## DEPARTMENT OF CHEMICAL ENGINEERING

## B. TECH - CHEMICAL ENGINEERING (FT-PT)

| | | | | | | |
|---|---|---|---|---|---|---|
| **Semester - III** | | | | | | |
| 1 | BEE212 | ElectricalTechnology | 3 | 0 | 0 | 3 |
| 2 | BCT201 | Chemistry-II | 3 | 0 | 0 | 3 |
| 3 | BMA207 | Mathematics-III | 3 | 1 | 0 | 4 |
| 4 | BCT203 | Mechanical Engineering | 3 | 0 | 0 | 3 |
| 5 | BCE* | Mechanics of Solids | 3 | 0 | 0 | 3 |
| 6 | BBT207 | Bio-Chemistry | 3 | 0 | 0 | 3 |
| 7 | BCT209 | Chemistry Lab | 0 | 0 | 3 | 1 |
| 8 | BCE* | Strength of Materials Lab | 0 | 0 | 3 | 1 |
| | | **Total** | **18** | **1** | **6** | **21** |
| **Semester - IV** | | | | | | |
| 1 | BCT202 | Computer Applications in Chem Engg | 2 | 0 | 2 | 3 |
| 2 | BCT204 | Material Science and Technology | 3 | 0 | 0 | 3 |
| 3 | BCT206 | Industrial Microbiology | 3 | 0 | 0 | 3 |
| 4 | BCT208 | Chemical Process Industries- I | 3 | 0 | 0 | 3 |
| 5 | BCT210 | Instrumental Methods of Analysis | 3 | 0 | 0 | 3 |
| 6 | BMA212 | Statistics & Linear Programming | 3 | 1 | 0 | 4 |
| 7 | BBT212 | Biochemistry Lab | 0 | 0 | 3 | 0 |
| 8 | BCT214 | Technical Analysis Lab | 0 | 0 | 3 | 1 |
| 9 | BEE223 | Electrical Engg Lab | 0 | 0 | 3 | 1 |
| | | **Total** | **17** | **1** | **8** | **21** |
| **Semester - V** | | | | | | |
| 1 | BCT301 | Chemical Process Calculations | 3 | 0 | 0 | 3 |
| 2 | BCT303 | Fluid Mechanics | 3 | 0 | 0 | 3 |
| 3 | BBT305 | Molecular Cell Biology | 3 | 0 | 0 | 3 |
| 4 | BCT307 | Chemical Process Industries-II | 3 | 0 | 0 | 3 |
| 5 | BCT309 | Mechanical Operations | 3 | 0 | 0 | 3 |
| 6 | BMA301 | Numerical Methods | 3 | 1 | 0 | 4 |
| 7 | BBT311 | Micro & Molecular Biology Lab | 0 | 0 | 3 | 1 |
| 8 | BCT313 | Chemical Engineering Lab- I | 0 | 0 | 3 | 1 |
| | | **Total** | **18** | **1** | **6** | **21** |
| **Semester - VI** | | | | | | |
| 1 | BCT302 | Chemical Engineering Thermodynamics-I | 3 | 0 | 0 | 3 |
| 2 | BCT304 | Chemical Reaction Engineering- I | 3 | 0 | 0 | 3 |
| 3 | BCT306 | Mass Transfer -I | 3 | 0 | 0 | 3 |
| 4 | BCT308 | Heat Transfer | 3 | 0 | 0 | 3 |
| 5 | BCT310 | Process Instrumentation Dynamics & Control | 3 | 0 | 0 | 3 |
| 6 | BMA302 | special functions, diff equns & Z-transforms | 3 | 1 | 0 | 4 |
| 7 | BCT312 | Chemical Process Eqmnt Design&Drawing Lab-I | 1 | 0 | 3 | 4 |
| 8 | BCT314 | Chemical Engineering Lab- II | 0 | 0 | 3 | 1 |
| | | **Total** | **19** | **1** | **6** | **24** |
| **Semester - VII** | | | | | | |
| 1 | BCT401 | Chemical Engineering Thermodynamics-II | 3 | 0 | 0 | 3 |
| 2 | BCT403 | Process Economics & Industrial Management | 3 | 0 | 0 | 3 |
| 3 | BCT405 | Chemical Reaction Engineering- II | 3 | 0 | 0 | 3 |
| 4 | BCT407 | Mass Transfer- II | 3 | 0 | 0 | 3 |
| 5 | BBT409 | Bio Process Principles | 3 | 0 | 0 | 3 |
| 6 | BCT411 | Principles of Environmental Science & Engg | 3 | 1 | 0 | 4 |
| 7 | BCT413 | Chemical Process Eqmnt Design &Drawing lab-II | 1 | 0 | 3 | 4 |
| 8 | BCT415 | Chemical Engineering Lab-- III | 0 | 0 | 3 | 1 |
| 9 | BCT417 | Seminar & Comprehension | 0 | 2 | 0 | 1 |
| | | **Total** | **19** | **2** | **6** | **25** |
| **Semester -** | | | | | | |
| 1 | BCT402 | Total Quality Management | 3 | 0 | 0 | 3 |
| 4 | BCT404 | Transport Phenomena | 3 | 1 | 0 | 4 |
| 2 | BCT406 | Project Work | 0 | 2 | 12 | 6 |
| 4 | BCTE* | Elective- I | 3 | 0 | 0 | 3 |
| 5 | BCTE* | Elective- II | 3 | 0 | 0 | 3 |
| | | **Total** | **12** | **3** | **12** | **19** |

**Total Credits to be earned for the award of the Degree: 188**

**List of Electives**

| Code No. | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| BCTE402 | Fertilizer Technology | 3 | 0 | 0 | 3 |
| BCTE404 | Petrochemical Technology | 3 | 0 | 0 | 3 |
| BCTE406 | Drugs and Pharmaceutical Technology | 3 | 0 | 0 | 3 |
| BCTE406 | Polymer and Plastics Technology | 3 | 0 | 0 | 3 |
| BCTE408 | Food Technology | 3 | 0 | 0 | 3 |
| BCTE410 | Surface Coating Technology | 3 | 0 | 0 | 3 |
| BCTE410 | Electrochemical Engineering | 3 | 0 | 0 | 3 |
| BCTE412 | Environmental Engineering | 3 | 0 | 0 | 3 |
| BBTE414 | Biochemical Engineering | 3 | 0 | 0 | 3 |
| BBTE416 | Biomedical Engineering | 3 | 0 | 0 | 3 |
| BCTE418 | Process Automation | 3 | 0 | 0 | 3 |
| BCTE420 | Process Modelling and Simullation | 3 | 0 | 0 | 3 |
| BCTE422 | Optimisation of Chemical Processes | 3 | 0 | 0 | 3 |
| BCTE424 | Computer Aided Design | 3 | 0 | 0 | 3 |
| BCTE426 | Energy Management in Chemical Industries | 3 | 0 | 0 | 3 |
| BCTE428 | Safety in Chemical Process Industries | 3 | 0 | 0 | 3 |
| BCTE430 | Oils and Fats Technology | 3 | 0 | 0 | 3 |
| BBTE432 | Bio Catalytic Reaction Engineering and Design | 3 | 0 | 0 | 3 |
| BBTE434 | Bio Geo Chemical Engineering | 3 | 0 | 0 | 3 |
| BCTE436 | Creativity, Innovation and New Product Development | 2 | 0 | 2 | 3 |
| BCTE438 | Technical Writing and Communication | 3 | 0 | 0 | 3 |
| BCTE440 | Communication Skills for Engineers | 2 | 0 | 2 | 3 |
| BCTE442 | Intellectual Property Right (IPR) | 3 | 0 | 0 | 3 |
| BCTE444 | Indian Constitution and Society | 3 | 0 | 0 | 3 |
| BBTE446 | Bioinformatics | 3 | 0 | 0 | 3 |
| BBTE448 | Genetics | 3 | 0 | 0 | 3 |
| BBTE450 | Molecular Modelling & Drug Design | 3 | 0 | 0 | 3 |

Note: BMA* - Denotes coding for Mathematics subjects for which coding would be given after finalisation.

**SEMESTER III**

**BEE 212 ELECTRICAL TECHNOLOGY 3 0 0 3**

**1. DC CIRCUITS:** Introduction - circuit parameters - Kirchoffs laws - circuit reduction techniques - Thevenin's Theorem -Maximum power transfer theorem.

**AC CIRCUITS:** RMS and average velocity of periodic waves - form factor - phase and phase difference - RL, RC, RLC circuits - power and power factor - Introduction to three phase systems - solution of balanced three phase circuits.

**2. D.C. MACHINES**

Construction details of DC machines - principles of operation of DC generator - EMF equation - Characteristics of DC generators - principle of DC motor - Back EMF - Torque equation - Characteristics shunt, series and compound motors - Losses and efficiency - Starters - Speed control - applications.

**3. TRANSFORMERS**

Principles of ideal transformers - constructional details - EMF equation - Equivalent circuit - Voltage regulation - losses and efficiency - OC and SC tests on transformer - Autotransformer - Power supplies - basic principle of SMPS and UPS.

**4. SYNCHRONOUS MACHINES AND INDUCTION MOTORS CONSTRUCTION DETAILS - PRINCIPLES OF ALTERNATOR -**

Constructiona details - principle of alternator - EMF equation - Voltage regulation - starting of synchronous motor - effect of field excitation - Induction motor - principle of operation - torque equation - torque-slip characteristics - starting methods and speed control - principle of single-phase induction motor - applications ( Qualitative treatment only).

**5. ELECTRICAL DRIVES**

Types of Electrical drives - Factors influencing the Choice of Electrical Drives, Heating and Cooling Curves - Loading Conditions and Classes of Duty - Determination of Power Rating - Drives for textile mills, Steel rolling mills, machine tools and Cranes & Hoist Drives. (Quantitative Treatment only)

**Total No of periods: 45**

**Text Books**:

1. S.K.Battacharya, "Electrical Machines" Tata McGraw Hill Publications, 2nd Edition, 1998.
2. Sudhakar & Shyammohan, "Circuits & Networks Analysis & Synthesis", Tata McGrw Hill, 2001.

**References**:

1. J.A.Edminister, " Theory and Problems on Electrical Circuits" McGrw Hill, 1994.
2. I.J.Nagrath & D.P.Kothari, "Electrical Machines" , TMH publications.
3. "Hughes Electrical Techonology", Revised by I McKeenzie Smith, Low Price Edition, Pearson Education, 7th Ed.

**BCT201 CHEMISTRY-II** 3 0 0 3

**1. ORGANO METALLIC COMPOUNDS** 6

Grignard reagents and their synthetic utility - Organo Silicon compounds.

**2. HETEROCYCLIC COMPOUNDS** 8

Furan, Thiophone, Pyrrole, Pyridine, and Indole - Their important derivatives

**3. DYES AND DYEING** 8

Colur and Constitution - Synthesis of some important azodyes (Methyl orange, Methyl red and Congo red) - Synthesis of Triphenylmethane dyes (Malachite green, Para Rosaniline Anthraquinone dyes (Alizarin). - Phthalein dyes - Eosin preparation - Introduction to Natural and Reactive dyes

**4. PHARMACEUTICAL CHEMISTRY** 8

Synthesis of antimalarial drugs - Isopentaquine and chloroquine - Antibacterial drugs - Synthesis of sulphanilamide, sulphaphyridine.

**5. COLLOIDS** 7

Introduction to colloids - properties of colloids - Electrokinetic phenomena - Donnan Membrane equilibrium -Emulsions - Gels - colloidal electrolytes.

**6. PHOTOCHEMISTRY** 8

Laws of Photochemistry, Quantum efficiency, Photochemical reactions, Actinometry, Kinetics and mechanism of Hydrogen - Bromine reaction.

**Total No of periods:45**

**References*:***


1. Puri B.H. and Sharma L.R., " Principles of Physical Chemistry ", S.Nagin Chand and Company, Delhi (1994).
2. Kund and Jain, " Physical Chemistry ", S. Chand and Company, Delhi (1996).
3. Gordon M.Barrow, " Physical Chemistry ", Sixth Edition, Tata McGraw Hill (1998).
4. Agarwal, O.P., " Synthetic Organic Chemistry ", Vth Edition, 1980-81, Goel Publishing house, Meerut.
5. Ashutoshkar, " Medicinal Organic Chemistry ", New Age International Private Ltd., 1993, Chennai.
6. Bahl, B.S. and Arun Bahl, " Advanced Organic Chemistry ", IIIrd Edition(1994), Sultan Chand and sons, New Delhi.
7. Mrs. Lakshmi, S., " Pharmaceutical Chemistry ", First Edition (1995), Sultan Chand and Sons, New Delhi.
8.Morrison, R.T. and Boyd, R.N., " Organic Chemistry ", VI Edition, Prentice Hall Inc.(1996), USA.
9. Tiwari, K.S., Vishnoi, N.K. and Vishnoi, S.N., " A Text book of Organic Chemistry ", Second Edition, Vikas Publishing House (1998), New Delhi.


**BCT203 MECHANICAL ENGINEERING** 3 0 0 3

**1. LAWS OF THERMODYNAMICS** 10

Basic concepts and hints; Zeroth law; First Law of Thermodynamics - Statement and application; Steady flow energy equation; Second law of Thermodynamics - Statement; Limitations Heat Engine; Heat Pump, Available energy, Kelvin - Plank statement and Clausius statement; Equivalenceentropy; Reversibility: Entropy charts; Third law of Thermodynamics - Statement.

**2. HEATING AND EXPANSION OF GASES** 5

Expressions for; work done; Internal energy, Hyperbolic and polytropic processes; Free expansion and Throttling.

**3. AIR STANDARD EFFICIENCY** 5

Carnot cycle; Stirlings Cycle: Joule Cycle; Otto Cycle; Diesel Cycle; Dual combustion Cycle.

**4. I.C. ENGINES** 4

Engine nomenclature and classifications; SI Engine: CI Engine; Four Stroke cycle' Two stroke cycle; Performance of I.C. Engine; Brake thermal efficiency; Indicated Thermal Efficiency, Specific fuel consumption.

**5. STEAM AND ITS PROPERTIES** 4

Properties of steam; Dryness fraction; latent heat; Total heat of wet steam; Superheated steam. Use of steam tables; volume of wet steam; Volume of superheated steam; External work of evaporation; Internal energy; Entropy of vapour, Expansion of vapour, Rankine cycle; Modified Rankine cycle.

**6. STEAM ENGINES AND TURBINES** 3 Hypothetical indicator diagram of steam engine; Working of a simple steam engine; steam turbines - Impulse and Reaction types - Principles of operation.

**7. SIMPLE MECHANISM** 3

Kinematic Link, Kinematic Pair Kinematic Chain; Slider Crank mechanism and inversions; Double slider crank mechanism and inversions.

**8. FLY WHEEL** 4

Turning moment Diagram; Fluctuation of Energy; Design of fly wheel.

**9. DRIVES** 5

Belt and rope drives; Velocity ratio; slip; Ratio of tensions; Length of belt; Maximum HP; simple compound and Epicyclic gear trains.

**10. BALANCING** 2

Balancing of rotating masses in same plane; Balancing of masses rotating in different planes.

**Total No of periods: 45**

**Text Books:**


1. Smith, " Chemical Thermodynamics ", Reinhold Publishing Co., 1977.
2. Bhaskaran, K.A., and Venkatesh, A., " Engineering Thermodynamics ", Tata McGraw Hill, 1973.

3. Pandya A. and Shah, " Theory of Machines ", Charatakar Publishers, 1975.
4. Nag, P.E., " Engineering Thermodynamics ", II Edition, Tata McGraw Hill Publishing Co., Ltd., 1995.

**BCE 235 MECHANICS OF SOLIDS** 3 0 0 3

**1. STRESS, STRAIN AND DEFORMATIONS OF SOLIDS** 8

Rigid bodies and deformable solids - forces on solids and supports - equilibrium and stability - strength and stiffness - tension, compression and shear stresses - Hooke's law and simple problems - compound bars - thermal stresses - elastic constants and poission's ratio - welded joints - design.

**2. TRANSVERSE LOADING ON BEAMS** 6

Beams - support conditions - types of beams - transverse loading on beams - shear force and bending moment in beams - analysis of cantilevers, simply-supported beams and over hanging beams - relationships between loading, S.F. and B.M. in beams and their applications - S.F. & B.M. diagrams.

**3. DEFLECTIONS OF BEAMS** 8

Double integration method - Macaulay's method - Area - mement theorems for computation of slopes and deflections in beams - conjugate beam method.

**4. STRESSES IN BEAMS** 9

Theory of simple bending - assumptions and derivation of bending equation (M/I = F/Y = E/R) - analysis of stresses in beams - loads carrying capacity of beams - proportioning beam sections - leaf springs - flitched beams - shear stress distribution in beams - determination of shear stress in flanged beams.

**5. TORSION** 6

Torsion of circular shafts - derivation of torsion equation (T/J = C/R = Gq/L) - stresses and deformation of circular and hollow shafts - stresses and deformation of circular and hollow shafts - stepped shafts - shafts fixed at both ends - stresses in helical springs - deflection of springs - spring constant.

**6. COLUMNS** 7

Axially loaded short columns - columns of unsymmetrical sections - Euler's theory of long columns - critical loads for prismatic columns, with different end conditions - effect of eccentricity.

**Total No of periods:44**

**Text Books**:

1. Junarkar, S.B., " Mechanics of Structures ", Vol. I, 21st Edition, Character Publishing House, nand, India, (1995).
2. William A.Nash, " Theory and Problems of Strength of Materials ", Schaum's Outline Series, McGraw Hill International Editions, 3rd Edn.94.
3. Elangovan, A., " Thinma Visai Iyal " (Mechanics of Solids in Tamil), Anna University, Madras, 1995.

**BBT207 BIOCHEMISTRY** 3 0 0 3

**1. INTRODUCTION TO BIOMOLECULES** 5

Structure and properties of Mono, Di, Oligo and polysaccharides, complex carbohydrates, Structure and properties of Fatty acids, Glycerolipids, phospholipids, sphingolipids, glycolipids, steroids, Structure and properties of amino acids, Peptides, proteins and conjugated proteins. Structure and properties of purines, pyrimidines, nucleosides, nucleotides, polynucleotides, Ribonucleic acids and deoxy ribonucleic acids, nucleoprotein complexes.

**2. METABOLISM** 10

Biosyntheses and degradation of fatty acids and cholesterol, Biosyntheses and degradation of amino acids, peptides and proteins; Biosynthesis and degradation of amino acids, peptides and proteins, Biosyntheses and degradation of Purines, pyrimidines and nucleic acids.

**3 . INTERMEDIARY METABOLISM** 10

TCA Cycle, glycolysis, gluconeogenesis, Pentose phosphate shunt, Embden Meyerhof pathway, urea cycle, interconnection of pathways, Metabolic regulation, Bioenergetics: Respiratory chain, TP cycle, energy rich compounds.

**4. STRUCTURE FUNCTION RELATIONSHIP** 10

Complex carbohydrates, proteins and nucleic acids.

**5. TUTORIAL** 10

**Total No of periods: 45**

**Text Books:**

1. Lehninger A.L., Nelson D.L., Cox M.M., " Principles of Biochemistry ", CBS Publications, 1993.
2. Voet D., Voet G., " Biochemistry ", Second Edition, John Wiley and Sons, 1994.
3. Stryer L., " Biochemistry ", Fourth Edition, 1994.

**BMA207 MATHEMATICS III** 3 1 0 4

**1. FOURIER SERIES** 9

Dirichlet's conditions - General Fourier series - Half range Sine & Cosine series - Parseval's identity - Complex form of Fourier series - Harmonic Analysis.

**2. FOURIER TRANSFORMS** 9

Statement of Fourier integral theorem - Fourier transform pairs - Fourier Sine and Cosine transforms - Properties - Transforms of simple functions - Convolution theorem - Parseval's Identity.

**3. PARTIAL DIFFERENTIAL EQUATIONS** 9

Formation - Solutions of standard types of first order equations - Lagrange's equation - Linear partial differential equations of second and higher order with constant coefficients.

**4. ONE DIMENSIONAL WAVE EQUATION AND HEAT EQUATION 9**

Classification of second order partial differential equations - Transverse vibrations of a string - one-dimensional heat equation in Cartesian and polar forms - Fourier series solutions.

**5. TWO DIMENSIONAL HEAT EQUATION 9**

Steady state heat flow - Two-dimensional Laplace equation in Cartesian and Polar forms - Fourier series solutions.

**Tutorials : 15 hrs**

**Total No.of Hours : 60**

**Text Books:**

Grewal,B.S., " Higher Engineering mathematics" (35th ed.), Khanna Publishers, Delhi, (2000).

Kreyszig,E., " Advanced Engineering mathematics" (8th ed.), John Wiley & Sons, (Asia Pvt.Ltd.), singpore, (2001).

**Reference Books:**

Kandasamy,P., Thilakavathy,K., & Gunavathy,K., "Engineering Mathematics" Vol.II & III ( 4th Revised Edition), S.Chand & Co., New Delhi,(2001).

Narayanan,S., Manicavachagam Pillay,T.K., Ramanaiah,G., "Advanced Mathematics for Engineering Students", Vol.II & III, S.Viswanthan(Printers & Publishers Pvt.Ltd.), Chennai, (2001).

Ventkatraman,M.K., "Engineering Mathematics", Vol.III-A & B, National Publishing Company, Chennai, (2003)

**BCT209 CHEMISTRY LAB 0 0 3 2**

1. Ore/alloy analysis
2. Pigment Analysis
3. Industrial Waste Water Analysis
4. Estimation of Phenol
5. Analysis of fertilizers
6. Sugar Analysis
7. Polymer Analysis

**BCE 273 STRENGTH OF MATERIALS LAB 0 0 3 2**

1. Port timing diagram
2. Valve timing diagram
3. Study of 2,4 stroke I.C. Engines.
4. Study of steam engine and Gear box
5. Load test on 4 stroke Villiers Petrol Engine.
6. Load test on 4 stroke Lister Diesel Engine
7. Load test on 4 stroke P.S.G. Diesel Engine
8. Compression test
9. Deflection test
10. Hardness test (Rockwell and Brinnel)
11. Spring test
12. Study on behaviour of columns
13. Torsion test
14. Impact test.

**SEMESTER IV**

**BCT202 Computer Applications in Chemical Engg 2 0 2 3**

**1. INTRODUCTION 4**

Review on Programming languages, Basic, Fortran, Review on operating system commands.

**2. SPREAD SHEETS 7**

Application in Density, molecular weight, mole and percentage compositions, Empirical and Molecular formula calculations, Heat of mixing, Gas laws, Vapor pressure, Chemical Kinetics calculations.

**3. SPREAD SHEETS (DATA ANALYSIS) 7**

Application in data processing, Statistical analysis of data, Regression Analysis of variance, interpolation, Graphical representations.

**4. DATABASE 7**

Design and developments of simple databases on Chemical and Physical properties of substances. Retrieval and Databases in report, query and other formats, Interfacing with other software.

**5. MATHEMATICAL PROGRAMMING 5**

Linear Programming, Transportation, Assignment, Dynamic Programming in Chemical Engineering, Formulation and Solution through PC based programs.

**6. PRACTICALS 30**

**Total No of periods:60**

**References*:***

1. Jerry, O., Breneman, G.L., " Spreadsheet Chemistry ", Prentice Hall, Englewood Cliffs, 1991.

2. Hanna, O.T., Scandell, O.C., " Computational Methods in Chemical Engineering ", Prentice Hall, 1995.

3. Taxali, R.K., T.K., " dBase IV made simple ", Tata McGraw Hill 1991.
4. Myers, A.L., Seider W.D., " Introduction to Chemical Engineering and Computer Calculations ".

**BCT204 MATERIALSCIENCE & TECHNOLOGY 3 0 0 3**

**1. NATURE OF MATERIALS** **7**

Micro and macro structures, properties and definitions; mechanical, thermal, chemical, electrical and magnetic properties, processing of metals and alloys - casting - hot and cold rolling - extrusion - forging - deep drawing -plastic deformation of metal, single crystals and polycrystalline metals - recovery and recrystallization of plastically deformed metals.

**2. FERROUS METALS** **8**

Pure iron; cast iron; mild steel, stainless steels, special steels and alloys; high temperature steels; iron - iron carbide phase diagram; heat treatment of plain - carbon steels. Manufacture, properties and application in chemical industries.

**3. NON-FERROUS METALS** **16**

Lead, tin and magnesium; manufacturing methods, properties and application in process industries.

**NON METALS**

i. ***POLYMERIC MATERIALS***

Polymerization reactions - Industrial polymerization methods - Crystallinity and stereo-isomerism in same thermoplastics - thermosetting elastomers - creep and fracture of polymeric materials.

ii. ***COMPOSITE MATERIALS***

Fiber - reinforced - plastic composite materials - manufacturing methods - concrete - asphalt and asphalt mixtures - wood - sandwich structures.

iii. ***CERAMIC MATERIALS***

Ceramic crystal and silicate structures processing of ceramics - properties - glasses - enamels.

**4. INORGANIC MATERIALS** **3**

Manufacture of cement and its properties; special cement; cement concrete; reinforced and pre stressed concrete: their properties and applications; mixing and curing.

**5. CORROSION** **6**

Definition and scope; basic theories and mechanism of corrosion; types of corrosion; application of corrosion theories in equipment design and fabrication - anti-corrosion methods.

**6. COATINGS** **3**

Organic paints and coatings; metal coatings; ceramic coatings; lining.

**7. SELECTION OF MATERIALS** **2**

General criteria for selection of materials of construction in process industries.

**Total No of periods:45**

***References:***

1. Carl, A. and Keyser, C.E., " Material Science in Engineering ", Marrill Publishing Company, 1968.
2. Leighou (Rober B), " Chemistry of Engineering Materials ", International Chemical Series, Ed by Hammett, P.B.
3. Henry R. Clauster, " Industrial and Engineering Materials ", McGraw Hill Book Company 1975.
4. Bhattacharya, B.C., " Selection of Material and Fabrication for Chemical Process Equipment (Question Based)", CEEDC, I.I.T., Madras.

**BCT206 Industrial Microbiology 3 0 0 3**

**UNIT - I INTRODUCTION** **6**

Basic of microbial existence; history of microbiology, classification and nomenclature of microorganism, microscopic examination of microorganisms, light and electron microscopy; principles of different staining techniques like gram staining, acid fast, capsular staining, flagellar staining.

**UNIT - II MICROBES-STRUCTURE AND MULTIPLICATION** **12**

Structural organization and multiplication of bacteria, viruses, algae and fungi with a special mention of life history of actinomycetes, yeast, mycoplasma and bacteriophage.

**UNIT – III MICROBIAL NUTRITION, GROWTH AND METABOLISM** **12**

Nutritional requirements of bacteria and different media used for bacterial culture; growth curve and different methods to quantitate bacterial growth, aerobic and anaerobic bioenergetics and utilization of energy for biosynthesis of important molecules.

**UNIT - IVCONTROL OF MICROORGANISMS** **6**

Physical and chemical control of microorganisms; host-microbe interactions; anti-bacterial, anti-fungal and anti-viral agents, mode of action and resistance to antibiotics; clinically important microorganisms.

**UNIT - V INDUSTRIAL AND ENVIRONMENTAL MICROBIOLOGY** **9**

Primary metabolites; secondary metabolites and their applications; preservation of food; production of penicillin, alcohol, vit.b-12; biogas; bioremediation; leaching of ores by microorganisms; biofertilizers and biopesticides; microorganisms and pollution control

**Total hours: 45**

**Text Books**

1. Pelczar MJ, Chan ECS And Krein NR, Microbiology, Tata McGraw Hill Edition, New Delhi, India.

**Reference:**

1. Talaron K, Talaron A, Casita, Pelczar And Reid. Foundations In Microbiology, W.C.Brown Publishers, 1993.
2. Prescott LM, Harley JP, Klein DA, Microbiology, 3rd Edition, Wm. C. Brown Publishers, 1996.

**BCT208 CHEMICAL PROCESS INDUSTRIES -I** **3 0 0 3**

**1. INTRODUCTION** **5**

Chemical processing, the role of chemical engineers in process industries, importance of block diagrams and flow charts, unit operations, unit processes, process utilitie sand economics, industrial safety and pollution, outline plant and equipment design, process control and instrumentation.

**2. WATER IN INDUSTRY** **2**

Role of water treatment methods for industrial and domestic use, recovery of waste water, water conditioning.

**3. INDUSTRIAL GASES** **4**

Synthetic gas, natural gas, carbon dioxide sulphur-di-oxide, acetylene, helium and argon, hydrogen, oxygen, nitrogen.

**4. MARINE CHEMICALS** **2**

Sodium chloride, By-products of common salt industry, value added product.

**5. CHOLORO - ALKALI INDUSTRIES** **4**

Soda ash and sodium bicarbonate, Chlorine and caustic soda; bleaching powder and related bleaching agents, hydrochloric acid.

**6. SULPHUR AND SULPHURIC ACID INDUSTRIES** **3**

Minging and manufacturing of Sulphur, recovery of sulphur from polluting gases, sulphur trioxide and sulphuric acid.

**7. PHOSPHORUS INDUSTRIES** **3**

Phosphate rock, benefaction, phosphoric acid-phosphate.

**8. NITROGEN INDUSTRIES** **2**

Synthesis ammonia and nitric acid

**9. FERTILISER INDUSTRIES** **6**

Growth elements, Function, Nitrogenous fertilizers, Ammonium sulfate, Ammonium Nitrate and Urea, Phosphatic fertilizers, single and triple superphosphate, Ammonium phosphate, Nitro phosphate, Potassium Fertilizers, Potassium Chloride, Potassium Nitrate and phosphate, Compound fertilizers and bio-fertilizers.

**10. AGRICHEMICAL INDUSTRIES** **2**

Insecticides, pesticides, herbicides, plant nutrients and regulators

**11. NUCLEAR INDUSTRIES** **3**

Production of uranium, thorium and zirconium from ores and minerals, separation of isotopes, waste disposal.

**12. EXPLOSIVES AND PROPELLANTS INDUSTRIES** **2**

Explosives, types and characteristics, industrial and military explosives, propellants for rockets.

**13. ELECTROLYTIC AND ELECTROTHERMAL INDUSTRIES** **2**

Abrasives, Carborondum, Calcium Carbide, Aluminium and Magnesium.

**14. SURFACE COATING INDUSTRIES** **2**

Paints, pigments, varinishes, lacquirs, industria, and marine coatings.

**15. PHOTOGRAPHIC CHEMICALS** **2**

Photographic chemicals, manufacture of films, plates and papers, recovery.

**Total No. of Periods: 44**

***References:***

1. Austin, G.T. Shreve, " Chemical Process Industries ", Fifth Edition, McGraw Hill International Book Co., Singapore, 1984.
2. Dryden, C.E., " Outlines of Chemicals Technology ", Edited and Revised by Gopala Rao, M. and Sitting, M., Second Edition, Affiliated East-West Press, 1993.
3. Kent, J.A.(ed), Riggel, " Hand book of Industrial Chemistry ", Van Nostrant Reinhold, 1974.
4. "Chemtech 1-4", Chemical Engineering Education Development Centre, I.I.T., Madras 1975-1978.

**BCT210 INSTRUMENTAL METHODS OF ANALYSIS** **3 0 0 3**

**1. INTRODUCTION TO SPECTROSCOPIC METHODS OF ANALYSIS** **9**

ELECTROMAGNETIC RADIATION: Various ranges, Dual properties, Various energy levels, Interaction of photons with matter, absorbance and transmittance and their relationship, Permitted energy levels for the electrons of an atom and simple molecules, Classification of instrumental methods based

on physical properties. QUANTITATIVE SPECTROSCOPY: Beer-Lambert's Law, Limitations, Deviations (Real, Chemical, Instrumental). Nesslerimetry, Duboscq colourimetry, Estimation of inorganic ions such as Fe, Ni and estimation of Nitrite using Beer-Lambert's Law.

**2. MOLECULAR SPECTROSCOPY** **9**

Various electronic transitions in organic and inorganic compounds effected by UV, Visible and infra red radiations, Various energy level diagrams of saturated, unsaturated and carbonyl compounds, excitation by UV and Visible radiations, Woodward-Fischer rules for the calculation of absorption maxima (dienes and carbonylcompounds), Effects of auxochromes and effects of conjugation on the absorption maxima, Instrumentation for UV, VISIBLE and IR spectroscopies (Source, Optical parts and Detectors), Multicomponent analysis, Photometric titration (Experimental setup and various types of titrations), Applications of UV, VISIBLE AND IR spectroscopies.

**3. ATOMIC SPECTROSCOPY** **4**

Atomic absorption spectrophotometry: Principle, Instrumentation and Applications, Various interferences observed in AAS (Chemical radiation and excitation).

**4. POLARIMETRY AND REFRACTOMETRY** **3**

Principle, Instrumentation and Applications

**5. ELECTROMETRIC METHODS OF ANALYSIS** **7**

Introduction to electrometric methods, difference between redox and acid-base reactions, types of cells, schematic representation of cells, single electrode potential, laboratory reference electrodes (Standard hydrogen, saturated calomel, Ag - AgCI and inert electrodes), ion-selective electrodes. Potentiometry: Nernst equation, experimental set-up and measurement of pH; Conductometry - Measurement of conductance, experimental set-up and various titrations (strong and weak acid/base).

**6. XRD ANALYSIS** **3**

Introduction, Mosley's law, Different emission and diffraction methods, various X-ray detectors.

**7. THERMAL METHODS** **5**

Thermogravimetry: Instrumentation, factors affecting the shapes of thermograms, applications, thermograms of some important compounds (CuSO4, 5H2O, CaC2O42H2O etc). Differential thermal analysis : Principle, Instrumentation and applications, differences between DSC and DTA. Applications of DSC (Inorganic and Polymer samples).

**8. CHROMATOGRAPHIC METHODS** **5**

Classification of chromatographic methods, Column, Thin layer, Paper, Gas, High Performance Liquid Chromatographical methods (Principle, mode of separation and Technique). Separation of organic compounds by column and Thin layer, mixure of Cu, Co and Ni by Paper, separation of amino acids by paper, estimation of organic compounds by GC and HPLC.

**Total No of periods:45**

**References:**


1. Parikh V.M., " Absorption spectroscopy of organic molecules ", Addison - Wesley Publishing Company, 1974.
2. Willard, H.H., Merritt. I.I., Dean J.a., and Settle, F.A., " Instrumental methods of analysis ", Sixth edition, CBS publishers, 1986.
3. Skoog D.A. and West D.M., " Fundamentals of Analytical Chemistry ", Saunders-college Publishing, 1982.
4. Banwell, G.C., " Fundamentals of molecular spectroscopy ", TMH, 1992.
5. Vogel A.I., " Quantitative Inorganic analysis ", V.Edition.
6. Day R.A., Underwood A.L., " Qualitative Inorganic analysis", (A.I.Vogel), V.Edition, Prentice-Hall of India (P) Ltd., New Delhi, 1991.
7. Sharma, B.K., " Instrumental Methods of Analysis ", Goel publishing House, 1995.
8. Robert de Levie, " Principles of Quantitative Chemical Analysis", I Edition, Tata McGraw Hill, 1998.
9. Rouessac, F., " Chemical Analysis-Modern instrumental methods and techniques", Wiley-Publishers 1999.


**BMA212 STAISTICS & LINEAR PROGRAMMING** **3 1 0 4**

**1. PROBABILITY AND RANDOM VARIABLE**

Axioms probability - Conditional probability - Total probability - Bayes theorem - Random variable - Probability mass function - Probability density function - Properties - Moments - Moment generating functions and their properties.

**2. STANDARD DISTRIBUTIONS**

Binomial - Poison - Geometric - Negative binomial - Uniform - Exponential - Gamma, Weibull and normal distribution and their properties - Functions of random variable.

**3. TESTING OF HYPOTHESIS**

Sampling - Distribution - Testing of hypothesis for Mean , Variance - Proportions & differences using normal, Chi-square and distributions - Tests for independence of attributes and goodness of fit.

**4. LINEAR PROGRAMMING**

Formulation of linear programming problem - Graphical solution - Simplex algorithm - Artificial Variable - Big M method - Two phase method.

**5. FURTHER TOPICS IN LINEAR PROGRAMMING**

Duality - Primal dual computations - Dual simplex algorithm - Transportation and Assignment models.

**TEXT BOOKS:-**


1. Johnson,R.A., Miller "Probability and Statistics for Engineers, VI ed., Pearson Education, Delhi (2000).
2. Taha,H.A., "Operations Research - An introduction, VII ed., Pearson Education, New Delhi (2002).


**References:**


1. Walpole, R.E., Myers,S.L., and Ye,K. "Probability & Statistics for Engineers & Scientists, VII Ed., Pearson Education, Delhi (2002)

2. Gupta, S.C and Kapoor, J.N., "Fundamentals of Mathematical Statics., S.Chand & Co., 9th ed., New delhi (1996).
3. Manmoham, P.K and Gupta,S.C., "Operations Research" S.Chand & Co., 9th ed., New Delhi (2001).

**BBT 212 BIOCHEMISTRY LAB 0 0 3 2**

**LIST OF EXPERIMENTS**

Reactions of Monosaccharides; Reactions of Disaccharides; Reactions of Polysaccharides; Identification of Unknown Carbohydrate; Reactions of Albumin; Reactions of Casein; Reactions of Gelatin; Reactions of Peptodes; Identification of Unknown Protein; Separation techniques using TLC; Plant pigments; Secondary metabolites from plants;

- Minimum of TEN experiments shall be offered

**BCT214 TECHNICAL ANALYSIS LAB 0 0 3 2**

**List of Experiments**

1. Oil Analysis: (3 experiments)
   a) Acid value
   b) Saponification value
   c) Iodine value

2. Soap Analysis: (2 experiments)
   a) Alkali Content
   b) Fatty acid content of Soap

3. Estimation of purity of glycerol: by Dichromatic method
4. Analysis of water:
   Determination chlorine demand in water : Estimation of residual chlorine in water by Volumetric method

5. Cement Analysis (3 experiments)
   a) Estimation of silica content
   b) Estimation of calcium oxide content
   c) Estimation of mixed oxide content

6. Fertilizer Analysis:
   Estimation of Nitrozen in Urea by Kjeldals method

- **Minimum 10 experiments shall be offered.**

**BEE 223 ELECTRICAL ENGINEERING LAB 0 0 3 2**

**LIST OF EXPERIMENTS**

1. Open circuit characteristics of D.C. shunt generator.
2. Load characteristics of D.C. shunt generator
3. Load characteristics of D.C. compound generator
4. Load test of D.C.Shunt motor
5. Study of D.C.Motor starters
6. O.C. and S.C. tests on single phase transformer
7. Load test on single phase transformer.
8. Load test on 3 phase squirrel cage induction motor
9. Study of 3 phase induction motor starters
10. Load test on 3 phase slip ring induction motor
11. O.C. and S.C. tests on 3 phase alternator
12. Synchronization and V-curves of alternator

## SEMESTER V

**BCT301 CHEMICAL PROCESS CALCULATION 3 0 0 3**

**UNIT – I UNITS AND DIMENSIONS** **5**

Basic and derived units, use of model units in calcualtions, Methods of expression, compositions of mixture and solutions.

**UNIT - II GAS CALCULATIONS** **7**

Ideal and real gas laws - Gas constant - calculations of pressure, volume and temperature using ideal gas law. Use of partial pressure and pure component volume in gas calculations, applications of real gas relationship in gas calculation.

**UNIT - III MATERIAL BALANCE** **7**

Stoichiometric principles, Application of material balance to unit operations like distillation, evaporation, crystallisation, drying etc., - Material balance with chemical reaction - Limiting and excess reactants - recycle - bypass and purging - Unsteady state material balances.

**UNIT - IVHUMIDITY AND SATURATION** **7**

Calculation of absolute humidity, molal humidity, relative humidity and percentage humidity - Use of humidity in condensation and drying - Humidity chart, dew point.

**UNIT - V FUELS AND COMBUSTION** **6**

Determination of Composition by Orsat analysis of products of combustion of solid, liquid and gas fuels - Calculation of excess air from orsat technique, problems on sulphur and sulphur burning compounds.

**UNIT - VITHERMO PHYSICS** **6**

Heat capacity of solids, liquids, gases and solutions, use of mean heat capacity in heat calculations, problems involving sensible heat and latent heats, evaluation of enthalpy.

**UNIT - VII THERMOCHEMISTRY** **7**

Standard heat of reaction, heats of formation, combustion, solution, mixing etc., calculation of standard heat of reaction - Effect of pressure and temperature on heat of reaction - Energy balance for systems with and without chemical reaction. - unsteady state energy balances.

**Total No of periods: 45**

**Text Books**


1. Bhatt, B.L., Vora, S.M., " Stoichiometry ", Tata McGraw-Hill, 1976.
2. Himmelblau, D.M., " Basic Principles and Calculations in Chemical Engineering ",EEE Sixth Edition, Prentice Hall Inc., 2003 (with CD containing programmes and problems).


**References**


1. Process Calculation for Chemical Engineering, Second Revised Edition, Chemical Engineering Education Developement Centre, I.I.T., Madras, 1981.
2. Process Calculations, Venkataramani, V and Anantharaman, N, Prentice Hall of India Pvt. Ltd., 2003.


**BCT303 FLUID MECHANICS** **3 0 0 3**

**UNIT - I INTRODUCTION** **9**

The concept of fluid, the fluid as a continum - laws of dimensional homogeneity - properties of velocity field - thermodynamic properties of a fluid - viscosity and other secondary properties - basic flow analysis techniques - flow patterns.

**UNIT - II PRESSURE DISTRIBUTION IN A FLUID** **9**

Pressure and pressure gradient - equilibrium of fluid element - hydrostatic pressure distributions - applications to manometry - Hydrostatic forces on planed and curved submerged surfaces - laws of buoyancy and stability considerations for bodies in floatation.

**UNIT - III DIMENSIONAL ANALYSIS AND SIMILITUDE** **9**

The principle of dimensional homogeneity - the Pi-theorem - non-dimensional action of the basic equations - similitude - relationship between dimensional analysis and similitude - use of dimensional analysis for scale up studies.

**UNIT - IVVISCOUS FLOW IN DUCTS AND BOUNDARY LAYER FLOW** **9**

Reynold's number regimes, internal versus external viscous flow, flow in circular pipe - head loss, minor losses in pipe systems and multiple-pipe systems - boundary layer concepts, functions and pressure drag - flow through fixed and fluidised beds.

**UNIT - V FLOW MEASUREMENT AND TUBRO MACHINERY** **9**

Constant and variable headmeters - classification of pumps - performance curves - matching pumps to system charateristics, compressors and its efficiency.

**Total No of periods: 45**

**Text Books**


1. Noel de Nevers, " Fluid Mechanics for Chemical Engineers ", Second Edition, McGraw-Hill, 1991.
2. McCabe,W.L, Smith J.C and Harriot .P., " Unit Operations in Chemical Engineering ", McGraw-Hill, Sixth Edition 2000.


**References**


1. Shames, I.H., " Mechanics of Fluids ", Third Edition, McGraw-Hill Inc., 1992.
2. White, F.M., " Fluid Mechanics ", 4th Edition, McGraw-Hill Inc., 1999.
3. Daughenty, R.L., Franzini, J.B and Finnemore, E.J., " Fluid Mechanics with Engineering Applications ", SI metric Edn., McGraw-Hill Book Company, 1989.
4. Darby, R. Chemical Engineering Fluid Mechanics, Marcel Dokker, 1998.
5. Vennarol, J.K., Street, R.L. Elementary Fluid Mechanics. 6th Edition John Wiley & Sons. 1982.


**BBT305 MOLECULAR AND CELL BIOLOGY** **3 0 0 3**

**1. CELL STRUCTURE AND FUNCTION OF THE ORGANELLES**

Eukaryotic and Prokaryotic cells, Principles of membrane organisation, membrane proteins, cytoskeletal proteins, types of cell function, cell division, mitosis and meiosis, Extra cellular matrix, cell cycle and molecules that control cell cycle.

**2. CELL CULTURE**

Techniques for the propagation of prokaryotic cell and Eukaryotic cells. Cell line, generation of cell lines, maintenance of stock cells, charecterisation of cells, immunocyto chemistry, morphological analysis techniques in cell culture, explant cultures, primary cultures, contamination and differentiation, three dimensional cultures, role of matrix in cell growth.

**3. CLASSICAL GENETICS** **5**

Mendelian genetics, linkage, crossing over, classical experiments – Hershey and chase; Avery McLeod & McCarty. Bacterial conjugation, transduction and transformation.

**4. STRUCTURE AND FUNCTIONS OF NUCLEIC ACIDS** **15**

Conformation of DNA and RNA; replication in prokaryotes, models of replication, Organisation of eukaryotic chromosome – cot value, replication of telomeres in eukaryotes, Transcription - features of promoters and enhancers, RNA splicing, Translation - Genetic code. Gene regulation, mutation and repair.

**5. BASICS OF RECOMBINANT DNA TECHNOLOGY** **5**

Role of genes within cells, genetic elements that control gene expression, restriction and modifying enzymes, safety guidelines of recombinant DNA research.

**BCT307 CHEMICAL PROCESS INDUSTRIES-II 3 0 0 3**

**UNIT - I PULP AND PAPER INDUSTRIES 5**

Wood and Wood extracts – Wood Chemicals - Cellulose derivatives, Manufacture of pulp – different processes of pulping – Manufacture of paper – Manufacture of Boards

**UNIT - II SUGAR AND STARCH INDUSTRIES 4**

Raw and refined sugar, by products of sugar industries, Starch and starch derivatives.

**UNIT - III OILS, FATS, SOAPS AND DETERGENT INDUSTRIES 9**

Vegetable oils and animal fats, their nature, analysis and extraction methods, hydrogenation of oils, fatty acids and alcohols, waxes, soaps, synthetic detergents.

**UNIT - IVPETROLEUM AND PETROCHEMICAL INDUSTRIES 9**

Petroleum refining, physical and chemical conversion products, lubricating oils, petrochemical precursors, methane, olefines, acetylenes and aromatics and products obtained from them by various unit processes.

**UNIT - V RUBBER AND POLYMERS 9**

Monomers – Thermosetting and Thermoplastic materials – General properties and Applications of Resins – Polymerisation processes – different types - Natural rubber; Synthetic rubber such as SBR, NBR, CR - Fundamental methods of processing of synthetic Rubbers.

**UNIT - VISYNTHETIC FIBRE AND FILM INDUSTRIES 9**

Natural and synthetic fibres – properties of - Poly amides – manufacture of Nylon 6. 6. Polyesters Fibres – manufacturer of – Cellulosic Fibres – Viscose Rayon production manufacture of films - cellulose Acetate, PVC, Polyesters - polyethylene

**Total No of periods: 45**

**Text Books**

1. Austin, G.T., " Shreve's Chemical Process Industries ", Fifth Edition, McGraw-Hill International Book Co, Singapore, 1984.
2. Dryden, C.E., " Outlines of Chemical Technology ", Edited and Revised by Gopala Rao. M. and M.Sittig, Second edition, Affiliated East-West press, 1993.

**References**

1. Kent, J.A.(ed), " Riggel's Hand Book of Industrial Chemistry ", Van Nostrant Reinhold, 1974.
2. CHEMTECH 1-4, Chemical Engineering Education Development Centre I.I.T., Madras 1975-78.

**BCT309 MECHANICAL OPERATIONS 3 0 0 3**

**UNIT - I PARTICLE CHARACTERISTICS AND SIZE ANALYSIS 7**

General characteristics of solids, their behaviour under different external forces, agglomeration, techniques for size analysis.

**UNIT - II SIZE REDUCTION 8**

Laws of size reduction, classification of equipment, methods of size reduction, disintegration, preparation of colloids.

**UNIT - III MECHANICAL SEPARATIONS 9**

Screening and Screening equipment, effectiveness of screens, gravity settling, sedimentation, thickening, centrifugal separation,impingement methods, industrial dust removing equipment with special reference to electrostatic and magnetic separators, heavy media separations, floatation.

**UNIT - IVFILTRATION 7**

Theory of filtration, Batch and continuous filters, centrifuges, membrane and ultra filtration.

**UNIT - V MIXING AND AGITATION 7**

Equipment for blending and kneading, dispersion, power for agitation, correlations.

**UNIT - VISTORAGE AND CONVEYING OF SOLIDS 7**

Conveyors, elevators, pneumatic conveying, Different methods for storage of solids.

**Total No of periods: 45**

**Text Book**

1. McCabe,W.L, Smith J.C and Harriot, P., " Unit Operations in Chemical Engineering ", McGraw-Hill, Fourth Edition, 1984.

**References**

1. Coulson, J.M., Richardson, J.F., " Chemical Engineering ", Volume 2, Third Edition, Pergamon Press, 1977.

**BMA301 NUMERICAL METHODS 3 1 0 4**

**UNIT-I 9**

Curve Fitting Method of Group Averages - Principles of Least Squares - Method of Moments - Finite Differences - Operators E & Δ - Relationship between the Opeators.

**UNIT-II 9**

Interpolation - Newton & Legrange's Methods - Trapezoidal, Simpson's $1/3^{rd}$ rules & Weddles's rule - Numerical Differentiation & Integration - Finite Difference Equation.

**UNIT-III 9**

The Numerical solution of Algebric & Transcendental equations - Regula-Falsi Method - Newton-Raphson's Method - Graffe's root Square Method - Simultaneous Linear Algebric Equations - Gauss-Jordan Method - Crout's Method - Gauss-Seidal Iteration Method - relaxation Method.

**UNIT-IV** **9**

Numerical solution of Ordinary Differential Equations - Taylor's Series - Modified Euler's Method - Runga-Kutta's Method of Fourth Order - Predictor - Corrector methods - Milne's Method - Adam-Bashforth Method.

**UNIT-V** **9**

Introduction - Finite Difference Approximation to Derivatives - Laplace's Equations - Jacobis's Method - Gauss-Seidal Method - S.O.R.Method - Poisson's Eqatuon - Liehmann's Method - Parabolic Equations - Iterative methods for the Equations - Hyperbolic Equations.

**Text Books:**


**1.** Sastry,S.S., "Introduction Methods of Numerical Analysis"(3rd ed.), Prentice Hall of India, New Delhi (2003).

**2.** Kandssamy,P., Thilakavathy,K, & Gunavathy,K., "Numerical Methods", (2001), S.Chand & Co., New Delhi.


**References:**


1. Grewal,B.S., & Grewal,J.S., "Numerical Methods in Engineering & Science", (2001), Kanna Publishers, New Delhi.
2. Jain,M.K., Iyengar,S.R.K, & Jain,R.K., " Numerical Methods in Engineering & Scientific Computation", (2001), New Age International Pvt.Lt., New Delhi.
3. Gerald, C.F., & Wheatley, P.O, "Applied Numerical Analysis", Addison Wesley, Singapore, (2003).
4. Narayanan,S., Manicavachagam Pillay, T.K., Ramanaiah,G.," Advanced Mathematics for Engineering Students - volume III", S.Viswanathan Pvt,Ltd, (2003).


**BBT311 MOLECULAR AND MICRO BIOLOGY LAB** **0 0 3 2**

1. Isolation of bacterial DNA
2. Isolation of plant cell and animal cell genomic DNA
3. Agarose gel electrophoresis
4. Restriction enzyme digestion
5. Competent cells preparation
6. Transformation and screening for recombinants
7. Agarose gel electrophoresis
8. Restriction enzyme digestion
9. Competent cells preparation
10. Blue and white selection for recombinants
11. Plating of □phage
12. □ phage lysis of liquid cultures

**BCT313 CHEMICAL ENGINEERING LAB-I** **0 0 3 2**

**A) MECHANICAL OPERATIONS**

**List of Experiments ***

1. Jaw crusher
2. Crushing rolls
3. Ball mill
4. Size analysis by sieving
5. Size analysis by sub-sieving
6. Filter press
7. Leaf filter
8. Cyclone separator
9. Sedimentation
10. Elutriator
11. Rotary Drum filter
12. Effectiveness of screens

**B) FLUID MECHANICS**

**List of Experiments ***

1. Calibration of constant and variable Head meters
2. Calibration of Weirs
3. Drag reduction studies
4. Flow through straight pipe
5. Flow through Vertical concentric pipe
6. Pressure drop studies in packed column
7. Fluidisation
8. Open drum orifice and draining time
9. Flow through helical coil and spiral
10. Characteristic curves of centrifugal pump
11. Viscosity measurement of non Newtonian fluids
12. Flow of air thro' orifice using Aircompressor

*** Minimum 10 experiments shall be offered.** **Total No of periods: 60**

**SEMESTER VI**

**BCT302 CHEMICAL ENGINEERING THERMO DYNAMICS-I** **3 0 0 3**

**UNIT – I BASIC CONCEPTS** **6**

The terminologies of thermodynamics, the variables and quantities of thermodynamics, categorization of systems and processes. Energy classifications, point and path properties, energy in transition, heat and work, reversible and irreversible processes, phase rule.

**UNIT - II FIRST LAW OF THERMODYNAMICS** **6**

The first law and internal energy, statements of first law for the non flow and flow systems, enthalpy and heat capacity limitations of the first law.

**UNIT - III SECOND LAW OF THERMODYNAMICS** **6**

Statements of the second law of thermodynamics, available and unavailable energies, The entropy function, applications of the second law.

**UNIT - IVTHERMODYNAMIC FORMULATIONS** **6**

Measurable quantities, basic energy relations, maxwell relations, thermodynamic formulations to calculate enthalpy, internal energy and entropy as fuction of pressure and temperature, other formulations involving $C_p$ and $C_v$, complex thermodynamic formulations, thermodynamic properties of an ideal gas, entropy change in reversible and irreversible process.

**UNIT - V THERMODYNAMIC PROPERTIES OF REAL GASES** **9**

The PVT behaviour of fluids, laws of corresponding states and equation of states approaches to the PVT relationships of non ideal gas, problems; compressiblity factors, generalised equations of state, property estimation via generalised equation of state; fugacity and fugacity coefficients of real gases.

**UNIT - VICOMPRESSION OF FLUIDS** **9**

Thermodynamic aspects of compression process,classification of compression processes, basic equation for change of state of gases, the work expression for different situations, the effect of clearance volume, multistage compression, convergent divergent flow, Ejectors.

**Total No of periods: 45**

**Text Book**

1. Smith, J.M., and Van Ness, H.C., " Introduction to Chemical Engineering Thermodynamics ", Kogakushai 1976.
2. Narayanan K.V" A text book of chemical engineering thermodynamics" Prentice Hall of India pvt. Ltd 2001

**References**

1. Hougen, O.A., Watson, K.M., and Ragatz, R.A., " Chemical Process Principles Part II, Thermodynamics ", John Wiley 1970.
2. Dodge, B.F., " Chemical Engineering Thermodynamics ", McGraw-Hill, 1960.
3 Sandler, S.I., " Chemical and Engineering Thermodynamics 2nd edn. ", Wiley, 1989.
4 .Kyle, B.G., " Chemical and Process Thermodynamics 2nd edn. ", Prentice Hall of India Pvt.Ltd., 1990.

**BCT304 CHEMICAL REACTION ENGINEERING-I** **3 0 0 3**

**UNIT - I REACTION KINETICS** **8**

Law of mass action, rate equation, elementary, non-elementary reactions and their mechanisms, theories of reaction rate and temperature dependency, analysis of experimental reactor data, evaluation of rate equation, integral and differential analysis for constant variable volume system, fitting of data complex reaction mechanism.

**UNIT - II IDEAL REACTORS** **8**

Design for homogeneous systems, batch, stirred tank and tubular flow reactor, design of reactors for multiple reactions, combination reactor system, size comparison of reactors.

**UNIT - III CHOICE OF REACTORS** **8**

Factors affecting choice, optimum yield and conversion, selectivity, reactivity and yield problems, consecutive, parallel and mixed reactions, recycle.

**UNIT - IVHEAT EFFECTS IN REACTORS** **8**

Isothermal and nonisothermal homogeneous reactor systems, adiabatic reactors, rates of heat exchanges for different reactors, design for constant rate heat input and constant heat transfer coefficient,operation, batch and continuous reactors, optimum temperature progression.

**UNIT - V REACTOR STABILITY** **5**

Criteria for stability of reactors, limit cycles and oscillating reaction, parameter sensitivity.

**UNIT - VIREACTION EQUILIBRIA** **8**

Equilibrium in chemically reactive systems, evaluation of reaction equilibrium constant, effect of temperature on equilibrium, application to system involving gaseous components, computation of equilibrium composition.

**Total No of periods: 45**

**Text Books**

1. Levenspiel.O, " Chemical Reaction Engineering ", John Wiley, Second Edition, 1972.
2. Smith.J.M., " Chemical Engineering Kinetics ", McGraw-Hill Third Edition, 1981.

**BCT306 MASS TRANSFER-I** **3 0 0 3**

**UNIT - I DIFFUSION** **8**

Molecular and eddy diffusion in gases and liquids, steady state diffusion under stagnant and laminar flow conditions Diffusivity measurement and prediction, multicomponent diffusion, diffusion in solids and its applications.

**UNIT - II MASS TRANSFER COEFFICIENTS** **12**

Concept of mass transfer coefficients, mass transfer under laminar and turbulent flow past solids, boundary layers, mass transfer at fluids surfaces correlation of mass transfer coefficients, JD,HTU,and NTU concepts, theories of mass transfer and their applications, interphase mass transfer and over all mass transfer coefficients in binary and multicomponent systems, application to gas-liquid and liquid-liquid systems.

**UNIT - III HUMIDIFICATION AND AIR CONDITIONING** **8**

Basic concepts, psychrometric chart construction, Humidification and dehumidification operations, design calculations, cooling tower principle and operation, types of equipment, design calculation.

**UNIT - IVDRYING** **9**

Theory and mechanism of drying, drying characteristics of materials, batch and continuous drying, calculation for continuous drying, drying equipment, design and performance of various drying equipments.

**UNIT - V CRYSTALLISATION** **8**

Nuclei formation and crystal growth, theory of crystallisation, growth coefficients and the factors affecting these in crystallisation, batch and continuous industrial crystallisers, principle of design of equipment.

**Total No of periods: 45**

**Text Books**

1. McCabe, W.L., Smith, J.C., and Harriot, P., " Unit Operations in Chemical Engineering ", McGraw-Hill Edn, 1993.
2. Coulson, J.M., Richardson, J.F., " Chemical Engineering " Vol. I, Pergamon Press, 1977.
3. Foust, A.S.Wenzel, L.A., Clump, C.W., Naus, L., and Anderson, L.B., " Principles of Unit Operations ",Second Edition, Wiley, 1980.

**References**

1. Treybal, R.E., " Mass Transfer Operations ", McGraw-Hill Kogakusha, 1980.
2. Roman Zarzytci, Andrzai Chacuk, " Absorption: Fundamentals and Application ", Pergamon Press, 1993.
3. Skelland, A.H.P., " Diffusional Mass Transfer ", Krieger, Malabar FL (1985).Strigle (jr), R.F., " Packed Tower Design and Applications ", Second Edition, Gulf Publishing Company, USA., 1994.

**BCT308 HEAT TRANSFER** **3 0 0 3**

**UNIT - I BASIC PRINCIPLES** **4**

Importance of heat transfer in Chemical Engineering operations - Modes of heat transfer - Mean temperature difference.

**UNIT - II CONDUCTION** **8**

Concept of heat conduction - Fourier's law of heat conduction - one dimensional steady state heat conduction equation for flat plate, hollow cylinder, hollow sphere - Heat conduction through a series of resistances - Analogy between flow of heat and flow of electricity - Thermal conductivity measurement; effect of temperature on thermal conductivity; conduction through liquids.

**UNIT - III FILM COEFFICIENTS AND THEIR APPLICATION** **8**

Individual and overall heat transfer coefficients and the relationship between them - Conduction with heat source - Two dimensional steady state conduction - Analytical and graphical methods - Transient heat conduction.

**UNIT - IVCONVECTION** **8**

Concept of heat transfer by convection - Natural and forced convection - Application of dimensional analysis for convection - Equations for forced convection under laminar, transition and turbulent conditions - Equations for natural convection - Heat transfer from condensing vapours, heat transfer to boiling liquids - Influence of boundary layer on heat transfer - Heat transfer to molten metals - Heat transfer in packed and fluidised beds.

**UNIT - V HEAT EXCHANGERS** **8**

Parallel and counter flow heat exchangers - Log mean temperature difference - Single pass and multipass heat exchangers; plate heat exchangers; use of correction factor charts; heat exchangers effectiveness; number of transfer unit - Chart for different configurations - Fouling factors and wilson's plot - Design of various types of heat exchangers - Design of furnaces - Design of condensers, - Design of tubular reactors.

**UNIT - VIRADIATION** **4**

Concept of thermal radiations - Black body concept - Stefan Boltsman's law -concept of grey body – radiation between surfaces.

**UNIT - VII EVAPORATION** **5**

Types of evaporation - single effect and multiple effect evaporation - Design calculation for single and multiple effect evaporation.

**Total No of periods: 45**

**Text Books**

1. McCabe, W.L., Smith, J.C., and Harriot, P., " Unit Operations in Chemical Engineering ", McGraw-Hill Recent Edn.
2. Binay K.Dutta "Heat Transfer Principles and Applications", Prentice Hall of India, 2001.
3. Kern, D.Q., " Process Heat Transfer ", McGraw-Hill - Revised adition - 1999.

**References**

1. Coulson, J.M., Richardson, J.F., " Chemical Engineering ", Vol.I., Pergamon and ECBS, 1970.

**BCT310 PROCESS INSTRUMENTATION, DYNAMICS AND CONTROL** **3 0 0 3**

**UNIT- I** **10**

Laplace transformation, transform of standard functions, derivatives and integrals, inversion, theorems in Laplace transformation, application.Open-loop systems, first order systems and their transient response for standard input functions, first order systems in series, linearization and its application in process control, second order systems and their dynamics, transfer function for chemical reactors and dynamics.

**UNIT- II** **9**

Closed loop control systems, development of block diagram for feed-back control systems, servo and regulator problems, Transfer function for controllers and final control element, principles of pneumatic and electronic controllers, transportation lag, transient response of closed-loop control systems and their stability.

**UNIT- III** **8**

Introduction to frequency response of closed-loop systems, control system design by frequency, Bode diagram, stability criterion, Nyquist diagram; Tuning of controller settings.

**UNIT- IV** **8**

Controller mechanism,introduction to advanced control systems, cascade control, feed forward control, control of distillation towers and heat exchangers, introduction to microprocessors and computer control of chemical processes.

**UNIT- V** **10**

Principles of measurements and classification of process control instruments, measurements of temperature, pressure, fluid flow, liquid weight and weight flow rate, viscosity and consistency, $p^H$, concentration, electrical and thermal conductivity, humidity of gases, composition by physical and chemical properties and spectroscopy.

**Total No of periods: 45**

**Text Books**

1. Patranabis .D, Principles of Process control, II edition, Tata McGraw Hill Publishing Co Ltd., 1981.
2. Peter Harriott, Processcontrol, Tata McGraw Hill Publishing Co., Reprint 2004.

**References**

1. Thomas, E.Marlin, Process Control, 2nd Edn, McGraw Hills International Edn 2000.George Stephanopoulos, Chemical Process Control, Prentice Hall of India 2003.
2. Norman H.CEAGLSKE, Automatic process control for chemical engineers, John Wiley & Sons, Japan

**BMA302 SPECIAL FUNCTIONS, DIFFERENCE EQUATIONS AND Z-TRANSFORMS 3 1 0 4**

**UNIT - I IMPROPER INTEGRALS AND SERIES SOLUTIONS** **9**

Improper integrals-Gamma and Beta functions, Series solutions-Ordinary point, regular singular point of second order linear ordinary differential equation, series solution to a second order linear ordinary differential equation about an ordinary point and a regular singular point.

**UNIT - II BESSEL FUNCTIONS** **9**

Bessel's equation, Bessel functions, Recurrence relations, Orthogonality property, Generating function, Equations reducible to Bessel's equation, Modified Bessel functions. Applications to boundary value problems.

**UNIT - III LEGENDRE POLYNOMIALS** **9**

Legendre's equation, Legendre Polynomials, Rodrigue's formula generating function, recurrence relations, orthogonality property, Applications to boundary value problems.

**UNIT IV HERMITE AND LAGUERRE POLYNOMIALS** **9**

Hermite and Leguerre equations and their solutions-Polynomials, Rodrigue's formula, generating functions, recurrence relations, orthogonality property.

**UNIT V DIFFERENCE EQUATIONS AND Z-TRANSFORM** **9**

Linear difference equation with constant coefficients, elementary properties of z transform applications of z transform, application of z transform to difference equations.

**UNIT VI TUTORIAL** **15**

**Total No of periods: 60**

**Text Book**

1. Andrews.L.A., " Special Function for Scientist and Engineers ", McGraw-Hill, 1992.

**References**

1. Narayanan, S.Manicavachagam Pillay and Ramanaiah.G, " Advanced Mathematics for Engineering Students ", Vol II and III S.Viswanathan Printers Private Limited, Madras, 1985.
2. Grewal, B.S., " Higher Engineering Mathematics ", Khanna Publishers, Delhi, 1989.
3. Andrews, L.C., and Shivamoggi, B.K., " Integral Transforms for Engineers and applied Mathematicians ", MacMillan, New York, 1988.

**BCT312 CHEMICAL PROCESS EQUIPMENT DESIGN & DRAWING LAB-I 1 0 3 4**

**UNIT- I**

Design and drawing considerations of bolt, nut and screws, welded and riveted joints, flanged joints, nozzles and reinforcements. Pipe fittings.

**UNIT- II**

Design and drawing considerations of vessel supports such as bracket, saddle, skirt, etc. Storage Tanks for solids, liquids and gases.

**UNIT- III**

General design and drawing consideration of vessels subjected to internal pressure, and external pressure. High pressure vessels.

**UNIT- IV**

Fundamental principles, equations, general design and drawing considerations of cyclone separators centrifuges, thickeners and filtration equipments.

**UNIT- V**

General design and drawing considerations of crystallizers, agitated vessel, jacketed and coil heated vessels.

**Total No of periods: 60**

**Text Books:**

1. M.V.Joshi and V.V. Mahajan, “Process Equipment Design”, MacMillan India Ltd.
2. S.D.Dawande, “Process Design of Equipments”, Central Techno Publications, Nagpur, 2000.
3. Indian Standard Specifications IS-803, 1962; IS-4072, 1967; IS-2825, 1969. Indian Standards Institution, New Delhi.
4. R.H. Perry, “Chemical Engineers’ Handbook”, McGraw Hill.
5. W.L.McCabe, J.C.Smith and Harriet, “Unit Operation of Chemical Engineering”, McGraw Hill.
6. Robert Treybal, “Mass Transfer Operations”, McGraw Hill.
7. J.M. Coulson and J.Richardson, “Chemical Engineering”, vol. 6, Asian Books Printers Ltd.

**Reference Books**

1. R.S. Khurmi, “Machine design”.

2. M.V. Joshi and V.V. Mahajan, “Process Equipment Design”, MacMillan India Ltd.
3. S.D. Dawande, “Process Design of Equipments”, Central Techno Publications, Nagpur, 2000.
4. Indian Standard Specifications IS-803, 1962; IS-4072, 1967; IS-2825, 1969. Indian Standards Institution, New Delhi.
5. R.H. Perry, “Chemical Engineers’ Handbook”, McGraw Hill.
6. W.L. McCabe, J.C. Smith and P. Harriot, “Unit Operation of Chemical Engineering”, McGraw Hill., 2001.
7. Robert Treybal, “Mass Transfer Operations”, McGraw Hill.
8. J.M. Coulson and J.Richardson, “Chemical Engineering”, Vol. 6, Asian Books Printers Ltd.

**BCT314 CHEMICAL ENGINEERING LAB-II 0 0 3 2**

**A) HEAT TRANSFER**

**List of Experiments**

1. Thermal Conductivity measurement
2. Emissivity mesurement
3. Stefan-Boltzmann Constant verification
4. Thermocouple calibration
5. Natural Convection
6. Forced Convection
7. Parallel Flow Double Pipe Heat Exchanger
8. Counter Flow Double Pipe Heat Exchanger

**B) MASS TRANSFER LAB**

**List of Experiments**

1. Simple distillation
2. Steam distillation
3. Packed column distillation
4. Bubble cap distillation
5. Diffusivity measurements
6. Liquid-liquid extraction
7. Vacuum Dryer
8. Tray dryer
9. RDC
10. Adsorption
11. Surface Evaporation

*** Minimum 10 experiments shall be offered.** **Total No of periods: 60**

**SEMESTER-VII**

**BCT401 CHEMICAL ENGINEERING THERMODYNAMICS-II 3 0 0 3**

**UNIT - I PROPERTIES OF SOLUTIONS** **7**

Partial molar properties, ideal and non-ideal solutions, standard states definition and choice, Gibbs-Duhem equation, excess properties of mixtures.

**UNIT - II PHASE EQUILIBRIA** **10**

Criteria for equilibrium between phases in multi component non-reacting systems in terms of chemical potential and fugacity, application of phase rule, vapour-liquid equilibrium, phase diagrams for homogeneous systems and for systems with a miscibility gap, effect of temperature and pressure on azeotrope composition, liquid-liquid equilibrium, ternary liquid-liquid equilibrium.

**UNIT – III CORRELATION AND PREDICTION OF PHASE EQUILIBRIA** **10**

Activity coefficient-composition models, thermodynamic consistency of phase equilibria, application of the correlation and prediction of phase equilibria in systems of engineering interest particularly to distillation and liquid extraction processes.

**UNIT - IVCHEMICAL REACTION EQUILIBRIA** **10**

Definition of standard state, standard free energy change and reaction equilibrium constant, evaluation of reaction equilibrium constant, prediction of free energy data, equilibria in chemical reactors, calculation of equilibrium compositions for homogeneous chemical reactors, thermodynamic analysis of simultaneous reactions.

**UNIT - V REFRIGERATION** **8**

Principles of refrigeration, methods of producing refrigeration, liquefaction process, co-efficient of performance, evaluation of the performance of vapour compression and gas refrigeration cycles.

**Total No of periods: 45**

**Text Books**

1. Smith , J.M., Van Ness, H.C., " Introduction to Chemical Engineering Thermodynamics ", Kogakushai 1976.
2. Kyle, B.G., " Chemical and Process Thermodynamics 2nd edn. ", Prentice Hall of India Pvt.Ltd., 1990.

**References**

1. Hougen, O.A., Watson, K.M., and Ragatz, R.A., " Chemical Process Principles Part II ", Thermodynamics, John Wiley, 1970.
2. Dodge, B.F., " Chemical Engineering Thermodynamics ", McGraw-Hill, 1960.
3. Sandler, S.I., " Chemical and Engineering Thermodynamics ", 2nd Edition., Wiley, 1989.

**BCT403 PROCESS ECONOMICS AND INDUSTRIAL MANAGEMENT** **3 0 0 3**

**UNIT - I PRINCIPLES OF MANAGEMENT AND ORGANISATION** **10**

Planning, organisation, staffing, coordination, directing, controlling, communicating, organisation as a process and a structure; types of organisations.

**UNIT - II PRODUCTION AND MANAGEMENT & QUALITY CONTROL** **10**

Method study; work measurement techniques; basic procedure; motion study; motion economy; principles of time study; elements of production control; forecasting; planning , routing; scheduling; despatching; costs and costs control, inventory and inventory control. Elements of quality control, role of control charts in production and quality control.

**UNIT - III INTEREST, INVESTMENT COSTS AND COST ESTIMATION** **15**

Time Value of money; capital costs and depreciation, estimation of capital cost, manufacturing costs and working capital, invested capital and profitability. Estimation of project profitability, sensitivity analysis; investment alternatives; replacement policy; forecasting sales; inflation and its impact.

**UNIT - IVANNUAL REPORTS AND ANALYSIS OF PERFORMANCE** **10**

Principles of accounting; balance sheet; income statement; financial ratios; analysis of performance and growth. Different unit operations with single and multiple variables.

**Total No of periods: 45**

**Text Book**


1. Holand, F.A., Watson, F.A and Wilkinson, J.K., " Introduction to process Economics ", John Wiley, 1974.
2. Sumanth, D.T., " Production Engineering and Management ", McGraw-Hill, 1984.
3. Shukla, M.C., " Business Organisation and Management ", Sultan Chand and Sons, 1975.


**References**


1. Davis, G.S, " Chemical Engineering Economics and Decision Analysis ", CENDC, I.I.T., Madras, 1981.


**BCT405 CHEMICAL REACTION ENGINEERING - II** **3 0 0 3**

**UNIT - I NON-IDEAL REACTORS** **9**

The residence time distribution as a factor performance; residence time functions and relationship between them in reactor; basic models for non-ideal flow; conversion in non-ideal reactors.

**UNIT - II HETEROGENEOUS PROCESS AND SOLID CATALYSIS** **9**

Rate equations for heterogeneous reactions nature of catalysis, adsorption isothermal and rates of adsorption, desorption and surface reaction analysis of rate equation and rate controlling steps, surface area and pore-volume distribution, catalyst preparation.

**UNIT - III GAS-SOLID CATALYTIC REACTORS** **9**

Diffusion within catalyst particle effective thermal conductivity mass and heat transfer within catalyst pellets; effective factors, Thiele Modulus, fixed bed reactors.

**UNIT - IVGAS-SOLID NON-CATALYTIC REACTORS** **9**

Models for explaining the kinetics; volume and surface models; controlling resistances and rate controlling steps; time for complete conversion for single and mixed sizes, fluidised and static reactors.

**UNIV - V GAS-LIQUID REACTIONS** **9**

Absorption combined with chemical reactions; mass transfer coefficients and kinetic constants; application of film penetration and surface renewal theories; Hatta number and enhancement factor for first order reaction, tower reactor design.

**Total No of periods: 45**

**Text Book**


1. Fogler. H.S., "Elements of Chemical reaction engineering" 3rd edition, Prentice Hall of India Pvt. Ltd., 1999 (Indians Reprint 2003)


**References**


1. Levenspiel , O; " Chemical Reaction Engineering ", 2nd Edition, John Wiley, 1972.
2. Smith J.M., " Chemical Engineering Kinetics ", 3rd edition, McGraw-Hill, New York, 1981.


**BCT407 MASS TRANSFER-II** **3 0 0 3**

**UNIT - I ABSORPTION** **9**

Equilibrium and operating line concept in absorption calculations; types of contactors, design of packed and plate type absorbers; Operating characteristics of stagewise and differential contactors, concepts of NTU, HTU and overall volumetric mass transfer coefficients; multicomponent absorption; mechanism and model of absorption with chemical reaction; thermal effects in absorption process.

**UNIT - II DISTILLATION** **9**

Vapour-liquid equilibria, Raoult's law and deviations from ideality, methods of distillation; fractionation of binary and multicomponent system; design calculations by McCabe-Thiele and ponchon-Savarit, methods; continuous contact distillation tower (packed tower) design; extractive and azeotropic; distillation low pressure distillation; steam distillation.

**UNIT - III LIQUID-LIQUID EXTRACTION** **9**

Equilibrium in ternary systems; equilibrium stagewise contact calculations for batch and continuous extractors, differential contact extraction equipment - spray, packed and mechanically agitated contactors and their design calculations; pulsed extractors, centrifugal extractors.

**UNIT - IVSOLID-LIQUID EXTRACTION (LEACHING)** **6**

Solid-liquid equilibria; leaching equipment-batch and continuous types; calculation of number of stages.

**UNIT - V ADSORPTION AND ION EXCHANGE** **6**

Theories of adsorption of gases and liquids; industrial adsorbents, adsorption equipment for batch and continuous operation; design calculation of ion-exchange resins; principle of ion-exchnage; industrial equipment.

**UNIT - VIMISCELLANEOUS SEPARATION PROCESSES** **6**

Membrane separation process; solid and liquid membranes; concept of osmosis; reverse osmosis; electrodialysis; their applications; foam separation process; Thermal and sweep diffusion process.

**Total No of periods: 45**

**Text Books**


1. R.E.Treybal, " Mass Transfer Operations ", McGraw-Hill, Kogakusha, 1980.
2. W.L McCabe J.C.Smith, and Harriot. P., " Unit Operations of Chemical Engineering ", sixth edition McGraw-Hill. International Edition, 2001.


**References**


1, C.Judson King " Separation Processes ", Tata McGraw-Hill 1974.
2. A.H.P.Skelland, " Diffusional Mass Transfer ", Krieger, Malapur, FL (1985).
3. Roman Zarfyki and Andrzej Chacuk, " Absorption Fundamentals and Applications", Pergamon Press, 1993.
4. P.Wankat " Equilibrium Stage Separations ", Prentice Hall, 1993.
5. R.F.Strigle (jr), Packed Tower Design and Application, 2nd Edn Gulf Publishing company U.S.A. 1994.


**BBT409 BIOPROCESS PRINCIPLES** **3 0 0 3**

**UNIT - I OVERVIEW OF FERMENTATION PROCESSES** **6**

Overview of fermentation industry, general requirements of fermentation processes, basic configuration of fermentor and ancillaries, main parameters to be monitored and controlled in fermentation processes.

**UNIT - II RAW MATERIALS AND MEDIA DESIGN FOR FERMENTATION PROCESS** **8**

Criteria for good medium, medium requirements for fermentation processes, carbon, nitrogen, minerals, vitamins and other complex nutrients, oxygen requirements, medium formulation of optimal growth and product formation, examples of simple and complex media, design of various commercial media for industrial fermentations – medium optimization methods

**UNIT - III STERILIZATION KINETICS** **6**

Thermal death kinetics of microorganisms, batch and continuous heat sterilization of liquid media, filter sterilization of liquid media, air sterilization and design of sterilization equipment - batch and continuous.

**UNIT - IVMETABOLIC STOICHIOMETRY AND ENERGETICS** **12**

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 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** **13**

Modes of operation - batch, fed batch and continuous cultivation. Simple unstructured kinetic models for microbial growth, Monod model, growth of filamentous organisms, product formation kinetics - leudeking-piret models, substrate and product inhibition on cell growth and product formation.

**Total : 45 Hours**

**References**


1. Bailey and Ollis, " Biochemical Engineering Fundamentals", McGraw Hill (2nd Ed.), 1986.
2. Shule and Kargi, " Bioprocess Engineering ", Prentice Hall, 1992.
3. Pauline Doran, Bioprocess Engineering Calculation, Blackwell Scientific Publications.
4. Peter F. Stanbury, Stephen J. Hall & A. Whitaker, Principles of Fermentation Technology, Science & Technology Books.
5. Harvey W. Blanch, Douglas S. Clark, Biochemical Engineering, Marcel Dekker, Inc


**BCT411 PRINCIPLES OF ENVIRONMENTAL SCIENCE & ENGINEERING** **3 1 0 4**

1. **COMPONENTS OF ENVIRONMENT** **9**

Components – Water, Air and Land – Inter-relationships between components – Subcomponents: Ecosystem – Structure and Functional components of Ecosystem – Energy Flow and Material Cycling in Ecosystem – Natural and Man made Impacts on Water, Air and land: Environment and Development – Concept of Sustainable Development.

2. **SCIENCE OF ENVIRONMENT** **9**

Chemistry, Physics and Biology of Water, Air and Land: Stress on the Chemistry, Physics and biology of Water, Air and Land owing to the impacts: Environmental Quality objective and goals – Policies on development projects and their impacts, with emphasis on the branch of Engineering of the student

3. **CURRENT ENVIRONMETAL ISSUES** **9**

Current environmental issues at country level – Management of Municipal Sewage, Municipal Solid Waste, Hazardous waste and Bio-medical waste – Air pollution due to Industries and vehicles: Global Issues – Biodiversity, Climate change, Ozone layer depletion.

4. **ENGINEERING INTERVENTIONS TO REDUCE THE ENVIRONMENTAL STRESS** **9**

Minimising of Stress – principles of Physics, Chemistry and Biology in Engineering interventions such as waste treatment – Flow sheets of Engineering interventions relevant to the engineering Discipline of the student – Waste minimizing Techniques – Clean technology options – Standards performance of the interventions.

5. **(A) TOOLS FOR ENVITONMENTAL MANAGEMENT** **9**

Environment impact assessment: Precautionary principles and polluter pays principles: Constitutional Provisions, legal and Economic instruments in environmental management: Role of Non-government Organizations – Community Participation Environmental management Works: International Conventions and Protocols: Pollution Control Boards and Pollution Control Acts.

**(B) FIELD STUDY**

In-depth study Environmental Issues at least one environmentally sensitive site relevant to the discipline of the student and preparation of report thereupon.

**Total : 45**

**Text Books**:

1. G.M.Masters, Introduction to Environmental Engineering & Science, Prentice hall, New Delhi, 1997.
2. J.G.Henry and G.W.Heike, Environmental Science & Engineering, Prentice Hall International Inc., New Jersy, 1996.

**Reference Bokks**:

1. S.K.Dhameja, Environmental Engineering and Management, S.K.Kataria and sons, New Delhi, 1999.
2. State of India's Environment – A citizen's Report, Centre for Science and Environment and Others, 1999.

**BCT413 PROCESS EQUIPMENT DESIGN & DRAWING LAB-II 1 0 3 4**

(All Tables/Chemical Engineers' Handbook/Data Books/Graph Sheets are permitted during the Examination.)

**UNIT- I**

Fundamental principles, equations, general design and drawing considerations of cooling towers, evaporators and driers.

**UNIT- II**

Heat exchangers, condensers and reboilers.

**UNIT- III**

Distillation columns- sieve tray, and bubble cap tray columns and packed column.

**UNIT- IV**

Equipments for absorption and adsorption of gases.

**UNIT - V**

Equipments for liquid-liquid extraction and solid-liquid extraction.

**References**


1. M.V.Joshi and V.V. Mahajan, "Process Equipment Design", MacMillan India Ltd.
2. S.D.Dawande, "Process Design of Equipments", Central Techno Publications, Nagpur, 2000.
3. Indian Standard Specifications IS-803, 1962; IS-4072, 1967; IS-2825, 1969. Indian Standards Institution, New Delhi.
4. R.H. Perry, "Chemical Engineers' Handbook", McGraw Hill.
5. W.L.McCabe, J.C.Smith and Harriet, "Unit Operation of Chemical Engineering", McGraw Hill.
6. Robert Treybal, "Mass Transfer Operations", McGraw Hill.
7. J.M. Coulson and J.Richardson, "Chemical Engineering", vol. 6, Asian Books Printers Ltd.


**BCT415 CHEMICAL REACTION ENGINEERING LAB-III 0 0 3 2**

**List of Experiments ***

1. Kinetic studies in a batch reactor
2. Kinetics in a plug flow reactor
3. Kinetics in a PFR followed by a CSTR
4. RTD in a PFR
5. RTD in a packed bed
6. RTD in CSTRs in series
7. Combined Reactor
8. Packed Bed Reactor
9. Adiabatic Reactor
10. Catalytic Reactor
11. Kinetics in Semi-batch Reactor

***Minimum 10 experiments shall be offered.**

**BCT417 SEMINAR AND COMPREHENSION 0 2 0 1**

The Objective of the comprehension test is to assess the overall level of proficiency and the scholastic attainment of the student in the various subjects studied during the degree course.

**SEMESTER VIII**

**BCT402 TOTAL QUALITY MANAGEMENT 3 0 0 3**

**UNIT – I INTRODUCTION 9**

Definition of Quality, Dimensions of Quality, Quality Planning, Quality costs - Analysis Techniques for Quality Costs, Basic concepts of Total Quality Management, Historical Review, Principles of TQM, Leadership – Concepts, Role of Senior Management, Quality Council, Quality Statements, Strategic Planning, Deming Philosophy, Barriers to TQM Implementation.

**UNIT – II TQM PRINCIPLES 9**

Customer satisfaction – Customer Perception of Quality, Customer Complaints, Service Quality, Customer Retention, Employee Involvement – Motivation, Empowerment, Teams, Recognition and Reward, Performance Appraisal, Benefits, Continuous Process Improvement – Juran Trilogy, PDSA Cycle, 5S, Kaizen, Supplier Partnership – Partnering, sourcing, Supplier Selection, Supplier Rating, Relationship Development, Performance Measures – Basic Concepts, Strategy, Performance Measure.

**UNIT – III STATISTICAL PROCESS CONTROL (SPC) 9**

The seven tools of quality, Statistical Fundamentals – Measures of central Tendency and Dispersion, Population and Sample, Normal Curve, Control Charts for variables and attributes, Process capability, Concept of six sigma, New seven Management tools.

**UNIT – IV TQM Tools 9**

Benchmarking – Reasons to Benchmark, Benchmarking Process, Quality Function Deployment (QFD) – House of Quality, QFD Process, Benefits, Taguchi Quality Loss Function, Total Productive Maintenance (TPM) – Concept, Improvement Needs, FMEA – Stages of FMEA.

**UNIT – V QUALITY SYSTEMS** **9**

Need for ISO 9000 and Other Quality Systems, ISO 9000:2000 Quality System – Elements, Implementation of Quality System, Documentation, Quality Auditing, QS 9000, ISO 14000 – Concept, Requirements and Benefits.

**Text Book**

1. Dale H.Besterfiled, et at., Total Quality Management, Pearson Education Asia, 1999. (Indian reprint 2002).

**References**

1. James R.Evans & William M.Lidsay, The Management and Control of Quality, (5th Edition), South-Western (Thomson Learning), 2002 (ISBN 0-324-06680-5).
2. Feigenbaum.A.V. "Total Quality Management, McGraw Hill, 1991.
3. Oakland.J.S. "Total Quality Management Butterworth – Hcinemann Ltd., Oxford. 1989.
4. Narayana V. and Sreenivasan, N.S. Quality Management – Concepts and Tasks, New Age International 1996.
5. Zeiri. "Total Quality Management for Engineers Wood Head Publishers, 1991.

**BCT404 TRANSPORT PHENOMENA** **3 1 0 4**

**UNIT - I PHILOSOPHY AND FUNDAMENTALS OF TRANSPORT PHENOMENA** **3**

Importance of transport phenomena; analogous nature of transfer process; basic concepts, conservation laws; continuous concept, field, reference frames, substantial derivative and boundary conditions; methods of analysis; differential, integral and experimental methods.

**UNIT - II TRANSPORT BY MOLECULAR MOTION** **5**

Phenomenological laws of transport properties Newtonian and non Newtonian fluids; rheological models; theories of transport properties of gases and liquids; effect of pressure and temperature.

**UNIT – III ONE DIMENSIONAL TRANSPORT IN LAMINAR FLOW (SHELL BALANCE)** **12**

General method of shell balance approach to transfer problems; Choosing the shape of the shell; most common boundary conditions; momentum flux and velocity distribution for flow of Newtonian and non-newtonian fluids in pipes for flow of Newtonian fluids in planes, slits and annulus heat flux and temperature distribution for heat sources such as electrical, nuclear viscous and chemical; forced and free convection; mass flux and concentration profile for diffusion in stagnant gas, systems involving reaction and forced convection.

**UNIT – IV EQUATIONS OF CHANGE AND THEIR APPLICATIONS** **14**

Conservation laws and equations of change; Development of equations of continuity motion and energy in single multicomponents systems in rectangular co-ordinates and the forms in curvilinear co-ordinates; simplified forms of equations for special cases, solutions of momentum mass and heat transfer problems discussed under shell balance by applications of equation of change, scale factors; applications in scale-up

**UNIT - V TRANSPORT IN TURBULENT AND BOUNDARY LAYER FLOW** **7**

Turbulents phenomena; phenomenological relations for transfer fluxes; time smoothed equations of change and their applications for turbulent flow in pipes; boundary layer theory; laminar and turbulent hydrodynamics thermal and concentration boundary layer and their thicknesses; analysis of flow overflat surface.

**UNIT - VIANALOGIES BETWEEN TRANSPORT PROCESSES** **4**

Importance of analogy; development and applications of analogies between momentum and mass transfer; Reynolds, Prandtl, Von Karman and Colbum analogies.

**Total No of periods: 45**

**Text Book**

R.B. Bird, W.E. Stewart and E.W.Lighfoot, "Transport Phenomena", John Wiley, 1978
Robert, S Brodkey, Harry C. Hershey, "Transport Phenomena", McGraw-Hill International Edn 1988.

**Reference**

1. L.S.Sissom, and D.R.Pitts, "Elements of Transport Phenomena", McGraw-Hill, New York, 1972.
2. R.W.Fahien, "Elementary Transport Phenomena", McGraw-Hill, New York, 1983.
3. J.R. Welty, R.W. Wilson, and C.W.Wicks, "Fundamentals of Momentum Heat and Mass Transfer", 2nd Edn. John Wiley, New York, 1973.

**BCT 406 PROJECT WORK** **0 2 18 6**

**Project:** Project works are to be done by the students whose duration will be larger than one week.

Criteria for Project Design:

I. Projects suggested by the staff on the basis of collected industrial problem.
II. Projects to cater to development of infrastructure of the department.
III. Projects to cater to preparation for application for funding agents.
IV. Projects to cater to obtaining relevant data for doctoral programme.
V. Projects to recalibrate and standardize existing equipment.
VI. Projects to establish relevant instrumentation and analytical procedures.
VII. Projects to give students an opportunity if they suggest an innovative / alternate approach to the existing solution.

**BCTE * Elective I** **3 0 0 3**

**BCTE * Elective II** **3 0 0 3**

**Total credit to be earned for the award of the Degree: 188**