

**I/IV B.Tech Biotechnology  
(M.P.C. Stream)**

S.No	Course Code	Title	Workload				Total Marks	
			Theory		Practical	Total	Univ.	Sessional
			L	T				
1.	BTM 101	English	2	1	-	3	70	30
2.	BTM 102	Mathematics-I	3		-	3	70	30
3.	BTM 103	Fundamentals of Biology	3		-	3	70	30
4.	BTM 104	Physics	3	-	-	3	70	30
5.	BTM 105	Inorganic & Physical Chemistry	3	-	-	3	70	30
6.	BTM 106	Organic Chemistry	3		-	3	70	30
7.	BTM 107	Engineering Graphics	3	1	-	4	70	30
8.	BTM 108	Computer Programming & Numerical Methods	3	-	-	3	70	30
9.	BTM 109	Physics lab	-	-	3	3	50	50
10.	BTM 110	Chemistry lab -I	-	-	3	3	50	50
11.	BTM 111	Chemistry Lab- II (Organic Chem.)	-	-	3	3	50	50
12.	BTM 112	CPNM Lab	-	-	3	3	50	50
13.	BTM 113	Work Shop	-	-	3	3	50	50
<b>Total:</b>			<b>23</b>	<b>2</b>	<b>15</b>	<b>40</b>	<b>810</b>	<b>490</b>

(Effective from the Admitted Batch of 2006 -2007)

**II/IV B.Tech Biotechnology (1<sup>st</sup> semester)  
M.P.C. Stream**

S.No	Course Code	Title	Workload				Total Marks	
			Theory		Practical	Total	Univ.	Sessional
			L	T				
1.	BTM 211	Mathematics – II	3	1	-	4	70	30
2.	BTM 212	Bio Chemistry	4	-	-	4	70	30
3.	BTM 213	Bio Anal. Techniques.	4	-	-	4	70	30
4.	BTM 214	Genetics	4	-	-	4	70	30
5.	BTM 215	Basic Electrical & Electronics Engineering	3	1	-	4	70	30
6.	BTM 216	Chemical Process Calculations	3	1	-	4	70	30
7.	BTM 217	Bio Chemistry Lab	-	-	3	3	50	50
8.	BTM 218	Bio Anal. Tech. Lab	-	-	3	3	50	50
Total:			21	3	6	30	520	280

(Effective from the admitted Batch of 2006 -2007)

**II/IV B.Tech Biotechnology (2<sup>nd</sup> semester)  
M.P.C.Stream**

S.No	Course Code	Title	Workload				Total Marks	
			Theory		Practical	Total	Univ.	Sessional
			L	T				
1.	BTM 221	Mathematics – III	3	1	-	4	70	30
2.	BTM 222	Micro Biology	4	-	-	4	70	30
3.	BTM 223	Environmental Studies	3	1	-	4	70	30
4.	BTM 224	Thermodynamics	4	-	-	4	70	30
5.	BTM 225	Mechanical Operations	3	1	-	4	70	30
6.	BTM 226	Fluid Mechanics	3	1	-	4	70	30
7.	BTM 227	Micro Biology Lab	-	-	3	3	50	50
8.	BTM 228	Fluid Mechanics & Mechanical Operations Lab	-	-	3	3	50	50
Total:			20	4	6	30	520	280

**III/IV B.Tech Biotechnology (1<sup>st</sup> semester)**  
**M.P.C.Stream**  
(Effective from the admitted Batch of 2006 – 2007)

S.No	Course Code	Title	Workload				Total Marks	
			Theory		Practical	Total	Univ.	Sessional
			L	T				
1.	BTM 311	Mathematics –IV	3	1	-	4	70	30
2.	BTM 312	Immunology	4	-	-	4	70	30
3.	BTM 313	Genetic Engg.	3	1	-	4	70	30
4.	BTM 314	Heat Transfer	3	1	-	4	70	30
5.	BTM 315	Mass Transfer	3	1	-	4	70	30
6.	BTM 316	Cell & Molecular Biology	4	-	-	4	70	30
7.	BTM 317	Heat & Mass Transfer Lab	-	-	3	3	50	50
8.	BTM 318	Cell & Molecular Biology Lab	-	-	3	3	50	50
9.	BTM 319	Soft Skills	-	-	3	3	-	50
Total:			20	4	9	33	520	330

**III/IV B.Tech Biotechnology (2<sup>nd</sup> semester)**  
**M.P.C.Stream**  
(Effective from the admitted Batch of 2006 -2007)

S.No	Course Code	Title	Workload				Total Marks	
			Theory		Practical	Total	Univ.	Sessional
			L	T				
1.	BTM 321	Biostatistics	3	1	-	4	70	30
2.	BTM 322	Chemical Reaction Engineering	3	1	-	4	70	30
3.	BTM 323	Bioprocess Engineering	3	1	-	4	70	30
4.	BTM 324	Industrial Biotech Products	4	-	-	4	70	30
5.	BTM 325	Env. Biotechnology	3	1	-	4	70	30
6.	BTM 326	Pharmaceutical Biotechnology	3	1	-	4	70	30
7.	BTM 327	Chemical Reaction Engineering Lab	-	-	3	3	50	50
8.	BTM 328	Ind. Biotech. Products Lab	-	-	3	3	50	50
Total:			19	5	6	30	520	280

**\*\*Summer Industrial Training is Compulsory at the end of III year second semester and assessment will be done at the end of IV year first semester**

**IV/IV B.Tech Biotechnology (1<sup>st</sup> semester)**  
**M.P.C.Stream**  
**(Effective from the admitted Batch of 2006-2007)**

S.No	Course Code	Title	Workload				Total Marks	
			theory		Practical	Total	Univ.	Sessional
			L	T				
1.	BTM 411	Enzyme Technology	4	-	-	4	70	30
2.	BTM 412	Bio Informatics	4	-	-	4	70	30
3.	BTM 413	Bioprocess Design	3	1	-	4	70	30
4.	BTM 414	Instrumentation & Process Control	3	1	-	4	70	30
5.	BTM 415	Down Stream Processing	4	-	-	4	70	30
6.	BTM 416	Elective – I	4	-	-	4	70	30
7.	BTM 417	Bioprocess Design Lab	-	-	3	3	50	50
8.	BTM 418	Process Instrumentation & Control Lab	-	-	3	3	50	50
9.	BTM 419	Project Seminar	-	-	3	3	-	50
10.	BTM 419-A	Industrial Training Viva-voce & Report	-	-	-	-	50	-
<b>Total:</b>			<b>22</b>	<b>2</b>	<b>9</b>	<b>33</b>	<b>520</b>	<b>380</b>

**IV/IV B.Tech Biotechnology (2<sup>nd</sup> semester)**  
**M.P.C.Stream**  
**(Effective from the admitted Batch of 2006 – 07)**

S.No	Course Code	Title	Workload				Total Marks	
			Theory		Practicals	Total	Univ.	Sessional
			L	T				
1.	BTM 421	Engineering Economics & Ind. Management	3	1	-	4	70	30
2.	BTM 422	Plant Cell & Tissue Culture	4	-	-	4	70	30
3.	BTM 423	Elective – II	4	-	-	4	70	30
4.	BTM 424	Plant Cell & Tissue Culture Lab	-	-	3	3	50	50
5.	BTM 425	Project Work	-	-	6	6	50	50
<b>Total:</b>			<b>11</b>	<b>1</b>	<b>9</b>	<b>21</b>	<b>310</b>	<b>190</b>

**Elective – I: i) Basic biomedical Engineering**  
**ii) Metabolic Engineering**

**Elective – II: i) Good manufacturing Practices**  
**ii) Intellectual Property Rights and Commercialization of Biotechnology**

**ENGLISH**

*Vocabulary:* (1) One word substitutes; (2) words often confused; (3) synonyms and antonyms; (4) foreign phrases; (5) phrasal verbs derived from the dynamic verbs, GO, PUT, TAKE, LOOK, GET, HOLD, GIVEN, RUN, and TURN; (6) idioms and phrases.

*Grammar:* (1) spotting the error in a sentence; (2) correction of the errors in a given sentence- errors in the use of words- errors in constructing a sentence- errors of Indianisms- use of slang- errors in punctuation; (3) concord; (4) tenses and uses of tenses; (5) articles, prepositions and words followed by prepositions.

*Reading:* Comprehension, locating the topic sentence- Main idea- Subordinate idea, picks out definitions, factual information, references and inferences.

*Writing:* Précis-writing, note-making, and note-taking, letter writing, technical report, writing general essay writing.

*Text:* An anthology of prose selections reflecting the Indian culture and the contemporary social problems.

***Prescribed book:***

1. Remedial English Grammar by F. T. Wood.

***References:***

1. Intermediate Grammar Usage and Composition by TICKOO and SUBRAMANIAN.
2. An intermediate English practice book by S.PIT CORDER.
3. English for Engineering students by Prof. G.V.L.N. Sarma.
4. Examine your English by MARGARET M MAISON.

*Advanced skills of communication and ESP (English for specific purpose) oral communication:*

- (a) social interaction
- (b) Mock interviews
- (c) formal-semiformal-informal situations
- (d) house hold situations
- (e) office
- (f) post office/bank/railway station
- (g).telephonic-.face.to.face.communication.

Group discussion (ESP- English for specific purpose)

- Project proposals-project reports
- How to prepare for a meeting
- How to write minutes of meeting
- How to write a research paper and dissertations.

**MATHEMATICS – I**

**Partial Differential Equations and its Applications.** Functions of two or more variables, Partial derivatives, Homogeneous functions- Euler's Theorem, total derivative. Differentiation of Implicit functions, Geometrical interpretation- Tangent plane and normal to a surface. Change of variables, Jacobians, Taylor's Theorem for functions of two variables. Errors and Approximations. Total differential, Maxima and Minima of functions of two variables. Lagrange's method of undetermined principles, Differentiation under the integral sign - Leibnitz Rule. involutes and evolutes.

**Multiple Integrals and their Applications :** Double integrals. Change of order of integration. Double integrals in Polar Co-ordinates, Areas enclosed by plane curves. Triple integrals. Volume of solids. Change of variables. Area of a Curve of a Curved Surface. Calculation of Mass, Center of Gravity, Center of pressure, Moment of Inertia. Product of Inertia, principle Axes. Beta Function, Gamma Function. Relation between Beta and Gamma Functions. Error Function or probability Integral.

**Solid Geometry (Vector Treatment):** Equation of a Plane. Equations of straight line. Condition for a line to lie in a plane. Coplanar lines. Shortest distance between two lines. Intersection of three planes. Equation of Sphere, Tangent plane to Sphere, Cone, Cylinder, Quadric Surfaces.

**Infinite Series:** Definitions Convergence, Divergence and oscillation of a series, General properties, series of positive terms, comparison tests, Integral test D'Alembert's Ratio test. Raabe's Test, logarithmic test. Cauchy's Root test. Alternating series-Leibnitz's Rule, Series of positive or negative terms. Power series. Convergence of exponential. Logarithmic and binomial series. Uniform convergence. Weirstrass M-test. Properties of uniformly convergent series.

**Forier Series:** Euler's formula, conditions for Fourier expansion, Functions having points of discontinuity, Change of interval, odd and even functions- Expansions of odd or even eriodic function. Half range series. Parsevel Formula, practical harmonic analysis.

**Text Books :** 1. "Higher Engineering Mathematics" By B.S. Grewal  
2. "mqathematics for Engineers" By Chandrica Prasad.

**Reference Books:** 1. " Higher Engineering Mathematics" By M.K. Venkatraman.  
2. " Advanced Engineering Mathemtics" By Erwin Kreyszig.

**FUNDAMENTALS OF BIOLOGY****Cell Biology**

Structure and function of prokaryotic and eukaryotic cell. Cell organelles – cell membrane, Chloroplast, Mitochondria, Golgi complex, Endoplasmic reticulum, Lysosomes, Ribosomes and Nucleus. Chromosome structure Mitosis and Meiosis.

**Plant Biology**

Parts of Flowering plant; Flower-structure of a typical flower, outline description of floral parts – Androecium, Gynoecium

**Embryology**

Structure of anther, microsporogenesis and development of male gametophyte. Structure of ovule, megasporogenesis, development of embryo sac. Fertilization and process of fertilization, Post fertilization changes.

**Anatomy**

Structure and function of xylem and phloem. Internal structure of Dicot root, stem and leaf. Monocot root, stem and leaf. Secondary growth of dicot stem.

**Plant Physiology**

Water relations of plants : Absorption of water by plants, diffusion, water potential, osmosis, plasmolysis, imbibition, active and passive absorption.

Mineral nutrition: Criteria for essentially, macroelements (Nitrogen, Phosphorus and Potassium) and microelements.

Photosynthesis: photosynthetic pigments, light reaction-Emerson enhancement effect, Photosystem I and II, photolysis of water, photophosphorylation, CO<sub>2</sub> fixation – C<sub>3</sub>, C<sub>4</sub> and CAM pathway, Photorespiration, Factors affecting photosynthesis – Blackmann's Law of limiting factors.

Nitrogen metabolism: Introduction, nitrogen cycle, biological nitrogen fixation.

Plant Growth Regulators: auxins, Gibberellins, Cytokinins, Abscisic acid and Ethylene.

**Plant Breeding:**

Method of plant Breeding-selection, hybridization, hybrid vigor and mutational breeding.

**Animal Biology**

General Characters of Invertebrate: Morphology, Life cycle and reproduction of, *Plasmodium Vivax*, General Characters of Vertebrates.

**Animal Physiology**

Animal nutrition: Modes of nutrition, digestive system of Humans and accessory digestive organs, gastrointestinal secretions. Digestion, absorption and assimilation of digested products, excretion.

**Respiration:**

Respiration in humans – Respiratory system, mechanism of respiration.

Circulatory system: Blood vascular system in humans – Blood and its components, heart, pumping action of hearts, heart beat and pulse, important blood vessels and course of blood circulation, Lymphatic system-lymph, lymph vessel, lymph nodes and lymphatic ducts and pacemakers.

**Excretion:**

Elimination of nitrogenous waste- Ammonotelic, ureotelic and uricotelic. Structure of human excretory system- structure of urinary system, anatomy of kidney and structure of nephron.

**Nervous system:**

Structure of neuron, nerve impulse and its conduction, synapse, central nervous system- lobes of brain and its meninges, spinal cord. Peripheral nervous system- Cranial nerves and spinal nerves. Autonomous nervous system- sympathetic and parasympathetic nervous system, reflex action – reflex art of humans.

**TEXT BOOKS**

- 1) Biology text book for class XI and XII, NCERT.
- 2) AP academy textbook for botany and zoology at intermediate



**PHYSICS**

**Thermodynamics:** Heat and Work, First Law of Thermodynamics and applications, Reversible and Irreversible Process, Carnot Cycle and Efficiency, Entropy, Entropy and Second Law, Entropy and Disorder, Entropy and Probability, Third Law of Thermodynamics (Statement Only).

**Electromagnetism:** Concept of Electric Flux, Gauss Law and Applications, Electric Potential and Field Strength, Potential due to point charge and dipole, Magnetic Field, Magnetic Force on current, Torque on a current loop, Hall Effect, Ampere's Law, B near a long wire, B for Solenoid, Biot-Savart's Law, B for a circular loop, Faraday's Law of Induction, Lenz's Law, Inductance, calculation of Inductance, L. R Circuit, Induced Magnetic Fields, Displacement Current, Maxwell's Equations.

**Optics:** Interference, Principle of Superposition, Young's Experiment, Coherence, Interference in Thin Films, Wedge Shaped Film, Newton's Rings, Michelson's Interferometer, and its applications.

**Diffraction:** Single Slit (Qualitative and Quantitative treatment)

**Polarisation:** Polarization by Reflection, Refraction and Double Refraction, Nicol Prism, Quarter and Half Wave plate, Circular and Elliptical Polarization and Detection.

**Lasers And Fibre Optics:** Spontaneous and Stimulated Emissions, Population Inversion, Ruby Laser, Gas Laser, Semi Conductor Laser, applications of Laser, Fiber Optics, Optical Fiber and Total Internal Reflection, Acceptance Angle and Cone of a Fiber, Fiber Optics in Communications, Optical Paths in Fiber.

**Ultrasonics:** Production of Ultrasonics by Magnetostriction, and Piezoelectric Effects, Ultrasonics and Diffraction Pattern, application of Ultrasonics.

**Diffraction:** De Broglie's concept of Matter Waves, Uncertainty Principle, Schrödinger Wave equation, application to Particle in a Box, Elementary Concepts of Maxwell- Boltzmann, Bose-Einstein's and Fermi-Dirac Statistics (No Derivations). Fermi-Dirac Distribution Function (No Derivation), Free Electron Theory of Metals, Band Theory of Solids, Kronig-Penny Model, Metals, Insulators and Semiconductors. Superconductivity, Meisner Effect, types of Super Conductors and Applications of Super Conductor

**Prescribed Books:**

1. "Engineering physics" by R. K. Gaur and S. D. Gupta
2. "Physics" by David Halliday and Robert Resnick- Part I and II.
3. "Modern Engineering Physics", by A.S. Vasudeva

**INORGANIC & PHYSICAL CHEMISTRY****Atomic Structure and Periodicity**

Hydrogen Spectrum-Bohr's theory - wave-particle duality-uncertainty principle-Schrodinger wave equation-quantum mechanical model of hydrogen atom. Periodic Table-periodic properties-atomic size, ionization energy, electron affinity, electronegativity.

**Structure and Bonding**

Ionic bond-Ion-pair molecules. Covalent bond-Lewis theory-valence bond theory-hybridization-VSEPR theory and shape of molecules- molecular orbital treatment for  $H_2$ ,  $He_2$ ,  $N_2$ ,  $O_2$ ,  $O_2^-$ ,  $O_2^{2-}$ ,  $F_2$ ,  $NO$  and  $CO$ .

**Coordination Compounds**

Werner's theory- effective atomic number- bonding in transition complexes- valence bond and crystal field theory-octahedral, tetrahedral and square planar complexes.

**Representative elements**

General Properties and oxidation states of s and p block elements.

*Groups IA and IIA* – Alkali and Alkaline earth metals: oxides-hydroxides-halides-carbonates and bicarbonates – anomalous behavior of lithium and beryllium – differences between IA and IIA.

*Group IIIA* – Boron family: oxides, halides and hydrides of boron – structure of diborane.

*Group IVA*- Carbon family: carbides- carbonyls- silicates –silicones.

*Group VA*- Nitrogen family: hydrides –halides-oxides and oxoacids of nitrogen and phosphorous.

*Group VIA*-Oxygen family: halides-oxides and oxoacids of sulphur.

*Group VIIA*-Halogen family:hydrogen halides-halogen oxides-oxoacids of chlorine-inter halogen compounds-pseudo halogens.

**Transition Elements**

Oxidation states – colour – magnetic properties – complexes – comparison of the elements of second and third transition series with the first transition series.

**Lanthanides**

Oxidation states- colour and spectra – magnetic properties – lanthanide contraction.

**Solid, Liquid and Gaseous state**

Amorphous and crystalline solids – classification of solids according to bond type – ionic, covalent, metallic, molecular solids – crystal systems – space lattice and unit cell – crystal defects.

Vapour pressure of Liquids – Clapeyron-Clausius equation – surface tension and viscosity.

Gas Laws – ideal gas equation – Dalton’s law of partial pressure – Graham’s law of diffusion – kinetic theory of gases – molecular velocities – deviation from gas laws – van der Waal’s equation – critical constants.

### **Thermodynamics**

First law – internal energy – enthalpy – heat capacity of a system – work done in isothermal adiabatic expansion of an ideal gas. Heat of reaction – heat of formation, heat of combustion and heat of neutralization – Kirchoff’s equation – thermo chemical laws – Lavoisier and Laplace and Hess law of constant heat summation. Second law – spontaneous process – entropy – physical significance, entropy change accompanying phase change – Gibb’s – Helmholtz equation and its applications.

### **Chemical Equilibrium and Electrochemistry**

Reversible reactions-law of Mass action- Le Chatlier’s principle-homogeneous equilibria in gaseous and liquid systems- effect of temperature on equilibrium-vant Hoff’s equation.

Conductance- Kohlraush’s Law- electrochemical series-half-cell potential-EMF-Nernst equation-Galvanic cells.

### **Colligative properties**

Raoult’s law, Osmotic pressure, elevation of boiling points, depression in freezing points (no thermodynamic derivations)-elementary treatment of vapour pressure-composition diagrams of binary liquid mixtures.

### **Chemical Kinetics**

Rate constant-order and molecularity- zero, first and second order kinetics-activation energy- effect of temperature on reaction rate-elementary treatment of collision theory and activated complex theory.

### **Phase Rule**

Terms used – phase diagrams-one component system (Water and Sulphur) – two- component system (Silver-Lead and Potassium Iodide-Water)-Eutectic point and Triple point.

### **Prescribed books:**

#### **Inorganic Chemistry:**

1. Concise Inorganic Chemistry, 5<sup>th</sup> edition- J. D. Lee., Blackwell Science Ltd., London.
2. University General Chemistry, by C. N. R. Rao., Macmillan India Pub. Co.,

#### **Physical Chemistry:**

1. Physical chemistry by P. W. Atkins, third edition, Oxford University press.
2. Essentials of Physical Chemistry, Revised edition 2005-B.S.Bahl, Arun Bahl and G.D.Tuli, S. Chand & Company Ltd., India.

**ORGANIC CHEMISTRY**

**Structure and Properties:** Elemental analysis – Molecular Weight , empirical and Molecular Formula determination. Basics of optical and geometrical Isomerism – sequence rules, R and S Configurations E,Z –notation.

Sources of organic compounds- coal tar and petroleum

**Structure, Preparation And Properties Of Alkanes:** Free Radical Substitution, Wurtz Reaction. Energy of activation and transition state

**Structure, Preparation and properties of alkyl halides:**  $S_N1$ ,  $S_N2$  reactions with mechanisms

**Structure, Preparation And Properties Of Alkenes :** Industrial Method of preparation of Ethylene, 1,2 elimination reactions-  $E_1$  and  $E_2$  with mechanisms – Electrophilic and Free Radical Addition reactions. Polymerization , Polyethylene and PVC.

**Structure Preparation and Properties of Dienes -** 1,2 and 1,4 addition – Diels- Alder Reaction – Isoprene rule, rubber and vulcanization.

**Preparation and Properties of alkynes**

*Preparation and properties of simple aliphatic cyclic compounds and Bayers strain theory Stereoisomerisms of Cyclic Aliphatic Hydrocarbons (Cyclohexane and its Derivatives only, Boat, Chair and Twisted Boat conformations)*

**Structure Of Benzene:** Aromatic Character, Electrophilic Aromatic Substitution, Mechanism of Nitration, Sulphonation, Halogenation, Friedel-Crafts Alkylation and Acylation – Orientation of disubstituted Benzenes – activating and deactivating groups – Orientation and Synthesis

**Preparation and Properties of Arenes:** Friedel-Crafts Alkylation and its Limitations – Clemmenson and Wolf- Kischner's reductions.

**Preparation Properties of Aryl halides:** Sand Meyer and Gattermann reaction, Nucleophilic aromatic substitution.

**Preparation and Properties of Aliphatic Amines:** Industrial Methods of Preparation of Aniline and Aliphatic amines. Reductive amination – Hoffmann elimination – Benzidine rearrangement – effect of substituents on basicity – Distinguishing tests for amines. Preparation of Diazonium salts and applications. Sulpha Drugs

**Preparation and Properties of Alcohols:** Industrial method of preparation of Ethyl Alcohol – Differentiation tests , Grignard synthesis of alcohols.

Preparation of ethers and epoxides – Williamson synthesis

Preparation and Properties of Phenol , alpha naphthol, beta naphthol – Fries rearrangement – Kolbe`s reaction – Reimer-Tiemann reaction. Preparation of Bakelite.

**Structure preparation and properties of Aldehydes and Ketones:**

Nucleophilic addition reactions, Carbanion reactions, Cannizzaro reaction, Aldol Condensation, Perkin, Reformatsky and Wittig reactions

**Preparation and Properties of Carboxylic Acids:** Effect of substituents on Acidity, HVZ reaction *Preparation and properties of Dicarboxylic acids:* Oxalic, Succinic, and Adipic Acids – Preparation of nylon-6,6 and nylon-6. Preparation and Properties of Functional Derivatives of carboxylic acids – Hoffman Bromamide reaction and Claisen condensation. Preparation and applications of Malonic Ester and Acetoacetic Ester. Keto-enol tautomerism

**Soaps and Detergents:** Ziegler-Natta Polymerization

**Carbohydrates-** Classification, Stereochemistry, reactions of Glucose and Fructose and their interconversions - Kiliani-Fischer Synthesis, Ruff Degradation and Wohl`s Degradation.

Problems based on reactions of organic compounds.

**Prescribed Book:**

Text book of organic chemistry by R. T. Morrison and R. N. Boyd.

**References:**

1. A Text book of organic chemistry by I. L. Finar (Vol. I) Longman group
2. A Text book of organic chemistry by L.G.Wade, Jr. Pearson education
3. A Text book of organic chemistry by Francis A . Carey. Tata Mc Graw-Hill

**ENGINEERING GRAPHICS**

**Introduction** : Drawing instruments and uses. Lettering, scales in common use.

**Curves** : Curves used in engineering practice. Conic sections, construction of conics by different methods, rectangular-hyperbola, cycloidal curves, trochoids, EPI and hypo-cycloids. Involute and Archimedean spiral.

**Orthographic Projection:** Projections of points, projections of straight lines, traces of a line – projections of planes and projection on auxiliary planes.

**Solids and Developments** : Projection of solid in simple positions, projection of solids with axis inclined to one of the reference planes and parallel to the other, projection of solids with axis inclined to both the reference planes, projections of spheres. Development of surface solids. Development of a transition piece connecting a square and circular pipes, Helices and screw threads.

**Sections and Intersections:** Sections of different solids and true shape of sections. Intersection of surfaces- simple problems with cylinders, prisms and cones.

**Isometric and perspective projection:** Isometric projection and conversion of orthographic projection into isometric projection. Perspective projection. Theory of visual ray method and vanishing point method. Simple problems involving regular geometrical solids.

**Text Books:**

1. “ Elements of Engineering Drawing “ by N D Bhatt ( Choratar Publications )

**Reference Books :**

2. Engineering Graphics by Narayana & P K Kanniah ( TMH-Publcn.)

**COMPUTER PROGRAMMING & NUMERICAL METHODS**

**Introduction:** Concepts of algorithm and flow charts – Higher level languages and basic structure of C programs.

**Constants, Variables and Data Types:** C Tokens, Key Words and Identifiers, Constants, Variables, Data types, Declaration of variables (Primary Type Declarations only), Defining symbolic constants.

**Operators and Expressions:** Arithmetic of operators – Relational operators – Logical operators – Assignment operators – Increment and decrement operators – Arithmetic expressions – Evaluation of expression – Precedence of arithmetic operations

**Managing Input and Output operators:** Reading a character – Writing a character – Formatted input – Formatted output

**Decision making and branching:** decision making with IF statement – simple IF statement – the IF ELSE statement – nesting of IF ELSE statements – the ELSE IF ladder – the switch statement – the ? : operator – the GOTO statement

**Decision making and looping:** the WHILE statement – the DO statement – the FOR statement – jumps in loops

**Arrays:** One-dimensional arrays – Two-dimensional arrays – Initializing two-dimensional arrays

**Functions:** The form of C functions – Return values of type – Calling a function – Nesting of functions – Recursion – functions and arrays

**Structure:** Structure definition – Giving values to members – Structure initialization – Comparison of structure variables – Arrays of structures

**File Management in C:** Defining and opening a File – Closing a File – Input/Output operations on files.

**Pointers:** Pointers and addresses – Pointers and function arguments – Pointers and arrays – Address arithmetic – Character pointers and functions – Pointer arrays: Pointers to Pointers – Initialization of Pointer arrays.

**Case studies:**(only programs)

**Numerical Methods:** Newton Raphson method – Simpson 1/3 integration – Gauss Elimination

**Searching:** Sequential Search and Binary Search

**Sorting:** Arranging a set of given numbers in ascending order or descending order by bubble sort method

**Strings:** Concatenation and comparison of strings

**Prescribed Books:**

1. Programming in ANSI C by E. Balaguruswamy, Tata McGraw-Hill Publishing Co.Ltd.
2. The C programming language by Brian W. Kernighan and Dennis M. Ritchie, Prentice-Hall of India Ltd.



**PHYSICS LAB**

(12 OF THE FOLLOWING EXPERIMENTS MUST BE COMPLETED)

1. Lee's method – Determination of co-efficient of thermal conductivity of a bad conductor.
2. Melde's experiment – Determination of the frequency of an electrically maintained tuning fork.
3. Newton's rings – Determination of radius of curvature of a convex lens.
4. Diffraction grating – Determination of wavelengths in mercury line spectrum using spectrometer.
5. Determination of Cauchy's constant using spectrometer and mercury light.
6. Wedge method – Determination of thickness of paper by forming parallel interference fringes.
7. Michelson's interferometer (a) Determination of wavelength of light (b) Resolution of spectral lines.
8. Determination of  $\mu_o$  and  $\mu_e$  using Calcite crystal.
9. Optical bench (a) Young's Double Slit (b) Lloyd's mirror (c) Biprism (d) Diffraction at edge (e) Thickness of wire.
10. Ultrasonic diffraction – Velocity of ultrasonic waves in liquids.
11. Variation of magnetic field along the axis of a current carrying circular coil – Stewart and Gee's apparatus.
12. Calibration of Voltmeter using potentiometer.
13. Carey Foster's Bridge (a) Laws of Resistance (b) Temp coefficient of resistance.
14. B-H Curve Determination of Hysterisis Loss.
15. Callender and Barne's method – Determination of specific heat of water.
16. Hall Effect (a) Determination of Hall coefficient (b) Determination of Charge density.
17. Photoelectric Effect (a) Characteristics of Photoelectric cell (b) Determination of Planck's constant
18. Determination of Rydberg constant using Hydrogen Discharge Tube
19. Determination of e/m of an Electron – Thomson's Method
20. Determination of Band Gap of Semi-Conductor.

**CHEMISTRY LAB – I**

1. Estimation of Sodium hydroxide using Hydrochloric acid and Sodium carbonate
2. Estimation of Sulphuric acid using Sodium hydroxide and Hydrochloric acid
3. Estimation of Sodium carbonate in Soda ash
4. Estimation of Oxalic acid using Potassium permanganate
5. Estimation of Mohr's salt using Potassium permanganate
6. Estimation of Calcium in Portland cement
7. Estimation of Volume strength in Hydrogen peroxide using Potassium permanganate
8. Estimation of Ferrous Iron using Potassium dichromate
9. Estimation of Potassium dichromate using Sodium thiosulphate
10. Estimation of available chlorine in Bleaching powder
11. Estimation of Copper using Sodium thiosulphate
12. Estimation of Total hardness of water by EDTA method
13. Estimation of Zinc using EDTA
14. Estimation of Magnesium using EDTA

**Demonstration Experiments:**

1. Determination of reaction rate constant of acid catalysed hydrolysis of ester
2. pH metric titration
3. Potentiometric titration
4. Determination of BOD and COD of a given sample of water

**Text Book:**

1. A text book of quantitative inorganic analysis by A. I. Vogel (Orient Longmans Ltd.)

**CHEMISTRY LABORATORY – II****(ORGANIC CHEMISTRY)****1. Preparation of simple organic compounds involving the following reactions:**

- a) Acetylation : Acetanilide from Aniline and Aspirin from Salicylic acid
- b) Benzoylation: Benzanilide from Aniline
- c) Nitration: p-nitroacetanilide from acetanilide
- d) Methylation:  $\beta$ -naphthyl methyl ether from  $\beta$ -naphthol
- e) Sulphonation: Sulphanilic acid from Aniline
- f) Oxidation: p-benzoquinone from Hydroquinone

**2. Qualitative analysis: Identification of the following functional groups in at least****SIX organic compounds by adopting a systematic qualitative procedure:**

- a) Carboxylic acids
- b) Phenols
- c) Aldehydes and Ketones
- d) Esters
- e) Carbohydrates
- f) Hydrocarbons and Ethers
- g) Primary, Secondary and Tertiary amines
- h) Amides and Imides
- i) Nitro groups

**Text Book:**

A Text book of Qualitative Organic Analysis by A.I. Vogel ( Orient Longmans Ltd.,)

**CPNM LAB**

The following programs in C language are to be developed.

1. Files in C: Creating a data file, reading a data file and processing a data file.
2. Control statements: while, do – while, for, if, if-else etc.,
3. Functions: Functions and functions with parameter passing.
4. Bubble sort
5. Structures
6. Pointers
7. Solutions of Single non-linear equations by Newton-Raphson and Bisection method.
8. Numerical Integration Simpson's and Trapezoidal Rules.
9. Solution of a set of linear equations by Gauss elimination and Gauss Jordan methods.
10. Solution of ordinary differential equations by Euler's and Runge Kutta methods

**TEXT BOOKS:**

1. The C Programming language, Kernighan and Ritchie. Prentice Hall of India 1999.
2. Numerical Recipes in C. Teukolsky et al.,
3. Programming in C. Balaguruswamy. Tata Mc.Graw Hill

**WORK-SHOP PRACTICE**

*Carpentry:* Bench Work Tools Used In Carpentry – Jobs For Class Work--- Half-Lap Joint – Mortise And Tenon Joint – Half-Lap Dove-Tail Joint – Corner Dove-Tail Joint – Bridle Joint.

*Sheet Metal:* Tools Used In Sheet Metal Work – Laying Developments Of Sheet Metal Job – Soldering Jobs For Class Work: Square-Tray – Taper-Side Tray – Funnel – Elbow Pipe.

*Fitting:* Tools Used In Fitting Work – Different Files, Chisels, Hammers, And Bench Wises, Jobs For Class Work,: Hexagon, Rectangular, Circular And Triangular Fits. – External And Internal Threads With Dies And Taps.

*Electrical:* House Wiring.

***References:***

“Elements Of Work Shop Technology” Volume I By S.K. & H.K. Hazra Chowdary (Media Promoters And Publishers).

**Linear Algebra:**

Rank of a matrix, Eigen value and Eigen vectors of a matrix, Cayley- Hamilton theorem, consistency of equations, matrix inversion, Gaussian Elimination scheme, Cholesky factorization theorem, Jacobi & Gauss siedel iterative method's for solving simultaneous equations, Eigen value solution using forward iteration, Inverse iteration.

**Differential Equations of First Order:**

Formation of differential equation , solution of a differential equation – Geometrical meaning , equations of the first order and first degree , variable separable , Homogeneous equations , Linear equations , Bernoulli's equation , Exact equation , equations reducible to exact equations.

**Linear Differential Equations:**

Higher order linear differential equation with constant coefficients, Cauchy's and Legendre's linear equations, Simultaneous linear equations with constant coefficients.

**Laplace Transforms:**

Transforms of elementary functions, properties of Laplace Transforms , Inverse transforms , Transforms of derivatives, Transforms of Integrals , Multiplication by 't', Division by 't' , Convolution Theorem. Elementary applications to Ordinary Differential equations and Simultaneous linear equations with constant coefficients, Unit step function, Unit impulse functions and Periodic functions.

**TEXT BOOKS:**

- 1) 'Theory Of Matrices' by Shantinarayan
- 2) ' Higher Engineering Mathematics' by B.S.Grewal
- 3) 'Advanced Mathematics For Engineering Students' Vol-2 by Narayana Manichayamvachagam Pillai and Ramanaiah.

*BIOCHEMISTRY*

Scope and importance of Biochemistry.

**Carbohydrates:** Classification, chemistry and properties of monosaccharides (Ribose, Glucose, Fructose), disaccharides (maltose, lactose, sucrose) and polysaccharides (homopolysaccharides and heteropolysaccharides). Metabolism of carbohydrates : Glycolysis, TCA cycle, electron transport and oxidative phosphorylation, HMP shunt pathway, Glycogenesis and Glycogenolysis.

**Proteins and amino acids:** Classification and properties of amino acids and proteins, peptide bond, chemical synthesis of peptides and Solid-phase peptide synthesis. Structural organization of proteins: primary, secondary, tertiary and quaternary structure of proteins, denaturation of proteins.

**Lipids:** Classification, structure and physiological functions of triglycerides, fatty acids, phospholipids, cerebrosides, gangliosides and cholesterol. Digestion and absorption of fats, biosynthesis and degradation of fatty acids and triglycerides.

**Nucleic acids:** Structure and properties of purines and pyrimidine bases, nucleosides, nucleotides, cellular localization, isolation and estimation of nucleic acids. Types of nucleic acids, double helical structure of DNA, types of RNA. Biosynthesis and catabolism of purines and pyrimidines.

**Enzymes:** Introduction, nomenclature and classification of enzymes, kinetic properties of enzymes, factors affecting enzyme action, coenzymes. Enzyme inhibition- competitive, non-competitive and uncompetitive inhibitions.

**Porphyryns:** Chemistry of haemoglobin and chlorophyll; synthesis of heme and chlorophyll and heme catabolism.

**Vitamins and hormones:** definition, classification, chemistry, source, functions and deficiency of vitamins. Out lines of hormones and their functions.

**Text Books:**

1. Fundamentals of Biochemistry – J.L.Jain, S.Chand & company Ltd, New Delhi.
2. Principles of Biochemistry- Lehninger, Nelson and Cox  
CBS Publications.

**BIOANALYTICAL TECHNIQUES**

**Chromatography:** Distribution coefficients- modes of chromatography.

**Paper, Thin Layer, Ion-exchange and Affinity Chromatography-** Principles and applications.

**Gas Liquid Chromatography-** Principle- Apparatus and materials-Sample preparation and Application-Detectors, Flame ionization detector-Nitrogen-Phosphorous detector- Electron capture detector- applications.

**High pressure liquid chromatography-**Principle-components-solvent,pumping systems, column and detectors- applications.

**Electrophoresis:** General principles-Support media- Electrophoresis of proteins-

SDS PAGE- Isoelectric focusing-Electrophoresis of Nucleic acids-Agarose gel electrophoresis-Capillary electrophoresis and applications.

**Centrifugation:** Principle of sedimentation-Sedimentation coefficient-Preparative and Analytical ultracentrifuges- Separation methods in ultracentrifuges -Differential and density gradient centrifugation- Applications of analytical centrifuge- relative molecular mass determination, purity and conformational changes in macromolecules.

**Radioisotope techniques:** Detection and measurement of radio activity-Gas ionization- Excitation of solids and solutions- Autoradiography – Applications in biological sciences- metabolic pathways, turn over times,isotope dilution analysis, radiodating, clinical diagnosis and sterilization-Tracer techniques.

**U V – Visible Spectroscopy :** Principle –Beer – Lambert’s Law-Instrumentation- Single and Double beam Spectrophotometers – Bathochromic and hypsochromic shifts – Applications.

**Turbidometry and Nephelometry:** Principles and Applications.

**Infrared and Raman Spectroscopy:** Principles and Applications.

**Spectrofluorimetry:** Principles- Instrumentation- Applications.

**Biosensors:** Principles and applications of Electrochemical, Thermometric, Optical and Piezoelectric biosensors.

**ESR Spectroscopy:** Principle-Hyperfine splitting - Instrumentation - Applications.

**NMR Spectroscopy:** Principle- Theory of Proton magnetic resonance – Instrumentation-NMR parameters – Chemical Shift – Spin-spin splitting – Intensity – Line width – Applications – Magnetic resonance imaging.

**Mass Spectrometry:** Principle – Instrumentation – ionization techniques – Electron impact and Chemical Ionization – Ion desorption and evaporation methods – Magnetic and electric sector analysers – Detectors – Faraday Cup

**X-Ray Crystallography :** Principle – Bragg Equation – Determination of Crystal structure- Rotating crystal and Powder methods- Applications.

**Text Books :**

1. “Practical Bio-chemistry – Principles and Techniques “, Fifth edition by Keith Wilson and John Walker, Cambridge University Press.
2. “ Biochemical Chemistry – Principles and techniques” by Avinash Upadhyay, Kakoli Upadhyay anhd Nirmalendu Nath, Himalaya Publishing House.



## GENETICS

**Mendel's law of Inheritance** : Gregor Mendel's life, pre-Mendelian experiments, Mendel's experiments–Mendel's materials, crossing technique, results of Mendel's experiments; Phenomenon of Dominance, Variation in dominance relation–incomplete dominance, Co-dominance; Principle of segregation–monohybrid cross, mechanism of segregation, monohybrid ratio; Principle of independent assortment–Mendel's dihybrid cross, mechanism of independent assortment, Dihybrid ratio; Back cross and test cross; Deviations from dihybrid phenotypic ratio; Trihybrids and polyhybrids.

**Interaction of Genes** : Interaction of genes–combs in fowls, Epistasis, complementary genes, duplicate genes; Additional interactions involving two gene pairs; Interaction between more than two gene pairs.

**Quantitative / Multiple factor inheritance** : Multiple factors; Quantitative and quantitative traits; Examples of quantitative inheritance–Kernel color in wheat, skin color in man, corolla length in tobacco; Continuous variations.

**Multiple alleles** : (Based on classical concept of Allelomorphism)

Multiple alleles and isoalleles; skin color in rodents, eye color in *Drosophila*, self sterility in *Nicotiana*, blood groups in humans; complementation test or cis-trans test.

**Linkage, crossing over and mapping** .

**Linkage** – coupling and repulsion hypothesis, Morgan's view on linkage, chromosome theory of linkage, kinds of linkage–complete linkage, incomplete linkage, linkage groups, significance of linkage.

**Crossing over** – Types of crossing over–somatic (or) mitotic crossing over, germinal (or) meiotic crossing over, mechanism of meiotic crossing over–synapsis, duplication of chromosomes, crossing over by breakage and union, terminalization.

Molecular mechanism of Recombination–Holiday model cytological basis of crossing over; significance of crossing over.

**Construction of a genetic mapping** : Two point and three point test crosses and gene mapping, interference and coincidence.

**Sex Determination** :

Genetically controlled sex determining mechanisms – Sex chromosomal mechanism of sex determination; Types–heterogenetic males, heterogenetic females; Genic balance mechanism (X/A ratio in *Drosophila*), Sex determination in man (TDF and SRY genes), sex determination in plants; Single gene control of

sex; Haploid males in hymenoptera; Hormonal control of sex; environmental control of sex; Dosage compensation (in man and *Drosophila*).

**Sex Linkage :** Inheritance of sex linked (X-linked) traits-eye color in *Drosophila*, Haemophilia and Color blindness in human and barred plumage in poultry; Inheritance of Y-linked genes; Inheritance of XY-linked genes; Primary and secondary non-disjunction of sex chromosomes, sex influenced (horned character in sheep) and sex limited traits (cock feathering in poultry and baldness in man), sex linked disorders in human beings.

**Cytoplasmic Inheritance :** Maternal effects-shell coiling in snails, pigment in flour moth; Cytoplasmic inheritance involving dispensable heredity units-Kappa particles in *Paramecium*; CO<sub>2</sub> sensitivity in *Drosophila*; Cytoplasmic inheritance by cellular organelles-Plastid inheritance in variegated four-o'clock plant, Iojop inheritance in corn, Mitochondrial inheritance-male sterility in plants, Petite in Yeast, Poky in Neurospora; uniparental inheritance in Chlamydomonas.

**Chromosomal variations :** Origin, types and cytogenetic effects

**Structural changes in chromosomes :** Duplications, Translocations, Inversions (paracentric and pericentric cross over suppressors )

**Numerical changes in chromosomes :** Aneuploidy (monosomy, nullisomy, trisomy, tetrasomy); Euploidy (monoploidy, haploidy, polyploidy-autopolyploids and allopolyploids).

**Population genetics : gene frequencies in population :**

Gene pool and gene frequencies; equilibrium of gene frequencies and Hardy-Weinberg law-application of Hardy-Weinberg law in calculating gene frequencies in a population (two alleles and more than two alleles) changes in gene frequencies (mutation, selection and migration; random drift)

**Text Books :**

1. Genetics : Gupta P.K.; Rastogi Publications.
2. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology : P.S. Verma & V.K. Agerwar – S. Chand & Company

**Reference Books :**

1. Principles of Genetics: E.J. Gardner, M.J. Simmons & D. Peter Snustard; John Wiley & Sons, INC.

*BASIC ELECTRICAL AND ELECTRONICS ENGINEERING*

(**Five** questions to be set from **Section A** and **Three** questions from **Section B**)

**Section-A**

**Fundamentals Laws and Theorems:** KVL, KCL, Ohm's law, Superposition theorem, Thevenin's theorem, Norton's theorem, Reciprocity theorem.

**D.C. and A.C. Circuits:** Mesh analysis, Nodal analysis, Star-Delta transformation, Sinusoidal steady state analysis of 1- $\phi$  circuits, series and parallel circuits, 3- $\phi$  circuits, Star-Delta circuits.

**D.C. Machines :** Construction and working of D.C. Generators, EMF equation, classification, characteristics, armature reaction, construction and working of D.C.Motors, torque equation, characteristics, speed control methods and 3-point starter, efficiency calculation.

**Single phase Transformers:** Construction and working of single phase transformers, equivalent circuits, efficiency, regulation, O.C and S.C tests.

**A.C. Machines:** Construction and working of 3 -  $\phi$  Induction motor, slip, torque equation, efficiency, calculation, construction and working of Synchronous Generator (Alternator), EMF equation, regulation-synchronous impedance method, Synchronous Motor, torque equation, starting methods.

**Section-B**

**Electronics:** Characteristics of Semiconductor Diodes, Transistors, characteristics of CB, CE, CC transistor configurations, Oscillators, Cathode Ray Oscilloscope, construction, working, applications, Mechanical Transducers, Electrical Transducers, Pressure Gauges, LVDT.

**Text Books :**

- 1.V.K. Mehta: Elements of Electrical Engineering and Electronics.,S.Chand & Co.
2. B.L.Thereja: Fundamentals of Electrical Engineering and Electronics.
- 3.Allen Mottorshad: Electronic Devices and Circuits., Prentice Hall of India.
4. V.N. Mitthal: Basic Electrical Engineering., Tata Mc-Graw Hill

*CHEMICAL PROCESS CALCULATIONS*

**Stoichiometry and composition relationships** : The gram-mole and pound-mole – Limiting reactant – Excess reactant – Degree of completion – Basis of Calculation – Weight percent, Volume percent and mole percent – Density and Specific Gravity.

**Behavior of Ideal gases** : Application of the Ideal-gas law – Dalton and Amagat laws to gaseous mixtures – Composition of gases on dry basis and on wet basis.

**Vapour pressure** : Vaporisation – Condensation – Vapour pressure – Effect of temperature on vapor pressure – Antoine equation – Reference substance vapor pressure plots – Vapour pressure of immiscible liquids – Ideal solutions and Raoult's law – Non-volatile solutes.

**Humidity** : Molal Humidity – Percentage Saturation – Relative saturation or Relative Humidity – Dew point – Dry-bulb temperature – Wet-bulb temperature

**Material Balance** : Tie substance – Yield – Conversion – Processes involving chemical reactions – Material balance calculations involving drying – Dissolutions and Crystallization – Processes involving Recycle, Bypass and Purge.

**Heat Capacities of gases and gaseous mixtures** : Effect of temperature on heat capacity of gas – Mean heat capacity of gases – Latent heats – Heat of fusion – Heat of vaporization – Estimation of latent heat of vaporization using Clausius – Clapeyron equation – Enthalpy of humid air and humid heat capacity.

**Standard heat of reaction** – Standard heat of formation – Laws of thermo chemistry – Standard heat of combustion – Calculation of heat of formation from heats of combustion – Calculation of Standard heat of reaction from heats of formation and from heats of combustion – Effect of temperature on heat of reaction - Adiabatic and non-adiabatic reactions.

**Text Books :**

1. Chemical Process Principles – Part I, Material and Energy Balances by Olaf A Hougen, Kwenneth M. Watson, and Roland A Ragatz, CBS Publishers and Distributors (1995).

***BIOCHEMISTRY LABORATORY***

1. Estimation of total Carbohydrates
2. Estimation of Glucose.
3. Estimation of Amino acids.
4. Estimation of Proteins.
5. Estimation of Lipids and of Cholesterol.
6. Assay of Enzymes-Protease, Phosphatase, Urease, Catalyse and Amylase.
7. Determination of  $K_m$  value.
8. Estimation of Nucleic acids.
9. Determination of  $T_m$  of DNA.
10. Estimation of DNA by Di-phenyl amine reagent method,
11. Estimation of RNA by Orcinol method.
12. Extraction of Caffeine from tea leaves

**Text Books :**

1. Biochemical methods 2<sup>nd</sup> Edition Sadasivam and Manickam, New Age.
2. Introduction to Practical Biochemistry, Plummer, Tata Mc Graw Hill.
3. Practical Biochemistry, Sawhney.
4. Laboratory manual in Biochemistry- J.Jayaraman, New Age International Publications

**BIOANALYTICAL TECHNIQUES LABORATORY**

1. Calibration of pH meter and Preparation of Buffers using pH meters:
  - a) Acetate buffer
  - b) Phosphate buffer
  - c) Citrate buffer
2. Thin Layer Chromatographic separation of sugars.
3. DEAE Column Chromatogry for ion- exchange of bio-molecules and fraction collection.
4. Electrophoretic separation of Proteins.
5. Two-dimensional paper chromatography of amino acids.
6. Elution from chromatography column and estimation.
7. Spectrophotometric estimation of reducing sugars with DNS (Dinitro-salicylic acid) reagent.
8. Isolation of RNA and DNA.
9. Gel filtration of Leaf extract.
10. Determination of Molecular weights by SDS-PAGE.
11. Estimation of thiamine and Riboflavin by Fluorimetry,
12. Native PAGE-for separation of proteins, staining and destaining.
13. Estimation of Turbidity using Nephelometer.

**( Any ten experiments from the above may be conducted.)**

**Demonstration Experiments:**

1. Separation of aminoacids using HPLC
2. Separation of lipids using GLC.

**Vector and Tensor Calculus:**

Scalar, Vector-fields gradient, Divergence and directional derivative, Identities, Irrotational and Solenoidal vector fields, Linear integral, Surface integral and cylindrical, spherical and polar coordinates, Introduction to tensors, Quotient law.

**Complex Analysis:**

Differentiability, Cauchy-Riemann equations, Analytic functions, Cauchy Theorem, Cauchy Integral formula, Taylor and Laurent expansions (without proofs), Singularities, Residue Theorem, Contour Integration, Geometric representation of  $f(z)$  conformal transformation, standard transformations.

**Fourier Transforms:**

Fourier Integral, Sine and Cosine Integrals, Complex forms of Fourier Integral, Fourier Transforms, Fourier and Cosine Transforms, Finite Fourier Sine and Cosine Transforms, Properties of F-Transforms, Convolution theorem for F-Transforms, Parseval's Identity for F-Transforms, Fourier Transforms of the derivatives of a function, Applications to Boundary value problems, using inverse Fourier Transforms only.

**Z-Transforms:**

Some standard Z –Transforms, Linear Property, Damping rule, Shifting rule, Initial and Final value theorems, formation of difference equations, Solution of difference equations, Linear difference equations, rules for finding CF and PI. Difference equations reducible to linear form, Simultaneous difference equations with constant coefficients, application to deflection of a loaded string. Application of Z-Transforms to difference equations.

**TEXT BOOKS: Scope as given in:**

1. **Higher Engineering mathematics, by Dr. B.S. Grewal, Khanna Pub, New Delhi- 110006, 34<sup>th</sup> Edition, 1998.**

**Reference:**

1. **Higher Engineering Mathematics, by M.K. Venkataraman, National Pub Co. Madras.**
2. **Advanced Engg Mathematics, by Erwin Kreyszig, Wiley Eastern Pvt Ltd, New Delhi-49**
3. **Engineering Mathematics by P.P Gupta, Krishnaprakasham media Pvt Ltd, Meerut, Vol – 2.**

## **MICROBIOLOGY**

**History and Development of Microbiology:** Contributions of van Leeuwenhock, Joseph Lister, Pasteur, Koch, Jenner, Winogradsky, Beijerinck. Further developments of Microbiology.

**Microbial Taxonomy and Physiology:** Bacteria, Archea and their broad classification. Molecular approaches to Microbial taxonomy. Physiology of Extremophiles.

### **Morphology and Functions of Viruses, Yeast, Molds and Bacteria :**

**Viruses-** Morphology of viruses- size, shape and symmetry, replication of viruses- Lytic and Lysogenic cycle.

**Yeast and Molds:** Morphology, Life cycle, economic importance of Yeast and *Aspergillus*

**Bacteria :** Ultra structure of Bacteria, Cell wall, cell membrane, flagella, pili, capsule, endospore, and cell inclusions, differences between prokaryotic and eukaryotic cell.

**Microbial growth :** Definition of growth- growth curve. Measurement of bacterial growth ( cell number and cell mass ) growth yield, continuous culture- chemostat, turbidostat, synchronous growth, effect of environmental factors on growth.

**Control of Microorganisms :** Sterilisation, and disinfection, effect of physical( moist and dry heat, radiation and filtration ) and chemical agents, antibiotics- mode of action and resistance.

**Microbial Nutrition :** Nutrition requirements, Nutritional types of bacteria up- take of nutrients by cell.

**Methods in Microbiology :** Culture media, synthetic and complex media, solidifying agents, types of media, isolation of pure cultures- spread plate, pour plate and streak plate, preservation of microorganisms, Light(bright field only) and electron microscopy.

**Applied Microbiology :** Water , Food and Milk born contamination and remedy; Basic microbial genetics- transformation, conjugation, transduction, strain improvement of industrially important Micro-organisms.

### **Text Books**

1. Microbiology :Pelzar, M.J., Chan, E.C.S.,Kreig,N.R., Tata McGraw-Hill
2. Microbiology :Prescott L.M.,Hrley J.P.,Klein D.A., McGraw- Hill
3. Brock biology of Microorganisms, Madigan M.T.,Martino J.M. and Parker J., Prentice Hall'



Environmental studies  
(ENGINEERING STREAM)

**MODULE-1 INTRODUCTION**

Definition, scope and importance; measuring and defining environmental development: indicators.

**MODULE-2 ECOSYSTEMS**

Introduction, types, characteristic features, structure and functions of ecosystems-Forest, grassland, desert and aquatic(lakes, rivers and estuaries)

**MODULE-3 ENVIRONMENT AND NATURAL RESOURCES MANAGEMENT**

Land resources-land as a resource, common property resources, land degradation, soil erosion and desertification, effects of modern agriculture, fertilizers-pesticides problems

Forest resources- Use and over exploitation, mining and dams- their effects on forest and tribal people

Water resources- Use and over utilization of surface and ground water, floods, droughts, water logging and salinity, dams- benefits and costs, conflicts over water

Energy resources- Energy needs, renewable and non renewable energy sources, use of alternate energy sources, impact of energy use on environment.

**MODULE-4 BIODIVERSITY AND ITS CONSERVATION**

Value of biodiversity- Consumptive and productive use, social, ethical, aesthetic and option values, bio-geographical classification of India- India as a mega diversity habitat, threats of biodiversity- in-situ and ex-situ conservation

**MODULE-5 ENVIRONMENTAL POLLUTION- LOCAL AND GLOBAL ISSUES**

Causes, effects and control measures of- air, indoor air, water, soil, marine, noise pollutions, solid waste management, composting, vermiculture, urban and industrial wastes, recycling and re-use, nature of thermal pollution and nuclear hazards, global warming, acid rain, ozone depletion.

**MODULE-6 ENVIRONMENTAL PROBLEMS IN INDIA**

Drinking water, sanitation and public health, effects of activities on the quality of environment- urbanization, transportation, industrialization, green revolution, water scarcity and ground water depletion, controversies on major dams- resettlement and rehabilitation of people: problems and concerns, rain water harvesting, cloud seeding and watershed management.

**MODULE-7 ECONOMY AND ENVIRONMENT**

The economy and environment interaction, economics of development, preservation and conservation, sustainability: theory and practice,

limits to growth, equitable use of resources for sustainable life styles, environmental impact assessment

#### MODULE-8 SOCIAL ISSUES AND THE ENVIRONMENT

Population growth and environment, environmental education, environmental movements, environmental vs development

#### MODULE-9 INSTITUTIONS AND GOVERNANCE

Regulation by government; monitoring and enforcement of environmental regulation; environmental acts, water(prevention and control of pollution) act, air(prevention and control of pollution) act, environmental protection act, wild life protection act, forest conservation act, coastal zone regulations; institutions and policies relating to India; environmental governance.

#### MODULE-10 INTERNATIONAL CONVENTIONS

Stockholm conference 1972, earth summit 1992, world commission for environmental development(WCED).

#### MODULE-11 CASE STUDIES

Chipko movement, narmada bachao andolan, silent valley project, Mathura refinery and taj mahal, industrilisation of pattancheru, nuclear reactor at nagarjuna sagar, their dam, ralegaon siddhi(anna hazare), kolleru lake- aqua culture, flourosis in AP

#### MODULE-12 FIELD WORK

Visit to local area to document and mapping environmental assests- river/forest/grassland/hill/mountain; study of local environment- common plants, insects, birds; study of simple ecosystems- pond, river, hill, slopes, etc; visit to industries, water treatment plants, effluent treatment plants.

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**THERMODYNAMICS**

**The first law and other basic concepts** : Joule's Experiments – Internal Energy – The first law of Thermodynamics – Thermodynamics state and state functions – Enthalpy – the steady stage – Steady – Flow Process – Equilibrium – The Phase Rule – The Reversible Process – Constant 'V' and Constant 'P' processes – Heat capacity.

**The second law of Thermodynamics:** Statement of the second law – Heat engines – Thermodynamic temperature scales – Thermodynamic temperature and ideal – Gas scale.

**Entropy** : Entropy changes of an ideal gas – Mathematical statement of the second law – The third law of thermodynamics – Entropy from the microscopic view point.

**Chemical Reaction Equilibria** : The reaction coordinate – Application of equilibrium criteria to chemical reactions – The standard Gibbs energy change and the equilibrium constant – Effect of temperature on the equilibrium constant – Evaluation of equilibrium constants – Relation of equilibrium constants to composition – Equilibrium conversions for single reactions – Phase Rule and Duhem's Theorem for reacting systems – Multi-reaction equilibria.

**Biochemical Thermodynamics :**

Energetics of metabolic pathways – Energy coupling (ATP & NADH) – Stoichiometry and energetic analysis of cell growth and product formation – Elemental balances – Degree of reduction concepts – Oxygen consumption and heat evolution in aerobic cultures – Thermodynamics efficiency of growth.

**Text Books :**

1. "Introduction to Chemical Engineering Thermodynamics". J.M. Smith, H.C. Vanness & M.M. Abbott, 6<sup>th</sup> Ed. McGraw Hill Book Co., New York, 2001.
2. "Kinetics and Energetics & Biotechnology", J.A. Roels, Elsevier, 1983.

## MECHANICAL OPERATIONS

**Characteristics of solid particles** : Shape – Size Differential and cumulative screen analysis – Specific surface Area – Particle population – Different mean diameters for a mixture of particles – Storage of solids.

Principles of comminution – Laws of crushing (Rittinger's, Bond's, Kick's laws) – Work Index – Classification, description and working of size reduction equipment – Jaw, Gyratory and Roll crushers – Hammers – Revolving mills – Attrition mills – Fluid energy mill – Cutting machines – Open and Closed circuit grinding – wet and Dry grinding – Grindability Index.

**Size separation:** Screening – Industrial screens – Grizzly – Gyratory and vibratory screens – Revolving screens – Trommels – Capacity and effectiveness of screens – Froth flotation.

**Filtration** : Description and working of filtration equipment – Plate and frame filter press. Shell and leaf filters, Rotary drum filter – Filter aid – Centrifugal filtration – Top suspended batch centrifuge.  
Theory of filtration – washing of cakes.

**Motion of particles through fluids** : Drag – Free and hindered settling –  
Settling velocities – Classification – Sink & float methods – Differential Settling – Batch sedimentation – Thickeners – Flocculation – Centrifugal sedimentation – Gravity and centrifugal decanters.

**Agitation of liquids** – Power consumption in agitated vessels – Scale up of agitation equipment – Mixing equipment for mixing of solids and pastes – Mixers for dry powders – Mixing index.

**Text Books :**

1. "Unit Operations of Chemical engineering" Mc Cabe W.L. Smith J.C. and Harriot. P. Mc Graw – Hill Book co.

**FLUID MECHANICS**

**Dimensional analysis** – Types of fluids – Hydrostatic Pressure – Pressure distribution in static fluids – Pressure measuring devices

**Introduction to fluids in motion** : Concept of stream lines, stream tubes – Viscosity – Types of fluids – Flow in boundary layers its formation and growth in tubes and a plates – Basic equations of fluid flow : Continuity – Momentum - Bernoulli's equation and Navier – Stoke's equation.

**Flow of incompressible fluids in pipes** – Relation between skin friction and wall shear – Laminar flow in pipes – Hagen-Poiseuille equation – Turbulent flow in pipes – Velocity distribution equation – Friction factor – Friction from changes in velocity or direction – Flow of compressible fluids, basic equations, flow through variable area conduits.

**Flow past immersed bodies** – Flow through beds of solids – Motion of particles through fluids – Fluidization: Mechanism of fluidization applications of fluidization

**Transportation and metering of fluids:** Pumps, fans, blowers and compressors – reciprocating, rotary and centrifugal pumps – flow measuring devices : venturi meter, Orifice meter, Pitot tube, rotameter, notches and weirs.

**Text Books :**

1. "Unit Operations of Chemical Engineering" , Warren L. Mc Cabe and Julian C. Smith 6<sup>th</sup> Edition.
2. "Transport processes and Unit Operations", Christie J. Geankoplis; Prantice-Hall of India (pvt) Ltd., New Delhi.

**Microbiology Laboratory  
(List of Experiments )**

1. Preparation of Nutrient broth and inoculation of Bacteria.
2. Preparation of Nutrient agar and inoculation of Bacteria
3. Isolation of pure cultures
4. Staining of Microbes- Simple staining, Gram staining, Negative staining, Capsule staining and spore staining.
5. Motility of Microbes.
6. Morphology of Fungi-( *Aspergillus niger*)
7. Morphology of Yeast-( *Saccharomyces cerevisiae* )
8. Bio-chemical tests- IMViC test, Amylase test, Hydrogen Sulphide production test
9. Testing of Microbiological quality of milk.
10. Testing of Microbiological quality of water.
11. Microbial assay of antibiotics.
12. Evaluation of disinfectant.

**Text Books :**

Microbiology- a Laboratory Manual, Cappuccino T.G., Sherman N-Addison Wesley.

***FLUID MECHANICS & MECHANICAL OPERATIONS LAB***

**List of Experiments: (Fluid Mechanics Lab)**

1. Identification of Laminar and Turbulent flows (Reynolds Apparatus)
2. Measurement of Point Velocities (Pitot Tube)
3. Verification of Bernoulli's Equation
4. Calibration of Rotameter
5. Variation of Orifice Coefficient with Reynolds Number
6. Determination of Venturi Coefficient
7. Friction losses in fluid flow in pipes
8. Pressure drop in a packed bed for different fluid velocities
9. Studying the coefficient of discharge in a 'V' notch.
10. Studying the coefficient of contraction for a given open orifice.
11. Study of the characteristics of a centrifugal pump

**List of Experiments: (Mechanical Operations Lab)**

1. Sampling of Materials (Riffle sampling & Cone quartering sampling)
2. Determination of Energy consumption in size reduction [Crushability test (Roll or Jaw crusher), Hard Groove & Ball Mill Grindability indices]
3. Size separation: Froth Flotation

(For the batch admitted in 2006-07)

BT 311

L : 3 T : 1

### MATHEMATICS – IV

**Partial Differential Equations and Applications** : Introduction – First and Second order equations – Method of separation of variables – Vibrations of a stretched string – Wave equation – One-dimensional and Two-dimensional heat flow equations – Solution of Laplace equation – Laplace equation in polar co-ordinates.

**Numerical Analysis** : Solution of non-linear equations of one variable using false position – secant and Newton-Raphson methods – solution of linear algebraic equations using Jacobi – Gauss-Seidel iterative methods – eigen values – eigen vectors using power methods – Numerical integration using trapezoidal - Simpson's and other quadrature formulae.

Numerical solutions of ODE's and PDE's : Numerical solutions of ODE's by Picard's method – Euler's method – Runge-Kutta method and numerical methods for solutions of PDE's

- (1) Elliptic (Liebmann iteration process)
- (2) Parabolic (Schmidt explicit formulae)
- (3) Hyperbolic and
- (4) Poisson's equations (Gauss-Siedel method)

#### Text Books :

1. "Higher Engineering Mathematics" (34 edition, 1998) by Dr.B.S. Grewal
2. "Higher Engineering Mathematics" by Dr.B.S. Grewal, Khanna Pub. New Delhi – 110006, 34 edition, 1998.

#### References Books :

1. "Higher Engineering Mathematics", by M.K. Venkataraman, National Pub. Co., Madras.
2. "Advance Engineering Maths", by Drwin Kreyszi, Wiley Eastern Pvt. Ltd., New Delhi – 110019.
3. "Engineering Maths", by P.P. Gupta, Krishna Prakasam Media Pvt. Ltd., Meerut , vol-2



## IMMUNOLOGY

Introduction, Cells of Immune system, Origin and differentiation of Lymphocytes, Structure and biological functions of Antigens. Types of immune responses, anatomy of Immuneresponse, Innate and acquired Immunity.

B-Lymphocytes, structure, classification and biological importance of Antibodies. Genetic control of Antibody production, Monoclonal antibodies and their diagnosis, idiotypes and idiotypic antibodies, major histocompatibility complex (MHC) Structure and classification of complement system.

Thymus derived Lymphocytes (T-cells) and their classification, Antigen Presenting cell, Macrophages, Langerhance cells, their origin and functions mechanism of phagocytosis, identificatgion of cell types of immune system, Immuno suppression, immune tolerance, hybridoma technology, stem cell technology.

Antigen, - Antibody integracton, Hypresensitivity reactions, mechanisms of T – cell activation, cytokines and their role in immune response, Vaccines and Vaccine development.

Graft rejection, evidence and mechanisms of graft rejection, prevention of graft rejection, immunosuppressive drugs, mechanisms of immunity to tumour antigens, immunotoxins, Auto antibodies in humans, pathogenic mechanisms, treatment of auto immune disorders, cancer and immune systems.

### Text Books:

1. “Immunology”, by Kuby, Kindt, Goldby, Osborne, 6<sup>th</sup> edition, W.H.Freeman and comp.
2. “Immunology” by Ivan Roitt, ELBS

### Reference Books:

1. Cellular and Molecular Immunology by Abul K Abbas, Andrew H Lichtman, Shiv pillai,- Philadelphia, Saunders Elsevier, 2007
2. “Fundamental Immunology, Paul W.E. Raveen press

## **GENETIC ENGINEERING**

Unit 1 : History and Scope of gene manipulation, Isolation, separation and purification of nucleic acids, Enzymology and DNA manipulation – definition and mechanism of action of Restriction endonucleases, ligases and recombinases.

Unit 2: Cloning vectors – construction and application of plasmids, cosmids, phasmids phagemid, plasmid yeast & YAC's, Transfer and cloning of recombinant vectors gene cloning strategies. Construction of genomic DNA libraries, cDNA libraries and their screening.

Unit 3: Preparation of labeled probes and primers, DNA sequencing methods, PCR and its applications – Southern blotting, northern blotting, DNA fingerprinting technique, RFLP and RAPD.

Unit 4 : Gene transfer techniques – transformation, transfection, electroporation, lipofection and gene gun methods – Site specific mutations, case the mitogenesis & transposon mutagenesis, gene knock out technologies.

Unit 5: Application of genetic engineering in agriculture, Animal husbandry, medicine, environmental management and in Industry. Achievements, limitations and negative aspects of genetic engineering.

Text Books :

1. Principles of gene manipulation, Old and Primrose, Black well Publishers.
2. Gene cloning and DNA analysis, B.Brown, Blackwell science
3. Recombinant DNA, Watson et al, Scientific American Books.

## HEAT TRANSFER

**Introduction** : Modes of heat transfer – Basic laws of heat transfer – Analogy between heat flow and electrical flow.

**Conduction** : The fourier heat conduction equation – Steady state one dimensional heat conduction through plane wall, cylindrical wall and composite structures – Three dimensional heat conduction equation – Critical Insulation.

**Convection** : The convective heat transfer coefficient – Introduction to thermal boundary layer – Dimension less numbers in heat transfer and their significance – Dimensional analysis.

**Forced convection** : Heat transfer by forced convection inside tubes and ducts in laminar, transition and turbulent flow – Analogy between momentum and heat transfer – Reynold's, Colburn and Prandtl analogies – Forced convection over exterior surfaces – Heat transfer to tubes in cross flow – Empirical relations in agitated vessels.

**Natural convection**: Natural convection from vertical and horizontal surfaces.

**Heat transfer with phase change** : Heat transfer from condensing vapors – Film wise and Drop wise condensation – Condensation of super heated vapors - Effect of non-condensable gases on rate of condensation.

**Heat transfer to Boiling Liquids** : Boiling of saturated liquids – Maximum heat flux and critical temperature drop – Minimum flux and film boiling.

**Heat Transfer by radiation** : Thermal radiation – Black body radiation – Kirchhoff's law – Emmissivity – Gray body – Laws of black body radiation – Combined heat transfer by conduction, convection and radiation.

**Heat Exchangers** : Types of heat exchangers – Fouling factors – Description of heat transfer equipment : Heat exchangers, condensers, Boilers and Kettles – Extended surface equipment.

**Evaporation** : Types of evaporators – Capacity and economy of evaporators – Boiling point elevation and Dühring rule – Material and energy balances in single effect evaporators – Multiple effect evaporators – Methods of feeding – Capacity and economy of Multiple effect evaporators.

### Text Books :

1. Unit Operations of Chemical Engineering 6<sup>th</sup> Ed. By W.L.Mc.Cabe, J.C.Smith and P.Harriot.

### Reference Books:

1. Transport Processes and Unit Operations by Christie J. Geankoplis Prantice – Hall of India Ltd. New Delhi.

**BT 315**

**L : 3 T : 1**

### **MASS TRANSFER**

**Introduction :** Mass transfer Operations – Molecular diffusion in fluids, binary solutions – Ficks law – equation of continuity – Steady state equimolar counter diffusion – Multicomponent diffusion – Stefan’s Diffusion – Estimation of diffusivity of gases and liquids – Application of molecular diffusion – Diffusion in solids : fick’s law of diffusion in solids – Types of solid diffusion.

**Mass Transfer Coefficients & Interphase Mass Transfer :** Mass Transfer coefficients – Mass transfer coefficients in laminar flow – Theories of mass transfer – analogy between momentum, heat and mass transfer – Concept of equilibrium – Diffusion between phases – Relation between Individual & Overall mass transfer coefficients – Material balances in steady state Co-current and counter current stage processes.

**Distillation :** Principles of VLE for binary systems – Phase diagrams – Relative volatility – Ideal solutions – Isotopes – Flash Vaporization – Partial Condensation – Differential Distillation – Steam Distillation – Continuous Distillation – Mc Cabe – Thiele Method for construction of theoretical stages – Tray efficiencies – Azeotropic and Extractive Distillation.

**Absorption :** Solubilities of gases in liquids – Two component system – Ideal and non-ideal solutions – Choice of solvent for absorption – Single component absorption – Material balance – Counter current multistage Operations – Dilute gas mixtures – HETP – HTU – NTU concepts for single component absorption – Graphical construction for transfer units.

**Humidification Operations :** Definition of fundamental terms – Psychrometric Charts – Theory of adiabatic saturation and wet bulb temperature – Lewis relation – Gas-liquid contact operations – Water cooling with air – Dehumidification of air & water-vapour mixture – Cooling towers – Evaporative cooling.

#### **Text Books :**

1. “Mass Transfer Operations”, Robert E. Terybal, 3<sup>rd</sup> Edition, Mc Graw Hill Book Co.,

#### **Reference Books:**

1. “Unit Operations in Chemical Engineering”. Mc.Cabe, W.L.Smith, J.C.and Harriot, P., 6<sup>th</sup> edition, Mc Graw-Hill Book Co.,
2. “Chemical Engineering Hand Book”, J.H.Perry

**CELL AND MOLECULAR BIOLOGY**

**The nucleus chromatin and the chromosome** : Structure and function of nucleus; organization of genetic material – Packing of DNA into Chromatin, nucleosome organization; Chromosome Structure; Cell cycle – Check points and regulation.

**The biochemical basis of Inheritance** : DNA as the genetic material – DNA structure and replication in Prokaryotes and eukaryotes – Apparatus for replication – Enzymes involved and mechanism replication at telomere.

**DNA Kinetics and cot curves** – Nucleotide composition – Unique – Middle and highly repetitive DNA Mitochondrial and plastid genomes and genes.

**Genetic Code** : Properties of genetic code – Wobble hypothesis.

**Gene Expression** ; Transcription in Prokaryotic and eukaryotic systems – Enzymes and factors involved, mechanism;

RNA processing in eukaryotes – capping, addition of poly(A) and removal of introns; Translation in prokaryotes and eukaryotes – machinery involved and mechanism; regulation of gene expression in eukaryotes by promoters, enhancers, silencers and transactors..

**Mutations** – Terminology – Types of mutations – Biochemical basis of mutants – Mutagenesis – Base analogue mutagenesis – Chemical Mutagens – Intercalating substances – U.V. radiation and ionizing radiation – AMES test – Repair of DNA damage.

**Text Books :**

1. Molecular Cell biology by Lodish et.al . Freeman Publications

**Reference books:**

1. “Cell & Molecular Biology”, Roberties, E.D.P. International Edition
2. “Molecular Biology”, Friefelder, D., Narosa publications
3. “Molecular Biology of the Gene”, J.D.Watson et. al., Banzamin.
4. The world of the cell Beaker, Klein smith & Hordin

**BT 317**

**P : 3**

**HEAT AND MASS TRANSFER LABORATORY**

List of Experiments : (Any 12 of the following experiments)

1. Determination of total thermal resistance and thermal conductivity of composite wall.
2. Determination of the thermal conductivity of metal rod.
3. Determination of the natural convective heat transfer coefficient for a vertical tube.
4. Determination of critical heat flux point for pool boiling of water.
5. Determination of forced convective heat transfer coefficient for air flowing through a pipe.
6. Determination of over-all heat transfer coefficient in double pipe heat exchanger.
7. Study of the temperature distribution along the length of a pin fin under natural and forced convection conditions.
8. Determination of emissivity of a given plate at various temperatures.
9. Ternary Liquid Equilibria (Binodal Curve)
10. Liquid-Liquid Equilibria
11. Limiting flow rates in Spray Towers
12. Hydrodynamics of perforated plate towers
13. Volumetric Mass Transfer Coefficients in Perforated Plate Tower
14. Studies of Axial Mixing Characteristics in a Packed Bed.
15. Gas-Liquid Mass transfer in Packed Tower
16. Langmuir Adsorption on Isotherm: Determination of surface area of activated charcoal.

**BT 318**

**P : 3**

**CELL AND MOLECULAR BIOLOGY LAB**

**Cell Biology :**

Study of Mitosis, meiosis, Differential staining of euchromatin and heterochromatin, Chromosome staining by fluorescent dye,

**Molecular Biology :**

Isolation of genomic DNA, qualification of DNA Agarose gel electrophoresis, Isolation of plasmid DNA, Restriction Digestion, Ligation, Transformation, southern blotting, isolation and analysis of RNA

**Text Books :**

1. "A Guide to Molecular Cloning", Vol. 1,2 & 3 Sambrook, J. et al., Cold Spring Harbor Laboratory Publications.
2. Chromosome techniques. Sharma & Sharma

**BT 319**

**P : 3**

**SOFT SKILLS LAB  
COMMON FOR ALL**

**BT 321**

**L : 3 T : 1**

**BIOSTATISTICS**

Introduction for statistics and probability – sampling and sampling methods - presentation of data – curve fitting – linear regression – real analysis – measures of central tendency (mean/mode/median) – standard deviation – variance – standard error etc., Test of significance – matrices – 3-D geometry.

Statistics : Review of probability distributions

Sampling Theory : Sample distribution – standard error – testing of hypothesis - level of significance – confidence limits – simple sampling of attributes – sampling of variables–large samples and small samples – student's t-distribution, f-distribution, Fisher's z-distribution and Chi-square distribution.

Multi variant analysis: Correlation, Regression and test – Maximum likelihood estimation.

Text Books :

1. Higher Engineering Mathematics (34 edition .. 1998) by B.S. Gerwal.

Reference Books :

1. Numerical methods for Scientific and Engineering Computation by M.K. Jain, S.R.K. Iyengar, R.K. Jain, Publishers New Age International (p) Ltd, New Delhi.
2. Numerical Methods for Engineers by Santosh K. Gupta, Pub. New Age International (p) Ltd., New Delhi
3. Numerical Analysis by G. Shankar Rao, Publishers New Age International, New Delhi.

**BT 322**

**L : 3 T : 1**

**CHEMICAL REACTION ENGINEERING**

Batch Reactors : Introduction and Overview of the subject – Kinetics of homogeneous reactions – non-elementary reactions – Collision theory and Transition-state Theory-Arrhenius relation – Various methods of analysis of batch reactor data (including variable volume and variable pressure data) – Isothermal batch reactor design.

Homogeneous flow reactors : Design equation for plug flow reactor (PFR) and continuous stirred tank reactor (CSTR) – Data analysis in flow reactors – Design of PFR, CSTR & Cascade of CSTR's and combination for PFR & CSTR.

Multiple reactions : Design for multiple reactions – Parallel reactions – (Omit reversible and series – parallel reactions)

Heterogeneous Catalysis : Catalyst properties physical adsorption and chemisorptions – Adsorption-isotherm – Derivation of rate equations for various mechanisms (Adsorption surface reaction and desorption controlling etc.) – Effectiveness factor and internal pore diffusion – Criteria for internal pore diffusion limitation.

Text Books :

1. “Chemical Reaction Engineering”, Levenspiel, Octage, 3<sup>rd</sup> edition, John Wiley, 1999.

Reference Books:

1. “Elements of Chemical Reaction Engineering”, Fogler,H.S. 2<sup>nd</sup> Edition Prantice Hall India, 1992
2. “Chemical Engineering Kinetics”, Smith.J.M. 3<sup>rd</sup> edition, Mc Graw Hill 1981.

**BT 323**

**L : 4 T : 0**

## **BIOPROCESS ENGINEERING**

Introduction to Biotechnology and Bioprocess Engineering – Regulatory constraints in Bioprocesses.

Enzyme Kinetics – Michaelis-Menten Equation and determination of Kinetic Coefficients – Effect of pH and temperature

Stoichiometry of Microbial growth and product formation – Elemental balances – Degree of reduction – Prediction of yield coefficients.

Sterilization : Sterilization methods – Thermal death kinetics – Batch and continuous sterilization – Air sterilization.

Cell Kinetics and Fermentor Design : Batch growth cultivation – Batch, Plug flow and continuous stirred tank fermentors – Monod growth Kinetics in continuous culture and evaluation of coefficients – Fed-Batch Operation – Chemostat with recycle – Multistage chemostat systems.  $Y_p/X$  (product formation kinetics)

Alternative Bioreactors : Fluidised bed Reactor – Air-lift Fermentor – Drop Fermentors – Bubble column Reactors and Membrane Reactors.

Bioreactor instrumentation and control

Text Books :

1. M.L.Shuler and F.Kargi, Bioprocess Engineering 2<sup>nd</sup> ed. Prantice Hall India, New Delhi.
2. D.G.Rao Text book of Biochemical Engineering, Tata McGraw Hill, New Delhi, 2004

Reference Books :



1. J.M.Lee, Biochemical Engineering, Practice-Hall 1992
2. E.Bailey and D.F.Ollis, Biochemical Engineering Fundamentals, 2<sup>nd</sup> Ed., McGraw-Hill, 1986.

**BT 324**

**L : 4 T : 0**

## **INDUSTRIAL BIOTECH PRODUCTS**

**Microbial Processes** : Introduction, types of fermentations, components of industrial microbial process. Sources of industrial cultures, maintenance & improvement of cultures for better production. Primary & secondary metabolites, Idiophase & Trophophase.

Alcohol fermentation : Production of industrial alcohol – Biosynthetic mechanism – Recovery – latest developments. Brewing – malting – grain alcohol, wine manufacture – Glycerol fermentation.

Acetic acid production – Biochemistry of acetic acid production – Vinegar manufacture – spoilage of vinegar.

Fermentative production of citric acid & lactic acid. Fermentative production of Acetone & Butanol.

Microbial foods : food / fodder yeasts, Bakers yeast, mushrooms, fermented food (Cheese).

Amino acids, vitamins, Antibiotics – Glutamic acid, vitamin B<sub>12</sub>, Penicillin & streptomycin, latest developments.

Industrial enzymes : submerged & solid cultures for enzyme production, Production of amylase, protease, cellulase & lipase.

Miscellaneous – Biopolymers, Vaccines, immunomodulators.

### Text Books

1. Industrial microbiology – Cruiger & Cruiger
2. Industrial microbiology – Casada
3. Industrial microbiology – A.H.Patel

### Reference :

1. Prescott & Dunn – Industrial microbiology.

**ENVIRONMENTAL BIOTECHNOLOGY****Air Pollution Control:**

Classification and properties of air pollutants, Sources and Impacts, Meteorology: Influence of meteorological parameters on air quality, lapse rate, wind, Dispersion and Modeling. Engineered systems for air pollution control, control devices for particulate contaminants – Gravitational settling chamber, Cyclones, wet collectors, Fabric filters, Electrostatic precipitators- control devices for gaseous contaminants- adsorption, absorption, combustion.

**Wastewater Treatment:**

Characteristics of waste water, Disposal standards, Conventional wastewater treatment, Conventional biological wastewater treatment processes, Aerobic attached growth process(Tricking filter design), Suspended growth process (Activated Sludge process design) Advanced wastewater treatment processes (UASB, fixed film reactors etc), Sludge digestion (Anaerobic digester).

**Solid Waste Management :**

Sources and classification – Properties – Engineered systems for solid waste management : Onsite handling, transport and collection. Processing techniques – Mechanical volume reduction, thermal volume reduction and manual component separation. Ultimate disposal: land filling, land forming deep well injection, conventional biological treatment process – Analysis and design of bioreactors. Engineered systems for resource and energy recovery, material recovery systems – Recovery of biological, thermal and energy conversion products. Energy fuels from biomass – Biomass conversion routes.

**Prescribed Text Books :**

1. Environmental Pollution Control Engineering, C.S. Rao, Jew Age International (p) Ltd.
2. Environmental Engineering, Howard S. Peavy, Donald R. Rowe and George Tchobanoglous, Mc Graw-Hill.
3. Wastewater Engineering : Treatment, Disposal and Reuse, Metcalf & Eddy, Mc Graw-Hill.
4. Integrated Solid Waste Management, George Tchobanoglous, Hilary Theisen and Samuel A. Vigil, Mc Graw-Hill.

**Reference Books :**

5. Environmental Biotechnology : Principles and Applications, Bruce E. Rittmann, Perry.L. Mc.Carty, Mc Graw-Hill.

6. Wastewater Treatment for Pollution Control, soli J Arceivala, Tata Mc Graw Hill Publishing Company Ltd.,

7. Environmental Engineering – A Design Approach, Arcadio P. Sincero and Gregoria A. Sincero, Prentice – Hall of India Private Ltd.

**BT 326**

**L : 3 T : 1**

## **PHARMACEUTICAL BIOTECHNOLOGY**

Introduction : Development of Drug and Pharmaceutical Industry – Therapeutical agents, their uses and economics – Regulatory aspects.

Drug Metabolism and Pharmacokinetics : Drug metabolism – Physico-chemical principles – Radioactivity – Pharma kinetics action of drugs on human bodies.

Important Unit Processes and their applications : Bulk drug manufacture types of reactions in bulk drug manufacture and processes – Special requirements for Bulk Drug Manufacture.

Manufacturing Principles : Compressed tables – Wet Granulation – Dry granulation or slugging – Direct compression – Tablet presses – Coating of tablets – Capsules – Sustained action dosage – Forms – Parental solutions – Oral liquids – Injections – Ointments – Topical various drugs and pharmaceuticals – Packing – Packing techniques – Quality management – GMP

Pharmaceutical Products and their control : Therapeutical categories such as vitamins, laxatives, analgesics, non-steroidal contraceptives – Antibiotics – Biologicals – Harmones.

Text Books :

1. Leon Lachman et al – Theoty and Practice of Industrial Pharmacy, 3<sup>rd</sup> Edition, Lea and Febiger, 1986.
2. Remington's Pharmaceutical Sciences, Mark publishing and co.,

**BT 327**

**P : 3**

**CHEMICAL REACTION ENGINEERING LABORATORY**

1. Determination of the order of a reaction using a batch reactor and analyzing the data by (a) Differential method (b) Integral Method
2. Determination of the activation energy of a reaction using a batch reactor.
3. Enzyme kinetics in a Batch Reactor and estimation of Michaelis-Menten coefficients.
4. To determine the effect of residence time on conversion and to determine the rate constant using a CSTR.
5. To determine the specific reaction rate constant of a reaction of a known order using a batch reactor.
6. To determine the order of the reaction and the rate constant using a Tubular reactor.
7. Determination of RTD and Dispersion number in a Tubular reactor using a tracer.
8. Mass transfer with chemical reaction (solid-liquid system) – Determination of Mass Transfer Coefficient.
9. Axial mixing in a packed bed. Determination of RTD and the dispersion number for a packed-bed using tracer.
10. Performance of reactors in series :
  - (a) A plug-flow reactor followed by a CSTR.
  - (b) A CSTR followed by a Plug-flow reactor.

**BT 328**

**P : 3**

**INDUSTRIAL BIOTECH PRODUCTS LABORATORY**

1. Isolation and characterization of industrial cultures
2. Analysis of raw materials (eg: molasses, agricultural residues)
3. Ethyl alcohol fermentation and analysis of spirit.
4. Fermented beverages – Fermentation and analysis.
5. Amino acids (glutamic acid)
6. Citric acid production
7. Enzymes (amylase and amyloglucosidase etc.)
8. Bakes yeast production
9. Yeast protein, fat production by yeast
10. Vinegar fermentation

## ENZYME TECHNOLOGY

Introduction to enzyme technology, holoenzymes, non proteinaceous enzymes, extremozymes, advantages of enzyme as biocatalysts, mechanism of enzyme action.

Immobilization of enzymes and cells, distinctive advantages of immobilization assisted bioprocesses. Methods of immobilization (physical and chemical) comprising types of cell and enzyme immobilizations.

Basics of enzyme kinetics of immobilized enzymes, external and internal diffusional characteristics of immobilized systems

Major types of enzyme reactors - Competitive and non – competitive inhibition of enzymes

Basic concepts of Enzyme Engineering – Introduction to biosensors

Applications of enzymes:

- a) Industrial applications
- b) Medical and pharmaceutical applications
- c) Food processing applications

### TEXT BOOKS:

1. Applied biochemistry and bioengineering. Vol I Ed Wingard. L.B. Katchalski – Katzir. ER.Goldstein, L.Academic press
2. Biochemical engineering fundamentals. Bailey and Ollis
3. Fundamentals of Enzymology, 3<sup>rd</sup> Edition Price N.C. and Stevens, L. Oxford University press
4. Immobilization of enzymes and cells: Methods in Biotechnology.Vol I Bickerstaff. G.F

**BIOINFORMATICS****UNIT – I Major Bioinformatics Resources:**

Knowledge of the following databases with respect to: organization of data, retrieval of data using text-based search tools, sources of data method for deposition of data to databases.

Introduction, Primary & Secondary database,

Nucleic acid sequence databases: GenBank, EMBL, DDBJ

Protein sequence databases: SWISS-PROT, TrEMBL, PIR\_PSD

Genome Databases at NCBI, EBI, ExPASy, TIGR, SANGER Prosite, PRODOM, Pfam, PRINTS, CATH, SCOP, DSSP, FSSP, DALI

Sequence and Structure Databases: PDB, MMDB Metabolic pathways databases such as KEGG, EMP.

**UNIT – II Sequence Alignment and Database Searching:**

Introduction- Collection, annotation and alignment of sequences. Basic concepts of sequence similarity, identity and homology. Scoring matrices – PAM and BLOSUM, gap penalties, Database similarity searching, FASTA, BLAST.

**Pairwise sequence alignments:** basic concepts of sequence alignment, Dynamic programming- Needleman & Wuncsh, Smith & Waterman algorithms for pairwise alignments

**Multiple sequence alignments (MSA):** the need for MSA, basic concepts of MSA (e.g. progressive, hierarchical etc.). Algorithm of CLUSTALW. Use of HMM method, concept of dendograms and its interpretation.

**UNIT – IV Taxonomy and phylogenetic analysis:**

Basic concepts in taxonomy and phylogeny; molecular evolution; nature of data used, Definition and description of phylogenetic trees and various types of trees, tree building and tree evaluation methods, Phylogenetic analysis algorithms such as Maximum Parsimony, UPGMA, Neighbor-Joining; Maximum likelihood algorithm.

**UNIT – V: Secondary structure prediction methods-** ChouFASMAN/GOR, Nearest neighbor, Neural network

**UNIT – VI Genome Mapping and Applications:**

Human genome project, application of genome mapping, DNA microarrays.

**TEXT BOOKS:**

1. Introduction to Bioinformatics. T.K. Attwood and P.J. Parry – Smith. Pearson Bioinformatics.
2. Bioinformatics: Sequence and Genome Analysis by D.W. Mount, 2001, Cold Spring Harbor Laboratory Press.

**REFERENCES:**

1. Bioinformatics: A practical guide to the analysis of genes and proteins A.D. Baxevanis and B.F.F. Ouellette (Eds). 2002 John Wiley and Sons.
2. Evens, W.J. and Grant, G.R., Statistical Methods in Bioinformatics: An Introduction.
3. Bioinformatics Basics. Applications in Biological Science and Medicine by Hooman H. Rashidi and Lukas K. Buehler CAC Press 2000.
4. Algorithms on Strings Trees and Sequences Dan Gusfield. Cambridge University Press

**BIOPROCESS DESIGN**

Basic function of a Bioreactor for plant and microbial or animal cell culture.

Factors involved in bioreactor design and principal operating characteristics of bioreactors.

Body construction – construction material, temperature control.

Aeration and agitation – agitators (impellers), stirrer glands and bearings, baffles, aeration system (spargers).

Valves and steam traps used in fermentation industries.

Scale up: Basic concepts, problems related to the scale up of the microbial processes.

Designing of other fermentation vessels.

**TEXT BOOKS:**

1. M.L.Shuler and F.Kargi, Bioprocess Engineering 2<sup>nd</sup> Ed. Prantice Hall India, New Delhi.
2. Stanbury , PFA , Whitaker & Hall Pergamon. Principles of fermentation technology.

**REFERENCE BOOKS:**

1. D.G.Rao Text Book of Biochemical Engineering, Tata McGraw Hill, New Delhi, 2004.
2. E.Bailey and D.F.Ollis, Biochemical Engineering Fundamentals, 2<sup>nd</sup> Ed. McGraw Hill, 1986.

**INSTRUMENTATION AND PROCESS CONTROL**

Introduction to process control – process variables – degrees of freedom. Process modelling– Liquid level system-Linearization example– Two-tank liquid-level system– interacting and non-interacting systems–Thermal process–Mixing process–Heat exchanger–Distillation column. Dynamics of 1st and 2nd order systems, Batch process and Continuous process. Self-regulation. Control systems with inverse response.

Final control-final control operation, signal conversions-analog electrical signals-digital electrical signals, pneumatic signals, Electrical actuators– electric linear motors, Hydraulic systems-basic principle- hydraulic pumps- hydraulic actuators- pressure control valves- accumulator- directional control valves, Pneumatic systems compressor-dryer-tank-actuators. I/P, P/I converters, Valve positioner. Switches-different types, Relays electromechanical-solid state relays.

Control valves – construction, characteristics, different types –ball, gate, butterfly, and other types, Valve sizing, cavitation and flashing, control valve noise and methods of its reduction. Advanced Control Strategies-Cascade control-Feed forward control-Ratio Control-Internal model control- Selective control schemes- Split-range control-Adaptive control -Inferential control.

Process identification-purpose-step testing-pulse testing-ATV method-Least squares method-relationship among time, Laplace, and frequency domains. Multivariable control–control of interacting systems–response of multi-loop control system–non-interacting control–stability of multivariable systems

**TEXT BOOKS:**

1. G. Stephanopoulos: *Chemical Process Control: An Introduction to Theory and Practice*, Pearson Education, Delhi, 2004
2. D. R. Coughanowr, *Process Systems Analysis and Control, 2nd ed.*, McGraw Hill, New York, 1991
3. C. D. Johnson, *Process Control Instrumentation Technology, 7th ed.*, Pearson Education, Delhi, 2003
4. M. L. Luyben and W. L. Luyben, *Essentials of Process Control*, Tata McGraw Hill, New York, 1997

**Reference Books:**

1. C. T. Killian, *Modern Control Technology Components and Systems, 2nd ed.*, Thomson Asia, Singapore, 2001
2. D. M. Considine, *Process/Industrial Instruments and Controls Handbook, 4th ed.*, McGraw-Hill, New York, 1993
3. P. Harriot, *Process Control*, Tata McGraw-Hill, New Delhi, 1972



4. D. E. Seborg,, T. F. Edgar, and D. A. Mellichamp, *Process Dynamics and Control*, 2nd ed., John Wiley & Sons, New York, 2004

**BT 415**

**L:4, T:0**

## **DOWN STREAM PROCESS**

**Introduction:** An Overview of bioseparation engineering, nature of bioseparation, Role and Importance of downstream processing in biotechnological processes, Problems and requirements of bioproduct purification, Economics of downstream processing in Biotechnology physico-chemical basis of bioseparation processes.

**Separation of Insoluble products:** Filtration and micro filtration, cross- flow filtration, centrifugation (batch, continuous, basket), Coagulation and flocculation, gravity sedimentation, settling, decanting.

**Cell disruption:** Physical methods (osmotic shock, grinding with abrasives, solid shear, liquid shear), Chemical methods (alkali, detergents), Enzymatic methods

**Separation of Soluble Products:** Extraction, precipitation, adsorption, dialysis, reverse osmosis, ultra filtration, Cross- flow ultra filtration and micro filtration, electrophoresis and various kinds of chromatography and electro dialysis.

**Products polishing:** Crystallization and drying.

**New and Emerging techniques:** Pervaporation, Super liquid extraction, Foam based separation.

**Product recovery trains** – Enzymes, antibiotics, ethanol, citric acid, monoclonal antibody

### **TEXT BOOKS:**

1. Bioprocess Engineering Michael L.Shuler Fikret Kargi, Prentice Hall of India
- 2."Principles of fermentation technology" by P F Stanbury and A Whitaker, Pergamon press (1984)

### **REFERENCE:**

- 1."Biochemical engineering fundamentals" 2nd ed. by J E Bailey and D Ollis, McGraw-Hill (1986)

2. "Comprehensive Biotechnology" Vol.2 Ed.: M. Moo-Young (1985)
3. " Product Recovery in Bioprocess Technology ", BIOTOL Series, VCH, 1990.

**BT 416**

**L:4, T:0**

## **BASIC BIOMEDICAL ENGINEERING**

### **Section I**

General Introduction to Biomedical Engineering. Application of Engineering in Medicine. Electrical Potentials in the human body. Neuromuscular system: neurons, synapses and muscles, electrical properties of nerves and muscles, problems and diagnostics. Cardiovascular System: anatomy & physiology of heart, ECG and the cardiac cycle, problems and solutions to electrical problems in the heart, blood and vascular modeling, haemodynamics, vascular disease management, Skeletal System (including Prosthetics).

### **Section II**

Biomaterials and Implantable sensors, testing of Biomaterials in vitro and in vivo. Excretory, system (including Dialysis): renal anatomy & Physiology, the nephron, dialysis machines & mass transport. Medical Imaging: X-rays, design considerations of X-ray tubes, medical Image processing – projections, 3D-2D, slice identification, CAT, NMR, MRI, PET / SPECT. Cellular engineering and genetic engineering – introduction: Ethical consideration in Medical Research.

### **TEXT / REFERENCES:**

1. J.T. Bushberg, J.A. Scibert, E.M. Leidholdt (Jr), J.M.Boone: The Essentials Physics of medical Imaging, Lippincott Williams and Wilkins, USA, 2002.
2. R.B. Buxton: Introduction to Functional Magnetic Resonance Imaging: Principals & Techniques, Cambridge Univ, Press, UK, 2002.
3. J. Enderle, S. Blanchard & J. Bronzino (Eds): Introduction to Biomedical Engineering, Academic Press 2000.
4. John G. Webster (Ed): Medical Instrumentation – Application and Design, 3rd Ed. John Wiley & Sons, 1989.
5. J.B.West.(Ed) Best and Taylor's Physiological Basis of Medical Practice, 11<sup>th</sup> Ed., Williams and Wilkins, Baltimore 1985.
6. Y.C. Fung: Biomechanics, Springer – Verlag, New York, 1981.

**BT 416**

**L:4, T:0**

## **METABOLIC ENGINEERING**

### **UNIT I: INTRODUCTION**

Metabolic regulation in metabolic engineering. Basic concepts of Metabolic Engineering – Overview of cellular metabolism – Different models for cellular reactions, induction Differential regulation by isoenzymes, Feed back regulation.

### **UNIT II: SYNTHESIS OF PRIMARY & SECONDARY METABOLITES**

Amino acid synthesis pathways and its regulation at enzyme level and whole cell level, Alteration of feed back regulation, Limiting accumulation of endproducts. Regulation of secondary metabolite pathways, precursor effects, prophase, idiophase relationship, Catabolite regulation bypassing control of secondary metabolism.

### **UNIT III: REGULATION OF ENZYME PRODUCTION**

Strain selection, Genetic improvement of strains, Gene dosage, metabolic pathway manipulations to improve fermentation, Feed back repression, Catabolite Repression, optimization and control of metabolic activities. The modification of existing - or the introduction of entirely new - metabolic pathways.

### **UNIT IV: BIOCONVERSIONS**

Applications of Bioconversions, Factors affecting bioconversions, Specificity, Yields, Co metabolism, Product inhibition, sequential bioconversions.

### **UNIT VI : METABOLIC FLUX**

Integration of anabolism and catabolism, metabolic flux, material balance, kinetic types, equilibrium reaction. distribution, Metabolic flux analysis and its applications, Thermodynamics of cellular processes.

### **UNIT VI: APPLICATIONS OF METABOLIC ENGINEERING**

Application in pharmaceuticals, chemical bioprocess, food technology, agriculture, environmental bioremediation and biomass conversion.

### **TEXT BOOKS:**

1. Wang.D.I.C Cooney C.L., Demain A.L., Dunnil.P. Humphrey A.E. Lilly M.D., Fermentation and Enzyme Technology, John Wiley and sons 1980.
2. Stanbury P.F., and Whitaker A., Principles of Fermentation Technology, Pergamon Press, 1984.

## **BIOPROCESS DESIGN LAB**

1. Isolation and characterization of industrial cultures for use as biocatalysts in bioprocesses
2. Analysis of raw materials used in common industrial bioprocesses
3. Parameter optimization studies in bioprocesses eg. Ethyl alcohol, amino acid production etc.
4. Product purification in bioprocess studies. Eg. Enzyme production (amylase, protease etc).
5. Cell growth kinetics by batch and continuous modes
6. Measurement of Volumetric Oxygen transfer coefficient
7. Cell immobilization protocols
8. Immobilized bioprocess with cells and enzymes
9. Filter efficiency of common air filters
10. Heat inactivation of microbial cells, thermal death rate

**PROCESS INSTRUMENTATION AND CONTROL LAB**

1. Study the response of bare thermometer using step input.
2. Study the response of bare thermometer using impulse input.
3. Study the response of first order system for a step input.
4. Study the response of non interacting system for a step input.
5. Study the response of non interacting system for a impulse input.
6. Study the response of interacting system for a step input.
7. Study of control valve coefficient.
8. Study of inherent valve characteristics of control valve.
9. Calibration of pressure guage using U tube manometer.
10. Study the open loop response by manual method ( Temperature control Trainer)

*Engineering Economics & Industrial Management*

Value of money equivalence: value of money, equations for economic studies , equivalence, types of interest, discrete, continuous. Annuities: relation between ordinary annuity and the periodic payments . continuous cash flow and interest compounding, present worth of an annuity , perpetuities and capitalised costs. Bonds and debentures: value of a bond and yield rate.

Depreciation: types and various methods of calculating depreciations, depreciation accounting. Cost accounting: basic relationship in accounting, balance sheet and income statements. Cost estimation: cash flow for industrial operations, factors affecting investments and production costs – estimation of capital investment , cost indices, cost factors in capital investment, methods of estimating capital investment. estimation of total product cost: manufacturing costs and general expenses.

Concepts of Management and Organisation – Functions of Management Designing Organizational Structures : Basic concepts related to Organisation – Departmentation and Decentralization.

Plant location, definition, factors affecting the plant location. Plant Layout – definition, objectives, types of production, types of plant layout – various data analyzing forms-travel chart.

Work study - Definition, objectives, method study - definition, objectives, steps involved- various types of associated charts-difference between micromotion and memomotion studies.

Materials Management-Objectives, Inventory – functions, types, associated costs, inventory. Inspection and quality control, types of inspections - Statistical Quality Control-techniques.

Text books:

- a) Plant design and economics for chemical engineers(fourth edition) by Max S Peters and Klans D Timmerhans Mc Graw Hill Book Company.
- b) Process Engineering Economics by Herbest E Schweyer Mc Graw Hill Book Company.

**TEXT BOOKS:**

1. Amrine, Manufacturing Organization and Management, Pearson, 2nd Edition.

2. Industrial Engineering and Management O.P. Khanna Dhanpat Rai.

#### REFERENCES :

1. Panner Selvam, Production and Operations Management, PHI, 2004.
2. Stoner, Freeman, Gilbert, Management, 6th Ed, Pearson Education, New Delhi, 2005.

**BT 422**

**L:4, T:0**

### **PLANT CELL AND TISSUE CULTURE**

**UNIT I: Fundamentals of plant tissue culture:** laboratory organization, sterilization methods, culture medium and growth regulators.

**Totipotency, callus culture and organogenesis-** Expression of totipotency in cell culture and importance; Principle of callus culture, characteristics of callus culture and importance; Principle of organogenesis, factors effecting organogenesis and applications.

**UNIT II: Cell culture:** single cell culture-isolation, methods of single cell culture and importance; Cell suspension culture, types of suspension culture, growth pattern, synchronization, assessment of growth and viability of cultured cells, significance of suspension cultures.

**UNIT III: Somatic embryogenesis and synthetic seeds:** principle, induction of embryogenesis, embryo development and maturation, factors effecting somatic embryogenesis, synchronization, large scale production and importance of Somatic embryogenesis, synthetic seeds- methods of making synthetic seeds and applications.

#### **Germplasm conservation**

**UNIT IV: Somoclonal variations** – its genetic basis and application in crop improvement- cell line selection for resistance to herbicides, stress and diseases.

**Haploid production and its advantages-** androgenesis, principle, pollen culture, advantages of pollen culture over anther culture, homozygous diploids, importance of anther and pollen culture.

**UNIT V: Clonal propagation** –technique- multiplication by axillary and apical shoots, adventitious buds/bulbs/protocorms, by callus culture, transplantation, acclimatization

**Production of disease free plants-** meristem tip culture- virus indexing.

**UNIT VI: Protoplast technology-** isolation, culture and plant regeneration, protoplast fusion, methods, identification and characterization of somatic hybrids, cybrids and importance of somatic hybridisation.

**UNIT VII: Genetic transformation** – plant vectors – Ti plasmids, Ri plasmids - indirect and direct methods, current status and limitations.

**Automation and Economics of tissue culture.**

## **TEXT BOOKS**

1. Plant tissue culture – Kalyan Kumar De – New Central Book Agency

## **REFERENCE**

1. An Introduction to Plant tissue culture. Razdan. M. K., Oxford & LBH.
2. Plant tissue culture- theory and practice. Bhojwani, SS & Razdan MK.Elsevier
3. Plant tissue and Cell culture. Street, HE.Blackwell

**BT423**

**L:4, T:0**

## **GOOD MANUFACTURING PRACTICES**

### **Section I**

EC structure and tools, Directives Decision on Regulation (and how to find them), Biotechnology and the law: summary of some current legislation in fore / Cartagna, Protocol 1989 EDA rules. Good laboratory practice, Guidelines for Microbial and animal cell cultivation, Safety and the genetic manipulation of organisms, scientific procedure using animals, Radiation health and safety.

### **Section II**

Patents and biotechnology, Applying for marked authorization for medical products, Manufacture and evaluation of medicinal products product, Regulation of biotechnology in the food industry, A general comment on the biotechnological production of chemicals other then medicines and food ingredients.

### **Reference Books:**

- 1) Compendium of Good Practices in Biotechnology, BIOTOL series
- 2) Patent Strategy for Researchers and research managers – Knight, Wiley Publications.
- 3) Role of Patent and Patent information in Biotechnology inventions – Document of The international Bureau of world Intellectual Prosperity organization -1994
- 4) D. A. Shapton and R.G Board, 'Safety in Microbiology,' Academic Press, London 1972



**BT 423**

**L:4, T:0**

## **INTELLECTUAL PROPERTY RIGHTS, COMMERCIALIZATION OF BIOTECHNOLOGY**

General Introduction: Patent claims, the legal decision – making process, ownership of tangible and intellectual property. WTO with reference to biotechnological affairs, TRIPs. Basic Requirements of Patentability Patentable subject matter, novelty and the public domain, non obviousness. Special issues in Biotechnology Patents. Recent Developments in Patent System and Patentability of biotechnological inventions.

Plant biotechnology Indian patents and foreign patents, Plant variety protection act, the strategy of protecting plants. Patent Litigation different Doctrines. IPR issues in Indian Context Role of patent in pharmaceutical industry.

Why there is a need to commercialize biotechnology. Creating and marketing the image of the biotechnology Company. Art of negotiation & effective communication. Role of venture capitalism, business plan, selection of CEO and personnel, real estate for a biotech start-up.

Role of a biotechnology manager, Role of Research & development University-industry technology transfer arrangements, how and why a biotech company can benefit. Indian and foreign prospective of biotechnology, and current challenges for the biotechnology based products.

### **TEXT / REFERENCE BOOKS:**

- 1) The law and strategy of Biotechnological patents by Sibley. Butterworth publications.
- 2) Intellectual property rights – Ganguli – Tat McGrawhill
- 3) Intellectual property right – Wattal – Oxford Publishing House.
- 4) Positioning by All Rise and Jack Trout (1986), Warner Books.
- 5) Biotechnology: The science & the business by V. Moser & R.E. Cape (1999) Harwood.
- 6) Latest review articles and papers on the subject.

**PLANT CELL AND TISSUE CULTURE LAB**

1. Sterilization methods
2. Preparation of stock solutions
3. preparation of medium
4. Establishment of callus cultures from carrot cambial explants
5. Establishment of cell culture
6. Establishment of growth and preparation of growth curve
7. Embryo culture of maize or any suitable crop, root/shoot initiation (organogenesis) from different explants
8. Micropropagation and plant plant regeneration
9. Isolation, culture and fusion of plant protoplasts
10. Anther and pollen culture.

**TEXT BOOKS:**

1. Plant cell culture: A practical approach. Dixon. R.A
2. Plant cell and tissue culture – a laboratory manual, Rienert, J and Yeoman. M.M. Springer verlag
3. Plant tissue culture; theory and practice. Bhojwani. S.S.