Tech. Chemical Engineering

BRANCH Chemical Engineering SEMESTER: III YEAR: II[nd]

Theory Papers

S. N.	Code No.	Subject	L	T	Ex. Hr.	MM	
1.	3CH1(MA)	Mathematics-III	3	1	3	20+80	100
2.	3CH2(CY)	Applied Chemistry	3	-	3	20+80	100
3.	3CH3(CP)	Object Oriented Programming in C++	3	-	3	20+80	100
4.	3CH4(CH)	Chemical Process Calculations	3	1	3	20+80	100
5.	3CH5(CH)	Fluid Flow Operation	3	1	3	20+80	100
6.	3CH6	**Elective-I (Any One)**	3	-	3	20+80	100
	3CH6.1(CP)	Introduction to Computers and Operating Systems					
	3CH6.2(ME)	Power Plant Engineering					
	3CH6.3(EC)	Applied Electronics					
		Total (A)	**18**	**3**	**-**		**600**

20 marks are internal & Question paper will be of 80 marks.

Practicals and Sessionals

S. N.	Code No.	Subject	S	P	Ex. Hr.	MM	
7.	3CH7(CY)	Applied Chemistry Lab.	-	2	-	45+25	75
8.	3CH8(CP)	Object Oriented Programming in C++ Lab.	-	2	-	45+25	75
9.	3CH9(HU)	Social Science & Economics	2	-	-	30+20	50
10.	3CH10(CH)	Group Discussion & Seminar	-	2	-	30+20	50
11.	3CH11(CH)	Fluid Flow Operations Lab.	-	3	-	60+40	100
12.	3CH(DC)	Discipline & Extracurricular activities	-	-	-	50	50
		Total (B)	**2**	**9**			**400**
Grand Total (A +B)							**1000**

Total No. of Periods: 32

Note:

- L : Lecture, T : Tutorial, S : Sessional, P : Practical
- In practical course of each subject, the students should carry out at least 8 to 10 experiments, based on the course content of the respective theory subject.

ing SEMESTER: IV YEAR: II[nd]

Theory Papers

S. No.	Code No.	Subject	L	T	Ex. Hr.	MM	
1.	4CH1(CH)	Material Science & Technology	3	-	3	20+80	100
2.	4CH2(CH)	Fluid-Particle Mechanics	3	1	3	20+80	100
3.	4CH3(CH)	Environment Engineering	3	-	3	20+80	100
4.	4CH4(CH)	Chemical Engineering Thermodynamics ï I	3	1	3	20+80	100
5.	4CH5(CH)	Heat Transfer Operation	3	1	3	20+80	100
6.	4CH6	**Elective- II (Any One)**	3	-	3	20+80	100
	4CH6.1(MA)	Mathematics-IV					
	4CH6.2(HU)	Introduction to Economic Analysis					
	4CH6.3(ME)	Non Conventional Energy Sources					
		Total (A)	**18**	**3**	**-**		**600**

20 marks are internal & Question paper will be of 80 marks.

Practicals and Sessionals

S. No.	Code No.	Subject	S	P	Ex. Hr.	MM	
7.	4CH7	Fluid-Particle Mechanics Lab.	-	3	-	60+40	100
8.	4CH8	Environment Engineering Lab.	-	2	-	45+25	75
9.	4CH9	Heat Transfer Operation Lab.	-	3	-	60+40	100
10.	4CH10	Laboratory Techniques in Biotechnology	3	-	-	45+25	75
11	4CH(DC)	Discipline & Extracurricular activities	-	-	-	50	50
		Total (B)	**3**	**8**			**400**
Grand Total (A+B)							**1000**

Total No. of Periods: 32

Note:

- L : Lecture, T : Tutorial, S : Sessional, P : Practical
- In practical course of each subject, the students should carry out at least 8 to 10 experiments, based on the course content of the respective theory subject.

BRANCH : Chemical Engineering SEMESTER: V YEAR: III[rd]

Theory Papers

S. No.	Code No.	Subject	L	T	Ex. Hr.	MM	
1	5CH1	Process Instrumentation	2	-	3	20+80	100
2	5CH2	Inorganic Chemical Technology	3	-	3	20+80	100
3	5CH3	Mass Transfer Operation ï I	3	1	3	20+80	100
4	5CH4	Numerical Methods in Chemical Engineering	2	1	3	20+80	100
5	5CH5	Chemical Engineering Thermodynamics-II	3	1	3	20+80	100
6	5CH6	**Elective – III (Any One)**	3	-	3	20+80	100
	5CH6.1	Analytical Techniques					
	5CH6.2	Fertilizer Technology					
	5CH6.3	Energy Resources & Utilization					
		Total (A)	**16**	**3**	**-**		**600**

20 marks are internal & Question paper will be of 80 marks.

Practicals and Sessionals

S. No.	Code No.	Subjects	S	P	Exam.	MM	
7	5CH7	Environmental Instrumention Lab.	-	2	-	30+20	50
8	5CH8	Process Instrumentation lab	-	3	-	60+40	100
9	5CH10	Numerical Methods in Chemical Engineering Lab.	-	3	-	60+40	100
10	5CH11	Mass Transfer-I lab.	-	3	-	60+40	100
11	5CHDC	Discipline and Extra Curricular Activities	-	-	-	50	50
		Total (B)	**-**	**11**	**-**		**400**
Grand Total(A+B)							**1000**

Total No. of Periods : 30

Note:

- L : Lecture, T : Tutorial, S : Sessional, P : Practical
- In practical course of each subject, the students should carry out at least 8 to 10 experiments, based on the course content of the respective theory subject.
- Industrial & technical visit may be organized for ten days after fifth semester.

BRANCH: Chemical Engineering **SEMESTER: VI** **YEAR: III[rd]**

Theory Papers

S. No.	Code No.	Subject	L	T	Ex. Hr.	MM	
1	6CH1	Chemical Reaction Engineering-I	3	1	3	20+80	100
2	6CH2	Mass Transfer Operation -II	3	1	3	20+80	100
3	6CH3	Process Dynamics & Control	3	1	3	20+80	100
4	6CH4	Organic Chemical Technology	3		3	20+80	100
5	6CH5	Petroleum Refining	3	1	3	20+80	100
6	6CH6	**Elective – IV (Any One)**	3		3	20+80	100
	6CH6.1	Introduction to Oil/Fat Technology					
	6CH6.2	Rubber Science & Technology					
	6CH6.3	Introduction to Pulp & Paper Technology					
		Total (A)	**18**	**4**	**-**		**600**

20 marks are internal & Question paper will be of 80 marks.

Practicals and Sessionals

S. No.	Code No.	Subjects	S	P	Exam.	MM	
7	6CH7	Chemical Technology (Organic & Inorganic) Lab.	~	2	-	45+25	=75
8	6CH8	Mass Transfer Operation -II lab.	~	3		60+40	=100
9	6CH9	Process Dynamics & Control Lab.	~	2		45+25	=75
10	6CH10	Petroleum Refining Lab.	~	3		60+40	=100
11	6CHDC	Discipline & Extra Curricular Activities				50	50
		Total (B)		**10**			**400**
Grand Total (A+B)							**1000**

Total No. of periods: 32

Note:

- L : Lecture, T : Tutorial, S : Sessional, P : Practical
- In practical course of each subject, the students should carry out at least 8 to 10 experiments, based on the course content of the respective theory subject.
- Practical training during summer at the end of 6th semester will be held for 30 days.
- Student will have to give presentation on their Practical training after coming back in 7th semester.

BRANCH: Chemical Engineering SEMESTER: VII YEAR: IVth

Theory Papers

S. No.	Code No.	Subject	L	T	Ex. Hr.	MM	
1	7CH1	Chemical Reaction Engg. II	3	1	3	20+80	100
2	7CH2	Transport Phenomena	3	1	3	20+80	100
3	7CH3	Process Equipment Design	3	-	3	20+80	100
4	7CH4	Optimization of Chemical Process	3	1	3	20+80	100
5	7CH5	Molecular Biology	3	-	3	20+80	100
6	7CH6	**Elective-V (Any One)**	3	-	3	20+80	100
	7CH6.1	Bioprocess Engineering					
	7CH6.2	Process Safety and Hazard Mgmt.					
	7CH6.3	Sugar Technology					
		Total (A)	**18**	**3**	**-**		**600**

20 marks are internal & Question paper will be of 80 marks.

Practicals and Sessionals

S. No.	Code No.	Subjects	S	P	Exam.	MM	
7	7CH7	Practical Training Seminar (Project Part-1)	-	2	-	30+20=50	50
8	7CH8	Chemical Reaction Engg. Lab	-	3	-	60+40=100	100
9	7CH9	Bioprocess Engineering	-	3	-	60+40=100	100
10	7CH10	Process Equipment Design	-	2	-	60+40=100	100
11	7CHDC	Disciple and Extra Curricular Activities	-	-	-	50	50
		Total (B)		**10**			**400**
Grand Total (A+B)							**1000**

Total No. of Periods: 31

Note:

- L : Lecture, T : Tutorial, S : Sessional, P : Practical
- In practical course of each subject, the students should carry out at least 8 to 10 experiments, based on the course content of the respective theory subject.
- In practical training seminar, the students will have to submit a written report and del a talk, based on summer training at the end of VI semester

BRANCH Chemical Engineering SEMESTER: VIII YEAR: IVth

Theory Papers

S. No.	Code No.	Subject	L	T	Ex. Hr.	MM	
1	8CH1	Process Engineering & Plant Design	4	1	3	20+80	100
2	8CH2	Industrial Management	3	-	3	20+80	100
3	8CH3	Process Analysis & Simulation	4	1	3	20+80	100
4	8CH4	**Elective-VI (Any One)**	3	-	3	20+80	100
	8CH4.1	Biochemical Technology					
	8CH4.2	Catalysis Processes					
	8CH4.3	Polymer Science & Technology					
		Total (A)	**14**	**2**	**-**		**400**

20 marks are internal & Question paper will be of 80 marks.

Practicals and Sessionals

S. No.	Code No.	Subjects	S	P	Exam.	MM	
5	8CH5	Process Engineering and Plant Design	-	2	-	60+40	100
6	8CH6	Computer Aided Design & Drawing	3	-	-	30+20	50
7	8CH7	Novel Separation Techniques	3	2	-	60+40	100
8	8CH8	Seminar	-	2	-	60+40	100
9	8CH9	Project	-	2	-	200	200
10	8CH(DC)	Discipline & Extra Curricular Activity (8CHDC)	-	-	-	50	50
		Total (B)	**6**	**8**	**-**		**600**
Grand Total (A+B)							**1000**

Total No. of Periods: 28

Note:

- L : Lecture, T : Tutorial, S : Sessional, P : Practical
- In practical course of each subject, the students should carry out at least 8 to 10 experiments, based on the course content of the respective theory subject.

A)- MATHEMATICS-III

3L+1T MM: 100 Ex. Hrs.: 3

UNIT-I

Differential Equations & Fourier Series : Ordinary differential equations of second order with variable coefficients; Method of variation of parameters; Power series methods; Partial differential equations of first order Lagrangeøs method, standard forms, Fourier series and Harmonic analysis

UNIT-II

Legendreøs function of first and second kinds; simple recurrence relations; Rodriguesø formula; orthogonal property, and Besseløs differential equation, Bessel functions of first and second kind, simple recurrence relations, orthogonal property of Bessel function.

UNIT-III

Laplace Transforms with its simple properties; applications to the solution of ordinary differential equations, method of separation of variables, applications to the solution of wave equations in one dimension, Laplaceøs equation in two dimensions, diffusion equation in one dimension.

UNIT –IV

Numerical Analysis: Finite differences- Forward, Backward, and Central differences, Newtonøs forward and backward difference interpolation formulae, Stirlingøs formula. Numerical differentiation, Numerical Integration ï Trapezoidal rule, Simpsonøs one-third and three-eighth rule. Introduction to numerical solution of ordinary differential equations.

UNIT-V

Tensor Analysis: Definition of a tensor, Transformation of co-ordinates. Contravariant and co-variant vectors, addition and multiplication of tensors, contraction of tensors, inner product, fundamental tensor, Christoffel symbols, co-variant differentiation.

Text/ Reference Books

1. Grewal, B.S., ñ*Higher Engineering Mathematics*ò, Khanna Publishers, New Delhi.
2. Gaur, Y.N. and Koul, C.L., ñ*Higher Engineering Mathematics*ò, Book1 & 2, Jaipur Publishing House, Jaipur.
3. Sastry, S.S., ñ*Introductory Methods of Numerical Analysis*ò, Prentice-Hall of India, 1988.

- APPLIED CHEMISTRY

3L MM: 100 Ex. Hrs.: 3

UNIT-I

Electrochemistry: Specific, equivalent and molecular conductance, their determination, theories of electrolytic conductance, Debye-Huckle theory of strong electrolytes, galvanic cells, reference electrodes and their potentials. Standard cell, standard electrode potential, determination of dissociation constants of acids and bases, solubility product, hydrolysis constant, hydrogen ion concentration, complex formation, activity of electrolytes etc., theory of acid-base indicators, electrometric titrations.

UNIT –II

Photochemistry: Photochemical Reactions, Laws of Photochemistry.
Reactions and their Mechanism: Types of mechanism, types of reactions and method of determination of mechanism.

UNIT-III

Chemical Bonding: Basic concepts of bonding. Types of bonding, covalent bonding, multiple bonding, inductive and field effects and bond energy. Aromaticity and Huckleôs rule of electrons, Hyperconjugation and Tautomerism, Bonding weaker than covalent, resonance and field effects.

UNIT-IV

Aromatic Chemistry: Structure of benzene resonance and orbital picture, Orientation and directive influence of substituents.
Heterocyclic Compounds: Heterocyclic compounds containing one heteroatom, pyrole, thiophene, furan, pyridine. Their aromatic character.

UNIT-V

Carbohydrates: Introduction, definition and classification, structure of glucose and fructose.
Stereochemistry: A brief account of stereochemistry, optical activity and chirality, configuration and strain.

Text/Reference Books

1. Jerry March, ñ*Organic Chemistry*,ò John Wiley, New York.
2. Finar, I. L.,ñ*Organic Chemistry*,ò ELBS, New Delhi.
3. Morrison and Boyd, ñ*Organic Chemistry*,ò MacMillan.
4. Glasstone, S., ñ*A Textbook of Physical Chemistry*,ò MacMillan.
5. Bahl and Tuli, ñ*Essentials of Physical Chemistry*,ò S. Chand and Co.

RIENTED PROGRAMMING IN C++

3L MM: 100 Ex. Hrs.: 3

Characteristics of object-oriented languages.

UNIT-I

C++ Programming Basics: C++ Program structure, variables, input/ output with *cout* and *cin*, arithmetic operators.

Loops and Decisions: *for*, *while*, *do* loops; *if* and *if…else* statements, *switch* statement; *break*, *continue*, *go to* statements.

UNIT –II

Structures: Structure specifiers and definitions, accessing structure members; nested structures; structures as objects and data types; enumerated data types.

Functions: Function definitions and declarations; arguments and return values; reference arguments; overloaded arguments; default arguments; storage classes

UNIT-III

Objects and Classes: Definitions of objects and classes; member functions and data; constructors and destructors.

Arrays: Array definitions; accessing array elements; arrays of objects; strings.

UNIT-IV

Operator overloading: Overloading unary operators; overloading binary operators; data conversion.

Inheritance: Base and derived class; class hierarchies; public and private inheritance; multiple inheritance.

UNIT-V

Pointers: Addresses and pointers; pointers and arrays; pointers and function arguments; pointers and strings; memory management with *new* and *delete*; pointers and objects; pointers to pointers.

Files and streams: Stream class hierarchy; reading and writing objects; file pointers; redirection; printer output.

Text/Reference Books

1. Lafore, R., ñ*Object Oriented Programming in Turbo C++*,ò Galgotia Publications, New Delhi, 2000.
2. Balaguruswami, E., ñ*Object Oriented Programming with C++*,ò Tata McGraw-Hill, New Delhi, 1995.
3. Venugopal and Rajkumar, ñ*Mastering C++*ò, Tata McGraw-Hill, 1997.
4. Keogh, J., ñ*Introduction to Programming with C++*ò, Prentice Hall, 1996.

CAL PROCESS CALCULATIONS

3L+1T MM: 100 Ex. Hrs.: 3

UNIT-I

Introduction to Chemical Engineering Calculations definition and strichiometry: Units and dimensions, the mole unit, conventions in methods of analysis and measurement, basis, temperature, pressure, the chemical equation and chemical formulae.

UNIT –II

Gases, Vapours, Liquids and Solids: Ideal gas law and its related calculations, real gas relationships, vapour pressure and liquids, saturation, partial saturation and humidity, introduction to vapour-liquid equilibria for multicomponent systems, material balances involving condensation and vaporization.

UNIT-III

Material Balances: Material balance of physical processes with and without chemical reaction, including recycle, purge and bypass.

UNIT-IV

Energy Balances: Concept and Units, calculation of enthalpy changes, general balance with and without reactions, heats of solution and mixing.

UNIT-V

Unsteady-state material and energy balances. Solids, liquids and gaseous fuels, some industrial examples of the above, simple estimation of physical properties (transport, thermodynamic) of fluids and mixtures.

Text/Reference Books

1. Himmelblau, D. M., ñ*Basic Principles and Calculations in Chemical Engineering*,ò 6th ed., Prentice-Hall of India.
2. Bhatt and Vora, ñ*Stoichiometry*,ò 3rd ed., Tata McGraw-Hill, New Delhi.
3. Hougen, Watson and Ragatz, ñ*Chemical Process Principles*,ò Vol. 1, Asia Publishing House, New Delhi.
4. Saha, S. N., ñ*Fundamentals of Chemical Engineering*,ò Dhanpat Rai Publishing Co., New Delhi, 2000.

3CH5(CH) – FLUID FLOW OPERATIONS

3L+1T MM: 100 Ex. Hrs.: 3

UNIT-I

Continuity equation for compressible and incompressible fluids. Bernoulliôs equation, Eulerôs equation, introduction to Navier-Stokes equation

UNIT –II

Types of flows, steady and unsteady, laminar and turbulent flows; Relationship between shear stress and pressure gradient, Hagen-Poiseuille equation. Prandtlôs mixing length theory and eddy diffusivity losses in pipes and fittings, Darcy-Weisbach equation for frictional head loss, Moody diagram. Flow through packed and fluidized beds.

UNIT-III

Velocity Profile and boundary layer calculations for turbulent flow

UNIT-IV

Pumps and compressors for handling different fluids, types, cavitation, priming NPSH and characteristics of centrifugal pumps. Valves, pipe fittings and their standards. Power requirement for flow. Pipe layout and economical pipe diameter.

UNIT-V

Flow measuring devices such as orifice meter, venturimeter, rotameter, pitot tube comparison of centrifugal and reappricating pumps, anemometer, etc.
Vacuum producing devices.
Introduction to Newtonian and non-Newtonian fluids flow and their behaviours

Text/Reference Books

1. Streeter, V. L. and Wylie, ñ*Fluid Mechanics*,ò 8th ed., McGraw-Hill, New York, 1985.
2. Gupta, S. K., ñ*Momentum Transfer Operations*,ò Tata McGraw-Hill.
3. Coulson, J. M. and Richardson, J. F., ñ*Chemical Engineering*,ò Vol. 1, Asian books, New Delhi.
4. McCabe, W.L., Smith, J.C., and Harriott, P., ñ*Unit Operations of Chemical Engineering*ò, 6th ed., McGraw Hill.

ELECTIVE-I

3CH6.1 (CP) - INTRODUCTION TO COMPUTERS AND OPERATING SYSTEMS

3L MM: 100 Ex. Hrs.: 3

UNIT-I

Introduction: Data Types, Fixed point representation and floating point representation, Binary and error detecting codes.

Basic Computer Organization and Design: Central Processing Unit, Arithmetic Logic Unit, Stack organization, Instruction Formats and addressing modes.

UNIT –II

Arithmetic Algorithms: Arithmetic with signed 2ôs complement numbers. Multiplication and Division algorithms, Boothôs multiplication algorithm. Floating point arithmetic operations, decimal arithmetic operations and their hardware implementation.

UNIT-III

I/O Architecture: Peripheral devices, data transfer schemes (Programmed and DMA transfer), I/O processor. Multiprocessor system organization: Multiport memory, crossbar switch, Introduction to crossbar switch, introduction to timeshared common bus and dual bus. Data communication processor.

Memory and Storage: Processor vs. memory speed, memory hierarchy, cache memory, associative memory, Virtual memory mapping: different mapping schemes, random access, sequential access and direct access storage devices.

UNIT-IV

Introduction to System Software: Elements of an Assembler. Basic idea of compiler and interpreters, Loaders and Linkers.

UNIT-V

Introduction to Operating Systems: Classification of operating systems. Elements of an operating system. Basic idea of file system in DOS, Windows and UNIX operating systems.

Text/Reference Books

1. Mano, M. M., ñ*Computer System Architecture*,ò 2nd ed., Prentice Hall of India, New Delhi.
2. Dhamdhere, D. M., ñIntroduction to System Software,ò Tata McGraw-Hill, New Delhi.

ELECTIVE-I

3CH6.2(ME) - POWER PLANT ENGINEERING

3L MM: 100 Ex. Hrs.: 3

UNIT-I

Coal Thermal Power Plants: Steam Generation: High pressure and supercritical boilers, circulation of water in high pressure boilers; natural and forced calculation; Advantages and disadvantages; Water walls; Directly & indirectly heated boilers, LaMantm Benson, Loeffler, Romezin boilers Draught System; Losses in air gas loop system; natural, forced induced and balanced draught systems.

UNIT –II

Fuel Storage and Handling: Coal handling for thermal power plants; Coal feeding and burning methods; pulverized fuel firing and FBC. Ash handling and Dust Collection; Ash handling systems; Dust collection: Disposal of ash and dust.

UNIT-III

Diesel and Gas Turbine Power Plants: General layout; elements of diesel power plants; fields of use; systems of diesel power plants; general layout of gas of gas turbine plants; plant components; different arrangements for plant components; Governing system, combined gas and stream power plants. Introduction to integrated coal gasification combined cycle power plants

UNIT-IV

Nuclear power plants: Nuclear materials and waste disposal; nuclear fuels, coolants, moderating and reflecting materials, cladding materials, shielding materials; Disposal of nuclear waste; General components of nuclear reactor, different types of nuclear reactors, their construction and working. Fuel enrichment; Safety and control.

UNIT-V

Cooling Towers: Necessity of cooling condenser water, water cooling methods; types of cooling towers, hyperbolic, atmospheric, induced draft and forced draft cooling towers; Indirect and direct dry type cooling systems; water distribution in cooling towers.

Comparison of Power Plants: Suitability for base load, peak load; gestation period; water requirement, cost of electricity; fuel handling and transport; environment implications; suitability for small power, bulk power, thermal efficiency; land requirement per unit power.

Text/Reference Books

1. Skrotzki, B. G. A. and Vopat, W. A., ñ*PowerStation Engineering and Economy*,ò Tata McGraw-Hill, New Delhi, 1990.
2. Nag, P.K., ñ *Power Plant Engineering: Steam and Nuclear*,ò Tata McGraw-Hill, New Delhi, 1998.

ELECTIVE - I
3CH6.3 (EC) – APPLIED ELECTRONICS

3L MM: 100 Ex. Hrs.: 3

UNIT-I

Transistor: Transistor as an amplifier: low frequency, single stage and multistage amplifier. **Regulated Power Supply:** Capacitor filters for single-phase rectifiers. Application of 3-pin voltage regulator Ics 78xx/79xx/317/337.

UNIT –II

OPAMP: Introduction to operational amplifiers. Applications of OPAMP: 1) Summing scaling, averaging, integrator and differentiator; 2) OPAMP as comparator 3) Instrumentation Amplifier and its applications.

UNIT-III

Digital Electronics: 1) Combinational circuits: multiplexers, demultiplexers, decoders, encoders. 2) Flipflops: S-R F/F, clocked S-R F/F, D F/F, J-K F/F, T F/F 3) Counters: Asynchronous (ripple) counter, Asynchronous UP/DOWN counter, Synchronous counter, Synchronous UP/DOWN counter. 4) Registers: Serial-in, serial-out; Parallel-in, serial-out; Serial-in, parallel out; Serial/parallel in, Serial/parallel out.

UNIT-IV

D/A converters: R/ 2R register ladder. D/A converter. A/D converters: successive approx. A/D converter

UNIT-V

Microprocessor: Concept of microprocessor, software architecture of 8086, Addressing modes, Data transfer arithmetic logical, Jump/Call, String instructions, Writing simple assembly language programmes, Technical details of serial and parallel ports of IBM compatible PC.

Text/Reference Books

1. Millman, Halkias, ñ*Basic Electronics*ò, Tata McGraw-Hill.
2. Coughlin and Driscoll, ñ*Operational Amplifiers and Linear Integrated Circuits*ò, Prentice Hall of India.
3. Bray B.B., ñ*8086 – 486 Intel Microprocessor*,ò Prentice Hall of India.
4. Hall, D., ñ*8086 Microprocessor*ò, Tata McGraw-Hill

AL SCIENCE AND TECHNOLOGY

3L MM: 100 Ex. Hrs.: 3

Unit- I

Introduction to Materials

Engineering materials, their classification, characteristics and basic principles for their selection. Structure of atom, and types of bonds. Crystal structure. Defects in crystal structure and their influence on properties of a material.

Unit- II

Metals and Their Alloys

Phase equilibrium diagram for Iron-carbon and Copper-zinc system. Ferrous and non-ferrous alloys. Mild steels, special steels, stainless steels, brasses, bronzes, aluminum alloys, and titanium alloys. Methods for fabrications- Rolling, forging, extrusion and joining.

Unit- III

Polymers

Types of plastics, structure properties, correlations of important plastics, polymerisation processes and additives. Fibre-reinforced plastics, rubbers & elastomers and applications.

Unit- IV

Ceramics and Glass

Structure ï properties, correlations, oxide and non-oxide ceramics, vitreous and borosilicate glasses, glass-ceramics and enamels. Major electrical, optical and mechanical properties of ceramics and glasses. Enamelling and glass lining.

Unit- V

Corrosion and its Control

Types of corrosion, chemical and electrochemical reactions, methods of corrosion prevention. Corrosion-resistant materials.

Text/Reference Books

1. James, F. Shackelford, ñ*Introduction to Materials Science*ò, Macmillan Pub. Co., NY, 1990
2. Jestrazebaski, D.Z., ñ *Properties of Engineering Materials"*, 3rd ed., Toppen Co. Ltd.
3. Smith, W. F., ñ*Foundations of Materials Science and Engineering*,ò 2nd ed., McGraw-Hill, 1993.
4. Raghavan, V., ñ*Materials Science and Engineering*,ò PHI, New Delhi.
5. Van Vlack, L. H., ñ*Materials Science and Engineering*,ò Addison Wesley.

4CH2(CH)– FLUID-PARTICLE MECHANICS

3L+1T MM: 100 Ex. Hrs.: 3

Unit- I

Size Reduction: Principles of crushing and grinding, Determination of mean particle size and size distribution, Laws of crushing and grinding, Energy required for size reduction, crushing and grinding equipments, closed and open circuit grinding.
Agglomeration: Principles and applications. Techniques of agglomeration and methods of testing.

Unit- II

Screen Analysis and Size separation: Capacity and types of screens, mesh number and size distribution, different types of screening, effectiveness of screens, Particle size analysis, separation efficiency and screening equipments.

Unit- III

Filtration: Theory of Filtration, equations for compressible and incompressible cakes, Constant volume and Constant Pressure Filtration, Plate and frame filter press, Rotary drum and vacuum filter. Fiber and fabric filters, centrifuges, cyclone separators and electrostatic precipitator.

Unit- IV

Fluidization: Fluidization of solids and its applications, Design of Fluidized beds, Hydraulic and Pneumatic transport of solids.

Unit- V

Mixing: Mixing of liquids and solids types of mixers, Power requirement in mixing.
Storage and Handling of Materials: Sizing of hoppers and bins, Mechanical and pneumatic conveying systems like belt conveyors, bucket elevators, flight conveyors etc.

Text/Reference Books

1. McCabe, W.L., Smith, J.C., and Harriott, P., ñ*Unit Operations of Chemical Engineering*ò, 6th ed., McGraw Hill.
2. Brown, G. G., et al, ñ*Unit Operations*,ò CBS Publications, Delhi.
3. Coulson, J. H. and Richardson, J. F., ñ*Chemical Engineering*,ò Vol. 2, Asian Books Private Ltd., New Delhi.
4. Perry, R. H., et al, ñ*Chemical Engineers' Handbook*,ò 7th ed., McGraw-Hill.
5. Foust, A.S., et al., ñ*Unit Operations*ò, 2nd ed., John Wiley.
6. Bhattacharya, ñ*Unit Operations*ò, Vol. 1., Khanna Publishers.

VIRONMENT ENGINEERING

3L **MM: 100** **Ex. Hrs.: 3**

Unit – I

Atmosphere- Introduction, structure of the atmosphere, chemical and photochemical reaction in the atmosphere, primary air pollutants-sources. Carbon, Nitrogen & Sulfur Cycle.

Unit – II

Wastewater Treatment: Characterization of industrial wastewater, primary, secondary and tertiary treatment. Segregation, screening, equalization, coagulation, flocculation, precipitation, flotation, sedimentation, aerobic treatment, anaerobic treatment, absorption, ion exchange, membrane filtration, electrodialysis, sludge dewatering and disposal methods.

Unit – III

Air Pollution Control: Sources and classification of air pollutants, nature and characteristics of gaseous and particulate pollutants, from automobiles. Air pollution meteorology, plume and its behavior and atmospheric dispersion, control of particulate emission by **gravity settling chamber, cyclones , wet scrubbers, bag filters and electrostatic precipitators** (General Explanation). Control of gaseous emission by absorption, adsorption, chemical transformation and combustion.

Unit – IV

Solid Waste Management: solid waste, waste disposal methods, recycling of solid waste and its management. Hazardous and non-hazardous waste, methods of treatment and disposal, land filling, leachate treatment and incineration of solid wastes.

Unit – V

Environmentally Pollution Monitoring Legislation, standards for water and air, Effects of air pollutants on human health, vegetation and materials**,** Air pollution monitoring instruments

CO_x, NO_x, SO_x, Hydrocarbon and Ozone. Hydrocarbons particulates, sampling techniques. Global warming, Green house effect, depletion of ozone layer, human activity and meteorology

Text/Reference Books:

1. Dhameja, S.K., ñ*Environmental Engineering and Management*ò, S.K. Kataria & Sons, Delhi, 2002.
2. Masters, G.M., ñ*Introduction to Environmental Engineering and Science*ò, Prentice Hall of India, New Delhi, 2001.
3. Bhatia, S.C., ñ*Environmental Pollution and Control in Chemical Process Industries*ò, Khanna Publishers, Delhi, 2001.
4. Pandey G.N. and Karney, ñ*Environmental Engineering*ò Tata McGraw Hill, Delhi.
5. Instrumentation by Khandpur. Metcalf & Eddy, Inc., ñ*Wastewater Engineering: Treatment and Reuse*ò, 4th ed., Tata McGraw Hill, New Delhi, 2003.
6. Modi, P.N. ñ*Sewage Treatment and disposal and Waste Water*

l.II, Standard book house, Delhi, 2001.

4CH4 (CH) – CHEMICAL ENGINEERING THERMODYNAMICS-I

3L+1T **MM: 100** **Ex. Hrs.: 3**

Unit – I

Introduction; Definitions and Concepts: System, Surroundings, Property, Intensive and Extensive Energy, Work, Thermodynamic equilibrium, stability of equilibrium states. Zeroth Law of Thermodynamics, Perfect Gas scale.

Unit – II

First law of Thermodynamics and Its Applications, First law analysis of processes, Control mass and control volume analysis, Steady state and Transient state flow processes.
Thermodynamic properties of fluids, Pure substance, Concept of Phase, Ideal gas equation of state, Van der Waalsô equation of state, two parameter corresponding states principle, Compressibility charts, Steam Tables and applications.

Unit – III

Second law of Thermodynamics: Limitation of First Law, Kelvin-Planck and Clausius Statements, Reversible and Irreversible Processes, Carnot cycle, Entropy, Second Law analysis of a control volume, Heat Engine and Heat Pump.
Fundamental Thermodynamic Relations, Maxwell Relations, Clapeyronôs Equation, Kirchoffôs equation, Phase Rule.

Unit – IV

Ideal gas mixture, Air-Water mixture, Humidity, Psychrometric chart and its applications.
Power Cycles: Rankine cycle and its modifications, Otto cycle, Diesel cycle. Refrigeration Cycles: Vapor Compression Refrigeration cycle, Absorption Refrigeration cycle.

Unit – V

Statistical Thermodynamics: Postulates, Macrostates and microstates, Partition Function, Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac statistics. Applications of Statistical Thermodynamics: Ideal gas, Maxwell speed distribution, Einstein & Debye Models of a solid.

Text/Reference Books:

1. Rao, Y. V. C., ñ*An Introduction to Thermodynamics*,ò John Wiley, 1993.
2. Van Wylen, G. J. and Sonntag, R. E., ñ*Fundamentals of Classical Thermodynamics*,ò 2nd ed., John Wiley, New Delhi.
3. Chemical Engg. Thermdynamics by Yannes & Smith.
4. An-thermodyanamic Engg. Approach by Yunus A. Cengel Michael A. Boles.

Engg- thermodyanamicï Gordon Rogers Yon Mayhew.

AT TRANSFER OPERATION

3L+1T MM: 100 Ex. Hrs.: 3

Unit – I

Introduction: Modes of heat transfer: conduction, convection, radiation.

Steady-State Conduction in One Dimension: Fourierôs Law, thermal conductivity, steady-state conduction of heat through a single and composite solid, cylinder and sphere. Steady-state heat conduction in bodies with heat sources: plane wall, cylinder and sphere.

Heat Transfer Coefficient: Convective heat transfer and the concept of heat transfer coefficient, overall heat transfer coefficient, heat transfer from extended surfaces, thermal contact resistance, critical and optimum insulation thickness.

Unit – II

Forced Convection: Flow over a flat plate, thermal boundary layer, flow across a cylinder. Dimensional analysis: Buckingham Pi theorem, Dimensionless groups in heat transfer. Correlations for the heat transfer coefficient: Laminar flow through a circular pipe, turbulent flow, through a non-circular duct, flow over flat plate, flow across a cylinder, flow past a sphere, flow across a bank of tubes, heat transfer coefficient in a packed and fluidized bed.

Double-pipe heat exchanger in parallel and counter-current flow.

Free Convection: Introduction, heat transfer correlations for free convection: flat surface, cylinder, sphere, enclosure. Combined free and forced convection

Unit – III

Boiling and Condensation: Boiling phenomenon, nucleate boiling, Correlations for pool boiling heat transfer: Nucleate boiling, critical heat flux, stable film boiling. Forced convection boiling, condensation phenomena, film condensation on a vertical surface, turbulent film condensation, condensation outside a horizontal tube and tube bank. Condensation inside a horizontal tube, effect of non-condensable gases. Dropwise condensation.

Unit – IV

Radiation Heat Transfer: Basic concepts of radiation from a surface: black body radiation, Planckôs Law, Wienôs Displacement Law, Stefan-Boltzmann Law, Kirchoffôs Law, Gray body. Radiation intensity of a black body, spectral emissive power of a black body over a hemisphere. Radiation heat exchange between surfaces ï the view factor. Radiation exchange between black bodies and between diffuse gray surfaces.

Unit – V

Heat Exchangers: Construction of a shell-and-tube heat exchanger, fouling of a heat exchanger, LMTD, temperature distribution in multi-pass heat exchangers, individual heat transfer coefficients and their relations with overall H.T. coefficients. Types of shell-and-tube heat exchanger.

Evaporators: Types of evaporators: Natural-circulation evaporators, forced-circulation evaporators, falling-film evaporators, climbing-film evaporators, agitated thin-film evaporators and plate evaporators. Principles of evaporation and evaporators; Single and multiple effect evaporators. Capacity and economy, Boiling point rise, Enthalpy balance of a solution. Calculations of single effect and

ethods of feeding to multieffect evaporators.

nduction: Mathematical formulations and initial and boundary conditions. Analytical solution, numerical solution.

Text/Reference Books:

1. Dutta, B. K., ñ*Heat Transfer: Principles and Applications*,ò PHI, New Delhi, 2001.
2. Holman, J. P., ñ*Heat Tansfer*,ò 8th ed., McGraw-Hill, New York.
3. A.J. Chapman, ñ*Heat Transfer*,ò Maxwell Macmillan, 1984.
4. Kern D.Q., ñ*Process Heat Transfer*ò, Tata McGraw Hill, 1950.
5. Hewitt, G. F., Shires, G.L. and Bott, T. R., ñ*Process Heat Transfer*ò, CRC Press, 1994.
6. Rao, Y. V. C., ñ*Heat Transfer*ò. New Age International , Delhi

ELECTIVE-II

4CH6.1(MA) – MATHEMATICS-IV

3L MM: 100 Ex. Hrs.: 3

Unit – I

Complex Variables: Analytic functions, Cauchy-Riemann equations, Elementary conformal mapping with simple applications, Line integral in complex domain, Cauchyôs theorem, Cauchyôs integral formula, Taylorôs series, Laurentôs series, Poles, Residues, evaluation of simple definite real integrals using the theorem of residues. Simple contour integration.

Unit – II

Introduction to Statistics: Probability distribution: Bimodal, Poisson, Uniform, Normal, Correlation and Regression, Linear regression, Confidence limits, types of errors, testing of hypothesis based on normal, Chi-square test, F-test, Z-test, Studentôs T-test. Comparison of means and variances.

Unit – III

Optimisation Techniques: Basic concepts of optimization: continuity of functions, Unimodal versus Multimodal functions, Concave and Convex functions.

Unit – IV

Unconstrained single variable optimisation: Newton, Quasi-Newton, Secant method, Dichotomous search, Fibonacci method, Golden Section method.

Unit – V

Introduction to Dynamic programming: Deterministic Dynamic programming, Probabilistic Dynamic programming.

Introduction to Integer programming: The Branch and Bound algorithm for Binary layer programming, the Branch and Scan algorithm for mixed integer programming.

Text/Reference Books:

1. Gaur, Y. N., and Kaul, C. L., ñ*Higher Engineering Mathematics*,ò Book 2, Jaipur Publishing House, Jaipur.
2. Gupta, S.P., ñ*Mathematical Statistics*ò.
3. Kapoor, J.N. and Saxena, ñ*Mathematical Theory of Statistics*,ò S. Chand & Co., New Delhi
4. Rao, S.S., ñ*Optimisation Techniques*,ò John Wiley, New Delhi
5. Kambo, N.S., ñ*Optimisation Techniques*ò.

ELECTIVE-II

4CH6.2(HU) - INTRODUCTION TO ECONOMIC ANALYSIS

3L MM: 100 Ex. Hrs.: 3

Unit – I

Scope and Methods of economic analysis. Theory of consumer behaviour - cardinal and ordinal utility approaches. Theory of production - the law of variable proportions and return to scale.

Unit – II

Theory of cost ï short and long-run viewpoint. Theory of exchange - demand and supply. Equilibrium of firm and industry ï monopolistic competition and oligopoly. General theory of distribution.

Unit – III

General equilibrium of exchange and production. Concepts, significance of difficulties in the measurement of National income.

Unit – IV

Classical theory of income determination and simple multiplier analysis. Types of economic systems and their characteristics ï capitalism, socialism and mixed economy.

Unit – V

Economic role of the government, ways of interference and regulations by the government. The concept of economic development - structural change, measurement and ingredients of economic development. Leontiefôs input-output analysis.

Text/Reference Books:

1. Barda, C. S., ñ*Managerial Economics*,ò National Publishing House, Jaipur, 2000.
2. Peterson and Lewis, ñ*Managerial Economics*,ò Prentice-Hall.
3. Gupta, G. S., ñ*Managerial Economics*,ò Tata McGraw-Hill, New Delhi, 1990.
4. Hogendorn, J. S., ñ*Economic Development*,ò HarperCollins Publishers, 1987.

ELECTIVE-II
4CH6.3(ME) - NON-CONVENTIONAL ENERGY SOURCES

3L MM: 100 Ex. Hrs.: 3

Unit – I

Introduction: Energy scene of supply and demand in India and the world, energy consumption in various sectors, potential of non-conventional energy resources. Detailed study of the following sources with particular reference to India.

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

Unit – II

Bio-Fuels: Importance, combustion, pyrolysis and other thermo chemical processes for biomass utilization. Alcoholic fermentation, anaerobic digestion for biogas production.

Unit – III

Wind Power: Principle of energy from wind, windmill construction and operational details and electricity generation and mechanical power production.

Tidal Power: Its meaning, causes of tides and their energy potential, enhancement of tides, power generation from tides and problems. Principles of ocean thermal energy conversion (OTEC) analysis and sizing of heat exchangers for OTEC.

Unit – IV

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

Unit – V

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

Text/Reference Books:

1. Rai,G.D,Non-conventional Energy Sources, Khanna Publishers, Delhi.
2. Twiddle, J. Weir, T. ñ*Renewable Energy Resources*,ò Cambridge University Press, 1986.
3. Kreith, F. and Kreider, J. F., ñ*Principles of Solar Engineering*,ò McGraw Hill, 1978.
4. Duffie, J. A., Beckman, W. A., ñ*Solar Engineering of Thermal Processes*,ò John Wiley, 1980.
5. Veziroglu, N., ñ*Alternative Energy Sources*,ò Volume 5 & 6, McGraw-Hill, 1978.
6. Sarkar, S., ñ*Fuels and Combustion*,ò 2nd ed., Orient Longman, 1989.
7. Sukhatme, S. P., ñ*Solar Energy*,ò 2nd ed., Tata McGraw-Hill, 1996.

4 CHT 16(CH) LABORATORY TECHNIQUES IN BIOTECHNOLOGY

3S MM: 75 Ex. Hrs.: 3

The student should be taught about basic principles and applications and should also carry out experiments related to the following instruments / techniques:

1. pH meter, conductivitymeter spectrophotometer and TLC.
2. Media preparation and sterilization.
3. Isolation,purification,identification and preservation of common microorganisms.
4. Qualitative identification and quantitative estimation of biomolecules.
5. Isolation, Purification and assay of enzymes.
6. Study of growth curve and factors affecting growth.

Text/Reference Books

1) G. cappuccino and N. Sherman. Microbiology, A Laboratory Manual, 4th Edition.Addison-Wesley.
2) Rodney Boyer. Modern Experimental Biochemistry. 3rd. Pearson Education Asia.
3) Keith and Wilson, Practical Biochemical Principles and Techniques

ESS INSTRUMENTATION

2L MM: 100 Ex. Hrs.: 3

Unit – I

Introduction, general principles of measurement, its classification by physical characteristics, direct and inferential measurement.

Unit – II

Static and dynamic characteristics of instruments. Measurement of temperature, pH, pressure, vacuum, flow rate, liquid level, differential pressure

Unit – III

Viscosity, conductivity, nuclear radiation, humidity and gas composition, spectroscopy.

Unit – IV

Classification of sensors and transducers. Building blocks of an instrument, transducer, amplifier signal conditioner, signal isolation, transmission, display, data acquisition modules, interfaces, recording.

Unit – V

Control centre, instrumentation diagram, On line instrumentation in modern plants.

Text/Reference Books:

1. Nakra, ñ*Instrumentation, Measurement and Analysis*ò; Tata McGraw Hill, New Delhi.
2. Patranabis, D., ñ*Principles of Industrial Instrumentation*ò 2nd ed. Tata McGraw Hill, New Delhi.
3. Eckman, D.P., ñ*Industrial Instrumentation*ò Wiley Eastern, 1978.
4. Liptak, B.G., ñ*Industrial Engineers' Handbook*ò Vol.1 and 2, CRC Press, 1994.
5. Andrew, W.G., et al., ñ*Applied Instrumentation in the Process Industries*,ò Gulf Pub.1993.
6. Wightman, E.J., ñ*Instrumentation in Process Control*,ò Butterworth, 1972.
7. Doebelin, E., ñ*Measurement Systems: Applications and Design*,ò 4th ed., McGraw Hill, 1990

IC CHEMICAL TECHNOLOGY

3L MM: 100 Ex. Hrs.: 3

Study of the following chemical industries/processes involving processes details, production trend, thermodynamic construction, waste regeneration/recycling and safety, environmental and energy conservation measures.

Unit – I

Salts Sodium compounds, soda ash, Caustic soda, Chlorine and potassium salts.

Unit – II

Hydrochloric acid, sulphur and sulfuric acid, Phosphoric acid and phosphates.

Unit – III

Nitrogenous Industries, Ammonia and Nitric acid, Nitrogenous Fertilizer, mixed fertilizers, N-P-K Fertilizers and micronoutrients.

Unit – IV

Cement, Ceramic and Glass industries, Industrial gases : Nitrogen, Oxygen, Hydrogen, Helium and Argon.

Unit – V

Inorganic chemicals namely Bromine, Iodine and Fluorine, Alumina and Aluminum chloride, Inorganic pigments.

Text/Reference Books:

1. Austin G.T.- *Shreeves Chemical Process Industries* ï 5th Ed., McGraw Hill 1984
2. Dryden C.E., M.Gopala Rao- *Outlines Of Chemical Technology* ï 3rd Ed. Affiliated East ï West Press, New Delhi.
3. Pandey G.N. ï *Chemical Technology Volum* E ï I ï Lion Press, Kanpur.

TRANSFER OPERATION – I

3L+1T MM: 100 Ex. Hrs.: 3

Unit – I

Diffusion phenomenon: Molecular and eddy diffusion in gases, liquids and solids, interface mass transfer Mass transfer theories : Film theory penetration theory and surface renewal theory.

Unit – II

Concept of Mass transfer coefficient: Individual and film coefficients, overall mass transfer co-efficient and their inter relationships. Continuous contact and differential contact, mass transfer concepts of NTU and HTU, their inter relationship.

Interphase Mass Transfer : Equilibrium, diffusion between phases, material balances, stages and concept of operating line and tie line.

Unit – III

Equipment for gas liquid contact : Sparged vessel, mechanically agitated vessel, tray towers, venture scrubber, wetted wall towers, spray towers and packed towers, tray tower vs packed tower.

Absorption : Absorption in continuous contact columns, Co-current, Counter current and cross current contacting of fluids, calculation of NTU and HTU, concept of HETP.

Unit – IV

Adsorption : Adsorption theories, types of adsorbent, activated carbon silica, silica and molecular sieves, Batch and column adsorption. Break through curves, gas adsorption, BDST models for adsorption calculation.

Unit – V

Drying: Equilibrium mechanism theory of drying, drying rate curve, Batch and continuous drying, working principle of different types of dryers such as tray driers, Drum dryers, spray and tunnel dryers.

Text/Reference Books:

1 Treybal, R.E.; ñ*Mass Transfer Operation"*, McGraw-Hill, 1980.
2 King, C.J. ñ*Separation Processes*ò, McGraw ï Hill, NY.
3 Smith, B.D., ñ*Design of Equilibrium stage Processes*ò, McGraw-Hill, NY
4 McCabe, W.L. Smith, J.C. and Harriot, P., ñ*Unit Operations of Chemical Engineering*ò, 6th ed, McGraw-Hill, NY.
5 Coulson, J.M. and Richardson, J.F., ñ*Chemical Engineering*ò, Vol. I and II, Asian Books Pvt., New Delhi.

THODS IN CHEMICAL ENGINEERING

2L+1T MM: 100 Ex. Hrs.: 3

Unit – I

Linear Algebraic Equations : Introduction, Gauss-Elimination, Gauss-Siedel and LU Decomposition Methods, Thomasô algorithm.

Eigen Values and Eigen Vectors of Matrices: Introduction, Fadeev Leverrierôs method, Power method, Householderôs and Givensô method.

Unit – II

Nonlinear, Algebraic Equations: Single variable and multivariable successive substitution method, single variable and multivariable newton-Raphson technique, Polynomial rood finding methods

Unit – III

Ordinary differential Equations ï Initial Value Problems: Explicit Adams ï Bashforth technique, Implicit Adams-Moulton technique, Predictor-corrector technique, Runge-Kutta methods, stability of algorithms.

Unit – IV

Ordinary differential equations ï Boundary Value Problems: Finite difference technique, Orthogonal collocation (OC), Orthogonal collocation on finite Elements (OCFE), Galerkin Finite Element (GFE) technique, shooting techniques.

Unit – V

Partial differential Equations: Partial Differential Equations (PDE) Classification of PDE, Finite difference technique (Method of lines), Orthogonal collocation. Case Studies. Use of spreadsheets in Chemical Engineering.

Text/Reference Books:

1. Gupta, S.K., ñ*Numerical Methods for Engineers*ò, New Age International Ltd. New Delhi, 1995.
2. Hanna, O.T. and Sandall, O.C., ñ*Computational Methods in Chemical Engineering*ò Prentice-Hall, 1975

GINEERING THERMODYNAMICS-II

3L+1T MM: 100 Ex. Hrs.: 3

Unit – I

Review of first law and second law of thermodynamics

Volumetric Properties of Pure Fluids : PVT behavior of pure substances virial equation an its applications, cubic equations of state, generalized correlations for gases and liquids.

Heat Effects: Sensible heat effect, heat effects accompanying phase changes of pure substances, standard heats of reaction, formation and combustion, effect of temperature on the standard heat of reaction.

Unit – II

Thermodynamic Properties of Fluids: Fundamental property relations, Maxwellôs equations, Residual properties, clapeyronôs Equation, Generalized correlations for thermodynamic properties of gases.

Unit – III

Multicomponent Systems : Chemical potential, ideal-gas mixture, ideal solution, Raoultôs Law. Partial properties, fugacity and fugacity coefficient, generalized correlations for the fugacity coefficient, excess Gibbsô energy, activity coefficient.

Unit – IV

Phase Equilibria at low to moderate pressures: phase rule, phase behavior for vapor liquid systems, Margules equation, Van laar equation, Wilson equation, NRTL equatiojn. Dew point, bubble point and flash calculations.

Solution Thermodymics : Ideal solution, fundamental residual ï property relation, fundamental excess ï property relation. Evaluation of partial properties. Heat effects of mixing processes. Partially miscible systems.

Unit – V

Chemical Reaction Equilibria : Reaction coordinate, equilibrium criteria to chemical reactions, standard Gibbsô energy change and the equilibrium constant. Effect of temperature on the equilibrium constant, evaluation of equilibrium constants. Relations between equilibrium constants and compositions: gas-phase reactions, liquid- phase reactions, Calculation of equilibrium compositions for single- phase reactions. Multireaction equilibria.

Text/Reference Books:

1. Smith, J.M.; Van Ness, H.C. and Abbott, M.M., ñ*Introduction to Chemical Engineering Thermodynamics*ò, 6th Ed. McGraw ï Hill, 2001
2. Rao, Y.V.C, ñ*Chemical Engineering Thermodynamics*ò University Press, 1997

Elective – III

5CH6.1: ANALYTICAL TECHNIQUES

3L MM: 100 Ex. Hrs.: 3

Unit – I

Components of instruments for optical spectroscopy : Components and configuration of instruments for optical spectroscopy, radiation sources, sample contains, radiation detection, signal processor and vadouts.

An Introduction to absorption Spectroscopy : Terms employed in absorption spectroscopy, quantitative aspects of absorption measurements

Unit – II

Application of Ultraviolet and visible Spectroscopy: Absorption species, typical instruments, application of absorption measurements to qualitative and quantitative Measurement.

Infra Red Absorption Spectroscopy : Theory of infrared absorption, infrared instruments qualitative and quantitative application.

Unit – III

Raman Spectroscopy: Theory of Raman spectroscopy, instrumentation application of Raman spectroscopy

Nuclear Magnetic Resonance Spectroscopy : Theory of instrumentation of NMR, application of protein NMR to analysis of compounds.

Unit – IV

Mass Spectroscopy : Theory of Flame Spectroscopy, flame characteristics, atomizer for atomic spectroscopy atomic absorption spectroscopy.

Atomic Spectroscopy : Theory of Flame Spectroscopy, flame characteristics, atomizer for atomic spectroscopy, atomic absorption spectroscopy.

Unit – V

Polarography: Theory of polarogrphy, instrumentation and qualitative and quantitative application.

Gas Chromatorgraphy : Principle of gas liquid chromatography, instrumentation, application of gas liquid chromatography.

Text/Reference Books:

1. D. Holen and H.Peck, ñ*Analytical Biochemistry*ò Longman, 1983.
2. . Wilson and J. Walker, ñ*Practical Biochemistry*ò University Press, 2000

Elective – III

5CH6.2 : FERTILISER TECHNOLOGY

3L MM: 100 Ex. Hrs.: 3

Unit – I

Introduction: Plant nutrients, different types of fertilizers and their production in India.

Unit – II

Nitrogenous Fertilizers: Different feed stocks, synthesis gas production by steamnaptha reforming and gas purification. Ammonia synthesis, Urea manufacturing processes. Manufacture of sulphuric acid and ammonium sulphate. Nitric acid and ammonium nitrate manufacture.

Unit – III

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

Unit – IV

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

Unit – V

Engineering Problems: Fertilizers Storage and handling. Corrosion problems in fertilizers industries. Fertilizer plant effluent treatment and disposal.

Text/Reference Books:

1. Slack A.V. ñ*Chemistry and Technology of Fertilizers*ò, Wiley linter science Publishers.
2. Waggaman W.H., ñ*Phosphoric Acid, Phosphates and Phosphatic Fertilizers*ò Hafner Pub.
3. Austin G.T., ñ*Shreve's Chemical Processes Industries*ò, 5th Ed. McGraw Hill.
4. Rao M.G. and Sittig M., ñ*Dryden's Outlines of Chemical Technology*ò, Affiliated East West Press, Delhi.

Elective – III

5CH6.3 : ENERGY RESOURCES AND UTILISATION

3L MM: 100 Ex. Hrs.: 3

Unit – I

Introduction: Synthetic fuels and their manufacture introduction and classification of fuels, Fundamentals, Units and their conversions, Properties of coal, oil shale, and Tar Sands.

Unit – II

Solid Fuels: Wood, Wood charcoal and Peat. Origin, Composition, Characteristics, and Significance of constituents of coal, Petrography of coal, washing of coal, storage of coal. Pulverised fuel/coal, Uses of coal, comparison of Solid, Liquid, and Gaseous fuels. Selection of coal, Mineral matters in coal ash, and clinker formation; Properties and testing of coal, Classification of coal, Carbonization of coal ï coke making and byproducts recovery, Characteristics and distribution of Indian coals, Briqueting of Solid fuel/coal.

Unit – III

Liquid Fuels/Petroleum Refining : Origin, Composition, Classification, and constituents of petroleum: Indian crudes, Processing of Crude oil:Distillation, Cracking- Thermal and Catalytic, Reforming ï Thermal and catalytic, Polymerisation, Alkylation, and Isomerisation, Purification of Petroleum products, Antiknock value and Requisites of good quality gasoline, diesel and fuel oil, Liquidfuels from coal by hydrogenation/ liquefaction, other liquid fuels- Benzol, shale oil, alcohol, and colloidal fuels, Storage and Handling of Liquid fuels/Fuel oils.

Unit – IV

Gaseous Fuels : Methane, Wood Gas, Gobar gas, Sewage gas, Gas from underground gasification of coal, Natural gas, LPG, Refinery gases, Producer gas, and Water gas.

Unit – V

Furnaces: Introduction, Waste heat recovery in furnaces, Classification of furnaces.
Nuclear Fuels and their Utilization : Introduction, nuclear fuel resources in India, Nuclear reactors ï introduction, Classification of nuclear reactors, Types of nuclear reactors.

Text/Reference Books:

1. Gupta, O.P., ñ*Fuels, Furnaces Refractories*ò, Khanna Publishers, Delhi 2000
2. Probstein, R.F. and Hicks, R.E., ñ*Synthetic Fuels*,ò McGraw Hill, NY, 1985.
3. Sarkar, S., ñ*Fuels and Combustion*,ò 2nd ed., Orient Longman, Bombay, 1990

L REACTION ENGINEERING – I

3L+1T MM: 100 Ex. Hrs.: 3

Unit – I

Introduction : Definition of reaction rates, variable affecting reaction rates, classification of reactions, order, molecularity.

Unit – II

Kinetics of Homogenous Reactions: Concentration dependent term of a rate equation, temperature dependent term of a rate equation, searching for a mechanism.

Interpretation of Batch Reactor Data: Constant volume batch reactor, variable volume batch reactor, temperature and reaction rate.

Unit – III

Introduction to Reactor Design : Ideal reactors for single reaction: Ideal batch reactor, steady state mixed flow Reactor, steady state PFR, Holding time and space time for flow systems.

Design for single reactions: Size comparison, multiple reactor systems, recycle reactor, auto catalytic reactions.

Design for multiple reactions: Reactions in parallel, reactions in series, series ï parallel reactions.

Unit – IV

Temperature and Pressure Effects on Reactions: Single reactions: Heat of reaction, equilibrium constants, graphical design procedure, optimum temperature progression, adiabatic operations. Multiple reactions: Product distribution and temperature.

Unit – V

Stability of Multiple Steady – States : Multiple steady-states of a CSTR with a first order reaction, Ignition ï extinction curve.

Text/Reference Books:

1. Levenspiel, O., ñ*Chemical Reaction Engineering*ò 3rd ed., John Wiley & Sons, Singapore 1999.
2. Fogler, H.S., ñ*Elements of Chemical Reaction Engineering*ò 3rd ed., Prentice Hall of India, 2003.
3. Smith, J.M. ñ*Chemical Engineering Kinetics*ò, 3rd McGraw-Hill, 1981.
4. Dawande S.D. ñ*Principles of Chemical Reaction Engineering*,ò 2nd ed., Central Techno Publications, Nagpur, 2003.
5. Richardson, J.F. and peacock D.G., ñ*Coulson and Richardson's Chemical Engineering*,ò Vol.3, 3rd ed. Asian Books Pvt. Ltd. New Delhi 1998.

TRANSFER OPERATION –II

3L+1T MM: 100 Ex. Hrs.: 3

Unit – I

Distillation : Vapor liquid Equilibria, Boiling point diagram, Relative volatility, flash and differential distillation for two component mixture, steam distillation, azeotropic distillation, extractive distillation.

Continuous and differential contact distillation: Rectification, reflux ratio and its importance, Minimum reflux, total and optimum reflux ration, material balance and Q-line equation, open steam, multiple feed and multiple product calculations, Enthalpy concentration diagram, panchon-Savarit and McCabe Theile method for calculation of number of plates. Approximate wquation; Fensky and underwood equation for minimum reflux and minimum number of plate calculation, Batch distillation.

Unit – II

Liquid – Liquid extraction : Liquid-Liquid equilibrium, packed and spray column, conjugate curve and tie line data, plait-point, ternary liquid-liquid extraction, co-current, counter current and parallel current system, selection of solvent for extraction.

Unit – III

Leaching : Solid-liquid equilibrium, Equipment, principles of leaching, co-current and counter current systems and calculation of number of stage required.

Unit – IV

Humidification : General theory, psychometric chart, fundamental concepts in humidification and dehumidification, drybulb and wet bulb temperature, adiabatic saturation temperature, measurement of humidity calculation of humidification operation, cooling towers and related equipments.

Unit – V

Crystallization : Supersaturation, methods to achieve supersaturation, Factors governing nucleation and crystal growth rates, controlled-growth of crystals, super saturation curve, principle and design of batch and continuous type crystallizers, Inverted soliability, fractional crystallization.

Text/Reference Books:

1. Treybal, R.E; ñ*Mass Transfer Operation*ò, McGraw-Hill,1980.
2. King, C.J. ñ*Separation Process"*, McGraw-Hill, NY.
3. Smith, B.D., ñDesign of Equilibrium stage Processesò, McGraw-Hill, NY.
4. McCabe, W.L., Smith, J.C. and Harriot, P., ñUnit Operation of Chemical Engineeringò, 6th ed, McGraw-Hill, NY.
5. Coulson, J.M. and Richardson, J.F., ñChemical Engineeringò, Vol. I and II, Asian Books Pvt., New Delhi.

S DYNAMICS AND CONTROL

3L+1T MM: 100 Ex. Hrs.: 3

Unit – I

Introduction to process control and review of Laplace transforms

Linear Open-Loop Systems : Firstï order Systerms : Transfer Function, Transient response (step response, impulse response, sinusoidal response) examples of first ï order systems, response of first order systems in series : non-interacting systems and interacting systems. Second ï order systems: transfer function, step response, impulse response, k sinusoidal response, transportation lag.

Unit – II

Linear closed-loop Systems : Control System: components of a control system, block diagram, negative feedback and positive feedback, servo problem and regulator problem.

Unit – III

Controller and final control element: Mechanism of control valve and controller, transfer functions of control valve and controllers (P, PI, PD, PID). Example of a chemical reactor control system.

Unit – IV

Closed-Loop Transfer functions: Overall transfer function for single-loop systems, overall transfer function for set-point change and load change, multi-loop control systems.

Transient Response of simple control systems: P and PI control for set- point change and for load change.

Unit – V

Stability : Concept of Stability, Stability criteria, Routh test for stability, Root Locus.

Frequency Response : Introduction to Frequency Response, Bode Diagrams for First and second order systems, Bode stability Criteria, Ziegler-Nichols and Cohen-coon Tuning Rules.

Text/Reference Books:

1. Coughanowr, D.R., ñ*Process Systems Analysis and control*ò 2nd ed. McGraw-Hill, 1991.
2. Stephanopoulos, G., ñ*Chemical Process Control*ò PHI, 1984.
3. Luyben, W.L. ñ*Process Modeling, Simulation and Control for Chemical Engineers*,ò McGraw Hill, 1973.

C CHEMICAL TECHNOLOGY

3L MM: 100 Ex. Hrs.: 3

Study of organic process industries/processes involving, Process details, production trend, thermodynamics consideration, flowsheets, engineering problems pertaining to material of construction, waste regeneration/ recycling and safety, environmental and energy conservation measures.

Unit – I

Pulp and paper industry, soaps, detergents, dyes and dyes intermediates.

Unit – II

Agro based alcohol industries, production of cane sugar, molasses, formation of alcohol, alcohol derivatives like acetic acid, acetic anhydride, vinyl acetate, ethylene glycol, pyridine.

Unit – III

Intermediates for petrochemical from petroleum based stocks, phenol, methanol, ethylene, proplene, aromatic benzene, toluene and xylene acrylonitrite, stylene, butadiene.

Unit – IV

Carbohydrates and sugar, insecticides and pesticides.

Unit – V

Man made fibers, rayon, polyester, polyamides and acrylics, cellulose and acetate.

Text/Reference Books:

1. Austin G.T.- *Shreeves Chemical Process Industries* ï 5th Ed., McGraw Hill 1984.
2. Dryden C.E., M. Gopala Rao-*Outlines of Chemical Technology*-3rd Ed. Affiliated East-West Press, New Delhi.
3. Pandey G.N.-*Chemical Technology Volume*-I, Lion Press, Kanpur.

CTROLEUM REFINING

3L+1T MM: 100 Ex. Hrs.: 3

Unit – I

Introduction: World Petroleum resources, petroleum industry in India, origin, exploration, drilling, composition and classification of petroleum crude, ASTM, TBP and FEV and production of petroleum crude, transportation and pretreatment of crude oil.

Unit – II

Distillation of crude oil Atmospheric and Vacuum distillation. Properties and specification of petroleum products-LPG, Gasoline, naphtha, kerosene, diesel oil, lubricating oil, wax etc Testing and uses of petroleum products. Safety and pollution considerations in refineries

Unit – III

Conversion process: Thermal and catalytic in vapor, liquid and mixed phases, Hydro cracking, Thermal reforming, Polyforming and plat forming, Catalytic reforming

Unit – IV

Conversion of petroleum gases into motor fuel with reference to Alkylation, Polymerization, Isomerisation, Hydrogenation, Production of aviation gasoline, motor fuel, kerosene, diesel oil and jet fuel**..**

Unit – V

Vacuum distillation: Design and operation of topping and vacuum distillation units. Tube still furnaces solvent extraction, uses of lubricating oils & waxes, Chemical & clay treatment of petroleum products, Desulphurization

Text/Reference Books:

1. Nelson, W.L., ñPetroleum Refinery Engineering,ò 4th Ed., McGraw Hill, 1987
2. Garry, J.H. and Handwrek, G.E. ñPetroleum Refining, Technology and Economicsò 2nd Ed., Marcel-Dekker
3. Prasad, R., ñPetroleum Refining Technologyò Khanna Publishers, Delhi, 2000
4. Kobe, K.A., and Mcketta, J.J. ñAdvances in Petroleum Chemistry and Refiningò, Wiley Interscience
5. Gruse, W.A. and Steven, D.R. ñChemical Technology of Petreleumò McGraw Hill
6. Rao, M.G. and sitting, M. ñDrydenôs Outlines of Chemical Technologyò, East West Press, 1997

Elective -IV

6CH6.1 : INTRODUCTION TO OIL/FAT TECHNOLOGY

3L MM: 100 Ex. Hrs.: 3

Unit – I

Characteristics of Oilseed, Oils and fats
Oil Milling and Solvent Extraction

Unit – II

Oil Processing for Vanaspati and Refined Oil
Specialty Fats

Unit – III

Packaging of Oils and fats

Unit – IV

Oil and Fats Derivatives

Unit – V

Health and Nutrition
Engineering Aspects

Text/Reference Books:

1. Swern, D. (ed.) ñ*Bailey's Industrial Oil and Fat Products*,ò 4th Ed. John Wiley and Sons, NY 1982
2. Hilditch, T.P., ñ*The Industrial Chemistry of Fats and Waxes*,ò 3rd ed. Bailliere, Tindall and Cox, London, 1949
3. Patterson, H.B.W. ñ*Handling and storage of Oilseeds, Oils Fats and Meat"* Elsevier Applied Science, Landon 1989

Elective-IV

6CH6.2: RUBBER SCIENCE AND TECHNOLOGY

3L MM: 100 Ex. Hrs.: 3

Unit – I

Rubber Science : Classification of polymers ï Thermoplastic, elastomers (rubber), thermosets, Description of elastomers- rubber vulcanizates, classification of rubbers, glass rubber transition behavior, Rubber physics-elastic behaviour.

Unit – II

Rubber Rheology: Flow behaviour of unvulcanized rubber compounds, measurement of plasticity, viscoelasticity and relaxation properties, Rheological models

Unit – III

Natural Rubber : Hevea Brasiliensis, Preservation and concentration of NR latex, Comparison of natural rubber and synthesis CIS 1,4 polyisoprene, Special features and uses of natural rubber

Synthetic Rubber: Polymerization methods, addition polymerization and condensation polymerization

Unit – IV

Rubber Compounding : Introduction to rubber compounding bulcanization and its effects, vulcanization systems, vulcanizate physical properties and their significance, properties desired for different rubber compounds, compounding ingredients and formulations.

Unit – V

Rubber Processing : Mixing, extrusion, and molding techniques.

Manufacture of Rubber Products : Pneumatic tyres, lates products, rubber footwear and rubber moulded products

Rubber Characterization : Rubber Compound analysis and identification of rubber. Behavior in service.

Text/Reference Books:

1. Blow, C.M. and Hepburn, ñ*Rubber Technology and Manufacture*ò 2nd ed. Butterworth, London, 1982.
2. Evans, C.M. ñ*Practical Rubber Compounding and processing*ò Elsevier Applied Science Publisher, 1981.
3. ñ*Rubber Engineering*ò by Indian Rubber Institute published by Tata McGraw-Hill, 1998

Elective –IV

6CH6.4 INTRODUCTION TO PULP AND PAPER TECHNOLOGY

3L MM: 100 Ex. Hrs.: 3

Unit – I

Introduction : Present status of pulp industries: Fivrous raw materials, Fibre Chemistry.
Raw Material Preparation : Debarking, chipping, chip screening, storage.

Unit – II

Pulping : Chemical, semi chemical, mechanical, chemimechanical and nonconventional. Secondary fibre pulping. Advances and recent trends in pulping.
Pulp Manufacture : Stock preparation, beating and refining, functional and control additives for papermaking, wet-end chemistry, polymer chemistry, retention sizing.

Unit – III

Bleaching : Objective of bleaching, bleachability measurement, bio-bleaching
Chemical Recovery : Composition and properties of black liquor, oxidation and desilication, concentration of black liquor and its incineration, causticizing and clarification sludge washing and burning.

Unit – IV

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

Unit – V

Paper Properties : Physical (Optical, strength and resistance) Chemical and electrical properties, paper defects
Paper Grades : Types, composition, manufacturing techniques, properties and uses

Text/Reference Books:

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

L REACTION ENGINEERING - II

3L+1T MM: 100 Ex. Hrs.: 3

Unit – I

Catalysts : Description, method of preparation and manufacture; catalyst characterization ï BET surface area, pore volume, pore size distribution.

Catalyst Reaction Kinetic Models : Physical and chemical absorption; determination of rate expressions using absorption, surface reaction and desorption as rate-controlling steps.

Unit – II

Determination of Global Rate of Reaction : Heterogeneous laboratory reactors; Determination of rate expressions from experimental data.

Unit – III

Effect of Intrapellet Diffusion on Reaction Rates in Isothermal Pellets : Concept of effectiveness factor, Thiele modulus, experimental determination of effectiveness factor- wesiz-Prater criteria, Non-Isothermal effectiveness factor; Prater number, maximum temperature rise in a pellet, multiple steady states in heterogeneous reactors.

Unit – IV

Non-catalytic Gas-Solid Reactions : Progressive conversion model, Shrinking core model; various controlling regimes, design of gas-solid reactors.

Unit – V

Gas-Liquid Reactions : Effect of diffusion on rate of reaction, enhancement factor.

Introduction to Design of Heterogeneous Reactors : One dimensional model for fixed-bed reactors, parametric sensitivity; design of fluidized bed reactors.

Text/Reference Books:

1. Levenspiel, O., ñ*Chemical Reaction Engineering*ò 3rd Ed., John Wiley, 1999.
2. Smith, J.M., ñ*Chemical Engineering Kinetics*ò 3rd Ed., Mc Graw-Hill, 1981.
3. Fogler, H.S., ñ*Elements of Chemical Reaction Engineering*ò 3rd Ed., Prentice-Hall of India, Delhi, 2003.
4. Carberry, J.J., ñ*Catalytic Reaction Engineering*ò Mc Graw-Hill, 1976.
5. Dawande, S.D., ñ*Principles of Reaction Engineering*ò Central Techno Pub., Nagpur, 2001.
6. Levenspiel, O., ñ*The Chemical Reactor Omnibook*ò OSU Bookstores, Corvallis Oregon, 1996.

/CH2/7FT3/BT703 – TRANSPORT PHENOMENA

3L+1T MM: 100 Ex. Hrs.: 3

Unit – I

Newtonôs law of viscosity, pressure and temperature dependence of viscosity, theory of viscosity of gases (low density), and liquids, convective momentum transport. Shell momentum balances, boundary conditions, selected applications.

Unit – II

The equation of change for isothermal system. Navier stokes equation. Use of equation of change to solve steady state flow problems. Comparisons of laminar and turbulent flows, time smoothed equations of change for incompressible fluids. The time smoothed velocity profile near a wall, turbulent flow in ducts and jets.

Unit – III

Fourierôs law of heat conductions, temperature and pressure dependence of thermal conductivity. Thermal conductivity of gases, liquids, solids and composite solids.

Unit – IV

Shell energy balance, boundary conditions, heat conduction with an electrical heat source, nuclear heat source, viscous heat source, chemical heat source, composite walls and fins. Forced convection, and free convection.

Unit – V

Fickôs law of diffusions, analogy with heat & mass transfer. Transport by molecular motion, shell mass balance and boundary conditions, temperature and pressure dependence of diffusivities, concentration profile for stagnant gas film, a heterogeneous chemical reactions, homogenous chemical reaction and porous catalyst.

Text/Reference Books:

1 Bird, R.B., Steward W.E. and Lightfoot, E.N., ñTransport Phenomenaò John Wiley.
2 Christie J. Geankophis, ñTransport process and Unit operationsò. Prentice-Hall, India.

ESS EQUIPMENT DESIGN

3L MM: 100 Ex. Hrs.: 3

Unit – I

Heat Exchangers : Auxiliary calculations; Review of Kern method; Bellôs method and HTRI method of Shell-and-tube heat exchanger design; Plate heat exchanger design; finned tube heat exchanger; Optimization of shell-and-tube exchanger.

Unit – II

Reboliers : Design of Kettle and thermosyphon reboilers.
Evaporators : Sizing of drum; central core pipe size and number of tubes for short and long tube evaporators.

Unit – III

Agitated Vessels : Design of mixing vessels, gas-spraying systems; impellers, propellers, anchors and helical ribbon-type agitators.

Unit – IV

Gas Liquid Contact Systems : Distillation column, Absorption tower, tray hydraulics of sieve and valve trays; Design of packed bed columns.

Unit – V

Design of Reactors: CSTR, Batch and packed bed.

Text/Reference Books:

1. Sinnott, R.K., ñ*Coulson and Richardson's Chemical Engineering*ò Vol. 6, 3rd Ed., Butterworth Heinmann, New Delhi, 2002.
2. Kern, D.Q., ñ*Process Heat Transfer*ò McGraw-Hill, 1950.
3. Evans, F.I., ñ*Equipment Design Handbook*ò 2nd Ed., Vol.2, Gulf Publishing, 1980.
4. Smith,B.D., ñ*Design of Equilibrium Stage Process*ò Mc Graw-Hill, 1963.
5. Dawande, S.D., ñ*Process Design of Equipments*,ò 2nd Ed., Central Techno Publications, Nagpur, 2000.

ION OF CHEMICAL PROCESSES

3L+1T MM: 100 Ex. Hrs.: 3

Unit – I

Formulation of the objective function.
Unconstrained single variable optimization: Newton, Quasi-Newton methods, polynomial approximation methods.

Unit – II

Unconstrained multivariable optimization: Direct search method, conjugate search method, steepest decent method, conjugate gradient method, Newtonôs method.

Unit – III

Linear Programming : Formulation of LP problem, graphical solution of LP problem, simplex method, duality in Linear Programming, Two-phase method.

Unit – IV

Non Linear programming with constraints : Necessary and sufficiency conditions for a local extremum, Quadratic programming, successive quadratic programming, Generalized reduced gradient (GRG) method.

Unit – V

Applications of optimization in Chemical Engineering.

Text/Reference Books:

1. Edgar, T.F., Himmelblau, D.M., Lasdon, L.S. ñ*Optimization of Chemical Process*ò 2nd ed, McGraw-Hill, 2001.
2. Rao, S.S., ñ*Optimization Techniques*ò Witey Eastern, New Delhi, 1985.
3. Gupta, S.K., ñ*Numerical Methods for Engineers*ò New Age, 1995.
4. Beveridge, G.S. and Schechter, R.S., ñ*Optimization Theory and Practice*ò McGraw-Hill, New York, 1970.
5. Rekllaitis, G.V. Ravindran, A. and Ragsdell, K.M., ñ*Engineering Optimization – Methods and Applications*ò John Wiley, New York, 1983.

OLECULAR BIOLOGY

3L+3P MM: 100 Ex. Hrs.: 3

Unit- I

Introduction: Living systems and their properties, Measure biological compounds, Physiological processes, Introduction to environment, Evolution, Ecology, Biogeography regions.

Unit – II

Biomolecules: Chemistry and function of the constituents of cells- water, Salts, Amino acids, Proteins and its synthesis, nucleic acids, Metabolism of carbohydrates, Lipids, Introduction to enzymes and their action, Hormones.

Unit – III

Cell biology: Prokaryotic and Eukaryotic cells, Organization of plant and animal cells, Organelles- structure, Chemical composition, function.

Unit – IV

Cellular processes and information transfer: Carbon and Nitrogen cycles in nature, Glycolysis, TCA cycle, Signal transduction, Receptor concept.

Unit – V

Genetics: Facts and theories of heredity, Elements of population genetics and species concept, Mendel's laws-segregation, independent assortment, Phenotype and Genotype, Mono- and di- hybrid crosses, Chromosomes, Gene concept, DNAï Protein interactions, Central Dogma-DNA Replication, RNA Transcription and its control, RNA Processing, Protein Translation, Translation mechanism of gene expression, Genetic code, Prokaryotic and Eukaryotic genomes, Introduction to the methods of introducing genes into the recipient cells- transformation, Transudation, Conjugation.

Text/Reference Books:

1. Jain S.K. ñFundamentals Molecular Biologyò CBS Publisher, 2004
2. Srivastava ñMolecular Biology and Biotechnology ñCBS Publisher, 2007
3. Singh ñMolecular Biology: A Complete Courseò CBS Publisher, 2008

ELECTIVE V
7CH6.1 – BIOPROCESS ENGINEERING

3L MM: 100 Ex. Hrs.: 3

Unit – I

Introduction to Bioprocesses

Historical development of bioprocess technology, an overview of traditional and modern applications of biotechnology industry, outline of an integrated bioprocess and the various (upstream and down stream) unit operations involved in bioprocess, generalized process flow sheets.

Unit – II

Fermentation Process-I : General requirements of fermentation processes, Basic design and construction of fermentor and ancillaries, Main parameters to be monitored and controlled in fermentation process;

Fermentation Process-II : An overview of aerobic and anaerobic fermentation processes and their application in the biotechnology industry, solid-substrate, slurry fermentation and its applications, whole cell immobilization, behaviour of microbes in different reactors (air lift, fluidized, batch, continuous fed batch condition).

Unit – III

Media Design : Medium requirements for fermentation process, Carbon, nitrogen, minerals, vitamins and other complex nutrients, oxygen requirements, medium formulation for optimal growth and product formation, examples of simple and complex media, design and usage of various commercial media for industrial fermentations.

Sterilization : Thermal death kinetics of microorganisms, batch and continuous heat. Sterilization of liquid media, filter sterilization of liquid media, Air, Design of sterilization equipment.

Unit – IV

Metabolic Stoichiometry : Stoichiometry of Cell growth and product formation, elemental balances, degrees of reduction of substrate and biomass, available electron balances, yield coefficients of biomass and product formation, maintenance coefficients.

Energetics : Energetic analysis of microbial growth and product formation, oxygen consumption and heat evolution in aerobic cultures thermodynamic efficiency of growth.

Unit – V

Kinetics of Microbial Growth and Product Formation : Phases of cell growth in batch cultures. Simple unstructured kinetic models for microbial growth, Monod Model, Growth of Filamentous organisms, Growth associated (Primary) and non growth associated (secondary) product formation Kinteics. Leudeking-Piret models, substrate and product inhibition on cell growth and product formation, introduction to Structured Models for growth and product formation.

Text/Reference Books:

1. Biochemical Engineering Fundamentals Balley and Ollis, McGraw Hill (2nd Ed.), 1986.
2. Bioprocess Engineering, Shule and Kargi, Prentice Hall, 1992.
3. Stanbury, P.F., Whitaker, A., & Hall, S.J., (1998), Principles of fermentation Technology, 2nd ed., Elsevier Science Publishers, BV, Amsterdam.

ELECTIVE V

7CH6.2 – PROCESS SAFETY AND HAZARD MANAGEMENT

3L MM: 100 Ex. Hrs.: 3

Unit – I

Origin of process hazards, laws codes, standards, case historics, properties of chemicals, health hazards of industrial substances.

Toxicology : Toxic materials and their properties, effect of dose and exposure time, relationship and predictive models for response, threshold value and its definitions, material safetydata sheets, industrial hygiene evaluation.

Unit – II

Fire & Explosion : Fire and explosion hazards, causes of fire and preventive methods. Flammability characteristics of chemical, fire and explosion hazards, rating of process plant. Propagation of fire and effect of environmental factors, ventilation, dispersion, purifying and sprinkling, safety and relief valves.

Unit – III

Other Energy Hazards : Electrical hazards, noise hazards, radiation hazard in process operations, hazards communication to employees, plant management and maintenance to reduce energy hazards.

Unit – IV

Risk Analysis : Component and plant reliability, event probability and failure, plant reliability, risk analysis, HAZOP AND HAZAN, event and consequence analysis (vapour cloud modeling) Designing for Safety, measurement and calculation of risk analysis.

Unit – V

Hazard Assessment : Failure distribution, failure data analysis, modeling for safety, safety training, emergency planning ad disaster management, case studies.

Text/Reference Books:

1. Crawl D.A. and Louvar J.A., ñChemical Process Safety fundamentals with applicationsò, Prentice Hall of India, New Delhi
2. Wentz, C.A. ñSafety Health and Environmental Protectionò McGraw Hill, 2001
3. Smith, B.D. ñDesign of Equilibrium State Processò McGraw Hill
4. Van Winkle, ñDistillationò, McGraw Hill

ELECTIVE V
7CH6.3 – SUGAR TECHNOLOGY

3L MM: 100 Ex. Hrs.: 3

Unit – I

Sugar Industry and sugar scenario in India and world. Raw materials such as Sugar cane and beet root and their availability.
Raw materials and their preparation, continuous operations, cane processing, weighment, chopping, grading crushing, milling and imbibition. Seeparation of bagase and bagacillo.

Unit – II

Juice purification ï screening filtration, chemical treatment, sulfitation, carbonization, precipitation and clarification. Working of filter press, vacuum filtration and dorrclarifier settler.

Unit – III

Concentration of clarified juice in multi effect evaporation, triple and quadruple effect, and capacity, stream economy, Co-current and countercurrent flow of juice in the evaporators.

Unit – IV

Operations of vacuum pan. Theory of sugar crystallization, strike- pans sugar crystallizers. Crystal drying, screening and grading.

Unit – V

Sugar Industry bye products ï bagasse, press mud, molasses; mud wax captive power and their utilization.

Text/Reference Books:

1. Birch and Parket, ñSugar Sciences and Technologyò App. Sci Pub.
2. Hong. P. ñPrinciples of Sugar Technologyò 3rd ed., Elsevier New York
3. Gopal Rao and Marshal Sitting, ñDryden Outlines of Chemical Technology,ò East-West Press, 3rd ed., New Delhi 1977
4. Austin, G.T., ñShreveôs Chemical Process Industries,ò 5th Ed. McGraw Hill Book Co. Singapore.

GINEERING AND PLANT DESIGN

4L+1T MM: 100 Ex. Hrs.: 3

Unit – I

Process Design and Development : General design considerations: The hierarchy of chemical process design, the nature of process synthesis and analysis.

Unit – II

Developing a conceptual design and finding the best flowsheet : input information and batch versus continuous, input/output structure of the flowsheet; Recycle structure of the flowsheet; Separation system; Heat Exchanger Networks.

Unit – III

Plant Design : Process design Development and general design considerations.

Unit – IV

Process Economics : Economic feasibility of project using order-of-magnitude cost estimates, plant and equipment cost estimation, product cost estimation.

Unit – V

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

Text/Reference Books:

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

USTRIAL MANAGEMENT

3L MM: 100 Ex. Hrs.: 3

Unit – I

Business Forms and Organization : Form of Business: (i) Single proprietorship (ii) Partnership (iii) Joint Stock Company, Private Limited Companies and Public Limited Companies, forming Joint Stock Companies (a) Registration (b) Issue of Prospectus (c) Commencement Certificate (d) Co-operative society. Choice of business forms (e) State undertaking Organization.

Unit – II

Finances and Financial Statements : Introduction, needs of finance, Kinds of Capital, Sources of fixed capital, shares (i) Ordinary shares (ii) Preference shares, Borrow capital-surplus profits, Depreciation Allowance. Specialized Financial Institutions, sources of working capital, Management of working capital. Rates commentaries.

Unit – III

Personnel Management : Origin and Evolution. Meaning and Content, different definitions of personnel manager. Functions of personal manager; Recruitment, grievances, methods of settlement, Absenteeism, labour turnover, Employees morale and satisfaction. Welfare provisions. Retirement pensions, Gratuity, discharge and dismissals, merit rating.

Unit – IV

Production/Operations Management : Overview, Choice of technology; Forecasting, transportation, assignment, PERT/CPM, Total Quality Management (TQM), Just in Time (JIT).

Corporate Management : Board of Directors : Role and function. Top management: Role and skill.

Unit – V

Strategic Choices : Strategic alternatives, diversification, mergers and acquisitions.

Marketing : Marketing of services, understanding consumers, product management, pricing and promotional strategies, sales, distribution strategy and control.

ANALYSIS AND SIMULATION

4L+1T MM: 100 Ex. Hrs.: 3

Unit – I

Introduction to modeling and simulation. Analysis of Models : Role of analysis, basic concepts of analysis, an analysis process, simple examples, source of model equations.

Unit – II

Conservation equations of mass, energy and momentum, constitutive equations, control volume, dimensional analysis, stability analysis, sensitivity analysis.

Unit – III

Formulation of Process Models : Development of model equations for simple isothermal non-reacting and reacting liquid systems for both steady state and unsteady state conditions.

Unit – IV

Isothermal two phase systems and rate of mass transfer, equilibrium staged processes, non-isothermal systems. Modeling of distillation column, absorber, heat exchanger, heat transfer in a jacketed verssel.

Unit – V

Chemical Process Simulation : Introduction to simulation methodologies, process flowsheet simulators.

Text/Reference Books:

1. Russell, T.W.F. and Denn, M.M. ñIntroduction to Chemical Engineering Analysis.ò John wiley, NY 1972
2. Denn, M.M. ñProcess Modelingò, NY, 1990
3. Holland, C.D., ñFundamentals of Modeling Separation Processes,ò Prentice Hall, 1975
4. Biegler, L., Grossmann, I.E. and Westerberg, A.W., ñSystematic Method of Chemical Engineering and Process Design,ò Prentice Hall, 1975
5. Hussain, A., ñChemical Process Simulation,ò Wiley Eastern, N. Delhi, 1986
6. Walas, S.M., ñModeling with Differential Equations in Chemical Engineeringò Butterworth 1991.

ELECTIVE - VI
8CH4.1 : BIOCHEMICAL TECHNOLOGY

3L MM: 100 Ex. Hrs.: 3

Unit – I

Overview of industrial bioprocesses with emphasis on new material.

Unit – II

Microorganisms/enzyme, metabolic pathway, yield, bioprocess, chemical engineering operations and applications.

Unit – III

Solvents, enzymes, organic acids.

Unit – IV

Antibiotics, vitamins.

Unit – V

Pharmaceutical products.

Text/Reference Books:

1. Atkinson, B. andMavituna, F., ñBiochemical Engineering and Biotechnology Handbook,ò Nature Press, Macmillan, 1983
2. Glazer, A.N. and Nikaido, H., ñMicrobial Biotechnology: Fundamentals of Applied Microbiology,ò WH Freeman & Co., New York, 1995
3. Reed, G. (Ed.), ñPrescott & Dunnôs Industrial Microbiologyò 4th Ed., CBS Publishers & Distributors, New Delhi, 1999.

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ELECTIVE - VI
8CH4.2 : MULTIPHASE FLOW

3L MM: 100 Ex. Hrs.: 3

Unit – I

Introduction to the flow of multiphase mixture : Gas or vapor-liquid, liquid-liquid, liquid-solid, gas-solid, solid-liquid-gas and gases carrying solids (pneumatic transport) stratification and disperson, Flow regimes and flow patterns.

Unit – II

Gas (vapor) and Liquid Flows : Horizontal flow, Vertical flow, pressure, momentum and energy relations, methods of evaluation pressure drop. Lockhard-Martinell, Chisholm correlations, critical flow, non-Newtonian flow.

Unit – III

Solid -Gas Flow : Effect of pipeline diameter, inclination, bends, valves and length. Liquid and its physico-chemical properties, rheology, corrosive nature, viscosity, Solid particle size, distribution phase, and density i.e. their factors effecting behavior in a fluid, concentration of particles and the flow rates of both solids and liquid.

Unit – IV

Solid –Gas Flow : Horizontal flow, Suspension mechanism, determination of voids, energy requirements for conveying, pressure drop and solid velocities in dilute phase flow, dense phase conveying, vertical transport.

Unit – V

Bubble and drop formation : Phase holdups, Interfacial areas, mixing and pressure drops, multiphase (Gas liquid solid) Operations.

Text/Reference Books:

1. Govier, G.W. and Aziz K., ñThe Flow of Complex Mixtures in Pipe,ò Krieger Publication Florida, 1982
2. Coulson JM and Richardson J.F. ñChemical Engineering,ò Vol-I, Butterworth-Heinmann, Oxford, 1999

LECTIVE - VI
8CH4.3 : CATALYTIC PROCESSES

3L MM: 100 Ex. Hrs.: 3

Unit – I

Review of Heterogeneous Catalysis.

Unit – II

Transport Processes : Analysis of external transport processes in heterogeneous reactions in fixed ed, fluidized bed and slurry reactors, Intrapellet mass transfer, heat transfer, mass transfer with chemical reaction and simultaneous mass and heat transfer with chemical reaction.

Unit – III

Catalyst Selectivity : Effect of intrapellet diffusionon on selectivities in complex reactions, effect of external mass transfer on selectivities.

Unit – IV

Catalyst Deactivation : Modes of deactivation ï poisoning, fouling and sintering. Determination of deactivation routes, combined effect of deactivation and diffusion on reaction rates, effect of deactivation on selectivity.

Unit – V

Reactor Design : Design calculation for ideal catalytic reactor operating at isothermal, adiabatic and non-adiabatic conditions. Deviations from ideal reactor performance. Design of industrial fixed-bed, fluidized bed and slurry reactors, Thermal stability of packed bed and fluidized bed reactors.

Text/Reference Books:

1. Smith, J.M., ñChemical Engineering Kinetics,ò 3rd ed., McGraw-Hill, 1981
2. Carberry, J.J., ñCatalytic Reaction Engineering,ò McGraw-Hill, 1977.
3. Lee, H.H., ñHeterogeneous Catalytic Reactors,ò Butterworth
4. Tarhan, M.O., ñCatalytic Reactor Design,ò McGraw-Hill, NY 1983
5. Anderson, J.R. and Boudart, M., ñCatalysis, Science and Technology,ò Vol.7., Springer Verlag. N.Y.
6. Thomas, J.M. and Thomas, W.J., ñIntroduction to the Principles of Heterogeneous Catalysis,ò Academic Press, 1967.

R SCIENCE AND TECHNOLOGY

3L MM: 100 Ex. Hrs.: 3

Unit – I

Chemistry of Polymerization Reactions : Functionality, polymerization reactions, polycondensation, addition free radical and chain polymerization. Copolymerization, block and graft polymerizations, stereospecific polymerization.

Unit – II

Polymerization Kinetics : Kinetics of radical, chain and ionic polymerization and co-polymerization systems.

Unit – III

Molecular Weight Estimation : Average molecular weight: number average and weight average. Theoretical distributions, methods for the estimation of molecular weight.

Unit – IV

Polymerization Processes : Bulk, solution, emulsion and suspension polymerization. Thermoplastic composites, fibre reinforcement fillers, surface treatment reinforced thermoset composites ï Resins, Fibres, additives, fabrication methods.

Unit – V

Rheology : Simple Rheological response, simple linear viscoelastic models ï Maxwell,, Voigt, material response time, temperature dependence of viscosity, Rheological studies.

Text/Reference Books:

1. Rodringuez, ñPrinciples of Polymer Systemsò, Tata McGraw Hill, 1970
2. Billmayer Jr. and Fred. W., ñTextbook of Polymer Scienceò, Wiley Tappers, 1965
3. David, J.W., ñPolymer Science and Engineeringò, Prentice Hall, 1971
4. Schmidt, A.K. and Marlies, G.A., ñHigh Polymers ï Theory and Practiceò, McGraw Hill, 1948
5. McKelvey, J.M., ñPolymer Processing, ñJohn Wiley, 1962
6. Manoriffs, R.W., ñMan-made Fibres,ò Wiley Inter Science.

8CH8 : NOVEL SEPARATION TECHNIQUES

3S MM: 100 Ex. Hrs.: 3

Unit – I

Introduction : Separation process in chemical and Biochemical industries, Categorization of separation process, equilibrium and rate governed processes. Introduction to various new separation techniques e.g. Membrane separation, Ion-exchange foam separation, supercritical extraction, liquid membrane, PSA & Freeze drying.

Unit – II

Membrane based separation technique (MBSTs) : Historical background, physical and chemical properties of membranes, Techniques of membrane preparation, membrane characterization, various types of membranes and modules.

Unit – III

Osmosis and osmotic pressure. Working principle, operation and design of reverse osmosis, ultrafiltration, microfiltration, electrodialysis and pervaporation. Gaseous separation by membrances.

Unit – IV

Ion Exchange : History, basic principle and mechanism of separation, Ion exchange resins, regeneration and exchange capacity. Exchange equilibrium, affinity, selectivity and kinetics of ion exchange. Design of ion exchange systems and their uses in removal of ionic impurities form effluents.

Unit – V

Introduction to foam separation, micellar separation, supercritical fluid extraction, liquid membrane permeation and chromatographic separation.

Text/Reference Books:

1. King, C.J., ñSeparation Processesò, Tata McGraw-Hill
2. Sourirajan, S. and Matsura, T., ñReverse Osmosis and Ultra-filtration ï Process Principlesò NRC Publication, Ottawa, 1985
3. Porter, M.C., ñHandbook of Industrial Membrane Technologyò Noyes Publication, new Jersey, 1990
4. Henry, J.d. and Li, N.N., ñNew Separation Techniquesò, AICHE Today Series, AICHE (1975)
5. Hatton, T.A., Scamehorn, J.F. and Harvell, J.H. ñSurfactant Based Separation Processesò, Vol. 23, Surfactant Science Series, Marcel Dekker Inc., New York 1989.