIS OF NON ISOTHERMAL REACTOR: Design procedure (For single/ simple reactions only). Optimum temperature Progression.

7 Hours

TEXT BOOKS:

1. **Chemical Reaction Engineering -** Octave Levenspeil, 3rd edition, John Wiley & Sons, 2001.
2. **Elements of Chemical Reaction Engineering -** H. Scott Fogler, 3rd edition, Prentice Hall 2001.

REFERENCE BOOK:

1. **Chemical Engineering Kinetics** - J.M. Smith, 3rd Edition, McGraw Hill, 1984.

MASS TRANSFER – I

Subject Code	: **06CH54**	IA Marks	: 25
No. of Lecture Hours/Week	: 04	Exam Hours	: 03
Total No. of Lecture Hours	: 52	Exam Marks	: 100

PART - A

UNIT - 1

INTRODUCTION: Types of diffusion in fluids. Types of diffusion in solid. Measurement and calculations of diffusivities.

6 Hours

UNIT - 2

EDDY DIFFUSION: Mass transfer coefficients and their correlations. Theories of mass Transfer. Interphase mass transfer. J_d factor, Analogies in mass, heat and momentum transfer processes.

6 Hours

UNIT - 3

STAGE-WISE OPERATIONS: Material balance for co-current, cross-current and counter-current operations. Concept of stages, cascades operation, NTU and HTU concepts.

6 Hours

UNIT - 4

HUMIDIFICATION: General theory. Psychrometric chart. Concepts in humidification, dehumidification. Design of cooling towers.

8 Hours

PART - B

UNIT - 5

DRYING: Introduction, Equilibria, Drying rate curves. Mechanism of drying, types of dryers. Design of batch and continuous dryers.

7 Hours

UNIT - 6

CRYSTALLIZATION: Factors governing nucleation and crystal growth rates. Controlled growth of crystals. Incorporation of principles into design of equipment. Different types of crystallizer equipment.

6 Hours

UNIT - 7

ADSORPTION: Theories of adsorption. Isotherms, Industrial adsorbents. Equipment, Batch & continuous multistage Adsorption.

7 Hours

UNIT - 8

INTRODUCTION TO NOVEL SEPARATIONS: Ion exchange**,** Membrane processes - Reverse Osmosis, Dialysis, Ultra and Micro-filtrations, Super-critical fluid extraction.

6 Hours

TEXT BOOKS:

1. **Mass Transfer Operations -** Robert E Treybal, 3rd Edition, McGraw Hill, 1981.
2. **Unit Operations in Chemical Engineering** - McCabe & Smith, 6th Edition, McGraw Hill, 2001.

REFERENCE BOOKS:

1. **Chemical Engineering Vol I, II, IV and V -** Coulson and Richardson, 4th Edition, Pergamon Press, 1998.
2. **Introduction to Chemical Engineering -** Badger & Banchero, TMH 6th Reprint 1998.
3. **Principles of Unit Operation -** Foust et.el. 2nd Edition, John Wiley, 1994.
4. **Transport Processes and Unit Operation -** Geankoplis C J, Prentice Hall (I), 2000.
5. **Applied process design for Chemical and petrochemical plant** Ludwig, 2nd Edition, Gulf Publishing, 2002.

POLLUTION PREVENTION & CONTROL ENGINEERING

Subject Code	: **06CH55**	IA Marks	: 25
No. of Lecture Hours/Week	: 04	Exam Hours	: 03
Total No. of Lecture Hours	: 52	Exam Marks	: 100

PART - A

UNIT - 1

INTRODUCTION: Importance of environment for mankind. Biosphere and layers of atmosphere. Hydrological cycle and nutrient cycles. Types of pollution. Damages from environmental pollution. Need of environmental legislations and environmental Acts in India. Functions of central and state pollution control boards.

6 Hours

UNIT - 2

SOURCES, SAMPLING AND ANALYSIS OF WASTEWATER: Water resources. Origin of wastewater. Evaluation, classification and characterization of wastewater. Physical and chemical characteristics. BOD, COD and their importance. Types of water pollutants and their effects. Sampling, and methods of analysis.

7 Hours

UNIT - 3

WASTEWATER TREATMENT: Preliminary, primary, secondary and tertiary treatments of wastewater. Sludge treatment and disposal. Advanced wastewater treatment. Recovery of materials from process effluents.

7 Hours

UNIT - 4

APPLICATIONS TO INDUSTRIES: Norms and standards of treated water. Origin, characters, and treatment methods of typical industries – petroleum refinery, pulp and paper, fertilizer, distillery, tannery, and textile processing.

6 Hours

PART - B

UNIT - 5

AIR POLLUTION ASPECTS: Nature of air pollution. Classification of air pollutants. Sources of air pollutants. Air quality criteria and standards. Plume behaviour and dispersion of air pollutants. Effects of air pollution on health, vegetation, and materials.

7 Hours

UNIT - 6

AIR POLLUTION TREATMENT: Sampling of pollutants. Methods of estimation of air pollutants. Automobile pollution. Control methods for particulates and gaseous pollutants. Pollution from chemical industries. Origin, control methods, and equipment used in typical industries – Thermal power plants, metallurgical industries, and cement industries.

7 Hours

UNIT - 7

SOLID WASTE TREATMENT: Origin. Classification and microbiology. Properties and their variation. Engineered systems for solid waste management – generation, onsite handling, storage, collection, transfer and transport, composting, sanitary land filling.

6 Hours

UNIT - 8

NOISE CONTROL: Sources and definitions. Determination of noise levels. Noise control criteria and noise exposure index. Administrative and engineering controls. Acoustic absorptive materials.

6 Hours

TEXT BOOKS:

1. **Environmental Pollution Control Engg -** C. C.S. Rao, New Age International Reprint, 2002.
2. **Pollution Control in Process Industries -** S.S.P. Mahajan, Tata Mc Graw Hill, 1999.

REFERENCE BOOKS:

1. **Chetech-I**, Chemical Engg. Education Development Centre, 1975.
2. **Air Pollution -** H.C. Perkins, McGraw Hill, 1974.
3. **Solid Waste Management -** D.J. Hagery et.al., Van Nostrand Reinhold, 1973.
4. **Industrial Pollution Control Handbook -** Lund, H.F., McGraw Hill, 1971.
5. **Noise Abatement -** Duerden, Buttreworth, 1970.
6. **Introduction to Environmental Engg -** Davis., 3rd Edition, McGraw Hill, 1998.
7. **Waste Water Engineering Treatment Disposal Reuse -** Metcalf and Eddy,, Tata McGraw Hill, 4th Edition, 2003.
8. **Environmental Engineering -** G.N. Pandey and G.C. Carney, Tata McGraw Hill 2002.
9. **Integrated Solid Waste Management -** George Tchobanoglous et al, McGraw Hill & Co, 1993.

CHEMICAL EQUIPMENT DESIGN

Subject Code	: **06CH56**	IA Marks	: 25
No. of Lecture Hours/Week	: 04	Exam Hours	: 03
Total No. of Lecture Hours	: 52	Exam Marks	: 100

PART - A

UNIT - 1

INTRODUCTION: Basic considerations in design. General design procedure. Equipment classification. Various components of process equipment. Design parameters. Pressure vessel codes.

6 Hours

UNIT - 2

DESIGN CONSIDERATIONS: Material selection. Factors affecting design. Stresses due to static and dynamic loads (Internal & External). Temperature effects. Economic considerations.

6 Hours

UNIT - 3

DESIGN OF PRESSURE VESSELS: Design parameters, conditions & stresses. Design of shell and other vessel components. Vessel at low & high operating temperatures. Numerical design problems using given process parameters.

7 Hours

UNIT - 4

VESSEL COMPONENT DESIGN: Design of supports for vessels - Bracket, Lug, Leg, Saddle and Skirt supports. Design of flanges & nozzles – Classification of flanges. Flange thickness calculation, Gasket selection and design, Bolt selection and calculation. Nozzle design. Design of vessel closures – Flat plates, Formed heads, Elliptical & Hemispherical heads.

7 Hours

PART - B

UNIT - 5

STORAGE VESSELS: Process conditions and design parameters for storage of volatile, non-volatile fluids & gases. Design of cylindrical tanks with fixed roofs. Design of partially filled spherical tanks. Design of components, supports and selection of vessels accessories & mountings. Numerical problems.

7 Hours

UNIT - 6

REACTION VESSELS: Design of reaction tanks with agitation and jacket. Types of agitators, baffles. Power requirement calculations. Design of tank dimensions and agitation system components. Drive calculations & selection of accessories. Design of jackets. Support calculations for the system. Numerical problems.

7 Hours

UNIT - 7

TALL VERTICAL VESSELS: Vessels subjected to various loads, Multi shell constructions. Determination of shell thickness. Supports for columns.

6 Hours

UNIT - 8

PIPE LINE DESIGN: Pipe line sizing, Condensate and steam pipe design, Optimum size of delivery line in pumping operations. Concepts of P & I Diagrams, P & I Diagram for simple processes.

6 Hours

TEXT BOOKS:

1. **Process Equipment Design -** M. V. Joshi, Macmillan & Co. India, Delhi, 3rd Edn. reprint 1998.
2. **Process Equipment Design – Vessel Design -** Brownell & Young, John Willey, 1951
3. **Process Design of Equipment – Vol 1** - S. D. Dawande, Central Techno Publications. 3rd. Edn, 2003.

REFERENCE BOOKS:

1. **Chemical Engineers Handbook -** Perry & Green, 7th Edn, McGraw Hill, 1997.
2. **Pressure Vessel Code – IS 2825 -** IS Code, B.I.S., New Delhi, 1969.
3. Flow of Fluids through Valves, Fittings & Pipes Crane Amazon-2006.

POLLUTION CONTROL AND INSTRUMENTATION ANALYSIS LABORATORY

Subject Code	: **06CHL57**	IA Marks	: 25
No. of Practical Hours/Week	: 03	Exam Hours	: 04
Total No. of Practical Hours	: 42	Exam Marks	: 50

1. Analysis of effluents for pH, alkalinity and turbidity
2. Determination of COD and BOD
3. Volatile, Fixed, Filterable and Dissolved solid analysis
4. Analysis by ion selective electrode (any two anions)
5. Measurement of particulate matter in Air
6. Measurement of SO_2 in air
7. Analysis of exhaust be Orsat apparatus
8. Analysis of flue gases by Gas chromatograph
9. UV Spectrophotometer
10. KF Auto titrator
11. Flame photometer
12. Turbidometer
13. Dissolved Oxygen measurement
14. Bomb calorimeter
15. Viscometer
16. Polarograph
17. Potentiometer titration

HEAT TRANSFER LABORATORY

Subject Code	: **06CHL58**	IA Marks	: 25
No. of Practical Hours/Week	: 03	Exam Hours	: 04
Total No. of Practical Hours	: 42	Exam Marks	: 50

1. Natural Convection in Bare and Finned tube
2. Vertical Shell and tube Heat exchanger (Condenser)
3. Horizontal Shell and tube Heat exchanger (Condenser)
4. Helical Coil Heat exchanger
5. Emissivity Determination
6. Effect of Geometry on Natural convection
7. Heat Transfer in Packed Beds
8. Double Pipe Heat Exchanger
9. Heat Transfer in Jacketed Vessel
10. Determination of Insulation Thickness
11. Transient Heat Conduction
12. Heat Transfer in Fluidized Beds
13. Evaporator
14. Solar Heater
15. Spiral Plate Heat Exchanger
16. Cross Flow Heat Exchanger

VI SEMESTER

CHEMICAL PLANT UTILITIES AND SAFETY

Subject Code	: **06CH61**	IA Marks	: 25
No. of Practical Hours/Week	: 04	Exam Hours	: 03
Total No. of Lecture Hours	: 52	Exam Marks	: 100

PART - A

UNIT - 1

INTRODUCTION: Different utilities. Role of utilities in process plant operations and criteria for selection and estimation of suitable utilities.

WATER: Water resources. Process water, Cooling water, drinking water and boiler feed water Quality Standards. Water treatment processes for drinking, process and boiler feed. Storage and handling of water. Types and selection of pumps, piping and accessories. Water pre treatment, reuse and recyling.

7 Hours

UNIT - 2

AIR: Compressed air, blower air, fan air. Types of compressor and vacuum pumps and selection. Power requirements, performance and related calculations. Booster and receivers. Quality of compressed air for instruments and processes. Compressed air distribution system- piping and accessories. Air-watervapour system: humidification/ dehumidification and evaporative cooling-related calculations.

6 Hours

UNIT - 3

STEAM AND POWER: Steam generation in chemical plants. Types of boilers and waste heat boilers. Fuels-types, emissions and global warming, green fuels. Calorific value. Proximate and ultimate analysis. HHV, LHV and related calculations. Cogeneration power plants. CHPs and Boiler performance. Related Calculations. Economy of steam generation with different fuels, related calculation. Steam storage and handling-piping and accessories.

7 Hours

UNIT - 4

REFRIGERATION: Different refrigeration systems and their characteristics. Air-conditioning systems. Coefficient of performance. Power requirements and refrigeration effect- related calculations for each type of refrigeration system. Refrigerant properties and selection. Some commonly used refrigerants and secondary refrigerants.

6 Hours

PART - B

UNIT - 5

INSULATION: Insulation Materials & Selection- Economics of insulation. Insulating factors. Properties & Classification. Cold insulation and cryogenic insulation.

6 Hours

UNIT - 6

INTRODUCTION TO PROCESS SAFETY- Intrinsic & Extrinsic Safety. The Hazards- Toxicity, Flammability, Fire , Explosions. Sources of ignition, Pressure. Hazard and risk assessment methods. MSDS.

6 Hours

UNIT - 7

SAFETY DEVICES: Pressure relief valves. Ruptures discs. Blow down systems. Flare systems. Flame arrestors. Deflagration arrestors and explosion suppression. Personal safety devices.

7 Hours

UNIT - 8

PROCESS SAFETY ANALYSIS: HAZAN and HAZOP comparison. Risk analysis and estimation. Safety check list. Computer based quantitative risk analysis.

7 Hours

TEXT BOOKS:

1. **Thermal Engineering -** B.K. Sarkar, Tata Mc Grew Hill –1998.
2. **Heat Engines -** K.P. Roy, Media Promoters and Publishers-1995.
3. **Power Plant Engineering -** P.K. Nag, Tata Mc Grew Hill –1998.
4. **Water and Waste water engineering- Vol 2. -** Gordon M Fair, John C. Geyer and Daniel A Okun, Jhon Hutey –1996.
5. **Water and waste water Technology-** Mark J. Hammer Jr.4th Edition. Prentice Hall 1997.
6. **Chemical Engineers Handbook.** – Perry 8th Edition –2007.
7. **Chemical Engineering- Vol 6 -** R.K. Sinnot, Coulson and Richardson's, 3rd Edition, BH, Reprint, 2000.
8. **Loss prevention in chemical process industries', Vol 1, 2, 3 -** Frank P Lees, Butterworth-Heiremann, 1980.

CHEMICAL REACTION ENGINEERING – II

Subject Code	: **06CH62**	IA Marks	: 25
No. of Lecture Hours/Week	: 04	Exam Hours	: 03
Total No. of Lecture Hours	: 52	Exam Marks	: 100

PART - A

UNIT - 1

BASICS OF NON IDEAL FLOW: Importance & interpretation of RTD, C, E & F curves & Statistical interpretation. Dispersion model. Tanks in series model. Conversion in non- ideal flow reactors for simple systems.

7 Hours

UNIT - 2

NON CATALYTIC SYSTEMS: Fluid-Fluid reactions and Kinetics.

6 Hours

UNIT - 3

FLUID PARTICLE REACTIONS: Mechanism and Kinetics.

6 Hours

UNIT - 4

CATALYSIS: Introduction to catalysis. Properties of catalysts. Estimation methods for catalytic properties. Promoters, inhibitors etc, Mechanism of catalysis. Rate equations for different rate controlling steps

7 Hours

PART - B

UNIT - 5

DEACTIVATION: Deactivating catalyst. Mechanism, rate & performance equation.

6 Hours

UNIT - 6

SOLID CATALYZED REACTIONS: Heterogeneous reactions- Introduction., Kinetic regimes. Rate equation for surface kinetics. Pore diffusion resistance combined with surface kinetics. Thiele modulus and enhancement factor, Porous catalyst particles. Heat effects during reaction.

7 Hours

UNIT - 7

SOLID CATALYZED REACTIONS (Contd): Performance equations for reactors containing porous catalyst particles. Experimental methods for finding rates. Packed bed catalytic reactor & reactors with suspended solid catalyst. Fluidized reactors of various type.

7 Hours

UNIT - 8

GAS-LIQUID REACTORS: Trickle bed, slurry reactors. Three phase fluidized bed.

6 Hours

TEXT BOOKS:

1. **Chemical Reaction Engineering -** Octave Levenspiel, 3rd Edition, John Wiley & Sons - 2001.
2. **Chemical Engineering Kinetics -** J.M. Smith, 3rd Edition, McGraw Hill
3. **Elements of Chemical Reaction Engineering -** H. Scott Foggler, 3rd Edition, Prentice Hall - 2001.

REFERENCE BOOK:

1. **Chemical & Catalytic Reaction Engineering -** James J. Carberry, McGraw Hill - 1976.

MASS TRANSFER – II

Subject Code	: **06CH63**	IA Marks	: 25
No. of Lecture Hours/Week	: 04	Exam Hours	: 03
Total No. of Lecture Hours	: 52	Exam Marks	: 100

PART - A

UNIT - 1

GAS LIQUID CONTACTING SYSTEMS: Types, construction and working of plate and packed columns, types and properties of industrial packings, plate efficiencies, HETP and HTU concepts.

7 Hours

UNIT - 2

ABSORPTION: Absoption. Solvent selection for absorption. Material balance and concept of driving force and minimum solvent rates. Multistage absorption columns. Design of Plate columns. Absorption and desorption factors.

7 Hours

UNIT - 3

PACKED TOWER ABSORPTION: Liquid phase hold up and pressure drop in absorption towers. Operating line and minimum solvent flow rates. Design of packed towers (process design-height and diameter). Multi-component absorption. Absorption with chemical reaction.

6 Hours

UNIT - 4

DISTILLATION: Introduction. Vapour liquid equilibria (T-x,y, P-x,y. H-x,y and x-y diagrams for binary mixtures). Relative volatility. Prediction of VLE from vapour pressure data using Raoult's law. VLE for multi-component systems. Non-ideal systems. Azeotropes. Immiscible systems. Steam distillation.

6 Hours

PART - B

UNIT - 5

DISTILLATION (Contd.): Types of distillation. Flash and simple distillation. Multi-stage rectification column. Design using McCabe Thiele method for binary mixtures.

6 Hours

UNIT - 6

DESIGN OF DISTILLATION COLUMN: Using Ponchon Savarit method. Efficiencies –overall, local, and Murphree plate efficiencies: Introduction to Multicomponent distillation, Vacuum, molecular, extractive and azeotropic distillations.

7 Hours

UNIT - 7

LIQUID-LIQUID EXTRACTION: Ternary equilibrium. Solvent selection. Single stage. Multi-stage cross-current, counter-current extraction. Equipment for liquid-liquid extraction.

7 Hours

UNIT - 8

LEACHING OPERATION: Equipment for leaching. Preparation of solids for leaching. Equilibrium diagrams. Calculation of single stage and multi-stage leaching operation.

6 Hours

TEXT BOOKS:

1. **Mass Transfer Operations -** Robert E Treybal, 3rd Edition, McGraw Hill 1981.
2. **Unit Operations in Chemical Engineering** - McCabe & Smith, 6th Edition, McGraw Hall, 2001.

REFERENCE BOOKS:

1. **Chemical Engineering Vol I, II, IV and V -** Coulson and Richardson, 4th Edition, Pergmon Press, 1998.
2. **Introduction to Chemical Engineering** - Badger & Banchero, TMH 6th Reprint 1998.

3. **Principals of Unit Operation -** Foust et.el., 2nd Edition, John Wiley, 1994.
4. **Transport Processes and Unit Operation –** Geankoplis ,C J, Prentice Hall(I), 2000.

ENERGY TECHNOLOGY

Subject Code	: **06CH64**	IA Marks	: 25
No. of Lecture Hours/Week	: 04	Exam Hours	: 03
Total No. of Lecture Hours	: 52	Exam Marks	: 100

PART - A

UNIT - 1

INTRODUCTION TO ENERGY SOURCES: Conventional energy sources; non-conventional energy sources; advantages; limitations.

4 Hours

UNIT - 2

SOLAR ENERGY: Solar radiation and its measurement – solar constant, solar radiation at earths surface, solar radiation geometry, solar radiation measurement. Introduction to solar energy. Applications – solar water heating, space heating, space cooling, solar thermal electric conversion. Agriculture and industrial process heating, solar distillation, solar pumping, solar cooking.

8 Hours

UNIT - 3

ENERGY FROM BIOMASS (BIO – ENERGY): Introduction. Biomass conversion Technologies. Wet processes. Dry processes. Biogas generation. Factors affecting biodigestion or generation of gas. Classification of biogas plants. Advantages and disadvantages of floating drum plant. Advantages and disadvantages of fixed dome type plant. Types of biogas plants (KVIC model & Janata model). Selection of site for biogas plant.

8 Hours

UNIT - 4

BIO – ENERGY (THERMAL CONVERSION): Methods of obtaining energy from biomass. Thermal gasification of biomass. Classification of biomass gasifiers. Chemistry of gasification process. Applications of the gasifiers.

6 Hours

PART - B

UNIT - 5

WIND ENERGY: Introduction. Basic components of WECS (wind energy conversion system). Classification of WECS. Types of wind machines- horizontal axis machines, vertical axis machines. Applications of wind energy.

8 Hours

UNIT - 6

ENERGY FROM THE OCEANS: Introduction. Ocean thermal electric conversion (OTEC). Methods of ocean thermal electric power generation. Open cycle OTEC system. Closed or Anderson OTEC cycle, hybrid cycle. Application of energy from oceans.

6 Hours

UNIT - 7

ENERGY FROM TIDES: Basic principles of tidal power. Components of tidal power plants. Operation methods of utilization of tidal energy. Advantages and limitations of tidal power generation. Applications of tidal energy.

6 Hours

UNIT - 8

FUELS: Introduction. Classification of fuels. Calorific value. Characteristics of good fuels. Comparison between solid, liquid and gaseous fuels.

6 Hours

TEXT BOOKS:

1. **Non-Conventional Energy Sources -** G.D. Rai, Khanna Publications, 4th Edition, Second Reprint, 1997.
2. **Engineering Chemistry -** P.C. Jain & M. Jain, Dhanpat Rai & Sons, 10th Edition, 3rd Reprint, 1995.

REFERENCE BOOKS:

1. **Solar Energy, Second Edition** - S.P. Sukhatme, 3rd Reprint, Tata McGraw Hill, New Delhi, 1998.
2. **Solar Energy Utilization -** G.D. Rai, 4th Edition, Khanna Publications-2006.

PROCESS EQUIPMENT DESIGN & DRAWING

Subject Code	: **06CH65**	IA Marks	: 25
No. of Lecture Hours/Week	: 05 (02+03)	Exam Hours	: 04
Total No. of Lecture Hours	: 70 (28+42)	Exam Marks	: 100

Detailed chemical engineering process design of the following equipment. Necessary aspects studied in "Chemical Equipment Design" is to be applied for mechanical design. Use of standard code books to be taught. The detailed dimensional drawings shall include sectional front view, Full Top/side view depending on equipment and major component drawing with dimensioning and part Template.

1. Double pipe Heat exchanger
2. Shell and Tube Heat exchanger
3. Condensers – Horizontal and vertical
4. Evaporator – Single effect
5. Bubble Cap Distillation Column
6. Packed Bed Absorption Column
7. Rotary Dryer.

REFERENCE BOOKS:

1. **Chemical Engineers Handbook -** R.H. Perry & D.W. Green, 7th Edition, McGraw Hill, 1998.
2. **Process Heat Transfer -** Donald Q. Kern, McGraw Hill, 1997.
3. **Mass Transfer Operations -** Robert E, Treybal, McGraw Hill, 1981.
4. **Chemical Engineering- Vol 6 -** J.M. Coulson & J.F. Richardson, Pergemen Press, 1993
5. **Shell & Tube Heat Exchanger -** IS Code, IS 4503, BIS, New Delhi, 1969.
6. **Process Equipment Design -** Brownell & Young, Vessel Design, John Wiley, 1951.
7. **Process Equipment Design-** M.V. Joshi, McMillan & Co., India, Delhi, 3rd Edition, Reprint, 1998.
8. **Process Design of Equipment**- S.D. Dawande, Vol II, Central Techno Publications, 3rd Edition, 2003.

ELECTIVE - I (Group A)

PETROLEUM REFINERY ENGINEERING

Subject Code	: **06CH661**	IA Marks	: 25
No. of Lecture Hours/Week	: 04	Exam Hours	: 03
Total No. of Lecture Hours	: 52	Exam Marks	: 100

PART - A

UNIT - 1

INDIAN PETROLEUM INDUSTRY: Prospects & Future. Major companies. World production, Markets, Offshore and onshore, Oil well technology.

6 Hours

UNIT - 2

COMPOSITION OF CRUDE: Classification. Evaluation of petroleum. UOP-k factor. TBP analysis. EFV analysis. Average boiling point. ASTM curves. Thermal properties of petroleum fractions.

6 Hours

UNIT - 3

PRODUCT PROPERTIES AND TEST METHODS: Gas. Various types of gas and LPG. Reid vapor pressure analysis. Gasoline and naptha. Octane No. Oxidation stability. Additives for gasoline. Kerosene. Characterization for flash point or fire point, volatility, burning qualities etc, Diesel, octane testing, viscosity etc. Grades of diesels e.g. HSD, LDO. Diesel additives. Lube oils : Types, tests-carbon residue and viscosity index.

7 Hours

UNIT - 4

CRUDE PRETREATMENT: Pumping of crude oils. Dehydration of crude by chemical, gravity, centrifugal, electrical de-salter and comparision of each. Heating of crude- heater, different types of pipe still heaters including box type, cylindrical etc. Crude distillation, arrangement of towers for various types of reflux. Design aspects for atmospheric and vacuum column. Atmospheric distillation distillation unit: internals and operational.

7 Hours

PART - B

UNIT - 5

TREATMENT TECHNIQUES: Types of impurities present and various desulfurisation processes. Production and treatment of LPG. LNG

technology. Sweetening operations for gases including merox, ethanolamine, copper chloride, stertford etc. Catalytic de sulphonisation. Treatment of kerosene, De-aromatisation and merox. Treatment of diesel, naptha: desulpurisation by hydrogen and catalysts. Treatment of lubes: sulphuric acid, clay treatment, solvent treatment-phenol, furfural.

6 Hours

UNIT - 6

THERMAL PROCESSES: Thermal cracking reactions- theory of thermal cracking. Properties of cracked materials and factors influencing the properties of cracked materials. Visbreaking, dubbs two coil cracking process.

6 Hours

UNIT - 7

CATALYTIC CRACKING: Comparision of thermal and catalytic cracking. Carbonium ion chemistry. Feedback requirements. Cracking conditions. Commercial cracking analysis. Various catalytic cracking processes. Fixed bed crackers. Moving bed crackers. Fluid catalytic cracking-flexi cracking-ortho-flow reactor. Theory of coking: various types of coking processes. Delayed coking, fluid coking, contact coking, flexi coking. Naptha cracking, naptha cracking for ethylene as feed selection and gas yield. Hydro cracking. Theory of hydro cracking. Catalysts for hydro cracking.

7 Hours

UNIT - 8

CATALYSTIC REFORMING: Theory of reforming. Factors influencing, reforming, reforming catalysts, feedstock requirements. Plat-forming, isoplus hondriforming, refining forming, power forming and flexi forming etc.

7 Hours

TEXT BOOKS:

1. **Petroleum Refinery Engineering** - Nelson, McGraw Hill, 4th Edition, 14th Reprint, 1982.
2. **Modern Petroleum Refining Processes -** Bhaskara Rao, Oxford & IBH Publication, 3rd Edition, Reprint, 1999.

REFERENCE BOOKS:

1. **Petroleum Refining Technology**- Ram Prasad, Khanna Publishers, I Edition, 2000.
2. **Challenges in Crude Oil Evaluation**- Nagnal J.M., Gate, McGraw Hill.
3. **Petroleum Processing** - Sland W.F. and Davidson R.L. McGraw Hill, 1967.

PHARMACEUTICAL TECHNOLOGY

Subject Code	: **06CH662**	IA Marks	: 25
No. of Lecture Hours/Week	: 04	Exam Hours	: 03
Total No. of Lecture Hours	: 52	Exam Marks	: 100

PART - A

UNIT - 1

ELECTROPHILIC SUBSTITUTION REACTION: Preparation of cyclo alkane. Bayer's strain theory and orbital picture of angle stream.

6 Hours

UNIT - 2

ELECTROPHILIC SUBSTITUTION REACTION MECHANISM & APPLICATION: Dehydrogenation of alkyl halides. 1-2 elimination kinetics: E2 and E1 mechanisms. Isotope effect. Dehydration of alcohols. Ease of dehydration.

6 Hours

UNIT - 3

NUCLEOPHILIC ADDITION REACTION: Mechanism. Important chemicals. Oxidation-Reduction reactions.

6 Hours

UNIT - 4

RHEOLOGY OF FLUIDS IN MIXING AND BLENDING.

8 Hours

PART - B

UNIT - 5

PREPARATION: Test for purity and medical uses of Chlorobutal, Dimercopral, Glycerol trinitrate.

7 Hours

UNIT - 6

PREPARATION: Test for purity and medical uses of Urea, ethylene diamine dihydrate, vanillin, paraldehyde.

7 Hours

UNIT - 7

PREPARATION: Test for purity and medical uses of lactic acid, citric acid, salicylic acid, saccharin sodium.

6 Hours

UNIT - 8

PREPARATION: Test for purity and medical uses of Ethyl borate, dimethyl phthalate, aspirin.

6 Hours

TEXT BOOKS:

1. **Organic Chemistry -** T.R. Morisson and R. Boyd, 6th edition, Prentice Hall of India Pvt. Ltd., New Delhi – 1992.
2. **Organic Chemistry Fundamentals -** I. L. Finar, 2nd edition, ELBS, Pergemon Press – 1965.

OPERATIONS RESEARCH

Subject Code	: **06CH663**	IA Marks	: 25
No. of Lecture Hours/Week	: 04	Exam Hours	: 03
Total No. of Lecture Hours	: 52	Exam Marks	: 100

PART - A

UNIT - 1

INTRODUCTION: Definition. Scope of Operations Research (OR). Approach and limitations of O.R. Models. Characteristics and phases of O.R.

Linear Programming Problems: Mathematical formulation of L.P. Problems. Graphical solution method.

7 Hours

UNIT - 2

THE SIMPLEX METHOD: 1 & 2 – slack, surplus and artificial variables. Dual simplex method. Degeneracy and procedure for resolving degenerate cases.

7 Hours

UNIT - 3

ASSIGNMENT PROBLEMS: Balanced and Unbalanced assignment problems. Maximization assignment problems. Travelling salesman problems.

6 Hours

UNIT - 4

TRANSPORTATION PROBLEM: Basic feasible solutions by different methods. Finding optimal solution. MODI method. Degeneracy. Unbalanced transportation problems. Maximization Problems

6 Hours

PART - B

UNIT - 5

SEQUENCING: Johnson's algorithm. n jobs - 2 machines, n jobs -3 machines, and n jobs-n machines without passing sequence. 2 jobs-n machines. Graphical solutions.

6 Hours

UNIT - 6

DETERMINISTIC MODELS: Inventory, EOQ Models. With and without shortages. Ordering cost. Carrying cost.

6 Hours

UNIT - 7

PERT-CPM TECHNIQUES: Network construction. Determining critical path. Variance and probability of completing the project. Calculation of different floats. Project duration. Crashing of simple networks.

8 Hours

UNIT - 8

WAITING LINES: Queuing systems and their characteristics. Poisson queues. M/M/1 queuing system.

6 Hours

TEXT BOOKS:

1. **Introduction to Pert and CPM -** L. S. Srinath,, 3 Edition, East West, 1998
2. **Operation Research -** Kantiswaroop, P. K. Gupta and Manmohan,, 9th Edition, S Chand & Co. 1999.
3. **Scientific Inventory Management -** Hospach Buchan and Earnest Koenigberg 1989.
4. **Operation Research -** S. D. Sharma, 8th Edition, Kedarnath & Co, 2003.

PROGRAMMING IN C++

Subject Code	: **06CH664**	IA Marks	: 25
No. of Lecture Hours/Week	: 04	Exam Hours	: 03
Total No. of Lecture Hours	: 52	Exam Marks	: 100

PART - A

UNIT - 1

BEGINNING WITH C++: What is C++? Applications of C++. A simple C++ Program. More C++ Statements. An example with class. Structure of C++ Program. Creating source file, compiling and linking.

Hands-on Session: Programming exercises of Balagurusamy, Chapter 2. **Tokens, Expressions and Control Structures :**Introduction. Tokens, Keywords. Identifiers. Basic data types. User-defined data types. Derived data types. Symbolic constants. Type compatibility. Declaration of variables. Dynamic initialization of variables. Reference variables. Operators in C++. **Hands-on Session:** Programming exercises of Balagurusamy, Chapter 3.

8 Hours

UNIT - 2

TOKENS, EXPRESSIONS AND CONTROL STRUCTURES: Scope resolution operator. Member dereferencing operators. Memory management operators. Manipulators. Type cast operator, expressions and implicit conversions. Operator precedence. Control structures. An Overview of C++: Old-style vs. Modern C++. Introducing C++ Classes.

Hands-on Session: Programming exercises of Balagurusamy, Chapter 3.

7 Hours

UNIT - 3

AN OVERVIEW OF C++, CONSTRUCTORS AND DESTRUCTORS, CLASSES AND OBJECTS: Overview of C++: Function overloading. Operator Overloading. Inheritance. Classes and Objects: Classes. Structures and Classes are related. Unions and Classes. Constructors and destructors: Parameterized constructors. Copy constructor. Dynamic constructors. **Hands-on Session:** Programming exercises can be got from Balagurusamy. At least one example each of operator Overloading, function overloading and parameterized and copy Constructors.

6 Hours

UNIT - 4

CLASSES AND OBJECTS: Friend Functions. Friend Classes. Inline Functions. Defining Inline Functions within a Class, Static Class Members, Nested Classes, Local Classes. Passing Objects to functions. Returning Objects. Object Assignment.

Hands-on Session: Programming exercises can be got from Balagurusamy. At least one example each of Friend Function, Friend Class, Inline Function and Nested Class.

5 Hours

PART - B

UNIT - 5

INHERITANCE: Base class access control. Inheritance and Protected members. Inheriting multiple base classes. Constructors, destructors and inheritance Granting access. Virtual base classes.

Hands-on Session: Programming exercises can be got from Balagurusamy. At least one example each of single, multiple inheritance with Constructors, virtual and abstract classes.

6 Hours

UNIT - 6

POINTERS, VIRTUAL FUNCTIONS AND POLYMORPHISM: Introduction. Pointers to Objects. this Pointer. Pointers to Derived Classes. Virtual Functions. Pure Virtual Functions.

Hands-on Session: Programming exercises can be got from Balagurusamy. At least one example each of pointer to objects, derived classes, use of this, virtual and pure virtual functions.

5 Hours

UNIT - 7

WORKING WITH FILES: Introduction. Classes for File Stream Operations. Opening and Closing a file. Detecting end-of-file. More about open () file modes. File pointers and their manipulations.

Hands-on Session: Programming exercises can be got from Balagurusamy. At least one example each of creating and manipulating a file using file pointers.

Working with files: Sequential input and output operations. Updating a file: random access. Error handling during file operations. Command line arguments.

Hands-on Session: Programming exercises can be got from Balagurusamy. At least one example each of random access and handling file operation error.

8 Hours

UNIT - 8

EXCEPTION HANDLING: Exception handling fundamentals. Handling derived class exceptions. Exception handling options. Understanding terminate () and unexpected (). The uncaught_exception () functions. The exceptions and bad_exception classes. Applying exception handling.

Hands-on Session: Programming exercises can be got from Balagurusamy.At least one example each of handling derived class exceptions and usage of terminate (), unexpected (), uncaught_exception (), exceptions and bad_exception classes.

7 Hours

TEXT BOOKS:

1. **C++ The Complete Reference**- 4th Edition, Herbert Schildt, TMH, 2005
2. **Object Oriented Programming with C++**- 3rd Edition, E Balagurusamy, TMH, 2006.

REFERENCE BOOKS:

1. **C++ Primer** - Stanley B, Lippman, Josse Lajoie, Barbara E Moo, 4th Edition, Addison Wesley, 2005.
2. **Object Oriented Programming in TURBO C++**- Robert Lafore, Galgotia Publications Pvt Ltd, 2005.

CHEMICAL REACTION ENGINEERING LABORATORY

Subject Code	: **06CHL67**	IA Marks	: 25
No. of Practical Hours/Week	: 03	Exam Hours	: 04
Total No. of Practical Hours	: 42	Exam Marks	: 50

1. Batch Reactor
2. Isothermal plug flow reactor
3. Mixed flow reactor
4. Semi batch reactor
5. Heterogeneous catalytic Reactor
6. Segregated flow reactor
7. Adiabatic Reactor
8. Packed bed Reactor
9. RTD Studies in Tubular Reactor
10. Effect of temperature on Rate of reaction
11. Bio Chemical Reaction (Batch)
12. Enzyme catalyzed reactions in batch reactor
13. RTD Studies in mixed flow reactor
14. Sono-chemical reactor.
15. Photochemical reactor

MASS TRANSFER LABORATORY

Subject Code	: **06CHL68**	IA Marks	: 25
No. of Practical Hours/Week	: 03	Exam Hours	: 04
Total No. of Practical Hours	: 42	Exam Marks	: 50

1. Diffusion of organic vapours in air
2. Simple Distillation
3. Packed column/ plate column distillation
4. Steam distillation
5. Solid – liquid leaching
6. Surface evaporation
7. Tray dryer
8. Adsorption studies
9. Liquid-liquid/Vapour –liquid equilibrium
10. Liquid extraction – (cross current: 1 and 2 or 3 stage)
11. Hold up studies in packed columns
12. Rotary/ vacuum dryers
13. Wetted wall column
14. Cooling tower
15. Solid dissolution
16. Gel-electrophoresis

VII SEMESTER

CHEMICAL PROCESS INTEGRATION

Subject Code	: **06CH71**	IA Marks	: 25
No. of Lecture Hours/Week	: 04	Exam Hours	: 03
Total No. of Lecture Hours	: 52	Exam Marks	: 100

PART - A

UNIT - 1
INTRODUCTION TO PROCESS INTEGRATION: Graphical Techniques. Overall mass targeting.

6 Hours

UNIT - 2
SYNTHESIS OF MASS EXCHANGE NETWORK: Graphical approach. Direct recycle strategies.

7 Hours

UNIT - 3
VISUALISATION STRATEGIES: for development of mass integrated system. Algebraic approach to targeting direct recycles.

6 Hours

UNIT - 4
ALGEBRAIC APPROACH: To targeting mass exchange. Network. Recycle strategies using property integration.

7 Hours

PART - B

UNIT - 5
HEAT INTEGRATION: Combined heat and power integration.

6 Hours

UNIT - 6
OVERVIEW OF OPTIMIZATION: Mathematical approach to direct recycle.

7 Hours

UNIT - 7
MATHEMATICAL TECHNIQUES: For synthesis of mass & heat exchange.

6 Hours

UNIT - 8

MATHEMATICAL TECHNIQUES: for mass integration. Initiatives and applications. Case studies.

7 Hours

TEXT BOOKS:

1. **Chemical Process Design & Integration -** Robin Smith, Wiley, 29 Chapters 772, pages, 2005.
2. **Pinch Analysis and Process Integration -** A user guide on process integration for efficient use of energy, Kemp I.C, 2nd Edition, Butterworth – Heinneman, 2006.
3. **Process Integration -** Mahmoud. M., El – Hawalgi, Elsevier, 44 Pages, 2006.

INSTRUMENTATION AND PROCESS CONTROL

Subject Code	: **06CH72**	IA Marks	: 25
No. of Lecture Hours/Week	: 04	Exam Hours	: 03
Total No. of Lecture Hours	: 52	Exam Marks	: 100

PART - A

UNIT - 1

INSTRUMENTATION: Fundamentals Static and dynamic characteristics. Indicators and recorders. Pressure measurement- Bourdon, diaphragm and bellow type gages. Vacuum measurements. Temperature measurement- Bimetal and resistance thermometers, thermocouples and pyrometers.

6 Hours

UNIT - 2

FIRST ORDER SYSTEMS: Thermometer, level, mixing tank, STR:Linearisation: I order systems in series. Response for various input forcing functions.

6 Hours

UNIT - 3

SECOND ORDER SYSTEMS: Characteristics of manometer and damped vibrator. Transfer functions. Response for various input forcing functions, response for step input for under damped case – Terms associated with it. Transportation lag.

7 Hours

UNIT - 4

CLOSED LOOP SYSTEM: Basic components. Servo and regulator control. Controllers – P, I, D and On –Off modes. Controller combinations - Final control elements - Valves, actuators and valve positioners.

7 Hours

PART - B

UNIT - 5

CLOSED LOOP RESPONSE: Block diagram, Closed loop transfer function, Transient response of servo and regulator control systems with various controller modes and their characteristics.

7 Hours

UNIT - 6

STABILITY: Stability of linear control systems. Routh Test. Frequency Response – Bode diagrams.

6 Hours

UNIT - 7

CONTROL SYSTEM DESIGN BY FREQUENCY RESPONSE: Bode criterion. Gain and Phase margins. Ziegler – Nichols controller tuning, Cohen-Coon controller tuning.

7 Hours

UNIT - 8

ROOT LOCUS: Rules for plotting and problems.

6 Hours

TEXTBOOK:

1. **Process System Analysis and Control -** Coughner & Koppel, McGraw Hill, New Delhi, II Edition, 1991.

REFERENCE BOOKS:

1. **Process Modelling, Simulation & Control for Chemical Engineers** - Luyben, II Edition, McGraw Hill, 1990.
2. **Chemical Engineering Vol. III, III Edition** - Coulson & Richardson, Pergamon Press - 1998.
3. **Chemical Process Control** - George Stephanopoules, An Introduction to Theory & Practical, Prentice Hall, New Delhi, 1998.

COMPUTER APPLICATIONS AND MODELING

Subject Code	: **06CH73**	IA Marks	: 25
No. of Lecture Hours/Week	: 04	Exam Hours	: 03
Total No. of Lecture Hours	: 52	Exam Marks	: 100

ALGORITHM AND C PROGRAM FOR CASES OF UNIT I TO VI

PART - A

UNIT - 1
NUMERICAL TECHNIQUES: Simultaneous linear algebraic equation – Gauss Jordan. Non-linear algebraic equation-Newton Raphson. Ordinary Differential Equation- R-K Method. Numerical Integration-Simpson's 1/3 Rule. Curve Fitting-Least Squares.

7 Hours

UNIT - 2
APPLICATIONS: Vapor- Liquid equilibria for binary mixtures. Calculation of Bubble Pressure and Bubble Point. Dew Pressure and Dew point for Ideal Binary and multi-component system.

7 Hours

UNIT - 3
FLASH VAPORIZATION: For multi-component system. Design of Adiabatic Batch Reactor.

6 Hours

UNIT - 4
DESIGN OF ADIABATIC PFR, ADIABATIC CSTR AND COMBINATIONS

6 Hours

PART - B

UNIT - 5
DESIGN: Double Pipe Heat Exchanger (Area, Length and Pressure drop). Shell & Tube Heat Exchanger (Area, Number of tubes, Pressure drop.

6 Hours

UNIT - 6
ABSORPTION & DISTILLATION COLUMNS - Calculations for Plate and Packed Columns

6 Hours

UNIT - 7

MODELING: Models and model building, principles of model formulations, precautions in model building, Fundamental laws: Review of shell balance approach, continuity equation, energy equation, equation of motion, transport equation of state equilibrium and Kinetics, classification of mathematical models.

7 Hours

UNIT - 8

MATHEMATICAL MODELING AND SOLUTIONS TO THE FOLLOWING: Basic tank model – Level V/s time. Batch Distillation – Vapor composition with CSTRs in series time..

7 Hours

TEXT BOOKS:

1. **Computer based Numerical Analysis -** M. Shanthakumar, KPS Publisher, First Edition, 1987.
2. **Introduction to Chemical Engineering and Computer Calculations.-** Myers, A.L and Seider W.D, Prentice Hall – 1976.
3. **Process Modeling Simulation and Control for Chemical Engineering -** William. L Luyben, 2nd Edition, McGraw Hill, 1990.

REFERENCE BOOKS:

1. **Elements of Chemical Reaction Engineering -** H. Scott Fogler, 2nd Edition, Prentice Hall, 2001.
2. **Introduction to Chemical Engineering Thermodynamics -** Smith J. M. and H. C. Vanness, 5th Edition, McGraw Hill, 1996.

BIOCHEMICAL ENGINEERING

Subject Code	: **06CH74**	IA Marks	: 25
No. of Lecture Hours/Week	: 04	Exam Hours	: 03
Total No. of Lecture Hours	: 52	Exam Marks	: 100

PART - A

UNIT - 1

INTRODUCTION: Bioprocess engineering and technology. Role of a Chemical engineer in bioprocess industry. An introduction to basic biological sciences. Microbiology: Structure of cells: Prokaryotes and Eukaryotes. Classification of micro-organisms. Taxonomy, Environmental and Industrial microbiology.

6 Hours

UNIT - 2

BIOCHEMISTRY: Chemicals of Life: Lipids, Sugars, Polysaccharides, Amino acids and proteins, Vitamins, Biopolymers, Nucleic Acids: RNA, DNA and their derivatives (Structure, Biological function and Importance for life only to be studied).

7 Hours

UNIT - 3

ENZYMES AND PROTEINS: Detailed structure of proteins and enzymes. Functions. Methods of Production and purification of Enzymes. Nomenclature and Classification of enzymes. Kinetics of Enzyme action: Michaelis–Menten rate equation. Derivation.

6 Hours

UNIT - 4

KINETICS OF ENZYME ACTION: Reversible Enzyme. Two-substrate. Multi-complexes enzyme kinetics (Derivation of rate equations). Experimental determination of rate parameters: Batch and continuous flow experiments. Lineweaver–Burk, Eadie-Hofstee and Hanes-Woolf Plots. Batch Kinetics (Integral and Differential methods).

7 Hours

PART - B

UNIT - 5

ENZYME INHIBITION: Effect of Inhibitors (Competitive, noncompetitive, uncompetitive, substrate and product inhibitions), Temperature and pH on the rates enzyme catalyzed reactions. Determination of kinetic parameters for various types of inhibitions. Dixon method. Enzyme immobilization: Uses. Methods of enzyme immobilization.

7 Hours

UNIT - 6

FERMENTATION TECHNOLOGY: Ideal reactors: A review of Batch and Continuous flow reactors for bio kinetic measurements. Microbiological reactors: Operation and maintenance of typical aseptic aerobic fermentation processes. Formulation of medium: Sources of nutrients. Alternate bioreactor configurations. Introduction to sterilization of bioprocess equipment.

7 Hours

UNIT - 7

GROWTH KINETICS OF MICROORGANISMS: Transient growth kinetics (Different phases of batch cultivation). Quantification of growth kinetics: Substrate limited growth, Models with growth inhibitors, Logistic equation, Filamentous cell growth model. Continuous culture: Optimum Dilution rate in Ideal Chemostat. Introduction to Fed-batch reactors.

6 Hours

UNIT - 8

DOWNSTREAM PROCESSING: Strategies and Steps involved in product purification. Methods of Cell disruption, Filtration, Centrifugation, Sedimentation, Chromatography, Freeze drying / lyophilization. Membrane separation Technology: Reverse Osmosis, Ultra filtration, Micro filtration, Dialysis.

6 Hours

TEXT BOOK:

1. **Biochemical Engineering Fundamentals -** Bailey and Ollis, 2nd Edition, McGraw Hill, 1976.
2. **Bioprocess Engineering**- Shuler M. L. and Kargi F., 2nd Edition, Prentice Hall, 2002.

REFERENCE BOOKS:

1. **Biochemical Engineering –** James Lee Prentice Hall - 1992.
2. **Biochemical Reactors -** Atkinson B Llawbook co. and Australasia-1974.
3. **Microbiology Concept and Application** - Pelczer, 5th Edition, McGraw Hill, 2001 Reprint.

ELECTIVE-II (Group B)

FOOD TECHNOLOGY

Subject Code	: **06CH751**	IA Marks	: 25
No. of Lecture Hours/Week	: 04	Exam Hours	: 03
Total No. of Lecture Hours	: 52	Exam Marks	: 100

PART - A

UNIT - 1

INTRODUCTION AND QUALITY ATTRIBUTES OF FOOD: Function of foods. Food in relation to health. Aim of food science and technology. Quality attributes – Appearance factors, Textural factors, Flavour factors. Visual and objectively measurable attributes. Aroma of foods – introductory ideas, formation, chemistry and analysis. Taste – introductory ideas, formation and chemistry. Additional quality; quality standards, quality control. Introduction to sensory evaluation of foods and beverages.

6 Hours

UNIT - 2

FORMATION AND CHEMISTRY OF FOOD: Carbohydrates. Proteins. Lipids. Vitamins. Minerals. Water. Biotin. Choline. Phytochemicals.

4 Hours

UNIT - 3

FOOD PROCESSING AND PRESERVATION: Food deterioration – Causes. Aims and objectives of preservation and processing. Unit operations in processing. Different methods of food preservation – low temperature, high temperature, preservatives, osmotic pressure, dehydrations. food irradiation; processing and preservations of milk and dairy, vegetables and fruits, cereals, legumes and nuts, meat and meat products, fats and oils, beverages, sugars, sweeteners, honey and confectionary, salt and spices.

8 Hours

UNIT - 4

ENZYMATIC AND NON-ENZYMZTIC REACTIONS DURING STORAGES: Introduction to enzymes. Nature and function of enzymes. Classification of enzymes. Hydrolases – Esteraus, amylases, pectic enzymes. Proteases. Oxidoreductases – phenolases, glucose oxidase, catalose, peroxidase, lipoxygenase, xantine oxidase. Immobilized enzymes. Uses and suggested uses of enzyme in food processing. Non-enzymatic reactions.

8 Hours

PART - B

UNIT - 5

FOOD ADDITIVES: Introduction and need for food additives. Types of additives – antioxidants, chelating agents, coloring agents, curing agents, emulsions, flavors and flavor enhancers, flavor improvers, humectants and anti choking agents, leavening agents, nutrient supplements, non-nutritive sweeteners, pH control agents. Preservatives – types and applications. Stabilizers and thickeners, other additives. Additives and food safety.

8 Hours

UNIT - 6

FOOD CONTAMINATION AND ADULTERATION: Types of adulterants and contaminants. Intentional adulterants. Metallic contamination. Incidental adulterants. Nature and effects. Food laws and standards.

8 Hours

UNIT - 7

ENVIRONMENTAL CONCERNS AND FOOD SAFETY: Water in food production. Properties and requirements of processing water. Environmental concerns – solid waste disposal, wastewater properties, wastewater treatment. Safety hazards and risks. Food related hazards. Processing and handling. Cleaning and sanitizing.

5 Hours

UNIT - 8

MODERN TRENDS IN FOOD SCIENCE: Biotechnology in food. Biofortification. Nutraceuticals. Organic foods. Low cost nutrient supplements. Packaging of foods and nutrition labelin. Careers in food science and food industries.

5 Hours

REFERENCE BOOKS:

1. **Food Science -** B. Srilakshmi 4th Edn-New Age International-2007.
2. **Foods: Facts and Principles -** N. Shakuntala Manay and M. Shadaksharamurthy New Age Publishers - 2005.
3. **Introduction to Food Science -** Rick Parker - Thomsan Detmer-2001.
4. **Food Processing and Preservation -** G. Subbulakshmi and Shobha A. Udupi - New Age International-2001.
5. **Food Science -** Norman N. Potter and Joseph H. Hotchkin Avi Publishing Co-1968.
6. **Principles of Food Chemistry -** John M DeMan - 3rd Edition - Springer-1999.

POLYMER TECHNOLOGY

Subject Code	: **06CH752**	IA Marks	: 25
No. of Lecture Hours/Week	: 04	Exam Hours	: 03
Total No. of Lecture Hours	: 52	Exam Marks	:100

PART - A

UNIT - 1

PRINCIPLES OF PROCESSING OF POLYMERS: Melt processing of thermoplastics. Classification of processes. Thermoset plasting processing, crystallization, orientation & shrinkage, co polymers blendings, compounding for engineering application, stress – strain behavior, WLF equation, practical assessment for long term behavior.

6 Hours

UNIT - 2

POLYMER EXTRUSION: Requirements of Polymer for extrusion. Single screw and double screw plasticating extruder zones in extrusion, breaker plates, extruder screw, power calculation. PVC extruder. Die and calibration equipment prime mover for extrusion, co extrusion, extrusion coating, extrusion film blowing reactive extrusion. Extrusion blow moulding for PET bottles, wire drawing-PVC, spinning – various types and applications.

Application of various extruded products. Rheological aspects of extrusion and extrusion defects. Operational and maintenance of extrusion equipments.

7 Hours

UNIT - 3

INJECTION MOULDING: Polymer characteristics for injection moulding. Reciprocating screw injection moulding. Single impression mould. Multi impression moulds. Cooling requirements in moulds. Hot runner moulds, gate, mould clamping force calculations. Control of pressure, temperature and time of injection thermostat and fiber reinforced polymer injection moulding, sandwich moulding and injection blow moulding. Rheological aspects and defects of injection. Comparision of injection moulding and extrusion of injection. Operational and maintenance of injection moulding equiments. Reaction injection moulding. Applications.

7 Hours

UNIT - 4

COMPRESSION MOULDING: Applications. Principles. Comparison with other processing methods. Derivation of compression mould thickness or compaction force. Transfer moulding.

6 Hours

PART - B

UNIT - 5

CALENDERING: Characteristics of polymer for calendering. Principles and operation of calendaring. Derivation of film thickness and pressure required for rollers. Guage control during calendaring. Application of PVC calendered products.

6 Hours

UNIT - 6

THERMOFORMING: Basic principles. Vacuum forming. Pressure forming. Description of operations. Product design. Application. Derivation of thermoformed product thickness.

7 Hours

UNIT - 7

ROTATIONAL MOULDING: Principles. Operation & applications. Thickeness. Cooling calculations.

6 Hours

UNIT - 8

TESTING OF PLASTICS: Thermal, electrical, optical, mechanical properties testing.

7 Hours

TEXT BOOKS:

1. **Principles of Polymer Processing** - Morton Johnes chapman –Hall 1989.
2. **Plastic Engineering. -** R.J. Crawford 3rd Edition Research Studies-1996.

REFERENCE BOOKS:

1. **Principles of Polymer Engineering. -** N.G. McCrum, C.P. Buckley Oxford University Press – 1988.
2. **Polymer Materials –**Vol 1,2 & 3., Springer, Manas Chanda , Univ Press-1997. Tailer and Frances-2008

ELECTROCHEMICAL TECHNOLOGY

Subject Code	: **06CH753**	IA Marks	: 25
No. of Lecture Hours/Week	: 04	Exam Hours	: 03
Total No. of Lecture Hours	: 52	Exam Marks	: 100

PART - A

UNIT - 1

INTRODUCTION TO THEORETICAL ASPECTS: Faradays laws, mechanism of conduction in solids, liquids and gases and in ionic melts. Conduction in metals and semiconductors.

6 Hours

UNIT - 2

Reversible electrodes and potentials, electrode processes and electrode kinetics.

6 Hours

UNIT - 3

Various types of overpotentials. Polarisation.

6 Hours

UNIT - 4

Butler-volmer for one electron and mute electron steps. Models of electrical Double layer.

8 Hours

PART - B

UNIT - 5

Applied aspects: Potentiometry and ion-selective electrodes. Polaroraphy.

6 Hours

UNIT - 6
Electrode deposition of metals and alloys.

6 Hours

UNIT - 7
Primary, Secondary and Fuel Cells.

6 Hours

UNIT - 8
CORROSION AND ITS PREVENTION:. Electro winning. Electro organic and inorganic synthesis (and some typical examples). Environmental electrochemistry. Bio-electro chemistry**.**

8 Hours

TEXT BOOKS:

1. **Modern Electrochemistry -** J.O.M., Bockris & A.K.N. Reddy, Vol.1 & 2, Plenum, New York 2002.
2. **Industrial Electrochemical Processes -** A. Kuhn,, Elsevier, Amsterdam 1971.

REFERENCE BOOKS:

1. **Electro Analytical Chemistry** - J.J. Lingane, Wiley, New York-1958.
2. **Electrochemistry, Principles and Applications -** E.C. Potter, Cleaverhume Press, London 1956.
3. **Organic Electrochemistry** - M.M. Baizer, Marcel Dekker, New York – 1991.

SUGAR TECHNOLOGY

Subject Code	: **06CH754**	IA Marks	: 25
No. of Lecture Hours/Week	: 04	Exam Hours	: 03
Total No. of Lecture Hours	: 52	Exam Marks	: 100

PART - A

UNIT - 1
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.

6 Hours

UNIT - 2

PURIFICATION: Chemical technology of the purification process. Fundamental reactions and physical chemistry aspects of clarification, liming, sulphitation and carbonation process. Filtration of sugar juice.

8 Hours

UNIT - 3

EVAPORATION: Evaporation of sugar juice. Heat transfer in evaporations. Evaporation equipment and auxiliaries.

6 Hours

UNIT - 4

EVAPORATION: Methods of obtaining steam, and quality of steam. Steam economy. Chemistry of the evaporation process.

6 Hours

PART - B

UNIT - 5

CRYSTALLOGRAPHY: Solubility of sucrose. Nucleation in super saturated solutions – kinetics and growth of crystallization. Chemistry of crystallization.

7 Hours

UNIT - 6

CRYSTALLOGRAPHY: Control methods and equipment in sugar crystallization, technology of sugar crystallization. Evaporation and circulation in vacuum pans.

7 Hours

UNIT - 7

CENTRIFUGATION: Theory of the centrifugal process, centrifugal operation.

4 Hours

UNIT - 8

CENTRIFUGATION: Engineering principles of sugar centrifugals and the centrifugal equipment and auxiliaries. Production of final molasses and molasses's utilization. Grading of sugar.

8 Hours

TEXT BOOKS:

1. **Principles of Sugar Technology** - Honing P. Vol. I to III, Elsevier Publishing Company, 1953.
2. **Introduction to Cane Sugar Technology -** Jenkinos.G.H Elsevier, 1966.

REFERENCE BOOKS:

1. **Handbook of Cane Sugar Technology** - Mathur R.B.L 2nd Edition, Oxford and I.B.H. Publishing Co., 1997.
2. **Hand book of Sugars -** Jink. R.W. and Pan Cost H.M., Avi Publishing Co., 1974.

ELECTIVE-III (Group C)

APPLIED MATHEMATICS IN CHEMICAL ENGINEERING

Subject Code	: **06CH761**	IA Marks	: 25
No. of Lecture Hours/Week	: 04	Exam Hours	: 03
Total No. of Lecture Hours	: 52	Exam Marks	: 100

PART - A

UNIT - 1

MATHEMATICAL FORMULATION OF THE PHYSICAL PROBLEMS: Applications of laws of conservation of mass, energy. Statement of the problem. Modeling. Examples and problems.

10 Hours

UNIT - 2

ORDINARY DIFFERENTIAL EQUATIONS: Formulations of ordinary differential equations involving chemical engineering problems. Solutions- Equations of first order and first degree.

5 Hours

UNIT - 3

ORDINARY DIFFERENTIAL EQUATIONS: Solutions - Equations of first order and second degree. Bernoulli equation. Euler equation. Simultaneous linear differential equations.

5 Hours

UNIT - 4

PARTIAL DIFFERENTIAL EQUATIONS: Formulations of partial differential equations involving chemical engineering problems. Solutions. Fourier series.

6 Hours

PART - B

UNIT - 5

NUMERICAL METHODS: Solutions of ordinary differential equations.

5 Hours

UNIT - 6
NUMERICAL METHODS: Solutions of partial differential equations.

5 Hours

UNIT - 7
FINITE DIFFERENCES: Difference operator, linear difference equations, analysis of stage-wise, Processes.

8 Hours

UNIT - 8
Laplace transforms and their applications to chemical engineering.

8 Hours

TEXT BOOKS:

1. **Applied Mathematics in Chemical Engineering** - H.S. Mickley, T.K. Sherwood and C.E. Reed, 3rd Edition, Tata McGraw Hill, 1999.
2. **Mathematical Methods in Chemical Engineering.-** V.G. Jenson & G.V. Jeggreys, 1977.
3. **Mathematical Methods in Chemical Engineering,**- S. Pushpavanam, Eastern Economy Edition, 2004.

REFERENCE BOOK:

1. **Applications of Mathematical Modeling to Process Development and Design,** - L.M. Rose Applied Science Publishers Ltd., London, 1998.

ORACLE 9*i*

Subject Code	: **06CH762**	IA Marks	: 25
No. of Lecture Hours/Week	: 04	Exam Hours	: 03
Total No. of Lecture Hours	: 52	Exam Marks	: 100

PART - A

UNIT - 1
INTRODUCTION - Introduction to RDBMS and ORDBMS.

6 Hours

UNIT - 2
DATABASE COMPONENTS: Normalization. Types of Data Models. Introduction to Oracle 9.

6 Hours

UNIT - 3
SQ*PLUS: Introduction. Data types. Operators and Functions.

6 Hours

UNIT - 4

PARTS OF SQL: Data Definition Language, Data Manipulation Language. Data Control Language. Transaction Control Language. Data Query Language.

8 Hours

PART - B

UNIT - 5

INTEGRITY CONSTRAINTS: Other Scheme Objects. Pseudo Columns.

6 Hours

UNIT - 6

INTRODUCTION TO PL/SQL: Variables and Constraints. Cursor Management in PL/SQL.

6 Hours

UNIT - 7

EXCEPTION HANDLING: Subprograms. Stored Procedures. Store Functions. Packages.

8 Hours

UNIT - 8

DATABASE TRIGGERS: Dynamics SQL. Usage of Advanced Packages.

6 Hours

TEXT BOOKS:

1. **Oracle 9 -** Unleashed, Techmedia.
2. **Oracle 9 Programmers Guide -** Jose McGraw Hill.

REFERENCE BOOKS:

1. **Pl/SQL The Black Book**.
2. **OCP Guide** - Jose McGraw Hill

PETROCHEMICALS

Subject Code	: **06CH763**	IA Marks	: 25
No. of Lecture Hours/Week	: 04	Exam Hours	: 03
Total No. of Lecture Hours	: 52	Exam Marks	: 100

PART - A

UNIT - 1

DEFINITION OF PETROCHEMICALS: Petrochemical. Industries in India. Principal raw materials. Introduction to chemicals from C1, C2, C3 and C4 compounds.

4 Hours

UNIT - 2

CHEMICALS FROM C1 COMPOUNDS: Manufacture of methanol and chloromethanes. Manufacture of perchloro ethylene.

6 Hours

UNIT - 3

CHEMICALS FROM C2 COMPOUNDS: Ethylene and acetylene, ethanol, polyethylene, ethylene dichloride, acetaldehyde, vinyl chloride, ethylene oxide, ethanol amines, vinyl acetate, acetic acid.

8 Hours

UNIT - 4

CHEMICAL FROM C3 COMPOUNDS: Isopropanol, acetone, lumen (isopropyl benzene), acrylonitrile, isoprene, polypropylene, epichlorohydrin, propylene oxide.

8 Hours

PART - B

UNIT - 5

CHEMICAL FROM C4 COMPOUNDS: Butadiene dehydrogenation of butane (Houdry). Dehydrogenation of butylenes. Dehydrogenation-dehydration of ethanol. Steam cracking of hydrocarbons.

8 Hours

UNIT - 6

CHEMICALS FROM AROMATICS: Primary raw material. Hydroalkylation.

5 Hours

UNIT - 7

Manufacture of phenol – 5 methods. Styrene – 2 methods. Pthalic anhydride amleic anhydride, nitrobenzene, aniline

8 Hours

UNIT - 8

Manufacture of industrial dyes based on petroleum feed stocks**.**

5 Hours

TEXT BOOKS:

1. **Petrochemicals-** By B.K.B. Rao CRC Press –1990.
2. **Chem Tech II, III and IV** – Published by Chemical Engg. Education developments centre IIT, Madras 1979.

REFERENCE BOOKS:

1. **Outlines of Chemical Technology -** Gopal Rao M and Marshall Sittig 3rd Edition, East-West Press 1997.
2. **Chemical process industries** - 5th edition- Shreve McGrew Hill 1984.
3. **Chemical Technology-** G.N. Pandey 3rd Edition 1977.
4. **Chemical Technology-** Mukhlyonov-Mir Publications-1982.

OIL AND FATS

Subject Code	: **06CH764**	IA Marks	: 25
No. of Lecture Hours/Week	: 04	Exam Hours	: 03
Total No. of Lecture Hours	: 52	Exam Marks	: 100

PART - A

UNIT - 1

INTRODUCTION: Classification of fats and oil. Characteristic of oils. Utilization of fat and oils. Composition of oils (general).

6 Hours

UNIT - 2

VEGETABLE OILS: Composition. Extraction. Refining processes and uses of coconut oil, cottonseed oil.

7 Hours

UNIT - 3

VEGETABLE OILS: Refining processes and uses of palm oil, Soya been oil, peanut oil, sunflower oil.

7 Hours

UNIT - 4

MARINE OILS: Composition. Extraction. Refining processes and uses of fish oils.

6Hours

PART - B

UNIT - 5

OBTAINING OILS AND FATS FROM SOURCE MATERIALS: Mechanical pretreatment. Mechanical expression. Solvent extraction (two types of extractors).

10 Hours

UNIT - 6

PROCESS TECHNIQUES: Refining and hydrogenation (H_2 production and catalyst).

6 Hours

UNIT - 7

PROCESS TECHNIQUES: Degumming. Alkali refining and bleaching.

6 Hours

UNIT - 8

DEODORIZATIONS: Theoretical consideration and operation of commercial deodorizer.

4 Hours

TEXT BOOK:

1. **Basily Industrial Oil and Fat Products – Vol I to V** – Y.H.Hery John Wiley International, 2nd Edition-1976.

REFERENCE BOOKS:

1. **Chemistry and Technology of Oil and Fats -** Devine J and Williams P.N, 1961.
2. **Chemical process Industries -** Austin G. T., Shreve's Fifth Edition, McGraw-Hill international Book Company, Singapore, 1984.
3. **Outlines of Chemical Technology -** Dryden C. E., Edited by Gopala Rao. M and M. Sittig, Second Edition, Affiliated East West Press, 1993.
4. **Hand Book of Industrial Chemistry** - Kent J.A (Ed) Riegel's Van Nostrand Reinhold,1974.

PROCESS CONTROL LABORATORY

Subject Code	: **06CHL77**	IA Marks	: 25
No. of Practical Hours/Week	: 03	Exam Hours	: 04
Total No. of Practical Hours	: 42	Exam Marks	: 50

1. Thermometer
2. Single tank - Step Response
3. Non Interacting Tanks - Step Response
4. Interacting Tanks - Step Response
5. Pressure Tank
6. U – Tube Manometer
7. Single tank - Impulse Response
8. Non Interacting Tanks - Impulse Response
9. Interacting Tanks - Impulse Response
10. Level/Flow/Pressure/pH/Temperature control – P controller
11. Level/Flow/Pressure/pH/Temperature control – PI controller
12. Level/Flow/Pressure/pH/Temperature control – PD controller
13. Level/Flow/Pressure/pH/Temperature control – PID controller
14. Valve characteristics.
15. Flapper Nozzle System
16. Valve Positioner.

COMPUTER APPLICATIONS & SIMULATION LABORATORY

Subject Code	: **06CHL78**	IA Marks	: 25
No. of Practical Hours/Week	: 03	Exam Hours	: 04
Total No. of Practical Hours	: 42	Exam Marks	: 50

PART - A

NUMERICAL METHODS AND COMPUTER APPLICATIONS

20 Marks

1. Non-linear algebraic equation- Newton Raphson (Specific volume of binary mixture)
2. Ordinary Differential Equation- R-K Method ($dCa/dt=kCa^2$)
3. Numerical Integration- Simpson's 1/3 Rule (Batch Reactor to find time)
4. Curve Fitting-Least Square (Nre vs f)
5. Calculation of Bubble Point and Dew Point for Ideal multi-component system
6. Flash Vaporisation for multi-component system
7. Design of Adiabatic Batch Reactor, PFR
8. Adiabatic Flame Temperature
9. Double pipe heat exchanger (Area, Length and Pressure drop)
10. Distillation Column (Bubble cap)

PART - B
SIMULATION

30 Marks

1. Introduction to suggested software available (flow sheeting)
2. Simulations Studies of flash drum, Distillation Column, CSTR, PFR, Heat Exchanger.
3. Simulation Studies of pump, compressor, cyclone, heater.
4. Process simulation study involving mixing, reactor, distillation, heat exchanger for any of the following:
    a) Ethylene Glycol from Ethylene oxide
    b) Atmospheric distillation of crude oil
    c) Propylene Glycol from Propylene oxide
    d) Aromatic stripper with recycle stream (Benzene, Toluene, Xylene)
    e) Styrene from Ethyl Benzene

SOFTWARES SUGGESTED:

1. HYSYS
2. CHEMCAD
3. DESIGN-II
4. PROSIM
5. ASPEN PLUS

VIII SEMESTER

PROCESS ENGINEERING ECONOMICS

Subject Code	: **06CH81**	IA Marks	: 25
No. of Lecture Hours/Week	: 04	Exam Hours	: 03
Total No. of Lecture Hours	: 52	Exam Marks	: 100

PART - A

UNIT - 1

PROCESS DESIGN DEVELOPMENT: Overall planning of a plant involving chemical processes - Types of designs, feasibility studies, process development, material & energy balance, equipment sizing & selection, process flow sheet and P&I Diagram. Plant location and layout – Case studies of petroleum and Fertilizer industries, Factors affecting plant design.

7 Hours

UNIT - 2

COST ANALYSIS: Factors involved in project cost estimation, methods employed for the estimation of the capital investment. Estimation of working capital.

6 Hours

UNIT - 3

Time value of money and equivalence.

6 Hours

UNIT - 4

DEPRECIATION AND TAXES: Depreciation calculation methods. Equivalence after Taxes. Cost comparison after taxes.

7 Hours

PART - B

UNIT - 5

PROFITABILITY: Methods for the evaluation of profitability.

7 Hours

UNIT - 6

Replacement and Alternative Investments. Opportunity costs

7 Hours

UNIT - 7

FINANCIAL STATEMENTS: Cash flow diagrams. Break-even analysis.

6 Hours

UNIT - 8

DESIGN REPORT: Types of reports. Organization of report.

6 Hours

TEXT BOOKS:

1. **Plant Design and Economics for Chemical Engineers** - M.S. Peters and K.D. Timmerhaus, 4th Edition, McGraw Hill, 1991.
2. **Industrial Organization and Engineering Economics -** T.R. Banga and S.C. Sharma, 22nd Edition, Khanna Publishers, 1999.

TRANSPORT PHENOMENA

Subject Code	: **06CH82**	IA Marks	: 25
No. of Lecture Hours/Week	: 04	Exam Hours	: 03
Total No. of Lecture Hours	: 52	Exam Marks	: 100

PART - A

UNIT - 1

INTRODUCTION: Momentum Energy and Mass Transport Newton's law of viscosity (NLV). Newtonian and Non-Newtonian fluids. **Fourier's law of heat conduction (FLHC). Fick's law of diffusion (FLD).** Effect of temperature and pressure on transport properties of fluids.. **Numerical problems on the application ofNumerical problems on use of NLV, FLHC and FLD**

7 Hours

UNIT - 2

VELOCITY DISTRIBUTION IN LAMINAR FLOW: Different Flow situations, Steady state Shell momentum balances, Boundary conditions applicable to momentum transport problems, Flow over a flat plate, Flow through a circular tube, Flow through Annulus, Flow between parallel plates and a slit. Numerical problems using the equations derived in the above situations.

6 Hours

UNIT - 3

STEADY STATE SHELL ENERGY BALANCES: General Boundary conditions applicable to energy transport problems of chemical engineering. Heat conduction through compound walls. Overall heat transfer coefficient.

6 Hours

UNIT - 4

TEMPERATURE DISTRIBUTION IN SOLIDS AND IN LAMINAR FLOW: Different situations of heat transfer: Heat conduction with internal generation by electrical, nuclear, viscous energy sources. Numerical problems using the equations derived in the above heat transfer situations. Heat conduction in a cooling fin: Forced and free convection heat transfer.

7 Hours

PART - B

UNIT - 5

CONCENTRATION DISTRIBUTIONS IN LAMINAR FLOW: Steady state Shell mass balances. General Boundary conditions applicable to mass transport problems of chemical engineering. Diffusion through stagnant gas and liquid films. Equimolar counter diffusion. Numerical problems.

6 Hours

UNIT - 6

CONCENTRATION DISTRIBUTIONS IN LAMINAR FLOW : Diffusion with homogeneous and heterogeneous reaction. Diffusion into falling film – Forced convection mass transfer. Numerical problems for above.

7 Hours

UNIT - 7

ANALOGIES BETWEEN MOMENTUM, HEAT AND MASS TRANSPORT: Numerical problems using Reynold's, Prandtl's and Chilton & Colburn analogies.

7 Hours

UNIT - 8

EQUATIONS OF CHANGE: Equation of continuity Equation of motion; Navier – Stokes equation. Application of these equations in solving simple steady state problems previously discussed**.**

7 **Hours**

TEXT BOOK:

1. **Transport Phenomena -** Bird, Stewart and Lightfoot, Academic Press, 1994.

REFERENCE BOOKS:

1. **Momentum Heat and Mass Transport** - Welty, Wikes and Watson, John Wiley – 4th Ed.,, 2000.
2. **Principles of Unit Operations in Chemical engineering-** Foust et al John Wiley, 1990.
3. **Transport Phenomena – A Unified Approach -** Robert S. Brodley and Henry C. Heshes

ELECTIVE-IV (Group D)

INTERFACIAL PHENOMENA AND SURFACE ENGINEERING

Subject Code	: **06CH831**	IA Marks	: 25
No. of Lecture Hours/Week	: 04	Exam Hours	: 03
Total No. of Lecture Hours	: 52	Exam Marks	: 100

PART - A

UNIT - 1

INTRODUCTION: Concept of Interface and its formation with examples. Mechanical and Thermodynamic approaches to Interface. Equivalence in the concepts of surface energy and surface tension. Applications.

6 Hours

UNIT - 2

EXCESS PRESSURE: Generalized equation for excess pressure across a curved surface- the equation of Young and Laplace. Pressure jump across cylindrical surface, flat surface. Vapor pressure of a drop Solubility of drops. Ostwald ripening. Capillary condensation. Super saturation. Nucleation.

6 Hours

UNIT - 3

MEASUREMENT OF INTERFACIAL TENSION: Capillary rise method. Drop weight method, Wilhemy plate method, du nuoy method. Methods based on shape of static drops or bubbles. Dynamic methods-Flow and capillary waves.

6 Hours

UNIT - 4

THERMODYNAMICS OF INTERFACES: Thermodynamic treatment of interfaces. Free energy at interface. Temperature dependence of the surface tension. Effect of pressure on interfacial tension. Effect of curvature on surface tension. Thermodynamics of binary systems-Gibbs Equation. Surface excess concept. Verification of Gibbs equation. Gibbs monolayers.

8 Hours

PART - B

UNIT - 5

WETTING FUNDAMENTALS AND CONTACT ANGLES: Work of adhesion, cohesion. Criteria for spreading of liquids. Kinetics of spreading. Lens formation- three phase systems. Young's equation. Neumann triangle. Theories of equilibrium contact angles. Contact angle hysteresis.

5 Hours

UNIT - 6

ELECTRICAL ASPECTS OF SURFACES: The electrical double layer. Stern treatment of electrical double layer. Free energy of a diffused double layer. Repulsion between two plane double layers. Colloidal dispersions. Combined attractive and electrical interaction-DLVO theory. Kinetics of coagulation.

8 Hours

UNIT - 7

SURFACTANTS: Anionic and non ionic. Other phases involving surfactant aggregates. Surface films of insoluble surfactants. Thermodynamics of microemulsions. Phase behaviour of oil-water-surfactant systems. Effect of composition changes. Applications of surfactants-emulsions and detergency.

6 Hours

UNIT - 8

INTRODUCTION TO INTERFACES IN MOTION: Linear analysis of interfacial stability. Damping of capillary wave motion by insoluble surfactants. Stability and wave motion of thin liquid films-foams. Interfacial stability for fluids in motion.

7 Hours

TEXT BOOKS:

1. **Interfacial Phenomena, Equilibrium and Dynamic Effects -** C.A. Miller & P. Niyogi, Marshel Deckder, 1985.
2. **Physical Chemistry of Surfaces -** A.W. Adamson, John Wiley, 5th Edition, 1997.

REFERENCE BOOKS:

1. **Surface Activity-** Millet J.L., 2nd Edition, Van Nostrad, 1961.
2. **Surafce Active Chemicals -** Gorrett H.E., Pergamon Press, 1974.

ADVANCED BIOPROCESS ENGINEERING

Subject Code	: **06CH832**	IA Marks	: 25
No. of Lecture Hours/Week	: 04	Exam Hours	: 03
Total No. of Lecture Hours	: 52	Exam Marks	: 100

PART - A

UNIT - 1

INTRODUCTION TO GENETIC ENGINEERING (GE): Aim. Techniques. Achievements and prospects of GE;Translation & Transcription of genetic code. DNA Replication and Mutation and Alteration of cellular DNA. Viruses and Phages. Genetic manipulation: Plasmids. Recombinant DNA Technology.

7 Hours

UNIT - 2

DESIGN AND ANALYSIS OF BIOLOGICAL REACTORS: Review of Ideal bio reactors: Fed-Batch reactor. Sterilization of Reactors. Sterilization of Medium (Batch and continuous).

Review of Cell Growth Kinetics: Unstructured Models and Introduction to Structured models of Cell Growth.

6 Hours

UNIT - 3

TRANSPORT PHENOMENA IN BIOPROCESS SYSTEMS: Gas liquid mass transfer in Cellular Systems. Determination of O_2 transfer rates. Mass transfer of freely rising or falling bodies. Forced Convection Mass Transfer: Overall K_{la} Estimates, and power requirements (review) for sparged and agitated vessels. Mass transfer across free surfaces. Other factors affecting K_{la}, Models, Power Consumption and Mass transfer for Non Newtonian fluids. General heat transfer correlations applicable to biological systems.

7 Hours

UNIT - 4

ENZYME IMMOBLISATION: Review of methods. Immobilised enzyme kinetics: Effects of diffusion and reaction on kinetics of immobilized enzymes, Effect of other environmental parameters like pH and temperature.

Immobilized Cells: Formulations, Characterization and Applications

6 Hours

PART - B

UNIT - 5

MULTIPHASE BIOREACTORS: Packed, fluidized and trickle bed reactor. Bubble column reactor (design equations)

Fermentation Technology: Animal and Plant Cell Reactor Technology.Medical Applications of bioprocess engineering.

7 Hours

UNIT - 6

MIXED CULTURES: Introduction. Major Classes of Interactions: Simple Models, Competition between two species, Prey-Predator system, Lotka-Volterra Model Web Interaction, Population dynamics in models of mass action form.

6 Hours

UNIT - 7

MIXED CULTURE IN NATURE: Introduction and industrial utilization.**Biological Waste Treatment:** An overview. Activated sludge Process. Types of Equipment used. Advanced waste water treatments: Nitrification, Denitrification. Conversion of waste water to useful products.

6 Hours

UNIT - 8

INDUSTRIAL BIOPROCESS: Anaerobic process: Ethanol, lactic acid, acetone-butanol production. Aerobic Processes: Citric Acid, Baker's Yeast, Penicillin, High fructose corn syrup production.

7 Hours

TEXT BOOK:

1. **Biochemical Engineering Fundamentals** - Bailey and Ollis, 2nd Edition, McGraw Hill, 1976.

REFERENCE BOOKS:

1. **Bioprocess Engineering** - Shuler M L and Kargi F, 2nd Edition, Prentice Hall, 2002.
2. **Biochemical Engineering** - S. Aiba et al; Academic Press, London, 1965.
3. **Biochemical Reactors -** Atkinson A Pion Ltd, London. 1975.
4. **Microbiology Concept and Application** - Pelczar, 5th Edition, McGraw Hill, 2001 Reprint.
5. **Bioprocess Engineering -** Pauline M. Doran, 2nd edition, Prentice Hall.

NOVEL SEPARATIONS TECHNIQUES

Subject Code	: **06CH833**	IA Marks	: 25
No. of Lecture Hours/Week	: 04	Exam Hours	: 03
Total No. of Lecture Hours	: 52	Exam Marks	: 100

PART - A

UNIT - 1

ADSORPTIVE SEPARATIONS: Review of fundamentals. Mathematical modeling of column factors. Pressure swing & thermal swing adsorption. Counter current separations.

6 Hourrs

UNIT - 2

CHROMATOGRAPHY: Chromatography fundamentals. Different types. Gradient & affinity chromatography. Design Calculations for chromatographic columns.

7 Hours

UNIT - 3

MEMBRANE SEPARATION PROCESSES: Thermodynamic considerations. Mass transfer considerations. Design of RO &UF. Ion

selective membranes. Micro filtration. Electro dialysis. Pervaporation. Gaseous separations.

7 Hours

UNIT - 4

EXTERNAL FIELD INDUCED SEPARATIONS: Electric & magnetic field separations. Centrifugal separations and calculations.

6 Hours

PART - B

UNIT - 5

SURFACTANT BASED SEPARATIONS: Fundamentals. Surfactants at inter phases and in bulk. Liquid membrane permeation. Foam separations. Micellar separations.

8 Hours

UNIT - 6

SUPER CRITICAL FLUID EXTRACTION: Thermodynamics and physico chemical principles. Process description. Application. Case Study.

8 Hours

UNIT - 7

MECHANICAL –PHYSICAL SEPARATION PROCESS: Introduction, Classification, Filtration in solid liquid separation. Settling & sedimentation in particle fluid separation.

4 Hours

UNIT - 8

OTHER SEPARATIONS: Separation by thermal diffusion, electrophoresis and crystallization.

6 Hours

REFERENCE BOOKS:

1. **Handbook of Separation Process Technology -** R.W.Rousseu, John Wiley & Sons- 1987
2. Encyclopedia of Chemical Technology - Kirk-Othmer, John Wiley & sons-2001
3. **Rate Controlled Separations.-** Phillip C Wankat, Kluwer Academic Pub, 1990.
4. **Transportation and Separation Process -** Gaenkopolis, Printice Hall, 2003.
5. **Large Scale Adsorption Chromatography -** P C Wankat, CRC Press, 1986.
6. **Reverse Osmosis and Ultra Filtration Process Principle**- S. Sourirajan & T. Matsura,, NRC Publication, Ottawa, 1985.

7. **Surfactant Based Separation-** T.O. Hatton, Vol 23.
8. **Supercritical Fluid Extraction**- M A McHugh & V. J. Krukonis,, Butterworth, 1987.

COMPOSITE MATERIALS

Subject Code	: **06CH834**	IA Marks	: 25
No. of Lecture Hours/Week	: 04	Exam Hours	: 03
Total No. of Lecture Hours	: 52	Exam Marks	: 100

PART - A

UNIT - 1

SYNTHESIS AND FABRICATION: of advanced and future materials with emphasis on ceramic, Semi-conducting and Super-conducting materials with superior structural, optical and electrical properties.

6 Hours

UNIT - 2

PREPARATION TECHNIQUES: Techniques for preparation of ultra-pure, ultra-fine powders: of oxides, nitrides, carbides etc., with very well defined characteristics and superior properties.

7 Hours

UNIT - 3

PROCESSING TECHNIQUES: Techniques such as sintering, hot pressing, hot isostatic pressing, tape-casting, sol-gel processing for the formation of monolithic ceramics. Composites (ceramic, ceramic metal, as well as metal matrix). SiO2. Glasses from above powders**.**

6 Hours

UNIT - 4

PROCESSING TECHNIQUES BASED ON REACTION METHODS: such as Chemical vapour deposition (CVD), vapour phase epitaxy, plasma-enhanced chemical vapour deposition (PECVD), chemical vapour infiltration (CVI). Self propagating high temperature synthesis (SHS) for the preparation of monolithic ceramics, composites, coating, thin films, whiskers and fibres and semi conducting materials such as Si and Gallium Arsenide.

7 Hours

PART - B

UNIT - 5

Synthesis and processing of mixed ceramic oxides with high temperature super conducting properties.

6 Hours

UNIT - 6

Reinforcement, additives, fillers for polymer composite, master batch & compounding.

7 Hours

UNIT - 7

Polymer composite. Fibre reinforced composites. Stress – Strain modulus relationship Nano composites.

6 Hours

UNIT - 8

Characteristics & applications in marine, aerospace, building & computer industry. Manufacturing methods, hand layouts, filament winding, pultrusion, SMC, DMC.

7 Hours

TEXT BOOKS:

1. **Introduction to Ceramics** - W.D. Kingrey, 2nd Ed.m, John Wiley, 1976.
2. **Advanced Composites** – Chawla, Kluner Academic Publisher, 2003.

REFERENCE BOOKS:

1. **Introduction to Material Science for Engg. -** James T. Schockel Ford, McMillan Publications.
2. **Material Science and Engineering-** L.H. Van Vlack,
3. **Fibre Reinforced Plastic Deskbook.-** Nicholas P, Paul N, Chermisinoff, Ann Arbor science publishing Inc, 1978.

ELECTIVE-V (Group E)

PILOT PLANT AND SCALE UP METHODS

Subject Code	: **06CH841**	IA Marks	: 25
No. of Lecture Hours/Week	: 04	Exam Hours	: 03
Total No. of Lecture Hours	: 52	Exam Marks	: 100

PART - A

UNIT - 1

PILOT PLANTS: Evolution of process system. Need of pilot plants. Concept of prototypes, models, scale ratios, element.

4 Hours

UNIT - 2

PRINCIPLES OF SIMILARITY: Geometric similarity. Distorted similarity. Static, dynamic, kinematics, thermal and chemical similarity with examples.

6 Hours

UNIT - 3

DIMENSIONAL ANALYSIS: (Review of Rayleigh's, Buckingham ∏ methods), Differential equation for static systems, flow systems, thermal systems, mass transfer processes, chemical processes-homogeneous and heterogeneous.

6 Hours

UNIT - 4

REGIME CONCEPT: Static regime. Dynamic regime. Mixed regime concepts. Criteria to decide the regimes. Equations for scale criteria of static, dynamic processes, Extrapolation. Boundary effects.

10 Hours

PART - B

UNIT - 5

Scale up of mixing process, agitated vessel.

4 Hours

UNIT - 6

Scale up of chemical reactor systems-Homogeneous reaction systems. Reactor for fluid phase processes catalysed by solids. Fluid-fluid reactors.

10 Hours

UNIT - 7

Stagewise mass transfer processes. Continuous mass transfer processes.

8 Hours

UNIT - 8

Scale up of momentum and heat transfer systems. Environmental challenges of scale up.

4 Hours

TEXT BOOKS:

1. **Scale up of Chemical Processes** - .Attilio Bisio, Robert L. Kabel, John Wiley & Sons, 1985
2. **Pilot Plants Models and scale up method in Chemical Engineering -** Johnstone and Thring, McGraw Hill, 1957.

REFERENCE BOOK:

1. **Pilot Plants and Scale up Studies -** Ibrahim and Kuloor,

WASTE MANAGEMENT AND RECYCLE

Subject Code	: **06CH842**	IA Marks	: 25
No. of Lecture Hours/Week	: 04	Exam Hours	: 03
Total No. of Lecture Hours	: 52	Exam Marks	: 100

PART - A

UNIT - 1

INTRODUCTION: Definition, characteristics and perspectives of solid waste. Types of solid waste. Physical and chemical characteristics. Variation of composition and characteristics. Municipal, industrial, special and hazardous wastes.

6 Hours

UNIT - 2

GENERAL ASPECTS: Overview of material flow in society. Reduction in raw material usage. Reduction in solid waste generation. Reuse and material recovery. General effects on health and environment. Legislations.

7 Hours

UNIT - 3

ENGINEERED SYSTEMS: Typical generation rates. Estimation and factors effecting generation rates. On site handling. Storage and processing. Collection systems and devices. Transfer and transport.

7 Hours

UNIT - 4

PROCESSING TECHNIQUES: Mechanical volume reduction. Thermal volume reduction. Component separation. Land filling and land forming. Deep well injection.

6 Hours

PART - B

UNIT - 5

MATERIAL RECOVERY: Mechanical size alteration. Electromagnetic separation. Drying and dewatering. Other material recovery systems. Recovery of biological conversion products. Recovery of thermal conversion products.

7 Hours

UNIT - 6

ENERGY RECOVERY: Energy recovery systems and efficiency factors. Determination of output and efficiency. Details of energy recovery systems. Combustion incineration and heat recovery. Gasification and pyrolysis. Refuse derived fuels (RDF).

7 Hours

UNIT - 7

HAZARDOUS WASTES: Classification. Origin and reduction at source. Collection and handling. Management issues and planning methods. Environmental Acts.

6 Hours

UNIT - 8

CASE STUDIES: Major industries and management methods used in typical industries – Coal fired power stations, textile industry, oil refinery, distillery, sugar industry, and radioactive waste generation units.

6 Hours

TEXT BOOKS:

1. **Environmental Engineering** - Howard S. Peavy etal, McGraw Hill International Edition, 1986.
2. **Industrial Solid Water Management and Land Filling Practice**- Dutta etal, Narose Publishing House, 1999.

REFERENCE BOOKS:

1. **Waste Treatment Plants** - Sestry C.A. etal, Narose Publishing House, 1995.
2. **Hazardous Waste Management** - Lagrega, McGraw Hill, 1994.

MULTICOMPONENT DISTILLATION

Subject Code	**: 06CH843**	IA Marks	: 25
No. of Lecture Hours/Week	: 04	Exam Hours	: 03
Total No. of Lecture Hours	: 52	Exam Marks	: 100

PART - A

UNIT - 1

INTRODUCTION: Phase Equilibria for Multi component distillation. Thermodynamic relationships for multi component mixture, prediction of phase equilibria.

6 Hours

UNIT - 2

PHASE EQUILIBRIA: Use of fugacities and activities. Introduction to the method of convergence characteristics. The Theta method for converging temperature. Profile-Development & application to conventional distillation columns. The 2N Newton-Raphson method- Introduction and the Algorithm. The method of successive approximations.

7 Hours

UNIT - 3

METHODS OF MULTICOMPONENT DISTILLATION: Azeotropic and extractive distillation process- qualitative characteristics and applications.

6 Hours

UNIT - 4

PHASE BEHAVIOUR AT CONSTANT PRESSURE: Homogeneous and Heterogeneous azeotropes.

7 Hours

PART - B

UNIT - 5

REACTIVE DISTILLATION: Distillation accompanied by chemical reaction. Application of the theta method of convergence in reactive method.

7 Hours

UNIT - 6

REACTIVE DISTILLATION: Formulation of N[r+2] Newton Raphson method.

6 Hours

UNIT - 7

COMPLEX MIXTURE: Determination of minimum number of stages required to effect a specified separation.

6 Hours

UNIT - 8

COMPLEX MIXTURE: Optimum and economic design of distillation column for the complex mixtures.

7 Hours

REFERENCE BOOKS:

1. **Fundamentals of multicomponent distillation** - C.D. Holland,, McGraw Hill, 1997.
2. **Separation processes** - C.J. King, Tata McGraw Hill, 2nd edition 1980.
3. **Distillation-**Van Winkel McGraw Hill 1967.
4. **Distillation Engineering** - R. Billet, Chem. Publ. Co. NY1979.

PULP AND PAPER TECHNOLOGY

Subject Code	: **06CH844**	IA Marks	: 25
No. of Lecture Hours/Week	: 04	Exam Hours	: 03
Total No. of Lecture Hours	: 52	Exam Marks	: 100

PART - A

UNIT - 1

WOOD CHEMISTRY: Chemical composition- cellulose, hemi cellulose, lignin, wood extractives, raw material. Quality parameters under evaluation. Yield of raw material.

4 Hours

UNIT - 2

PULPING: General principle of pulping. Types of pulping processes: mechanical, chemical, semi-chemical, sulphate process, Kraft process. Process calculations. Raw material utility requirements. Process flow sheet and description. Washing and bleaching. Common unit operation. Wood treatment, digestion, evaporation, drying with equipments used.

8 Hours

UNIT - 3

TREATMENT OF PULP: Screening, washing, refining, thickening of pulp. Bleaching- conventional and non-conventional bleaching techniques.

6 Hours

UNIT - 4

PAPER MAKING: Preliminary operations on pulp. Beating and refining of pulp. Non-fibrous materials. Fillers and loading material. Internal sizing. Wet and additive surface treatment. Paper coloring. Surface sizing.

8 Hours

PART - B

UNIT - 5

PAPER DRYING AND FINISHING: Types of dryers. Calendaring. Reeling and winding. Paper machine drives, cutting, winding and rewinding. Conversion of papers.

6 Hours

UNIT - 6

PAPER QUALITY OF GRADES: Different grades of paper quality. Parameters and their evaluation. Saturation of paper. Special grade papers. Recycling of waste papers.

8 Hours

UNIT - 7

SUPPORTIVE OPERATIONS: Chemical recovery – water balance, oxidation, evaporation of black liquor, lime recovery. Quality control and safety aspects.

8 Hours

UNIT - 8

ENVIRONMENTAL ASPECTS: Effluent characteristics of pulp and paper industries. Treatment methods.

4 Hours

TEXT BOOK:

1. Casey, J.P., Pulp and Paper Chemistry and Technology, 2nd Edition, Inter Science, 1960.

REFERENCE BOOKS:

1. **Handbook of Pulp and Paper Technology** - Britt K.W., Rein Hord, 1964.
2. **Pulp and Paper Science and Technology** - Libby C.E. Vol 1 to 3, McGraw Hill, 1962.

PROJECT

Subject Code	: **06CH85**	IA Marks	: 100
No. of Seminar Hours/Week	: 12	Exam Hours	: 03
Total No. of Lecture Hours	: -	Exam Marks	: 100

The students in a group will be assigned an experimental, design, a case study or an analytical problem, to be carried out under the supervision of a guide. The project has to be assigned at the beginning of the seventh semester. The project group should complete the preliminary literature survey & plan of project and submit the synopsis at the end of seventh semester. The project work should be carried out and completed at the end of eighth semester.

SEMINAR ON PROJECT

Subject Code	: **06CH86**	IA Marks	: 50
No. of Seminar Hours/Week	: 03	Exam Hours	: --
Total No. of Lecture Hours	: -	Exam Marks	: --

The students are required to give the comprehensive presentation in the form of seminar on the project work carried out in the eighth semester. The seminar shall be evaluated as internal assessment. While evaluating, emphasis shall be given on the presentation and communication skills.

IN-PLANT TRAINING/INDUSTRIAL VISIT

Subject Code	: **06CH87**	IA Marks	: 50
No. of Hours/Week	: -	Exam Hours	: --
Total No. of Lecture Hours	: -	Exam Marks	: --

The students are expected to undergo in-plant training in any chemical industry or in a reputed research laboratory with pilot plant facility. This shall be for a minimum period of two weeks during the vacation of sixth or seventh semester. If it is not possible, the students may be permitted to go on industrial visit for a period of two weeks and they should visit minimum of five major chemical industries. Each student should submit a report separately, at the beginning of the eighth semester, which is evaluated by a committee constituted by the H.O.D for internal assessment.

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