

**UNIVERSITY SCHOOL OF CHEMICAL TECHNOLOGY
SCHEME OF EXAMINATION B.TECH (BIOCHEMICAL ENGINEERING)**

**Bachelor of Technology (Biochemical Engineering)
Program: BCE
Program Code: 004**

Duration - 4 Years (Full time)

**Program Scheme and Syllabus
(1st to 8th semester)**

**University School of Chemical Technology
GGG INDRAPRASTHA UNIVERSITY
SECTOR 16C, DWARKA, NEW DELHI-110078**

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FIRST SEMESTER EXAMINATION

L T P Credits
 17 5 11 28

<u>Theory Papers</u>						
Paper ID	Paper Code	Title	L	T	P	Credit
99109	BA-109	Mathematics I	3	1	0	4
99111	BA-111	Physics I	2	1	0	3
99117	BA-117	Organic Chemistry	3	1	0	4
98101	HS-101	Communication Skills I	2	1	0	3
98119	HS-119*	Impact of Science & Technology on Society	1	0	0	1
15105	IT-105	Introduction to Computers	3	0	0	3
15107	IT-107	Electrical Science	3	1	0	4
<u>Practical/Viva Voce</u>						
99163	BA-163	Organic Chemistry Lab	0	0	3	2
99153	BA-153	Physics I Lab	0	0	2	1
15155	IT-155	Computer Programming Lab	0	0	2	1
15157	IT-157	Engineering Graphics I	0	0	2	1
15159	IT-159	Electrical Science Lab	0	0	2	1
		Total	17	5	11	28

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Paper ID	Paper	L	T	P	Credit
99109	BA-109 Mathematics I	3	1	0	4

Unit I **14 Hrs**

Calculus of functions of one variable

- i.** Successive Differentiation, Leibnitz's theorem (without proof). Lagrange's Theorem, Cauchy Mean value theorems, Taylor's theorem (without proof), Remainder term, Asymptotes, Curvature, Curve Tracing.
- ii.** Infinite Series: Convergence, divergence, Comparison test, Ration Test, Cauchy n^{th} root test, Leibnitz's test (without proof), Absolute and Conditional Convergence, Taylor and Meclaurin series, Power Series, Radius of Convergence.
- iii.** Integral Calculus: Reduction Formulae of trigonometric functions, Properties of definite Integral, Applications to length, area, volume, surface of revolution, Definition of improper integrals, Beta-Gamma functions

Unit II **14 Hrs**

Calculus of Functions of several variables

Partial derivatives, Chain rule, Differentiation of Implicit functions, Exact differentials. Maxima, Minima and saddle points, Method of Lagrange multipliers. Differentiation under Integral sign, Jacobians and transformations of coordinates. Double and Triple integrals. Simple applications to areas, Volumes etc.

Unit III **14 Hrs**

Vector Calculus

Scalar and vector fields, Curves, Arc length, Tangent, normal, Directional Derivative, Gradient of scalar field, divergence and curl of a vector field. Line integral (independent of path), Green's theorem, Divergence theorem and Stoke's theorem (without proofs), Surface Integrals.

Text Books

1. Calculus and Analytic Geometry by G.B. Thomas and R.L. Finney, Addison Wesley/Narosa. publications
2. Higher Engineering Mathematics by Grewal B.S., Khanna Publications

Reference Books

1. Advanced Engineering Mathematics by E. Kreyszig, Wiley Eastern Ltd.
2. Theory and Problems of Vectors Analysis by Murray R. Spiegel, Schaum's Outline Series, Mc Graw Hill.
3. Mathematical Analysis by S.C. Malik, Wiley Eastern Ltd.
4. Advanced Calculus, Schaum's Outline Series, Mc Graw Hill
5. Advanced Calculus by Widder, Prentice Hall Publishers.
6. Shanti Narayan, "Differential Calculus", S. Chand & Co.
7. Shanti Narayan, "Integral Calculus", S. Chand & Co.

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Paper ID	Paper	L	T	P	Credit
99111	BA-111 Physics I	2	1	0	3

UNIT I

10 Hrs

Optics

- i. **Polarization:** Types of polarization, elliptically and circularly polarized light Brewsters law, Malu's law, Nicol prism, double refraction, quarter-wave and half-wave plates, optical activity, specific rotation, Laurent half shade polarimeter.
- ii. **Interference:** Coherence and coherent sources, interference by division of wave front (young's double slit experiment, Fresnel's biprism), interference by division of amplitude (thin films, Newton's rings, Michelson's interferometer, Fabry Perot interferometer)
- iii. **Diffraction:** (Fresnel and Fraunhofer types of diffraction) Fraunhofer diffraction: Single slit, double slit, circular aperture and N-slit, diffraction grating wavelength determination, resolving power and dispersive power, Fresnel Diffraction: Zone plate, circular aperture, opaque circular disc, narrow slit.

UNIT II

10 Hrs

Laser and Fibre Optics

- i. **Lasers :** Introduction, coherence, Einstein A and B coefficients, population inversion, basic principle and operation of a laser, type of lasers, He-Ne laser, Ruby laser, semiconductor laser, holography-theory and applications.
- ii. **Fibre Optics:** Introduction to optical fibre, types of optical fibres and their characteristics, (Attenuation and dispersion step index and graded index fibres, principle of fibre optic communication-total internal reflection, numerical aperture, fibre optical communication network (qualitative)-its advantages.

UNIT III

8 Hrs

Theory of relativity

Absolute and Inertial frames of reference, Galenlian transformations, Michelson-Morley experiment, the postulates of the special theory of relativity, Lorentz transformations, time dilation, length contraction, velocity addition, mass energy equivalence

Text Books

1. Concept of Modern Physics: A. Beiser
2. Optics by Ghatak

Reference Books

1. Modern Physics: Kenneth Krane
2. Fundamentals of Optics: Jenkins and White
3. Fundamental of Physics by Resnick and Halliday

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Paper ID	Paper	L	T	P	Credit
99117	BA-117 Organic Chemistry	3	1	0	4

UNIT I

12 Hrs

Classification of Organic Compounds

IUPAC nomenclature, structural isomerism, Cis-trans isomerism, shapes and molecular orbital structures of compounds containing C,N and O conformation of alkanes, structures of dienes, pyridine, pyrrole, aromatic compounds, delocalization, concept of aromaticity, stability of cycloallanes, resonance concept, inductive and mesomeric effects, directive effects, activating and deactivating group, hydrogen bonding, organic reagents and reaction intermediates.

UNIT II

12 Hrs

Chemistry of hydrocarbons

House synthesis halogenations of alkanes, free radical mechanism, cracking effect of structure on physical properties of compounds, alkenes catalytic hydrogenation, dehydration of alcohols, dehydrogenation, Sayteff rule, electrophilic addition reactions, peroxide effects, mechanism of allylic substitution, acidity of 1-alkynes conjugated dienes, 1,2 and 1,4 additions, free radical and ionic mechanisms of addition polymerization reactions. Ring opening reactions of cyclopropane and cyclobutane, chemistry of benzene and alkyl benzenes. Aromatic electrophilic substitution reaction Friedel-Crafts reaction.

UNIT III

10 Hrs

Chemistry of functional groups

Alkyl and aryl halides, nucleophilic substitution, synthetic utility of Grignard reagents and alkylolithiums, mechanism of Grignard reaction of alcohols, Benzyl alcohol, Benzaldehyde, Acetophene, benzophenone, aldol condensation, acidity of acids, alkyl and aryl amines

UNIT IV

8 Hrs

Synthetic utility of diazonium salts

Basicity of amines, multistep synthesis.

Text Books

1. Text book of organic chemistry by B.S.Bahl and Arun Bahl, S.Chand and company LTD. Delhi
2. Fundamentals of organic chemistry by T.W.G.Solomons, John Wiley and sons, Inc. NewYork.

Reference Books

1. Text book of organic chemistry by Girijesh Dubey
2. Organic Chemistry by Leroy G. Wade, Prentice Hall
3. Organic Chemistry, Fourth Edition : Structure and Function by K. Peter C. Vollhardt, Neil E. Schore, Publisher: W. H. Freeman

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Paper ID	Paper	L	T	P	Credit
98101	HS-101 Communication Skills I	2	1	0	3

UNIT I

6 Hrs

Remedial English

- i. Parts of speech; Tense and concord; Conditional clauses; Question tags & short responses; Punctuation; Common errors.
- ii. Vocabulary and Usage: Synonyms & Antonyms; One word substitutions; Words often confused; Idioms / Idiomatic expressions.

UNIT II

6 Hrs

Writing

- i. Technical Information: Technical description of simple objects, tools, appliances; processes and operations; scientific principles; Definitions ; Interpretation of Visual Data (graph, charts etc)
- ii. Writing of: Paragraph; Summary and Abstract; Taking and Making Notes.
- iii. Comprehension of Unseen Passages based on reading exercises like Skimming, Scanning and Inference making.

UNIT III

6 Hrs

Oral Communication

Dialogues – Creation of mock situations; Debates – Discussing the pros and cons of a given topic; Mock Interviews.

UNIT IV

10 Hrs

Texts for Analysis

- i. The Alchemist by Paulo Coelho
- ii. Wings of Fire by APJ Abdul Kalam

Text Books

1. Weiss, Edmond H. Writing Remedies: Practical Exercises for Technical Writing. University Press.

Reference Book

1. Day, Robert A. Scientific English: A Guide for Scientists and Other Professionals. UP.
2. Maison Margaret , Examine Your English, New Delhi: Orient Longman (rpt)
3. Tikoo M.L., A.E. Subramaniam and P.R. Subramaniam. Intermediate Grammar Usage and Composition. Delhi: Orient Longman.
4. Lesikar and Flatley. Business Communications. New Delhi, Biztantra Press.

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Paper ID	Paper	L	T	P	Credit
98119	HS-119* Impact of Science & Technology on Society	1	0	0	1

*NUES: The course shall depend on the teacher and will be delivered through semester presentation.

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Paper ID	Paper	L	T	P	Credit
15105	IT-105 Introduction to Computers	3	0	0	3

UNIT I

10 Hrs

Introduction

Overview of computer organization and historical perspective computer applications in various fields of science and management.

Introduction to computers

Data representation: Number systems, character representation codes, Binary, hex, octal codes and their inter conversions. Binary arithmetic, Floating point arithmetic, signed and unsigned numbers. Data Storage: Primary and Secondary storage, Introduction to various computer devices such as keyboard, mouse, printers, disk files, floppies etc. Concept of computing, contemporary, Operating Systems such as DOS, Windows'95, UNIX etc. (only brief user level description). Introduction to organization and architecture of mainframe, mini and micro systems. Introduction to E-mail, ftp, login and other network services, world wide web, MS-Office.

UNIT II

12 Hrs

Introduction to Programming

Concept of algorithms, Flow charts, Example of Algorithms such as how to add ten numbers, roots of a quadratic equation. Concept of sequentially following up the steps of a algorithm. Notion of program, programmability and programming languages, Structure of programs, Object codes, compilers. Introduction to the Editing tools such as vi or MS-VC editors. Concepts of the finite storage, bits, bytes, kilo, mega and gigabytes, Concepts of character representation.

UNIT III

26 Hrs

Programming with C

The emphasis should be more on programming techniques rather than the language itself. The C programming language is being chosen mainly because of the availability of the compilers, books and other reference materials. Example of some simple C program. Dissection of the program line by line, Concepts of Variables, program statements and function calls from the library (printf for example)

- C data types, int, char, float etc.
- C expressions, arithmetic operations, relational and logic operations.
- C assignment statements, extension of assignment to the operations. C primitive input output using getchar and putchar, exposure to the scanf and printf functions.
- C statements, conditional executing using if, else. Optionally switch and break statements may be mentioned.
- Concepts of loops, example of loops in C using for, while and do-while, Optionally continue may be mentioned.
- One dimensional arrays and example of iterative programs using arrays, 2-d arrays. Use in matrix computations.
- Concept of Sub-programming, functions, Example of functions, Argument passing mainly for the simple variables.
- Pointers, relationship between arrays and pointers, Argument passing using pointers, Array of pointers, Passing arrays as arguments.
- Strings and C string library
- Structures and Unions. Defining C structures, passing strings as arguments, programming examples.
- File I/O, Use of fopen, fscanf and fprintf routines

Text Books

1. Fundamentals of Computers by V. Raja Raman.
2. 'C' Language by Brian Gottfried by Schaum Series.
3. Introduction to Computers by Leon & Leon.

Reference Book

1. Let us C by Yashwant Kanetkar, BPB Publication

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Paper ID	Paper	L	T	P	Credit
15107	IT-107 Electrical Science	3	1	0	4

UNIT I **6 Hrs**

Introduction

Properties of Conductors and Insulators, Basic laws of Electrical Engineering, Temperature Resistance Coefficients

UNIT II **10 Hrs**

D.C. Circuits: Network theorems and applications, Division of Current, Potentiometer, Circuit Parameters, Energy and Power, Superposition, Thevenin and Reciprocity theorems, Star Delta Formations

Alternating Currents: Peak, Average and RMS values for alternating currents, Power and Power factor, Resistance, Inductance and Capacitance, Resonance, Q Factor

UNIT III **6+6 Hrs**

i. **Electromagnetism:** Magnetic Induction, Permeability, Hysteresis

ii. **Measuring Instruments:** Moving Coil and Moving Iron Instruments, Construction of Instruments, Attraction and Repulsion type, Permanent Magnet and Electrodynamic, Dynamometer type

UNIT IV **14 Hrs**

i. **D.C. Generators & Motors:** Principle of operation of Generators & Motors, Speed Control of shunt motors, Flux control, Rheostatic control, voltage control, Speed control of series motors

ii. **A.C. Generators & Motors:** Principle of operation, Removing Magnetic field, Squirrel cage and phase wound rotor, Starting of Induction motors, Direct on line and Star Delta starters, Synchronous machines

iii. **Transformers:** Construction, Regulation and efficiency calculations, Open and short circuit tests

Text Books

1. Electrical Engineering Fundamentals by Vincent DEL TURU. HUGHES, Electrical Technology.

Reference Book

1. Textbook of Electrical Engineering by B.L. Thareja and A.K. Thareja

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Paper ID	Laboratory	L	T	P	Credit
99163	BA-163 Organic Chemistry Lab	0	0	3	2

1. **Technical and preparation:** Lab safety, melting points, recrystallisation, distillation and reflux, drying agents, percentage yield, preparation of benzamide, aspirin, midnitobenzene dyes
2. **Identification of organic compounds:** Hydrocarbons, halogen compounds, phenols, aldehydes and ketones, carboxylic acids, amides, amines, formation of derivate, identification of unknowns.

Text / Reference Books

1. Experimental organic Chemistry by William Kemp and Arun Bahl, S.Chand and company Ltd. Delhi
2. Experimental organic chemistry by Charles A. Mackenzie, Prentice Hall, Inc., New Jersey(USA)

Paper ID	Laboratory	L	T	P	Credit
99153	BA-153 Physics I Lab	0	0	2	1

Practical based on BA 111

Text and Reference Books

1. **Textbook of practical physics by Induprakash, Ram Krishna and A.K.Jha, Publication: Kitab Mahal**

Paper ID	Laboratory	L	T	P	Credit
15155	IT-155 Computer Programming Lab	0	0	2	1

Practical based on IT-105

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Paper ID	Laboratory	L	T	P	Credit
15157	IT-157 Engineering Graphics I	0	0	2	1

1. General

Importance, Significance and scope of engineering drawing, Lettering, Dimensioning, Scales, Sense of proportioning, Different types of projections, Orthographic projections, B.I.S. Specifications.

2. Projections of Points and Lines

Introduction of planes of projection, Reference and auxiliary planes, projections of points and lines in different quadrants, traces, inclinations, and true lengths of the lines, projections on auxiliary planes, shortest distance intersecting and non-intersecting lines.

3. Planes Other than the Reference Planes

Introduction of other planes (perpendicular and oblique), their traces, inclinations etc., projections of points and lines lying in the planes, conversion of oblique plane into auxiliary plane and solution of related problems.

4. Projections of Plane Figures

Different cases of plane figures (of different shapes) making different angles with one or both reference planes and lines lying in the plane figures making different given angles (with one or both reference planes). Obtaining true shape of the plane figure by projection.

5. Projection of Solids

Simple cases when solid is placed in different positions, Axis, faces and lines lying in the faces of the solid making given angles.

6. Development of Surface

Development of simple objects with and without sectioning.

7. Nomography

Basic concepts and use

Text / Reference Books

- 1 Engineering Drawing by N.D.Bhatt and V.M.Panchal, Publication: Charota pub. House
- 2 Engineering Drawing by P.S.Gill

Paper ID	Laboratory	L	T	P	Credit
15159	IT-159 Electrical Science Lab	0	0	2	1

Practical based on IT-107

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SECOND SEMESTER EXAMINATION

L T P Credits
 17 6 8 27

<u>Theory Papers</u>						
Paper ID	Paper Code	Title	L	T	P	Credit
99108	BA-108	Mathematics II	3	1	0	4
99116	BA-116	Physics II	2	1	0	3
99118	BA-118	Physical Chemistry	3	1	0	4
47112	EM-112	Environmental Studies	4	0	0	4
15104	IT-104	Engineering Mechanics	3	1	0	4
98102	HS-102	Communication Skills II	1	2	0	3
98126	HS-126*	Impact of Science & technology on Society	1	0	0	1
<u>Practical/Viva Voce</u>						
99156	BA-156	Physics II Lab	0	0	2	1
99160	BA-160	Physical Chemistry Lab	0	0	4	2
15154	IT-154	Engineering Graphics II Lab	0	0	2	1
		Total	17	6	8	27

*NUES

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Paper ID	Paper	L	T	P	Credit
99108	BA-108 Mathematics II	3	1	0	4

UNIT I

10 Hr

Linear Algebra

Linear Independence and dependence of vectors, Systems of linear equations- consistency and inconsistency. Gauss elimination method, rank of a matrix, Bilinear, Quadratic, Hermitian, Skew- Hermitian Forms, Eigenvalues and Eigenvectors of a matrix, diagonalization of a matrix, Cayley- Hamilton Theorem (without proof).

UNIT II

14 Hrs

Ordinary Differential Equations

Formation of ODE's, definition of order, degree and solutions. ODE's of first order : Method of separation of variables, homogeneous and nonhomogeneous equations, exactness and integrating factors, linear equations and Bernoulli equations. General linear ODE's of nth order : solutions of homogenous and nonhomogenous equations, operator method, method of undetermined coefficients and variation of parameters. Solutions of simple simultaneous ODE's. Power series method of solution of DE, Legendre's Equation, Legendre's Polynomials, Bessel's equation, Bessel's function.

UNIT III

13 Hrs

Complex Variables

Curves and Regions in the Complex Plane, Complex Functions, Limits, Derivative, Analytic Function, Cauchy-Riemann Equations, Laplace's Equation, Linear Fractional Transformations, Conformal Mapping, Complex Line Integral, Cauchy's Integral Theorem, Cauchy's Integral Formula, Derivatives of Analytic Function, Power Series, Taylor Series, Laurent Series, Methods for obtaining Power Series, Analyticity at Infinity, Zeroes, Singularities, Residues, Residue Theorem, Evaluation of Real Integrals.

UNIT IV

5 Hrs

Probability

Definition of Sample Space, Event, Event Space, Conditional Probability, Additive and Multiplicative law of Probability, Baye's Law theorem, Application based on these results.

Text Books

1. Differential Equations by N.M. Kapoor, Pitamber Pub. Co.
2. Algebra by M. K Singhal and Asha Singhal, R. Chand & Co.
3. Complex Variables; Schaum Outline Series; Mc. Graw Hill.
4. Probability; Schaum Outline Series; Mc. Graw Hill.

Reference Books

1. Matrices by Shanti Narayan, S. Chand & Co.
2. Calculus and analytical Geometry by G. B. Thomas and R. L. Finney, Add. Wesley/Narora
3. Advanced Engineering Mathematics by E/ Kreysiz, Wiley Eastern Ltd
4. Differential Equations; Schaum Outline Series; Mc. Graw Hill.
5. Linear Algebra; Schaum Outline Series; Mc. Graw Hill.

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Paper ID	Paper	L	T	P	Credit
99116	BA-116 Physics II	2	1	0	3

UNIT I

8 Hrs

Quantum Mechanics

Wave particle duality, deBroglie waves, evidences for the wave nature of matter – the experiment of Davisson and Germer, electron diffraction, physical interpretation of the wave function and its properties, the wave packet, the uncertainty principle

The Schrodinger wave equation (1 – dimensional), Eigen values and Eigen functions, expectation values, simple Eigen value problems – solutions of the Schrodinger's equations for the free particle, the infinite well, the finite well, tunneling effect, simple harmonic oscillator (qualitative), zero point energy.

UNIT II

8 Hrs

Quantum Statistics

The statistical distributions: Maxwell Boltzmann, Bose-Einstein and Fermi-Dirac statistics, their comparisons, Fermions and Bosons Applications: Molecular speed and energies in an ideal gas. The Black body spectrum, the failure of classical statistics to give the correct explanations – the applications of Bose-Einstein statistics to the Black body radiation spectrum, Fermi-Dirac distribution, free electron theory, electronic specific heats, Fermi energy and average energy – its significance.

UNIT III

8 Hrs

Band Theory of Solids

Origin of energy bands in solids, motion of electrons in a periodic potential – the Kronig – Penny model. Brillouin zones, effective mass, metals, semi-conductors and insulators and their energy band structures. Extrinsic and Intrinsic semiconductors, doping – Fermi energy for doped and undoped semiconductors, the p-n junction (energy band diagrams with Fermi energy), the unbiased diode, forward and reverse biased diodes – tunnel diodes, zener diode, photo diode its characteristics, LED, Introduction to transistors.

UNIT IV

4 Hrs

Overview of Electro – Magnetism

Maxwell's Equations: The equation of continuity for Time – Varying fields, Inconsistency in ampere's law Maxwell's Equations, conditions at a Boundary Surface, Introduction to EM wave.

Text Books

1. Concept of Modern Physics: A. Beiser
2. Electronic Principles: Malvino

Reference Books

1. Modern Physics: Kenneth Krane
2. Solid State Physics by Kittel
3. Statistical Mechanics by Garg Bansal and Ghosh (TMH)

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Paper ID	Paper	L	T	P	Credit
99118	BA-118 Physical Chemistry	3	1	0	4

UNIT I **4 Hrs**

Gaseous state: Kinetic theory, molecular velocity, probable distribution of velocities, mean free path, collision frequency, distribution of molecules translational, rotational and vibrational, law of equipartition of energy; Equation of state of a real gas, Critical phenomenon and principle of corresponding states.

UNIT I **4 Hrs**

Phase rule: Derivation of phase rule; significance of various terms involved in the definition of phase rule, phase diagram of one component system (water, sulphur, CO₂). Two component system: Eutectic. Congruent and incongruent systems with examples Partial miscible liquids: Lower and upper consolute point.

UNIT III **6 Hrs**

Chemical kinetics: Rate, mechanism, steady state concept, kinetics of complex reactions, concept of energy barrier/ energy of activation. Theories of reaction rates. Endermann theory of unimolecular reaction and reaction in flow systems.

UNIT IV **14 Hrs**

Electro chemistry: Concept of electrolysis, electrical current in ionic solutions, Kohlrausch's law and migration of ions, Transference number, Hittroffs and moving boundary methods, applications of conductance measurements

Strong electrolytes: Onsager equation: Activity and activity coefficients of strong electrolyte.

Surface chemistry: Adsorption, adsorbate and adsorbents, types of adsorption, Freundlich adsorption isotherm, Langmuir adsorption isotherms, B.C.T Isotherm: surface area of the adsorbent, changes in entropy, enthalpy and free energy on adsorption, Gibb's adsorption equation.

UNIT V **14 Hrs**

Catalysis Types of catalysis, homogenous heterogeneous, enzyme catalysis, acid / base catalysis and their kinetics, mechanism of heterogeneous catalysis, kinetics of surface reactions: unimolecular and bimolecular, pH dependence of rate constants of catalyzed reactions autocatalysis

Colloids: Classification of colloids color of sols, electrochemical properties of sols, molecular weight v/s particle of colloidal dispersed particles, viscosity and plasticity, Gels and their properties: isobars and adsorption, isotherms, syneresis, thixotropy and diffusion in jellies. Emulsions, emulsifiers, theory of emulsification, properties and stability of emulsions.

Text books

1. Principles of physical chemistry, Maron Samuel H, Prutton, Carl. E., Oxford and IBH Publishing Co. Pvt. ND
2. Text books of physical chemistry, Glasstone Samuel, Macmillan and Co. ltd.
3. Principles of physical chemistry, Puri B.R., Sharma I.R. and Pathania Mada.
4. Physical Chemistry, Moore W.I., Orient Longman

Reference books

1. D.Tabor: Solids, liquids and gases, Penguin Press Paper back
2. A text book of physical chemistry, Atkins P.W., Oxford University Press, Oxford
3. Introduction to chemical reaction Engineering and kinetics, Missen, Ronald W. Mims Charles, A. Sacelli, Bradley A. John Wiley and Sons., NY
4. A textbook of physical chemistry, Negi A.S and Anand, S.C, eastern LTD. New Delhi.

UNIVERSITY SCHOOL OF CHEMICAL TECHNOLOGY
SCHEME OF EXAMINATION B.TECH (BIOCHEMICAL ENGINEERING)

Paper ID	Paper	L	T	P	Credit
47112	EM-112 Environmental Studies	4	0	0	4

UNIT I

12 Hrs

Fundamentals: Definition, scope and importance, need for public awareness, introduction to concept of green technology. Forest resources: Use and over-exploitation, deforestation, Timber extraction, mining, dams and their effects on forest and tribal people. Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources. Food resources: World food problems, changes caused by agriculture and over-grazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity. Energy resources: Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources-green fuel. Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. Resource Management-Sustainable development.

UNIT II

8 Hrs

Air Pollution - Types of pollutants, source, effects, sink & control of primary pollutants– CO, NOX, HC, SOx and particulates, effect of pollutants on man & environment: photochemical smog, acid rain and global warming, CO₂ Sequestration. Water Pollution - Classification of Pollutants, their sources, waste water treatment (domestic and industrial). Soil Pollution – Composition of soil, classification and effects of solid pollutants and their control.

UNIT III

12 Hrs

Solid Waste Pollution – Classification, waste treatment and disposal methods; composting, sanitary land filling, thermal processes, recycling and reuse methods. Hazardous wastes - Classification, radioactive, biomedical & chemical, treatment and disposal- Physical, chemical and biological processes. Marine Pollution – Causes, effects and control of marine pollution, coastal zone management. Toxic chemicals in the environment, Impact of toxic chemicals on enzymes, biochemical effects of arsenic, cadmium, lead, chromium, mercury, biochemical effects of pesticides. Polymer synthesis, Environmental degradation of polymers, photodegradable polymers, hydrolysis and hydrobiodegradable polymers, biopolymers and bioplastics, thermal degradation of plastics during recycling. Bioaccumulation, biodegradation, bioremediation, bioleaching, Biomethanation.

UNIT IV

8 Hrs

Green Technology-Introduction, Basic principles of green technology, concept of Atom economy, Tools of Green technology, zero waste technology.

Environmental Impact Assessment: Some important Environmental laws, Green bench, Carbon Credits, Environmental Management System standards-ISO 14000 series.

Books & References:

1. Roger Perman et. al., Natural Resources & Environmental Economics, 2nd Ed., Longman, USA, 2000.
2. Stern, A.C. (1980), Air Pollution, Vol. 1-VIII, Academic Press.
3. James M., Lynch & Alan Wiseman, Environmental Bio-monitoring : The Biotechnology
4. EcotoxicologyInterface, Cambridge University Press, 1998.
5. John Glasson, Riki Therivel and Andrew Chadwick, Introduction to Environmental Impact Assessment, 2nd Ed., UCL Press, Philadelphia, USA, 1994.

UNIVERSITY SCHOOL OF CHEMICAL TECHNOLOGY
SCHEME OF EXAMINATION B.TECH (BIOCHEMICAL ENGINEERING)

Paper ID	Paper	L	T	P	Credit
15104	IT-104 Engineering Mechanics	3	1	0	4

UNIT I

20 Hrs

- i. **Force System:** Introduction, force, principle of transmissibility of force, resultant of a force system, resolution of a force, moment of force about a line. Varignon's theorem, couple, resolution of force into force and a couple, properties of couple and their application to engineering problems.
- ii. **Equilibrium:** Force body diagram, equations of equilibrium and their applications to engineering problems, equilibrium of two force and three force member
- iii. **Structure:** Plane truss, perfect and imperfect truss, assumption in the truss analysis, analysis of perfect plane trusses by the method of joints, method of section and graphical method.
- iv. **Friction:** Static and Kinetic friction, laws of dry friction, co-efficient of friction, angle of friction, angle of repose, cone of friction, frictional lock, friction of flat pivot and collered thrust bearings, friction in journal-bearing, friction in screws, derivation of equation.
 $T_1 / T_2 = \lambda_e A$ and its application.
- v. **Distributed Forces:** Determination of center of gravity, center of mass and centroid by direct integration and by the method of composite bodies mass moment of inertia and area moment of inertia by direct integration and composite bodies method, radius of gyration, parallel axis theorem, Pappus theorems, polar moment of inertial., Dynamics.

UNIT II

8 Hrs

- i. **Kinematics of Particles:** Rectilinear motion, plane curvilinear motion-rectangular coordinates, normal and tangential coordinates
- ii. **Kinetics of Particles:** Equation of motion, rectilinear motion and curvilinear motion, work energy equation, conservation of energy, impulse and momentum conservation of momentum, impact of bodies, co-efficient of restitution, loss of energy during impact.

UNIT III

10 Hrs

- i. **Kinematics of Rigid Bodies:** Concept of rigid body, types of rigid body motion, absolute motion, introduction to relative velocity, relative acceleration (Corioli's component excluded) and instantaneous center of zero velocity, Velocity and acceleration polygons for four bar mechanism and single slider mechanism.
- ii. **Kinetics of Rigid Bodies:** Equation of motion, translatory motion and fixed axis rotation, application of work energy principles to rigid bodies conservation of energy

UNIT IV

4 Hrs

Vibrations

Classification, torsional free vibrations-single rotor and two rotor system, Spring mass system-its damped (linear dash pot) and undamped free vibrations, spring in series and parallel, simple problems

Text Books

1. Engineering Mechanics by U.C. Jindal, Galgotia Publication.
2. Engineering Mechanics (Statics and Dynamics) by A.K.Tayal

UNIVERSITY SCHOOL OF CHEMICAL TECHNOLOGY
SCHEME OF EXAMINATION B.TECH (BIOCHEMICAL ENGINEERING)

Paper ID	Paper	L	T	P	Credit
98102	HS-102 Communication Skills II	1	2	0	3

UNIT I **4 Hrs**

Key concepts

Communication as sharing; context of communication; the speaker/writer and the listener/reader; medium of communication; barriers to communication; accuracy, brevity, clarity and appropriateness in communication.

UNIT II **4 Hrs**

Writing

Types of Writing: Expository, Narrative; Descriptive, and Argumentative; Business Correspondence: Letters; Formal Reports: Memos; Notices and Circulars

UNIT III **2 Hrs**

Phonetics

Familiarity with Speech; Mechanism, Speech Sound and Phonetics Symbols; Consulting the Dictionary; the Syllable, Stress and Rhythm; Oral Exercises based on Dissimilarity; Transcription of commonly used words.

UNIT IV **4 Hrs**

Presentations and Group Discussions

Theoretical and practical aspects of formal oral presentations and GDs.

Text Books

1. Kaul, Asha, Business Communication, New Delhi: Prentice Hall of India Pvt. Ltd.

Reference Books

1. Bansal, R.K and J.B Harrison, Spoken English, Orient Longman (rpt) (Chapter 1-5, 8)
2. Lesikar and Flatley, Business Communications, New Delhi, Biztantra Press.

UNIVERSITY SCHOOL OF CHEMICAL TECHNOLOGY
SCHEME OF EXAMINATION B.TECH (BIOCHEMICAL ENGINEERING)

Paper ID	Paper	L	T	P	Credit
98126	HS-126* Impact of Science & technology on Society	1	0	0	1

*NUES: The course shall depend on the teacher and will be delivered through semester presentation.

Paper ID	Laboratory	L	T	P	Credit
99156	BA-156 Physics II Lab	0	0	2	1

Practical based on BA-116

Paper ID	Laboratory	L	T	P	Credit
99160	BA-160 Physical Chemistry Lab	0	0	4	2

List of Experiments

1. Draw calibration graph between concentration and viscosity of glycerol and hence evaluate the concentration of the unknown.
2. Study the distribution of I₂ between water and carbon tetrachloride.
3. Study of distribution of benzoic acid between water and benzene
4. To study the kinetics of hydrolysis of methyl acetate with Sodium hydroxide and calculate its order.
5. To study the kinetics of saponification of ethyl acetate charcoal at room temperature
6. To study the adsorption of acetic acid on activated charcoal at room temperature.
7. Determine the concentration of H₂SO₄/ HCl and CH₃COOH present in a mixture by conducts metric titration.
8. Verify Lambert Beer's law for copper sulphate solution.
9. Perform Photometric titration of Acid v/s base
10. Complemetric titration of Ca₂₊/Mg₂₊
11. To evaluate transition temperature of the reaction SrCl₂·6H₂O → SrCl₂ + 6H₂O

UNIVERSITY SCHOOL OF CHEMICAL TECHNOLOGY
SCHEME OF EXAMINATION B.TECH (BIOCHEMICAL ENGINEERING)

Paper ID	Laboratory	L	T	P	Credit
15154	IT-154 Engineering Graphics II Lab	0	0	2	1

1. Basic Concepts

I.S. drawing conventions, line symbols, kinds of line, drawing sheet lay-out, rules of printing, preferred scales.

2. Projections

Perspective, orthographic, isometric and oblique projections, isometric scale, isometric drawing, Technical sketching.

3. Shape Description (External)

Multiplanar representation in first- and third angle systems of projections, glass-box concept, sketching of orthographic views from pictorial views, precedence of lines.

Sketching of pictorial (isometric and oblique) views from Multiplanar orthographic views, Reading exercises, Missing line and missing view exercises.

4. Shape Description (Internal)

Importance of sectioning, principles of sectioning, types of sections, cutting plane representation, section lines, conventional practices.

5. Size Description

Dimensioning, tools of dimensioning, Size and location dimensions, Principles of conventions of dimensioning, Dimensioning exercises.

6. Computer Aided Drafting

Basic concepts and use.

Text / Reference Books

1. Engineering Drawing by N.D.Bhatt and V.M.Panchal, Publication: Charota Pub. House
2. Engineering Drawing by P.S.Gill

UNIVERSITY SCHOOL OF CHEMICAL TECHNOLOGY
SCHEME OF EXAMINATION B.TECH (BIOCHEMICAL ENGINEERING)

THIRD SEMESTER EXAMINATION

L T P Credits
17 4 9 27

<u>Theory Papers</u>						
Paper ID	Paper Code	Title	L	T	P	Credit
47211	EM-211	Introduction to Life Sciences	3	0	0	3
99213	BA-213	Applied Mathematics I	3	1	0	4
04201	BCT-201	Biochemical Process Calculations	3	1	0	4
04203	BCT-203	Fluid Mechanics	2	1	0	3
04205	BCT-205	Unit Operations	3	1	0	4
04207	BCT-207	Transport phenomenon	3	0	0	3
<u>Practical/Viva Voce</u>						
04251	BCT-251	Workshop	0	0	3	2
04253	BCT-253	Fluid Mechanics Lab	0	0	3	2
04255	BCT-255	Unit Operations Lab I	0	0	3	2
Total			17	4	9	27

UNIVERSITY SCHOOL OF CHEMICAL TECHNOLOGY
SCHEME OF EXAMINATION B.TECH (BIOCHEMICAL ENGINEERING)

Paper ID	Paper	L	T	P	Credit
47211	EM-211 Introduction to Life Sciences	3	0	0	3

UNIT I

16 Hrs

Origin of Life: History of earth theories of origin of life, nature of earliest organism.
Diversity of Life: Basic rules of classification and nomenclature, Classification –two kingdom, five kingdom – brief introduction to kingdoms, three domain Introduction and structure of virioids, prions and virus (HIV, TMV, Bacteriophage), Structure and reproduction of bacteria and their economic importance.
Chemical basis of life: Biomolecules – carbohydrates, proteins fats and lipids, nucleic acids (DNA and RNA)

UNIT II

10 Hrs

Enzymes: Definition, Properties, Types, Mechanism of action, factors affecting kinetics and their industrial applications
Cell – Structure and function: Prokaryotic and eukaryotic cells, plant and animal cells, structure and function of cell membrane, nucleus, chloroplast, mitochondria, golgi apparatus, endoplasmic reticulum.

UNIT III

8 Hrs

Histology Plants :- Meristem (apical, intercalary and lateral) , simple tissue (Paranchyma, collecchyma, and scleraenchyma), complex tissue (xylem and phloem)- structure and function; Tissue system (epideramal, ground and vascular);primary body and grewoth (root, stem and leaf), secondary growth.

UNIT IV

8 Hrs

Animal :- Epithelial , connective, muscular and nervous tissue –structure and function
Economic Biology:- Food - Cereals (wheat, rice, maize), Beverages (tea, coffee, cocoa), Sugarcane, Medicinal plants (Taxus, Catharanthus, Salix, Azadirachta); and Rubber (Hevea) Apiculture, Sericulture, Vermiculture, and Leather.

Text/Reference Books:

- 1, Biological Science, Taylor, D.J. Green, N.P.O, and Stout G.W., Cambridge
- 2, Bacteria, Singleton, P.John Wiley and Sons Ltd.
- 3, Cell Biology, Power C.B.. Himalayan Publication,
- 4, Animal Histology, Berry A.K. Emkay Publications,
- 5, Lehninger Principles of Biochemistry, Nelson, D.L. and M.M. Cox.. W.H. Freeman Costom Pub,

UNIVERSITY SCHOOL OF CHEMICAL TECHNOLOGY
SCHEME OF EXAMINATION B.TECH (BIOCHEMICAL ENGINEERING)

Paper ID	Paper	L	T	P	Credit
99213	BA-213 Applied Mathematics I	3	1	0	4

UNIT I

12 Hrs

Laplace Transformation Laplace transform, Inverse Transforms, Laplace Transform of Derivatives and integrals, Shifting Theorems, Differentiation and Integration of Transforms, Convolution, Periodic Functions, Solutions of ODE's using Laplace Transform.

UNIT II

10 Hrs

Fourier series and Integrals Periodic Functions, Fourier series, Euler Formulas, Even and ODD Functions, Half- Range Expansions, Harmonic Analysis, Fourier Integral.

UNIT III

15 Hrs

Partial Differential Equations Formation, solution of linear partial differential equations of 1st order, non-linear p.d.e of 1st order, Charpit's method (without proof), Classification of linear 2nd order equations, linear equations with constant coefficients, method of separation of variables, Wave equation, Heat equation, Laplace Equation.

UNIT IV

14 Hrs

Numerical Methods

Solution of Equation by iteration:- Bisection method, Newton Raphson method

Interpolation:- Lagrange Interpolation, Difference operators, Newton's Forward and backward interpolation, Error formulae. Numerical Integration & Differentiation: Trapezoidal rule, Simpson's one third rule including error formula, Numerical differentiation. Systems of Linear Equation: Gauss- Siedel iteration. Numerical Methods for Differential Equations:- Runge method, Runge-Kutta method, Adams- Moulton method.

Text Books

1. Higher Engineering Mathematics, Grewal B.S., Khanna Pub., New Delhi
2. Numerical methods for Scientific and engineering Computations, Jain, Iyenger, Jain, Wiley Publishers

Reference Books

1. Differential and Integral calculus, Vol-I & II Piskunov, Mir Publishers, Moscow
2. Advanced Engineering mathematics, Kreyszing Erwin, John Wiley and Sons
3. Elements of Partial differential Equations, Ian N. Sneddon, McGraw Hill Book Company, Inc.
4. Numerical Analysis, Akai T J, John Wiley & Sons
5. Elementary Numerical Analysis, Atkinson K., Wiley & Sons
6. Introductory Methods of Numerical Analysis, Sastry, Prentice Hall of India Pvt Ltd

UNIVERSITY SCHOOL OF CHEMICAL TECHNOLOGY
SCHEME OF EXAMINATION B.TECH (BIOCHEMICAL ENGINEERING)

Paper ID	Paper	L	T	P	Credit
04201	BCT-201 Biochemical Process Calculations	3	1	0	4

UNIT I

12 Hrs

Stoichiometric and composition relationship, behavior of ideal gases, gaseous mixtures, vapor pressure, humidity and humidity chart.

Units and dimensions, applications of laws of conservation of mass and energy to single and multistage process.

UNIT II

12 Hrs

Material balance for (a) Non-reacting systems- recycle, bypass etc.
(b) Reacting systems- recycle, bypass, purging etc.

UNIT III

10 Hrs

Energy balance for non reacting and reacting systems, flame temperature, adiabatic reaction temperature, combustion, heat capacity, heat of reaction etc.

UNIT IV

8 Hrs

Material and energy balances for unit operations and processes, integrated balances for manufacturing processes.

Mass and energy balances in bioprocesses, flow sheet and process calculations, metabolic stoichiometry of growth and product formation,

Text Books

1. Basic Principles of Calculations in Chemical Engineering, Himmelblau D.M., Prentice Hall.
2. Elementary Principles of Chemical Processes, Felder R.M. and Rousseau R. W., John Wiley & sons, Inc.

Reference Books

1. Stoichiometry, Bhatt V.I. and Vora S.M., Tata McGraw Hill
2. Introduction to material and energy balances by Reklaitis G V, Wiley, New York
3. Bioprocess Engineering Principles by P.M.Doran, Academic Press, Elsevier

UNIVERSITY SCHOOL OF CHEMICAL TECHNOLOGY
SCHEME OF EXAMINATION B.TECH (BIOCHEMICAL ENGINEERING)

Paper ID	Paper	L	T	P	Credit
04203	BCT 203 Fluid Mechanics	2	1	0	3

UNIT I

8 Hrs

Fluid Statics and Properties of Fluid Pressure measurement, forces on submerged bodies. Equation of continuity and motion, Navier-Stokes equations and their applications. Bernoulli's Equation and its applications. Newtonian and non-Newtonian fluids, Laminar and Turbulent flows.

UNIT II

4 Hrs

Measurement and Control of Flowing Fluids Principles and operation of variable head meter and variable area meter. Fluid moving machineries such as pumps, blowers. Application and selection of valves.

UNIT III

4 Hrs

Boundary layer flow and turbulence Laminar flow and boundary layer theory, Reynolds stress, Pandtl mixing length, universal velocity distribution. Flow past immersed bodies, drag and lift forces, motion of solids through a fluid.

UNIT IV

12 Hrs

Incompressible Flow & Fluidization: Laminar and turbulent flow in pipes, velocity distribution in pipes, frictional losses in pipes and fittings. Pressure drop calculations and friction factor. Estimation of economic pipe diameter. Agitation and mixing of liquids. Conditions of fluidization, aggregate and particulate fluidization, Flow through packed and fluidized Beds. **Flow of compressible fluid:** Basic equations, Flow through ducts, venturimeter, convergent-divergent nozzle. Laval Nozzle, Fanno flow.

Text Books

1. Unit Operations of Chemical Engineering, McCabe W.L, Smith J.C. and Harriott P, McGraw Hill International Edition, Singapore
2. Introduction to Fluid Mechanics, Fox and McDonald, John Wiley & Sons
3. Fluid Mechanics, Douglas J. F., Gasiorek J.M., Swaffield J.A., Addison-Wesley Longman

Reference Books

1. Introduction to Chemical Engineering, Badger W.L. and Banchemo J.T., Tata McGraw Hill
2. Chemical Engineering, Vol .1, Coulson J.M. and Richardson J.F, Butterworth Heinemann, Oxford

UNIVERSITY SCHOOL OF CHEMICAL TECHNOLOGY
SCHEME OF EXAMINATION B.TECH (BIOCHEMICAL ENGINEERING)

Paper ID	Paper	L	T	P	Credit
04205	BCT-205 Unit Operations	3	1	0	4

UNIT I

8 Hrs

Size Reduction : Size reduction of solids, energy for size reduction, law's of crushing and grinding, work index, particle size distribution.

Mechanical Separation: Screening: stationary screens, Trommel and vibrating screens

UNIT II

8 Hrs

Filtration: plate and frame filter press, continuous rotary vacuum filter, filter aids etc
Sedimentation: One dimensional motion of particles through fluid. Batch and continuous thickeners

Centrifuge: Tubular bowl centrifuge, disks centrifuge, and batch basket centrifuge. Cyclone separators, electrostatic and magnetic precipitator.

UNIT III

4 Hrs

Conveying Mechanical and pneumatic conveying system, storage and handling of materials, design and power requirement.

UNIT IV

8Hrs

Crystallization Theory of solubility and crystallization, phase diagram (temp solubility relationship), population balance analysis, method of moments for rate expression. For volume area and length growth., crystal size distribution, Mixed suspension mixed product removal operation, programmed evaporative and cooling (rate expressions), most dominant size ideal classified bed, melt crystallization, process design of crystallizers and their operation, selection and specification of crystallizers like OSLO, Swenson Walker, agitated type etc, performance evaluation of crystallizers.

Text Books

1. Unit Operations of Chemical Engineering, McCabe W.L Smith J.C. and Harriott P., McGraw Hill, Singapore

Reference Books

1. Chemical Engineering, Vol.1, Coulson J.M. and Richardson J.F, Butterworth Heinemann, Oxford
2. Introduction to Chemical Engineering, Badger W.L. and Banchero J.T.,Tata McGraw Hill
3. Unit Operations of Chemical Engineering Vol .1, Chattopadhy, P., Khanna Publishers

UNIVERSITY SCHOOL OF CHEMICAL TECHNOLOGY
SCHEME OF EXAMINATION B.TECH (BIOCHEMICAL ENGINEERING)

Paper ID	Paper	L	T	P	Credit
04207	BCT-207 Transport phenomenon	3	0	0	3

UNIT I

10 Hrs

Philosophy and fundamentals of three transport phenomena: Importance of transport phenomena; analogous nature of transfer process; basic concepts, conservation laws. Molecular transport of momentum, Heat and mass, laws of molecular transport, Newton's law of viscosity, Fourier law of heat conduction, and Fick's law of diffusion. Transport coefficients – viscosity, thermal conductivity and mass diffusivity.

UNIT II

16 Hrs

Shell momentum balances and velocity distributions in laminar flow: shell momentum balances and boundary conditions, flow of a falling film, flow through a circular tube, flow through annulus, flow of two adjacent immiscible fluids, creeping flow around a sphere.

Shell energy balances and temperature distributions in solids and laminar flow: shell energy balances; boundary conditions, heat conduction with an electrical heat source, heat conduction with a nuclear heat source, heat conduction with a viscous heat source, heat conduction with a chemical heat source, heat conduction through composite walls, heat conduction in a cooling fin, forced convection, free convection.

UNIT III

8 Hrs

Concentration distributions in solids and laminar flow: shell mass balances; boundary conditions, diffusion through a stagnant gas film, diffusion with a heterogeneous chemical reaction, diffusion with a homogeneous chemical reaction, diffusion into a falling liquid film (gas absorption), diffusion into a falling liquid film (solid dissolution).

UNIT IV

8 Hrs

The equations of change for isothermal systems: the equation of continuity, the equation of motion, the equation of mechanical energy, the equation of angular momentum, the equations of change in terms of the substantial derivative, use of the equations of change to solve flow problems. Velocity distributions in turbulent flow: comparisons of laminar and turbulent flows.

Text Books

1. Transport Phenomena, R.B. Bird, W.E. Stewart and E.W. Lighfoot; John Wiley

Reference Books

1. Fundamentals of Momentum Heat and Mass Transfer, J.R. Wilty, R.W. Wilson, and C.W. Wicks, John Wiley, New York
2. Transport Processes and Separation Process Principles, Christie J. Geankopolis, Prentice-Hall

UNIVERSITY SCHOOL OF CHEMICAL TECHNOLOGY
SCHEME OF EXAMINATION B.TECH (BIOCHEMICAL ENGINEERING)

Paper ID	Laboratory	L	T	P	Credit
04251	BCT-251 Workshop	0	0	3	2

1. Machine shop: Working on lathe, milling, drilling machines, power hacksaw etc.
2. Welding Shop: To make various types of joints by arc welding and gas welding.
3. Fitting shop: To know about the various equipments used in fitting shop and make some simple objects.
4. Carpentry shop: To know about the various equipments used in carpentry shop and to make some joints.
5. Sheet metal work: To make some objects by galvanized iron sheet.
6. To familiarize pipes and fittings including flanges and valves (upto 1")

Books & References:

1. Workshop Technology, Part I, II & III, Chapman, W.A.J., CBS publishers and distributors
2. Manufacturing Processes, Amstead B.H, Ostwald P.F., and Begeman M.L., John Wiley Sons, Inc., New York
3. Workshop Technology, Vol I, II and III, Chandola S.P., Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi
4. Elements of Workshop Technology, Vol I & II., Hajra Choudury S.K., Bose S.K., Hajra Choudury A.K. and Roy N., Media Promoters and Publishers Pvt. Ltd., Mumbai

Paper ID	Laboratory	L	T	P	Credit
04253	BCT-253 Fluid Mechanics Lab	0	0	3	2

1. Calibration of orifice meter.
2. Performance of venturi meter.
3. Pump characteristics
4. Power consumption in agitated vessel.
5. Pressure drop in pipe.
6. Bernoulli's experiment.
7. Verification of Stokes' Law
8. Flow through packed bed.
9. Flow through fluidized bed.

Paper ID	Laboratory	L	T	P	Credit
04255	BCT-255 Unit Operations Lab	0	0	3	2

1. Studies on crystallization
2. Experiment based on Sedimentation
3. Experiment on Leaf Filter
4. Experiment on Rotary Vacuum Filter.
5. Experiment on Plate & Frame Filter Press.
6. Experiment on Screen Separation.
7. Experiment on Size reduction by Jaw Crusher.
8. Experiment on Size reduction by Grinder
9. Solid particle separation by cyclone separator
10. Studies on pneumatic conveying system

UNIVERSITY SCHOOL OF CHEMICAL TECHNOLOGY
SCHEME OF EXAMINATION B.TECH (BIOCHEMICAL ENGINEERING)

FOURTH SEMESTER EXAMINATION

L T P Credits
16 6 10 28

<u>Theory Papers</u>						
Paper ID	Paper Code	Title	L	T	P	Credit
99212	BA-212	Applied Mathematics II	3	1	0	4
04214	BCT-214	Biochemistry	2	1	0	3
04202	BCT-202	Eng. Thermodynamics	2	1	0	3
04204	BCT-204	Mass Transfer I	3	1	0	4
04206	BCT-206	Microbiology	2	1	0	3
04208	BCT-208	Biochemical Reaction Eng.	3	1	0	4
<u>Practical/Viva Voce</u>						
04252	BCT-252	Biochemistry Lab	0	0	3	2
04254	BCT-254	Micro-Biology Lab	0	0	4	2
04256	BCT-256	Unit Operations Lab II	0	0	3	2
		Total	15	6	10	27

UNIVERSITY SCHOOL OF CHEMICAL TECHNOLOGY
SCHEME OF EXAMINATION B.TECH (BIOCHEMICAL ENGINEERING)

Paper ID	Paper	L	T	P	Credit
99212	BA-212 Applied Mathematics II	3	1	0	4

UNIT I

14 Hrs

Probability statistics

Elementary probability theory, Random variables: discrete and continuous, distribution and density functions, Expectation, Moments, Moment generating function, Skewness, Kurtosis, Binomial, Poisson and Normal distribution, method of least square for linear and parabolic curves, correlation of a bivariate distribution, Linear regression, properties of regression coefficient, sampling distribution of mean and variance, Testing of statistical hypothesis, F-Test, T-test and Chi square test.

UNIT II

14 Hrs

Linear programming

Mathematical preliminaries, Formulation of the problem and solution by graphical method, Simplex method, Dual problem formulation and solution, Dual simplex method, application to Transportation and Assignment problems.

UNIT III

8 Hrs

Optimization

Search and gradient methods (Fibonacci method, Golden section method, Steepest decent method) and Lagrange multipliers, K. K. T. necessary and sufficient optimality conditions

UNIT IV

6 Hrs

Network scheduling PERT and CPM

Rules of Network construction, Critical path analysis, Probability condition in PERT .

Text Books

1. Operational research, Kanti Swaroop, Gupta P.K., Manmohan, Sultan Chand and sons.
2. Fundamentals of mathematical statistics, S.C.Gupta and V.K.Kapur, Sultan Chand and sons

Reference Books

1. Probability and statistics for Engineers, Irwin Miller and John E.Freund, PHI
2. Probability and statistics, Murray R Speigel, John J. Schiller, R. Alu Srinivasan , Schaum series, Mc Graw Hill.
3. Operational research- an introduction, H.A Taha, McMillan Publishing company, NY

UNIVERSITY SCHOOL OF CHEMICAL TECHNOLOGY
SCHEME OF EXAMINATION B.TECH (BIOCHEMICAL ENGINEERING)

Paper ID	Paper	L	T	P	Credit
04214	BA/BT-214 Biochemistry	2	1	0	3

UNIT I **12 Hrs**

Introduction

Molecular basis of life, study of macro molecules

Carbohydrates: Their structure and biological functions, Monosaccharides disaccharides and polysaccharides Glycoproteins

Amino Acids and Proteins: Their structure and function, Types of amino acids, Fibrous proteins and globular proteins, Separation of proteins

Fats and Lipids: Their structure and biological functions, Types of lipids, triacylglycerol, Waxes, Phospholipids, Sphingolipids, Lipoproteins

Nucleic acid and Nucleotides: DNA, Structure of chromosomes and genes, Replication and transcription of DNA, RNA Protein synthesis and its regulation, Genetic recombination and cloning

UNIT II **8 Hrs**

Vitamins and Hormones: Types, Structure and functions

Photosynthesis: Chlorophylls, Kinds and roles of photosystems, Calvin cycle

Enzymes: Properties and types, Kinetics of enzyme action, Enzyme inhibition, Allosteric enzymes, Assay of enzymes, Regulation of enzyme activity

UNIT III **6 Hrs**

Bioenergetics and Metabolism: Metabolism, basic concepts and design, Glycolysis citric acid cycle oxidative phosphorylation pentose phosphate pathway and gluconeogenesis glycogen and disaccharide metabolism amino acid degradation and urea cycle

UNIT IV **2 Hrs**

Biological Membranes: Characteristics of biological membranes components of membranes types of membranes fluid mosaic model membrane asymmetry

Text /Reference Books

1. Biochemistry by Stryer L, W.H.Freeman and Company
2. Principles of Biochemistry by Lehninger, A ; Butterworth Publishers, New York
3. Outlines of Biochemistry by Conn E E and Stump P K ,John Wiley and Sons, New York
4. Proteins Biochemistry and Biotechnology by Walsh G , John Wiley and sons
Biochemistry by Rastogi, Tata Mc Graw Hill

UNIVERSITY SCHOOL OF CHEMICAL TECHNOLOGY
SCHEME OF EXAMINATION B.TECH (BIOCHEMICAL ENGINEERING)

Paper ID	Paper	L	T	P	Credit
04202	BCT-202 Eng. Thermodynamics	2	1	0	3

UNIT I

8 Hrs

The first law and other basic concepts

Dimensions, units, work, heat, energy, the first law of thermodynamics, enthalpy, equilibrium, phase rule, heat capacity, PVT behavior of pure substances, ideal gas, real gas, heat effects.

UNIT II

8 Hrs

Second law and Entropy

statements, heat engines, Kelvin-Planck and Clausius statements and their equality, reversible and irreversible processes, Carnot cycle, thermodynamic temperature scale, entropy, entropy calculations, T-S diagrams, properties of pure substances, use of steam tables and Mollier diagram.

UNIT III

6 Hrs

Refrigeration and liquefaction

The Carnot refrigerator, the vapor-compression cycle, comparison of refrigeration cycles, liquefaction processes, heat pump. Rankine power cycle.

UNIT IV

6 Hrs

Thermodynamic properties of fluids

Fluid property relations for homogenous phases, thermodynamic diagram, generalized property correlation for gases. **Thermodynamics of flow processes:** flow of compressible fluids through ducts, compression processes, turbines.

Text Books

1. Introduction to Chemical Engineering Thermodynamics, Smith J.M , Van Ness H.C., Abbott M. M The McGraw Hill Companies, Inc., USA
2. Chemical and Engineering Thermodynamics, Sandler S.I. John Wiley and Sons, Inc., New York

Reference Books

1. Introductory Chemical Engineering Thermodynamics, Elliott J. R. and Lira C. T., Prentice Hall
2. Applied Thermodynamics for Engineering Technologists, Eastop T. D. and McConkey A., Addison Wesley Longman Ltd., England

UNIVERSITY SCHOOL OF CHEMICAL TECHNOLOGY
SCHEME OF EXAMINATION B.TECH (BIOCHEMICAL ENGINEERING)

Paper ID	Paper	L	T	P	Credit
04204	BCT-204 Mass Transfer I	3	1	0	4

UNIT I **12 Hrs**

Fundamentals of Mass Transfer

Molecular diffusion in fluids, mass transfer coefficients and interphase mass transfer, steady state theories of mass transfer, analogy.

UNIT II **10 Hrs**

Absorption

Equilibrium solubility of gases in liquids, choice of solvent, co-current and counter-current multistage operation, absorption equipment design and performance evaluation. Concept of ideal stage, stage efficiency, operating line. Concepts of HTU and NTU.

UNIT III **10 Hrs**

Humidification/Dehumidification

Use of psychometric charts (temperature/ humidity and enthalpy/humidity charts). Method of changing humidity. Estimation of air quality. Mass and heat balances in bulk and at interface - counter current, co-current and cross current. Design of cooling towers.

UNIT IV **10 Hrs**

Drying

Wet bulb, dry bulb and adiabatic saturation temperatures, humidity, drying mechanism, drying rate curves, estimation of drying time and process design of dryers e.g. spray, rotary, tunnel, tray, fluid bed and thin film, performance evaluation of dryers.

Text Books

1. Mass-Transfer Operation, Robert E. Treybal, McGraw Hill

Reference Books

1. Unit Operations of Chemical Engineering, McCabe W.L., Smith J.C. and Harriott P. McGraw Hill International edition, Singapore
2. Principles of Unit Operations, Foust A.S. John Wiley & Sons, Singapore.
3. Introduction to Chemical Engineering, Badger W.L. and Banchemo J.T., Tata McGraw Hill Edition.
4. Chemical Engineering, Vol. I, Coulson J.M. and Richardson J.F. Butterworth Heinemann, Oxford.

UNIVERSITY SCHOOL OF CHEMICAL TECHNOLOGY
SCHEME OF EXAMINATION B.TECH (BIOCHEMICAL ENGINEERING)

Paper ID	Paper	L	T	P	Credit
04206	BCT-206 Microbiology	2	1	0	3

UNIT I **8 Hrs**

Scope and History of Microbiology:

Scope and History of Microbiology, Classification, Characterization, Identification and Nomenclature of Microorganisms, Microscopy, Morphological, Structural and Biochemical characteristics of prokaryotes and eukaryotes (bacteria, yeast, mold, algae, protozoa, actinomycetes)

Cultivation of Microorganisms: Microbiological media, physical conditions required for growth.

UNIT II **4 Hrs**

Reproduction and Growth of Microorganism: Modes of cell division, growth curve of microbes, Quantitative measurement of growth.

Methods in Microbiology: Chemical, Physical and Biological methods of selection of microorganisms, Methods of isolating pure cultures, Maintenance and preservation of pure cultures, microbial mutation.

UNIT III **12 Hrs**

Microbial Metabolism: Metabolic pathways and Bioenergetics, Aerobic and Anaerobic growth, Transport of nutrients across cell membranes

Physical and Chemical Control of Microorganism: Major groups of antimicrobial agents, Mode of action and practical applications

Energy Transduction Mechanisms in Microbial Cell: Aerobic and anaerobic respiration, Microbial photosynthesis, Transduction, Transformation, Conjugation

Microbial Interaction: - Roles of microbes in Nitrogen, Carbon and Sulphur cycle Application of Microorganism in various Field: - Agriculture, food, environment, medicine, public health and industry.

UNIT IV **4 Hrs**

Viruses: Classification, morphology and composition, DNA and RNA bacteriophages, Lysogeny and lytic cycle

Books Recommended

1. Microbiology by Pelczar M J, Chan E C S and Krieg N R “, Mc Graw Hill, New York
2. Fundamental Principles of Bacteriology by Salle A J, Tata McGraw Hill, New Delhi
3. Text in Microbiology by Stanier R Y, McMillan Press London
4. Microbiology by Davis B D, Harper and Row Publications, Hageston
5. Industrial Microbiology by Casida L E, New Age International Publishers, New Delhi

UNIVERSITY SCHOOL OF CHEMICAL TECHNOLOGY
SCHEME OF EXAMINATION B.TECH (BIOCHEMICAL ENGINEERING)

Paper ID	Paper	L	T	P	Credit
04208	BCT-208 Biochemical Reaction Engineering	3	1	0	4

UNIT I

8 Hrs

Review of kinetics for homogeneous reactions:

Classification of reactors, design equations for batch, flow and semi batch reactors and their performance. Collection and interpretation of rate data using batch and flow reactors,

UNIT II

10 Hrs

Kinetics of enzyme catalyzed reactions in free and immobilized states: Michaelis-Menten equation and its various modifications. Effects of External mass transfer in immobilized enzyme systems; analysis of intraparticle diffusion and reaction.

UNIT III

12 Hrs

Kinetics of substrate utilization, product formation and biomass production:

Monod growth model and its various modifications; structured and unstructured kinetic rate models; Thermal death kinetics of cells & spores; Transport phenomena in Bioprocess systems; gas liquid mass transfer in cellular systems. Mass transfer for bubbles swarms;

UNIT IV

12 Hrs

Microbial Growth Kinetics:

Batch, continuous sterilization, kinetics of sterilization

Air Sterilization:

Methods of air sterilization, mechanism of air sterilization, filter design

Design of Reactors:

Energy Balance and design of ideal, single phase flow reactors with heat effects.

Text Books

1. Chemical Reaction Engineering, Levenspiel O., John Wiley & Sons (Asia)

Reference Books

1. Chemical Engineering Kinetics, Smith J.M., McGraw Hill
2. Elements of Chemical Reaction Engineering, Scott Fogler H., Prentice Hall of India

UNIVERSITY SCHOOL OF CHEMICAL TECHNOLOGY
SCHEME OF EXAMINATION B.TECH (BIOCHEMICAL ENGINEERING)

Paper ID	Laboratory	L	T	P	Credit
04252	BCT-252 Biochemistry Lab	0	0	3	2

1. Estimation of carbohydrates
2. Protein estimation
3. Estimation of nucleic acids
4. Determination of Michaelis constant of enzymes.
5. Isoelectric precipitation
6. Extraction of lipids
7. Separation of amino acids by paper chromatography
8. Preparation of different buffer solutions for biochemical experiments
9. Separation by sugars by paper chromatography
10. Thin layer chromatography
11. Ultraviolet absorption of nucleic acids, amino acids and protein
12. Determination of acid value, iodine value and specification value of fat
13. Experimental analysis of biochemical compounds by TLC
14. Estimation of cholesterol.

Paper ID	Laboratory	L	T	P	Credit
04254	BCT-254 Microbiology Lab	0	0	4	2

1. To study the microscope.
2. Preparation and sterilization of the medium for bacteria yeast and mold.
3. Preparation of slants /plates /deeps for culture of bacteria yeast and mold.
4. To study the morphology of bacteria, yeast and mold.
5. Staining techniques: Simple staining, gram staining, endospore staining, capsule staining
6. Culture techniques: culture media preparation, cultivation of microorganisms
7. Microbiological examination of water: Coliform and Salmonella counts
8. Determination of phenol coefficient.
9. Determination of cell mass in a fermentation broth.
10. Calibration of cell mass vs. cell number and cell mass vs optical density
11. Isolation of microorganisms by streak plate method
12. Isolation by Serial dilution method, maintenance & preservation

References

1. 'Microbes in action', A lab manual of Microbiology, H.W.Seelay Jr. and Paul J.Van Denmark, D.B. Taraporewala Sons & Co. Pvt. Ltd.
2. 'Methods in microbiology', Ed. J.R. Norris & D.W. Robbins, Vol. 3 A, Academic Press, London & New York

UNIVERSITY SCHOOL OF CHEMICAL TECHNOLOGY
SCHEME OF EXAMINATION B.TECH (BIOCHEMICAL ENGINEERING)

Paper ID	Laboratory	L	T	P	Credit
04256	BCT-256 Unit Operation lab	0	0	3	2

1. Fractional distillation
2. Studies on drying characteristics
3. Experiments on humidification and dehumidification in a packed column.
4. Studies on batch distillation.
5. Determination of diffusion co-efficient of carbon tetrachloride in air.
6. Determination of diffusion co-efficient of naphthalene in air.

UNIVERSITY SCHOOL OF CHEMICAL TECHNOLOGY
SCHEME OF EXAMINATION B.TECH (BIOCHEMICAL ENGINEERING)

FIFTH SEMESTER EXAMINATION

L T P Credits
18 3 9 27

<u>Theory Papers</u>						
Paper ID	Paper Code	Title	L	T	P	Credit
04301	BCT-301	Protein Science & Engg	3	0	0	3
04303	BCT-303	Bio Reaction Engg.	3	1	0	4
04305	BCT-305	Heat Transfer	3	1	0	4
04307	BCT-307	Mass Transfer II	3	1	0	4
04309	BCT-309	Molecular Biology	3	0	0	3
04311	BCT-311	Immunology	3	0	0	3
<u>Practical/Viva Voce</u>						
04351	BCT-351	Heat and Mass Transfer Lab	0	0	3	2
04353	BCT-353	Bio reaction Engg. Lab	0	0	3	2
04355	BCT-355	Molecular biology Lab	0	0	3	2
		Total	18	3	9	27

UNIVERSITY SCHOOL OF CHEMICAL TECHNOLOGY
SCHEME OF EXAMINATION B.TECH (BIOCHEMICAL ENGINEERING)

Paper ID	Paper	L	T	P	Credit
04301	BCT-301 Protein Science & Engg.	3	0	0	3

UNIT I

14 Hrs

Structure of protein: Primary, secondary, tertiary, quaternary structure, Protein folding, molten globule structure, characterization of folding pathways. Post translation modification.

Methods to alter primary structure of protein: Random mutation Site directed mutation, Catalytic activity.

Protein modification: thermal, enzymatic, physical, pressure, solvents, interactions. Protein raw materials: cereals, legume, oil seeds and pseudo cereals. Muscle protein, Milk protein, egg protein, Hemoglobin, Collagen, Keratin. Nutritive role of food proteins. Sequence and 3Dstructure analysis: Data mining, Ramachandran map, Mechanism of stabilization of proteins from psychrophiles and thermophiles vis-à-vis those from mesophiles; Protein design.

UNIT II

16 Hrs

Methods to determine structure of proteins: Protein structure determination, X-Ray analysis of protein, NMR and mass Spectroscopy, Absorption and Fluorescence, Circular Dichroism, FT-Raman, FT-IR, MALDITOF. Protein characterization, 2 D Gel electrophoresis.

Structure and function prediction: Protein Bimolecular interaction, Drug protein interaction Thermal properties of proteins and application of DSC. Protein denaturation, aggregation and gelation. Flow properties of proteins and sensory properties of pertinacious foods.

UNIT III

4 Hrs

Protein engineering: definition, application; Features or characteristics of proteins that can be engineered (definition and Electives methods of study)–affinity and specificity

Spectroscopic properties; Stability to changes in parameters as pH, temperature and amino acid sequence, aggregation propensities, etc.

UNIT IV

8 Hrs

Methods of measuring the stability of a protein: Spectroscopic methods to study physicochemical properties of proteins: far-UV and near-UVCD; Fluorescence; UV absorbance; Hydrodynamic properties–viscosity, hydrogen-deuterium exchange; Brief introduction to NMR spectroscopy – emphasis on parameters that can be measured/obtained from NMR and their interpretation

Books Recommended

1. Proteomics from Protein sequence to function by Permington S R , Dunn M J, Viva Books Pvt. Ltd., New Delhi
2. Protein function. A practical approach Edited by T E Creighton,Oxford university press.
3. Protein Engineering, Principles and Practice, Vol 7, by Cleland and Craik, Springer Netherlands
4. Protein engineering protocols by Mueller and Arndt. Humana Press
5. Protein Engineering Methods in Enzymology Ed. Robertson DE, Noel JP, Elsevier Academic Press
6. Structure in protein chemistry by J Kyte, , Garland publisher
7. Proteins Biochemistry and Biotechnology by Walsh G, John Wiley and sons

UNIVERSITY SCHOOL OF CHEMICAL TECHNOLOGY
SCHEME OF EXAMINATION B.TECH (BIOCHEMICAL ENGINEERING)

Paper ID	Paper	L	T	P	Credit
04303	BCT-303 Bio Reaction Engg.	3	1	0	4

UNIT I

8 Hrs

Enzyme & Kinetics of Enzyme-Catalytic Reactions

Enzyme - Basic knowledge, Physico-chemical properties, Micro-organism as a source of enzyme.

Enzyme Kinetics - Single & double substrate steady state kinetics, effect of pH & temperature, inhibition. Down stream processing of commercial enzymes. Enzyme purification techniques.

UNIT II

16 Hrs

Microbial growth in a batch and continuous bioreactor; substrate utilization and product formation kinetics. Estimation of cell mass; Study of different phase of microbial growth, concept of limiting nutrient and effect of its concentration on cell growth; Study of growth inhibition kinetics, study of product formation kinetics in a fermentation process; comparison between aerobic and anaerobic bioconversion process; estimation of KLa in fermentation process.

Aeration and agitation: bubble aeration and mechanical agitation, calculation of power consumption, correlation between oxygen transfer coefficient and operating variables, estimation of KLa in fermentation process, factors affecting volumetric oxygen transfer, rheology of fermentation fluids

UNIT III

10 Hrs

Scale up: concepts, criteria for bioreactors scale up.

Concept of ideal and non-ideal reactor: residence time distribution; operating considerations in bioreactors for suspension and immobilized cultures, modifying batch and continuous reactors, immobilized cell systems, solid state fermentation.

UNIT IV

8 Hrs

Models of non-ideal reactors: plug flow with axial dispersion, tanks-in-series model. Unconventional bioreactors: Hollow fiber reactor, membrane reactor, perfusion reactor for animal and plant cell culture.

Kinetics of mixed cultures: Major classes of interaction in mixed cultures, models describing mixed-culture interactions, reaction dynamics, industrial application of mixed cultures.

Books & References:

1. Chemical Reaction Engineering, Levenspiel O., John Wiley & Sons (Asia), 3rd Ed., 2000
2. Biochemical Engineering Fundamentals by James E. Bailey & David F. Ollis, McGraw-Hill.
3. Bioprocess Engineering by Shuler & Kargi, Prentice Hall
4. Encyclopedia of Chemical Engineering by Kirk & Othmer,
5. Lee J M, "Biochemical Engineering", Prentice Hall (1992)
6. Shuler M L, Kargi F, "Bioprocess Engineering- Basic Concepts", 2nd ed, Prentice Hall of India Ltd. (2002)
7. Aiba S, Humphrey A E and Millis N F, "Biochemical Engineering", Academic Press (1973)
8. Bio reaction engg. Principles, John Villadsen, Jens Nielsens, Gunnar Liden, Springer

UNIVERSITY SCHOOL OF CHEMICAL TECHNOLOGY
SCHEME OF EXAMINATION B.TECH (BIOCHEMICAL ENGINEERING)

Paper ID	Paper	L	T	P	Credit
04305	BCT-305 Heat Transfer	3	1	0	4

UNIT I **10 Hrs**
Conduction: Fourier's law, concept of resistance to heat transfer, critical insulation thickness, conduction with heat generation. Two-dimensional steady State Conduction: Analytical & Numerical Methods. Unsteady State unidirectional Heat Conduction.

UNIT II **8 Hrs**
Convection: Film theory and concept of heat transfer coefficient. Heat transfer in laminar and turbulent flows.

UNIT III **10 Hrs**
Heat Exchanger: sizing of shell & tube heat exchangers. Heat transfer in agitated vessels.

UNIT IV **14 Hrs**
Boiling & Condensation: heat transfer to boiling liquids and from condensing vapours.

Evaporation: Evaporator types, Single and multiple effect evaporators. Calculation of Surface area

Text Books

1. Heat Transfer, Holman J. P., McGraw Hill, New York.
2. Process Heat Transfer, Kern D. Q., Tata Mc Graw Hill Edition.
3. Unit Operations of Chemical Engineering, McCabe W.L., Smith J.C. and Harriott P. McGraw Hill International edition, Singapore.

Reference Books

1. Transport Processes and Unit Operations, Geankoplis C.J., Prentice Hall of India
2. Fundamentals of Heat and Mass Transfer, Dewitt et al., John Willey & Sons
3. Chemical Engineering Vol.1, Coulson J.M. and Richardson J.F. Butterworth Heinemann, Oxford
4. Heat Transfer, Chapman A. J., Mac Millan, New York
5. Fundamentals of Momentum, Heat and Mass Transfer, Welty J.R., Wilson R.E., and Wicks C.E., John Wiley & Sons, Inc. New York

UNIVERSITY SCHOOL OF CHEMICAL TECHNOLOGY
SCHEME OF EXAMINATION B.TECH (BIOCHEMICAL ENGINEERING)

Paper ID	Paper	L	T	P	Credit
04307	BCT-307 Mass Transfer II	3	1	0	4

UNIT I **14 Hrs**
Distillation : Fundamentals of vapor liquid equilibrium, Henry's, Raoult's and Dalton's laws, x-y and T-x-y diagrams, partial vaporization/condensation, performance evaluation of distillation column including reboiler and condenser, flash, differential and steam distillation. Number of plate's calculation using McCabe-Thiele and enthalpy-concentration diagram. Relation of HTU to HETP.

UNIT II **10 Hrs**
Liquid-Liquid Extraction: Extraction process and equipment, equilibrium diagram, choice of solvent, single and multistage co-current, countercurrent extraction.

UNIT III **14 Hrs**
Solid - Fluid Operations: Adsorption. Nature of adsorbents- silica gel, activated alumina, molecular sieves, activated carbon. Structure of adsorbents – surface area, pore size etc. Adsorption equilibria. Multi-component adsorption. Isotherms – Langmuir, BET, Gibb's. Potential theory. Design of fixed bed and moving bed adsorbers.

UNIT IV **4 Hrs**
Ion Exchange & Leaching: Theory and operation.

Text Books

1. Mass-Transfer Operation, Robert E. Treybal, McGraw Hill

Reference Books

1. Unit Operations of Chemical Engineering, McCabe W.L., Smith J.C. and Harriott P. McGraw Hill International edition, Singapore
2. Principles of Unit Operations, Foust A.S. John Wiley & Sons, Singapore.
3. Introduction to Chemical Engineering, Badger W.L. and Banchero J.T., Tata McGraw Hill Edition.
4. Chemical Engineering, Vol. I, Coulson J.M. and Richardson J.F. Butterworth Heinemann, Oxford.
5. Separation Processes, King C.J., Tata McGraw Hill
6. Transport Processes and Unit Operations, Geankoplis, C.J. Prentice Hall

UNIVERSITY SCHOOL OF CHEMICAL TECHNOLOGY
SCHEME OF EXAMINATION B.TECH (BIOCHEMICAL ENGINEERING)

Paper ID	Paper	L	T	P	Credit
04309	BCT-309 Molecular Biology	3	0	0	3

UNIT I

10 Hrs

Introduction to the Cell: Evolution of cell: prokaryotic and eukaryotic cell, unicellular and multicellular organisms. Cell Organells: Cell wall, cell membranes, cytosol, mitochondria, chloroplast, nucleus, nucleolus, ribosome, lysosomes, Golgi body, endoplasmic reticulum, motility organelles, flagella, pilli, cilia

UNIT II

18 Hrs

Structure and function of nucleus: organization of the chromosome; eu-and heterochromatins; nucleosome; cell cycle regulation - CDC mutants, protein kinase; cyclin; synthetic pattern and control of cell divisions; biochemistry of meiosis

Chromosome biology: ultra structure of chromosomes, types of chromosome, chromosomal aberration (Numerical & structural), chromatin, Chromosomal DNA, chromosomal proteins and its packaging

Molecular Genetics: Cell cycle, Cell division, mechanism of cell division, Cell theory, mechanism of cell development, formation of tissues, types of tissue (both plant and animals)

UNIT III

10 Hrs

Cell Signaling: General principles of cell signaling, signaling via G-Protein linked cell-surface Receptors, Signaling via Enzyme- linked cell-surface Receptors, target cell adaptation
 The biochemical basis of inheritance: DNA as the genetic material; DNA structure and replication in Prokaryotes and eukaryotes; nucleotide sequence composition: unique, middle and highly repetitive

DNA; Redundant DNA; Genetic Code; transcription and translation machinery in Prokaryotic and eukaryotic system. Regulation of gene expression in E. coli-operon concept; hormonal control of gene expression in eukaryotes.

UNIT IV

4 Hrs

Microscopy: Compound, Phase contrast, Fluorescent, Confocal, EM, Fractionation: Cell rupture techniques, Fractionation of subcellular organelles by centrifugation, flow cytometry

Books Recommended

1. De- Robertis, F D P and De Robertis E M F, "Cell and Molecular Biology", Saunders, Philadelphia (1991).
2. Lewin B "Gene IX", Oxford University Press, Oxford (2008)
3. Sambrook J, Fritsch E F and Maniatis T, "Molecular Cloning" ., Cold Spring Harbor Laboratory Press (1989)

UNIVERSITY SCHOOL OF CHEMICAL TECHNOLOGY
SCHEME OF EXAMINATION B.TECH (BIOCHEMICAL ENGINEERING)

Paper ID	Paper	L	T	P	Credit
04311	BCT-311 Immunology	3	0	0	3

UNIT I

16 Hrs

The immune system: innate and acquired immune system, components of immune system, role of humoral and cell-mediated immunity. Antibodies, the genetic basis of antibody diversity, structure-function, immunoglobulin classes. Polyclonal and Monoclonal antibodies, Catalytic antibodies. Structure and properties of antigens, biological aspects of antibody-antigen interaction. Identification and measurement of antibodies and antigens, Radial Immuno diffusion,

Cells and Organs of Immune System: Lymphoid cell, heterogeneity of lymphoid cells, TCells, primary and secondary lymphoid organs- thymus, bursa of fabricus, spleen, Lymph nodes, lymphatic system,, mucosal associated lymphoid tissue (MALT)

UNIT II

14 Hrs

Humoral Immunity: B-lymphocytes and their activation, structure and function of immunoglobulins, immunoglobulin classes and subclasses, genetic control and production, monoclonal antibodies and diagnosis, major histocompatibility complex, complement fixing antibodies and complement cascade

Cellular Immunity: Thymus derived lymphocytes (T-cells their classification antigen presenting cells (APC), Macrophage their origin and function, mechanism of phagocytosis, Identification of cell types of immune systems, immuno suppression and immune tolerance, interferons and their mechanism of action, interleukins and their functions.

UNIT III

12 Hrs

Immunity and Infection: Hypersensitivity reactions, types and mechanisms of T Cell activation, Cytokines and their role in immune response, transplantation and rejection, graft rejection, Immunosuppressive drugs, mechanism of immunity, tumor antigens. Immune Disorders and Diseases: Primary immuno deficiency, secondary immuno-deficiency, Acquired immuno deficiency syndrome (AIDS)

Auto Immunity: Auto antibodies in humans, Pathogenic mechanisms, experimental models of auto immune disease, treatment of autoimmune disorders. Immunological Techniques and Vaccines: Precipitation, agglutination, RIA, ELISA, Immunoelectrophoresis, Immunodiffusion

Books

1. Kuby J "Immunology", W.H. Freeman and Company, New York (2003)
2. Roitt I M "Essentials of Immunology", Blackwell Scientific Publications Oxford (1991)
3. Benjamin E and Leskowity S "Immunology, A Short Course", Wiley Liss (1991)
4. Pinchuk G, "Schaum's Outline of Immunology", Tata McGraw Hill (2004)

UNIVERSITY SCHOOL OF CHEMICAL TECHNOLOGY
SCHEME OF EXAMINATION B.TECH (BIOCHEMICAL ENGINEERING)

Paper ID	Laboratory	L	T	P	Credit
04351	BCT-351 Heat & Mass Transfer Lab	0	0	3	2

1. Sterilization of bio reactor.
2. Heat transfer in shell & tube heat exchanger.
3. Heat transfer in double pipe heat exchanger.
4. To determine Volumetric Oxygen Transfer Coefficient (K_{la}) in fermentation system by dynamic method.
5. To determine Volumetric Oxygen Transfer Coefficient (K_{la}) in fermentation system by sulphite oxidation method.
6. Vacuum evaporation
7. Drying and crystallization
8. Liquid-liquid separation
9. Separation of proteins and other biomolecules by various Chromatography techniques

Paper ID	Laboratory	L	T	P	Credit
04353	BCT-353 Bio -Reaction Engg. Lab	0	0	3	2

1. Batch Reactor
2. To estimate growth kinetic parameters of Escherichia coli.
3. To determine mixing time in a stirred tank reactor (STR).
4. Estimation of cell maintenance coefficient and true growth yield by studying the mass and energy balance during cell growth.
5. Comparison between aerobic and anaerobic fermentation.
6. To determine Residence Time Distribution (RTD) for a CSTR.
7. Immobilization of the enzymes over the carriers.
8. Immobilization of the cells over the carriers.
9. Studies on the kinetics of immobilized enzyme and immobilized cells

UNIVERSITY SCHOOL OF CHEMICAL TECHNOLOGY
SCHEME OF EXAMINATION B.TECH (BIOCHEMICAL ENGINEERING)

Paper ID	Laboratory	L	T	P	Credit
04355	BCT-355 Molecular Biology Lab	0	0	3	2

1. Isolation and purification of genomic DNA from bacteria, plant and animal tissues.
2. Isolation and purification of plasmid DNA.
3. Analysis of DNA by agarose and polyacrylamide gel electrophoresis.
4. Recovery of DNA from gels.
5. Restriction analysis of DNA and restriction mapping.
6. Spectrophotometric estimation of DNA, RNA and proteins.
7. In situ gel assays for peroxidase, SOD, acid phosphatase and LDH.
8. Southern, Northern and dot blotting technique
9. Determination of phosphorous content of nucleic acids
10. Analysis of proteins by gel electrophoresis
11. Analysis of proteins by 2D gel electrophoresis
12. Estimation of RNA by means of orcinol *reaction*

UNIVERSITY SCHOOL OF CHEMICAL TECHNOLOGY
SCHEME OF EXAMINATION B.TECH (BIOCHEMICAL ENGINEERING)

SIXTH SEMESTER EXAMINATION

L T P Credits
17 7 7 28

<u>Theory Papers</u>						
Paper ID	Paper Code	Title	L	T	P	Credit
04302	BCT-302	Instrumentation & Control	3	1	0	4
04304	BCT-304	Bioprocess Equipment Design	2	2	0	4
04306	BCT-306	Computational Methods for Biochemical Engineers	3	1	0	4
04308	BCT-308	Environmental Biotechnology	3	1	0	4
04312	BCT-312	Biosafety, Hazards & IPR issues	3	0	0	3
39312	MS-312	Organization Behavior & Industrial Management	3	0	0	3
<u>Practical/Viva Voce</u>						
04352	BCT-352	Instrumentation & Control Lab	0	0	3	2
04354	BCT-354	Minor computational project	0	0	4	2
04356	BCT-356	Seminar*	0	2	0	2
Total			17	7	7	28

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UNIVERSITY SCHOOL OF CHEMICAL TECHNOLOGY
SCHEME OF EXAMINATION B.TECH (BIOCHEMICAL ENGINEERING)

Paper ID	Paper	L	T	P	Credit
04302	BCT-302 Instrumentation & Control	3	1	0	4

UNIT I

Concept of measurement: error, accuracy, sensitivity.

Instrumentation for process variables such as pressure, temperature, level and flow of fluids.

Concept of automatic control, feed back control, control loop and its components.

Dynamic behavior of first order and second order, interacting, non interacting & higher order systems. Distance velocity lag. Transfer function. Response of distributed systems.

UNIT II

Laplace domain analysis of closed loop systems, Routh stability and Root Locus Diagrams.

Frequency response analysis. Bode and Nyquist stability criterion.

Choice of controller and controller settings. Simple cases of single variable control system design.

UNIT III

Monitoring of Bio processes: online data analysis for measurement and control of important physicochemical and biochemical parameters, parameter estimation techniques for biochemical processes, computer based data acquisition

Text Books

1. Industrial Instrumentation, Eckman. D.P,Wiley Eastern Ltd.
2. Process Systems Analysis and Control, Coughanowr D.R., McGraw Hill.

Reference Books

1. Chemical Process Control-an introduction to theory and practice, Stephanopoulos, G. Prentice Hall of India
2. Process Dynamics & Control, Seborg D. E., T. F. Edgar and D. A. Mellichamp, John Wiley & Sons.
3. Process Control, Harriott P., McGraw Hill.

UNIVERSITY SCHOOL OF CHEMICAL TECHNOLOGY
SCHEME OF EXAMINATION B.TECH (BIOCHEMICAL ENGINEERING)

Paper ID	Paper	L	T	P	Credit
04304	BCT-304 Bioprocess Equipment Design	2	2	0	4

UNIT I

10 Hrs

Introduction to various codes (ASTM, API, Japanese, German etc.) used in chemical process industries and their application.

Basic Engineering design approach and selection of pressure vessel components such as Head, closure, flanges, gasket, nozzles etc,

Design of pressure vessel support and its mechanical design. Material specification and general design information.

UNIT II

10 Hrs

Mass and energy balance, flow sheeting, piping and instrumentation; materials of construction for bioprocess plants; mechanical design of process equipments, vessels for biotechnology applications; design of fermenters; design consideration for maintaining sterility of process streams and processing equipment; selection and specification of equipment for handling fluids and solids; selection, specification and design of heat and mass transfer equipment used in bioprocess industries;

UNIT III

8 Hrs

Design of facilities for cleaning of process equipment's used in biochemical industries; utilities for biotechnology production plants;

Process economics; bioprocess validation; safety considerations; case studies.

Text Books :

1. Introduction to Chemical Equipment Design, Mechanical Aspects, Bhattacharya, B.C., CBS Publisher and Distributor.
2. Plant Design and Economics for Chemical Engineers Max S.Peters, Klaus D. Timmerhaus McGraw Hill.

Reference book

1. Process Equipment Design, Joshi, M.V., Mahajani, V.V., Macmillan India Ltd.
2. Parry's Chemical Engineer's Hand Book, Robert H. Parry, Don W. Green, McGraw Hill,
3. Chemical Process Equipments selection and design, Stanley M. Walas, Butterworth Heinemann,
4. Conceptual Design of Chemical Process Douglas J M, McGraw Hill.
5. An introduction to biochemical Process Design in Chemical Engineering Problem in Biotechnology Shuler M L Vol I AICHE.

UNIVERSITY SCHOOL OF CHEMICAL TECHNOLOGY
SCHEME OF EXAMINATION B.TECH (BIOCHEMICAL ENGINEERING)

Paper ID	Paper	L	T	P	Credit
04306	BCT-306 Computational Methods for Biochemical Engineers	3	1	0	4

UNIT I

10 Hrs

Mathematical formulation of the physical problem. Formulation of the differential Equation: Application of law of conservation of Mass, Momentum and Energy.

UNIT II

10 Hrs

Mathematical formulation of finite difference equation. Finite difference methods in analysis of stage wise processes, numerical solution of partial differential equation.

UNIT III

12 Hrs

Probability theory: handling stochastic phenomena, groundwork for statistics. Vectors and matrices: applied to population dynamics, quantitative genetics and statistics.

UNIT IV

10 Hrs

Dynamical systems: techniques to analyse models of population growth, reaction kinetics, etc.

Text Books

1. Applied Mathematics in Chemical Engineering, Mickley, H.S., Sherwood, T.K., and Reed, C.E., McGraw Hill, N.Y.
2. Mathematical models in biology. L. Edelstein-Keshet McGraw-Hill Education, ISBN 0075549506.\

Reference books

1. Calculus for biology and medicine ,C. Neuhauser. Prentice Hall, ISBN 0131234412.
2. Mathematical techniques by D. W. Jordan & P. Smith. Oxford University Press, ISBN 0199249725.
3. Dynamic models in biology by S. P. Ellner & J. Guckenheimer. Princeton University Press, ISBN-10: 0691125899.

UNIVERSITY SCHOOL OF CHEMICAL TECHNOLOGY
SCHEME OF EXAMINATION B.TECH (BIOCHEMICAL ENGINEERING)

Paper ID	Paper	L	T	P	Credit
04308	BCT-308 Environmental Biotechnology	3	1	0	4

UNIT I

12 Hrs

Introduction: Pollution monitoring, biotechnological treatment of wastes.

Introduction of water microbiology: Waterborne infectious agents and control of pathogenic microbes in water, sewage and sludge. Waste water characteristics, physical, chemical and biological. Waste water treatment, activated sludge processes, biological nutrient removal, waste water treatment efficiency assessment

UNIT II

10 Hrs

Aerobic processes of secondary treatment: Activated sludge, lagoons, stabilization ponds, suspended growth, nitrification, trickling filters, rotating biological contactors, anoxic suspended growth and fixed film denitrification.

UNIT III

10 Hrs

Anaerobic processes of treatment: Biological concepts, suspended growth and fixed film processes and reactor configuration, Sequential batch reactor for combined processes (aerobic and anaerobic)

UNIT IV

10 Hrs

Tertiary Treatment: Effluent disposal and reuse.

Bioenergy from biological waste: Production of biogas and bio hydrogen from various biological wastes by fermentative processes.

Biotransformation and biodegradation of pollutants, methods for determining biodegradability and biodegradation of lignocellulose, PAH, agricultural chemicals.

Molecular biological techniques in the characterization of environmental populations of microorganisms. **Emerging** technologies, biosensors and microprobes.

Text Books

1. Environmental bio Technology by Sayler & Fox

Reference books

1. Environmental Biotechnology by S. K. Aggarwal
2. Foster C.F., John Ware D.A., Environmental Biotechnology, Ellis Horwood Ltd., 1987.
3. Environmental Biotechnology by A.K. Chatterjee.

UNIVERSITY SCHOOL OF CHEMICAL TECHNOLOGY
SCHEME OF EXAMINATION B.TECH (BIOCHEMICAL ENGINEERING)

Paper ID	Paper	L	T	P	Credit
04312	BCT-312 Biosafety, Hazards & IPR issues	3	0	0	3

UNIT II

10 Hrs

Biotechnology and Society: Introduction to science, technology and society, biotechnology and social responsibility, public acceptance issues in biotechnology, issues of access, ownership, monopoly, traditional knowledge, biodiversity, benefit sharing, environmental sustainability, public vs. private funding, biotechnology in international relations, globalisation and development divide.

UNIT II

12 Hrs

Bioethics: Legality, morality and ethics, the principles of bioethics: autonomy, human rights, beneficence, privacy, justice, equity etc. Ethical issues – ethical issues against the molecular technologies. Bioethics – Necessity of Bioethics, different paradigms of Bioethics – National & International. Legal issues – legal actions taken by countries for use of the molecular technologies. Social issues - public opinions against the molecular technologies. Intellectual Property Rights – Why IPR is necessary, TRIPS & IPR, IPR – national & international scenario, IPR protection of life forms. The expanding scope of ethics from biomedical practice to biotechnology, ethical conflicts in biotechnology - interference with nature, fear of unknown, unequal distribution of risks and benefits of biotechnology, bioethics vs. business ethics, ethical dimensions of IPR, technology transfer and other global biotech issues.

UNIT III

10 Hrs

Biosafety concepts and issues: Rational vs. subjective perceptions of risks and benefits, relationship between risk, hazard, exposure and safeguards, biotechnology and biosafety concerns at the level of individuals, institutions, society, region, country and the world. Biosafety in the laboratory institution: Laboratory associated infections and other hazards, assessment of biological hazards and levels of biosafety, prudent biosafety practices in the laboratory/ institution Biosafety regulations in the handling of recombinant DNA processes and products in institutions and industries, biosafety assessment procedures in India and abroad.

UNIT IV

10 Hrs

Patents, copyrights, trademarks, patent act (1970), patent (amendment) act (2002), salient features and different types of patent and patent specifications. Filing and processing of applications for patents, biopiracy and biocolonialism.

Text Books:

1. Thomas, J.A., Fuch, R.L. (2002). Biotechnology and Safety Assessment (3rd Ed). Academic Press.
2. Fleming, D.A., Hunt, D.L., (2000). Biological safety Principles and practices (3rd Ed). ASM Press, Washington.

Reference book

1. Biotechnology - A comprehensive treatise (Vol. 12). Legal economic and ethical dimensions
2. Encyclopedia of Bioethic

UNIVERSITY SCHOOL OF CHEMICAL TECHNOLOGY
SCHEME OF EXAMINATION B.TECH (BIOCHEMICAL ENGINEERING)

Paper ID	Paper	L	T	P	Credit
39312	MS-312 Organization Behavior & Industrial Management	3	0	0	3

UNIT I

10 Hrs

Nature of Organizations, Structure of Organization. Organizational Behavior. Organizations in Indian Context. Role Responsibilities of a Manager.

UNIT II

10 Hrs

Individual and Organization: Perception, Attitude, Motivation, Personality, Values of Sets, Stress and its Management.

UNIT III

10 Hrs

Interpersonal communications, Group dynamics, Decision Making. Organizational change and Development.

UNIT IV

12 Hrs

Economic Planning and Policy in India, Industrial Policy, Industrial Development in India. Position and Problems of Chemical Industries in India.

Text Books:

1. Organization Behavior by Robbing, S.P.:

Reference books

1. Management by Stonier
2. Managemnet behavior by Euthans, Fred, McGraw Hill

UNIVERSITY SCHOOL OF CHEMICAL TECHNOLOGY
SCHEME OF EXAMINATION B.TECH (BIOCHEMICAL ENGINEERING)

Paper ID	Laboratory	L	T	P	Credit
04352	BCT-352 Instrumentation & Control Lab	0	0	3	2

1. Flow control system.
2. Air pressure control system
3. Temperature control system.
4. Level control system.
5. Dynamics of a first order system.
6. Dynamics of a second order system.
7. Dynamics of distributed parameter system.

Paper ID	Laboratory	L	T	P	Credit
04354	BCT-354 Minor computational project	0	0	4	2

Student will be required to take a computational project in the field of biochemical engineering

Paper ID	Laboratory	L	T	P	Credit
04356	BCT- 356 Seminar*	0	2	0	2

*NUES

- Student will be required to prepare a critical review of selected topics in Biochemical Engineering and allied subjects and submit in the form of a standard typed report.
- The student will also be required to make an oral presentation of the review

UNIVERSITY SCHOOL OF CHEMICAL TECHNOLOGY
SCHEME OF EXAMINATION B.TECH (BIOCHEMICAL ENGINEERING)

SEVENTH SEMESTER EXAMINATION

L T P Credits
15 2 11 24

<u>Theory Papers</u>						
Paper ID	Paper Code	Title	L	T	P	Credit
04401	BCT-401	Modeling and Simulation of Bioprocess	3	1	0	4
04403	BCT-403	Process Engineering	3	1	0	4
04405	BCT-405	Enzyme Technology	3	0	0	3
04407	BCT-407	Biochemical Processes	3	0	0	3
98411	HS-411	Introduction to Economics	3	0	0	3
<u>Practical/Viva Voce</u>						
04451	BCT-451	Modeling and Simulation Lab	0	0	3	2
04453	BCT-453	Project Work I	0	0	8	4
04455	BCT-455	Summer training/project	-	-	-	1
		Total	15	2	11	24

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SCHEME OF EXAMINATION B.TECH (BIOCHEMICAL ENGINEERING)

Paper ID	Paper	L	T	P	Credit
04401	BCT-401 Modeling and Simulation of bioprocess	3	1	0	4

UNIT I

10 Hrs

Simulation: basics, discreet event simulation, conducting a simulation project, building a system model, model verification and validation, Simulation of batch pharmaceutical manufacturing systems

Batch process simulation: concept, goals and capabilities. Software: SuperPro Designer, K-Tops, Aspen

UNIT II

8 Hrs

Modeling: basic process operations with SuperPro Designer, chemical reactions, separation operations

Study of Structured Models: Analysis of various bioprocesses; Model simulation using MATLAB-SIMULINK and ISIM software packages.

UNIT III

8 Hrs

Fundamental laws: continuity equation, energy equation, equation of motion, transport equation, equation of state, Phase and chemical equilibrium, chemical kinetics.

Examples of Mathematical Models: Modeling of gene regulation (Genetic switches), Modeling of signal transduction in prokaryotes and eukaryotes, Insilico microorganisms, metabolic flux analysis.

UNIT IV

14 Hrs

Elementary mode analysis: Heat and Mass Transfer Equipment such as Heat exchangers, evaporators, flash distillation, differential distillation, continuous binary distillation in tray and packed column, vaporizers, single phase separation adsorption, absorbers and strippers, agitated vessels, mixing process. Reaction Equipment: Batch reactor, Semi batch reactor, Continuous stirred tank reactor, Plug flow reactor, Packed column reactor, Bioreactors, Reactors used in effluent treatments, Fluidized bed reactor.

Books Recommended

1. Harrell, C., Ghosh, B., Bowden, R., "Simulation Using Promodel", McGraw Hill Software: ProModel v.6.1 (incl. with the textbook) SuperPro Designer v. 6.0 or higher.
2. Luyben W L, "Process Modeling Simulation and Control for Chemical Engineers", international ed. McGraw Hill .
3. Rose L M, "The Application of Mathematical Modeling to Process Development and Design", First Ed. Applied Science Publisher Limited. London.
4. Bequette, "Process Dynamics- Modeling, Analysis and Simulation", PHI International
5. Rase H F, "Chemical Reactor Design for Process Plants, Vol II: Case Studies and Design Data", John Wiley and Sons, New York
6. Denn M Morton, "Process Modeling", Longman Publisher
7. J.R. Leigh, Modeling and Control of fermentation Processes, Peter Peregrinus, London

UNIVERSITY SCHOOL OF CHEMICAL TECHNOLOGY
SCHEME OF EXAMINATION B.TECH (BIOCHEMICAL ENGINEERING)

Paper ID	Paper	L	T	P	Credit
04403	BCT-403 Process Engineering	3	1	0	4

UNIT I **10 Hrs**

System and subsystem in chemical process engineering. System analysis. Economic degree of freedom - various algorithms.

Economic design criteria. Terms involved in profitability analysis. Capital cost and manufacturing cost estimation methods.

UNIT II **8 Hrs**

Strategy of scale-up and design of chemical processes; Role of pilot plant, process validation, salient features of patent literature.

UNIT III **12 Hrs**

Process evaluation and selection with special reference to eco-friendly technologies. Preparation of process specifications for typical equipment. Choice of batch v/s continuous process. Concept of dedicated and multiproduct plant facilities. Time cycle for batch processes.

UNIT IV **12 Hrs**

Development and evaluation of alternative flow sheets; efficient utilisation of energy; heat exchanger net-works. Preparation of process and instrumentation diagrams. Conceptual, project implementation- stage wise.

Books and References:

1. Strategy of Process Engineering, Rudd and Watson,. Wiley
2. Chemical Engineering Handbook, Perry, J.H., Mc GrawHill.
3. Plant Design and Economics for Chemical Engineers, Peters , M.S. and Timmerhaus, K.D, Mc GrawHill. .

UNIVERSITY SCHOOL OF CHEMICAL TECHNOLOGY
SCHEME OF EXAMINATION B.TECH (BIOCHEMICAL ENGINEERING)

Paper ID	Paper	L	T	P	Credit
04405	BCT- 405 Enzyme Technology	3	0	0	3

UNIT I

8 Hrs

Basic concepts of enzyme: Mechanism of Enzyme Action and kinetic of reaction: Concept of active sites, and energetic of enzyme substrate complex formation, Specificity of enzyme action, Estimation of Michaelis-Menten Parameter

UNIT II

10 Hrs

Stability of enzymes: PH, Temperature, Mechanical forces, Heterogeneous system.

Production and purification of enzymes: Extract from plant, animal and microbial sources, Methods of characterization of enzymes, Development of enzymatic assays.

UNIT III

18 Hrs

Enzyme immobilization: Physical and chemical techniques for enzyme immobilization adsorption, Matrix entrapment, Encapsulation, cross linking, covalent binding, Advantages and disadvantages of different immobilization techniques.

Applications of enzymes: Classification of enzymes, Commercial application of enzymes in food, Pharmaceutical and other industries, Enzymes for analytical and diagnostic application.

UNIT IV

6 Hrs

Mass transfer effects in immobilized enzymes: Analysis of film and pore diffusion effects on kinetics of immobilized enzyme reaction, Formulation of dimensionless groups, Calculation of effectiveness factors

Books Recommended

1. Price N C and Stevens L, "Fundamentals of Enzymology: The Cell and Molecular Biology of Catalytic Proteins", 3rd Edition, Oxford University Press
2. Bailey and Ollis, "Biochemical Engineering Fundamentals", McGraw Hill
3. Lehninger, A L "Principles of Biochemistry", Butterworth Publishers, New York
4. Conn E E and Stump P K, "Outlines of Biochemistry" John Wiley and Sons, New York
5. Stanbury P F and Whitaker A, "Principles of Fermentation Technology," Pergamon Press

UNIVERSITY SCHOOL OF CHEMICAL TECHNOLOGY
SCHEME OF EXAMINATION B.TECH (BIOCHEMICAL ENGINEERING)

Paper ID	Paper	L	T	P	Credit
04407	BCT-407 Biochemical Processes	3	0	0	3

UNIT I

8 Hrs

Basic concepts of Bio-separation Technology; Separation characteristics of proteins and enzymes – size, stability, properties; purification methodologies; Characteristics of byproducts; Flocculation and conditioning of broth, overview of reaction processes involved Mechanical separation processes; Filtration at constant pressure and at constant rate; empirical equations for batch and continuous filtration, centrifugal and cross-flow filtration;

UNIT II

8 Hrs

Centrifugation: basic principles, design characteristics; ultracentrifuges:: principles and application;

Crystallization: principles and applications.

Techniques involved in Separation Processes of soluble products

Foam-fractionation; Solvent extraction of bio-processes, aqueous two-phase extraction, adsorption-desorption process; Salt precipitation;

UNIT III

8 Hrs

Chromatographic separation: Adsorption chromatography, Ion- exchange chromatography, gel filtration chromatography, affinity chromatography, high pressure liquid chromatography, hydrophobic chromatography; their preparation and uses, method of linkage, Electrophoresis

UNIT IV

10 Hrs

Membrane based separation processes

Micro-filtration, Reverse osmosis, Ultra filtration and affinity ultra filtration, concentration polarization, rejection, flux expression, membrane modules, dead-ended and cross-flow mode, material balances and numerical problems, biological applications.

UNIT V

10 Hrs

Cell Disruption: Mechanical methods, Non-mechanical methods.

Drying: Lyophilization, Spray drying, vacuum drying, air drying.

Industrial Applications: Industrial aspects of separation of biomolecules, Material balances, mathematical analysis and modeling, relative advantages and disadvantages of separation methods, Case studies.

Books & References:

1. M. R. Ladisch, Bioseparations Engineering, Wiley Interscience 2001
2. Kennedy and Cabral, Recovery processes for biological materials.
3. Heinemann, Product Recovery in Bioprocess Technology, Butterworth Publication
4. Schuler & Kargi, Bio-process Engg. PHI
5. Bailey & Olis, Biochemical Engg. Fundamentals, McGraw-Hill, 1990
6. Mukhopadhyay, S. N. Process Biotechnology Fundamentals, Viva Books Pvt. Ltd., 2001
7. Muni Cheryan, Handbook of Ultrafiltration
8. Perry, Chilton & Green, Chemical Engineers' Handbook, McGraw-Hill
9. Ho, W.S.W & K.K. Sirkar, Membrane Handbook, Van Nostrand Reinbold, N.Y. (1992).

UNIVERSITY SCHOOL OF CHEMICAL TECHNOLOGY
SCHEME OF EXAMINATION B.TECH (BIOCHEMICAL ENGINEERING)

Paper ID	Paper	L	T	P	Credit
98411	HS-411 Introduction to Economics	3	0	0	3

UNIT I

8 Hrs

Basic Economic Problems Alternative Economic Systems and their Functioning. Micro and Macro Economics. Basic Elements of Demand and supply Analysis.

UNIT II

10 Hrs

- i. **Consumer's Equilibrium:** Marginal Utility and Indifference Curve Analysis, Elasticity of Demand and Supply.
- ii. **Theory of Production:** Production Functions, Law of Variable Proportions Law of Returns to Scale, Isoquants, Expansion Path, Equilibrium of the Firm.

UNIT III

15 Hrs

- i. **Theory of Costs:** Social and Private Costs, Short run and long run costs, economies and diseconomies of scale.
- ii. **Market Equilibrium under alternative forms of market:** Perfect competition, Monopoly, Monopolistic competition and oligopoly

UNIT III

15 Hrs

- i. **Factor Pricing:** Determination of rent, wages, profit and interest.
- ii. **National Product and Income:** Basic concepts and its measurement Basic elements of monetary and fiscal policy.

Text Books

1. Principal of Economic, Lipsey & Crystal, Oxford University Press.
2. Samuelson Nordhans Economic, Tata Mc Graw Hill, Ed, New Delhi.

Reference Books

1. Economic Analysis. Theory and Application, Ferguson and Maurice, Richard D. Inwin Inc.
2. Economics, John Slowman, Financial Time, Prentice Hall, Prarson Education Ltd
3. Micro Economics: Principles and Policy. William J. Baumol and S. Binder

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SCHEME OF EXAMINATION B.TECH (BIOCHEMICAL ENGINEERING)

Paper ID	Laboratory	L	T	P	Credit
04451	BCT-451 Modeling and Simulation Lab	0	0	3	2

Application of the following software packages to assigned problems:

1. ASPEN PLUS
2. ASPEN DYNAMICS
3. ASPEN CUSTOMER MODELER
4. MATLAB-SIMULINK

Paper ID	Laboratory	L	T	P	Credit
04453	BCT-453 Project Work I	0	0	8	4

Each student shall be assigned a specific project. He/she shall select most appropriate process from various available alternatives and design the plant. A cost analysis, plant layout etc. may also form part of the total exercise. The final report will be examined by a panel. Experimental projects with well-defined aims may also be offered subject to the availability of the facilities.

Paper ID	Laboratory	L	T	P	Credit
04455	BCT-455 Summer Training/Project	-	-	-	1

Students should obtain training in chemical industries for a period of two months in summer and get acquainted with operation of commercial scale plants. The trainees should familiarize with all aspects such as purchase, quality control, operation and maintenance, R&D, finishing and packaging etc.

- i. Each student will be given an evaluation format, which student will give to the HR of the industry and that format after evaluation will be send back to USCT confidentially by the industry
- ii. At the end of the training period, each student should submit a report for assessment by a panel of examiners

UNIVERSITY SCHOOL OF CHEMICAL TECHNOLOGY
SCHEME OF EXAMINATION B.TECH (BIOCHEMICAL ENGINEERING)

EIGHTH SEMESTER EXAMINATION

L T P Credits
 12 0 18 27

<u>Theory Paper</u>						
Paper ID	Paper Code	Title	L	T	P	Credit
98412	HS- 412	Project Writing	3	0	0	3
<u>Electives</u>						
04422	BCT-422	Bioinformatics	3	0	0	3
04424	BCT-424*	Tissue Engineering	3	0	0	3
04426	BCT-426	Bio Chemical Separation Engineering	3	0	0	3
04428	BCT-428	Food Biotechnology	3	0	0	3
47612	EM-612	Environmental Impact Assessment & Risk Analysis	3	0	0	3
14424	CT-424	Biomass and Bioenergy	3	0	0	3
<u>Practical/Viva Voce</u>						
04452	BCT-452	Project Work II	0	0	18	9
Total			12	0	18	21

Any three of the above elective courses can be selected by the students, Courses will be offered to a minimum of 1/3rd students of class strength and also

* Subject to availability of resources

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Paper ID	Paper	L	T	P	Credit
04422	BCT-422 Bioinformatics	3	0	0	3

UNIT I

8 Hrs

Introduction to bioinformatics and data generation

What is bioinformatics and its relation with molecular biology. Examples of related tools (FASTA, BLAST, BLAT, RASMOL), databases (GENBANK, Pubmed, PDB) and software (RASMOL, Ligand Explorer). Data generation; Generation of large scale molecular biology data. (Through Genome sequencing, Protein sequencing, Gel electrophoresis, NMR Spectroscopy, X-Ray Diffraction, and microarray). Applications of Bioinformatics.

UNIT II

10 Hrs

Biological Database and its Types

Introduction to data types and Source. Population and sample, Classification and Presentation of Data. Quality of data, private and public data sources. General Introduction of Biological Databases; Nucleic acid databases (NCBI, DDBJ, and EMBL). Protein databases (Primary, Composite, and Secondary). Specialized Genome databases: (SGD, TIGR, and ACeDB). Structure databases (CATH, SCOP, and PDBsum)

UNIT III

8 Hrs

Data storage and retrieval and Interoperability

Flat files, relational, object oriented databases and controlled vocabularies. File Format (Genbank, DDBJ, FASTA, PDB, SwissProt). Introduction to Metadata and search; Indices, Boolean, Fuzzy, Neighboring search. The challenges of data exchange and integration. Ontologies, interchange languages and standardization efforts. General Introduction to XML, UMLS, CORBA, PYTHON and OMG/LIFESCIENCE.

UNIT IV

8 Hrs

Sequence Alignments and Visualization

Introduction to Sequences, alignments and Dynamic Programming; Local alignment and Global alignment (algorithm and example), Pairwise alignment (BLAST and FASTA Algorithm) and multiple sequence alignment (Clustal W algorithm). Methods for presenting large quantities of biological data: sequence viewers (Artemis, SeqVISTA), 3D structure viewers (Rasmol, SPDBv, Chime, Cn3D, PyMol), Anatomical visualization.

UNIT V

8 Hrs

Gene Expression and Representation of patterns and relationship

General introduction to Gene expression in prokaryotes and eukaryotes, transcription factors binding sites. SNP, EST, STS. Introduction to Regular Expression, Hierarchies, and Graphical models (including Markov chain and Bayes notes). Genetic variability and connections to clinical data.

Text Books:

1. Bioinformatics, A Practical Guide to the Analysis of Genes and Proteins by A.D. Baxevanis and B.F. Ouellette

Reference books

1. Beginning Perl for Bioinformatics by James Tisdall
2. Understanding Bioinformatics by Marketa Zvelebil and Jeremy Baum

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SCHEME OF EXAMINATION B.TECH (BIOCHEMICAL ENGINEERING)

Paper ID	Paper	L	T	P	Credit
04424	BCT-424 Tissue Engineering	3	0	0	3

UNIT I

10 Hrs

Introduction

Definitions, basic principles, structure-function relationships. Biomaterials: metals, ceramics, polymers (synthetic and natural). Biodegradable materials, native matrix.

UNIT II

12 Hrs

Tissue culture basics:

Primary cells vs. cell lines, sterile techniques, plastics, enzymes, reactors and cryopreservation. Oxygen transport. diffusion, Michaelis-Menten kinetics, oxygen uptake rates, limits of diffusion. Principles of self assembly. cell migration, 3D organization and angiogenesis., receptor/lig and interactions, cell adhesion, cell migration, signal transduction, cell growth and differentiation, and developmental processes.

UNIT III

12 Hrs

Skin tissue engineering.

Introduction, scar vs. regeneration, split skin graft, apligraf. Cardiovascular tissue engineering. introduction, blood vessels structure, vascular grafts. Liver tissue engineering. bioartificial liver (BAL) assist device, shear forces, oxygen transport, plasma effects. Liver tissue engineering. self-assembled organoids, decellularized whole livers. Stem cells. basic principles, embryonic stem cells, induced pluripotent stem cells.

UNIT IV

8 Hrs

Examples and problems

Gene therapy, cellular therapy, tissue engineering, and bioprocess design are used to illustrate fundamental bioengineering principals.

Text Books

1. Principles of Tissue Engineering Robert Lanza, Robert Langer, Joseph P. Vacanti, Academic Press
2. Tissue Engineering Bernhard O. Palsson and Sangeeta N. Bhatia, Prentice Hall

Reference books

1. Transport Phenomena in Biomedical Engineering: Artificial organ Design and Development, and Tissue Engineering Kal Sharma, McGraw Hill,

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SCHEME OF EXAMINATION B.TECH (BIOCHEMICAL ENGINEERING)

Paper ID	Paper	L	T	P	Credit
04426	BCT-426 Bio Chemical Separation Engineering	3	0	0	3

UNIT I

12 Hrs

Basic Concepts

Basic concepts of Bio-separation Technology; Separation characteristics of proteins and enzymes size, stability, properties; purification methodologies; Characteristics of byproducts; Flocculation and conditioning of broth, overview of reaction processes involved Mechanical separation processes; Filtration at constant pressure and at constant rate; empirical equations for batch and continuous filtration, centrifugal and cross-flow filtration; Centrifugation: basic principles, design characteristics; ultracentrifuges:: principles and application; Crystallization and drying: principles and applications.

UNIT II

12 Hrs

Techniques involved in Separation Processes

Foam-fractionation; Solvent extraction of bio-processes, aqueous two-phase extraction, adsorption-desorption process; Salt precipitation; Chromatographic separation: Adsorption chromatography, Ion- exchange chromatography, gel filtration chromatography, affinity chromatography, high pressure liquid chromatography, hydrophobic chromatography; their preparation and uses, method of linkage, Electrophoresis SDS-PAGE (Polyacrylamide Gel), horizontal and vertical type, methods, and case studies.

UNIT III

10 Hrs

Membrane based separation processes

Micro-filtration, Reverse osmosis, Ultra filtration and affinity ultra filtration, concentration polarization, rejection, flux expression, membrane modules, dead-ended and cross-flow mode, material balances and numerical problems, biological applications

UNIT IV

8 Hrs

Industrial Applications

Industrial aspects of separation of biomolecules, Material balances, mathematical analysis and modeling, relative advantages and disadvantages of separation methods, Case studies.

Text book:

1. M. R. Ladisch, Bioseparations Engineering, Wiley Interscience

Reference book

1. Kennedy and Cabral, Recovery processes for biological materials.
2. Heinemann, Product Recovery in Bioprocess Technology, Butterworth Publication Schuler
3. Bailey & Olis, McGraw Hills 1990, Biochemical Engineering fundamentals
4. S.N., Mukhopadhyay, Process biotechnology fundamentals , Viva Books Pvt
5. Schuler & Kargi, Bio-process Engineering. PHI

UNIVERSITY SCHOOL OF CHEMICAL TECHNOLOGY
SCHEME OF EXAMINATION B.TECH (BIOCHEMICAL ENGINEERING)

Paper ID	Paper	L	T	P	Credit
04428	BCT-428 Food Biotechnology	3	0	0	3

UNIT I

8 Hrs

Historical Background: History of Microorganisms in food, Historical Development. Taxonomy, role and significance of microorganisms in foods. Intrinsic and Extrinsic Parameters of Foods that affect microbial growth.

UNIT II

8 Hrs

Microorganisms in fresh meats and poultry, processed meats, seafood's, fermented and fermented dairy products and miscellaneous food products. Starter cultures, cheeses, beer wine and distilled spirits, SCP, Medical foods, probiotics and health benefits of fermented milk and foods products.

UNIT III

8 Hrs

Brewing, malting, mashing, hops primary & secondary fermentation: Biotechnological improvements: catabolic repression, High gravity brewing, B-glucan problem, getting rid of diacetyl. Beer, wine and distilled spirits. Nutritional boosts and flavor enhancers: Emerging processing and preservation technologies for milk and dairy products.

UNIT IV

8 Hrs

Microbiological Examination of surfaces, Air Sampling, Metabolically Injured Organisms, Enumeration and Detection of Food-borne Organisms. Bioassay and related Methods. Food Preservation, Food Preservation Using Irradiation, Characteristics of Radiations of Interest in Food preservation. Principles Underlying the Destruction of Microorganisms by Irradiation, Processing of Food for Irradiation, Application of Radiation, Radappertization, Radicidation, and Radurization of Foods Legal Status of Food irradiation, Effect of Irradiation of Food constituents.

UNIT V

10 Hrs

Storage Stability Food Preservation with Low Temperatures, Food Preservation with High Temperatures, Preservation of Foods by Drying, Indicator and Food -borne Pathogens, Other Proven and Suspected Food-borne Pathogens. Psychrotrophs: Thermophiles and Radiation resistant Microorganisms, Characteristics and Growth of Thermophilic Microorganisms, Nature of Radiation Resistance in Microorganisms. Rheology of Food Production. Consumer perspective and future of food Biotechnology.

Text Books:

1. Modern Food Micro-Biology by James M. Jay, an Aspen Publication, Maryland, USA.
2. Food Microbiology: Fundamentals and frontiers by M.P. Doyle, L.R. Beuchat and Thoma J. Montville, ASM press, USA.

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Paper ID	Paper	L	T	P	Credit
14424/ 47612	CT-424/EM-612 Environmental Impact Assessment & Risk Analysis	3	0	0	3

UNIT I

8 Hrs

Introduction to EIA: Definition and objectives of EIA, purpose of EIA, terminology, hierarchy in EIA, basic data collection for EIA,

Legislation and framework: EIA legislative requirements and administrative procedures in India/Indian States, EIA notification of MOEF, 2006 National Environmental Policy Act and implementation

UNIT II

12 Hrs

Public participation in environmental decision making: Regulatory requirements, techniques, advantages and disadvantages of public participation, managing a public hearing

Impact assessment techniques and methodology: Description of the environmental setting, methods of impact analysis, environmental risk assessment, baseline data collection, Prediction and assessment of impacts: Air, Gaussian plume model for air pollution assessment, water, noise, biological, cultural and socio-economic damage.

UNIT II

10 Hrs

Case studies of EIA for Industries: Oil, petrochemical, fertilizer, sugar and distilleries, mining industries (iron and steel, cement industry)

UNIT IV

12 Hrs

Risk Analysis: Definition of Risk, Environment Risk Analysis; Fundamentals of hazard, exposure and risk assessment; Basic steps in risk assessment – Hazard identification, dose response assessment, exposure assessment and risk characterization, Quantified risk assessment for industrial accidents, Design of risk management programs, risk assessment applications to environment management problems

Text Books

1. Canter, Larry W. Environment Impact Assessment. McGraw-Hill.
2. Rau, G.J. and C.D. Weeten, Environmental Impact Analysis Handbook. McGraw Hill.

References

1. Glasson, John, Rikki Therievel and Andrew Chadwick. 1996. Introduction to Environmental Impact Assessment, UCL Press
2. Richard Morgan, Environment Impact Assessment, a methodological perspective, Kluwar Academic Publication, Boston

UNIVERSITY SCHOOL OF CHEMICAL TECHNOLOGY
SCHEME OF EXAMINATION B.TECH (BIOCHEMICAL ENGINEERING)

Paper ID	Paper	L	T	P	Credit
98412	HS-412 Project Writing	3	0	0	3

UNIT I

10 Hrs

Writing Skills: Descriptive, Narrative, Argumentative and Discursive, Reflective and Literary-Evaluative Writing. Technical Writing: Definition, Purpose and Characteristics of Technical Writing.

UNIT II

10 Hrs

The Technical Writing Process: Prewriting Stage, The Writing Stage and the Postwriting stage. Technical Writing Skills: Researching, Summarizing and Outlining, Visual Aids, Definition, Description, Set of Instructions.

UNIT III

10 Hrs

Formal Formatting: Arrangement of Formal Elements, Front Material, Format Devices in the Body of Formal Report-Heading, Pagination, End Material—Citations, References and Bibliography, Appendix.

UNIT IV

12 Hrs

Technical Writing Applications: Memorandums and Informal Format, Formal Format, Recommendations and Feasibility Reports, Proposals, Progress Reports, Analysis Reports Professional Communication, Letters and Job Applications. Presentation and Meetings.

Text books

1. Forsyth, Sandy and Lesley Hutchison, "Practical Composition", Edinburgh Oliver and Boyd,

Reference books

1. Sides, Charles H., "How to Write and Present Technical Information", Cambridge, Cambridge University Press,
2. Guffey, Mary Ellen, "Business Communication, Cincinnati", South-Western College Publishing,

UNIVERSITY SCHOOL OF CHEMICAL TECHNOLOGY
SCHEME OF EXAMINATION B.TECH (BIOCHEMICAL ENGINEERING)

Paper ID	Laboratory	L	T	P	Credit
04452	BCT-452 Project Work II	0	0	18	9

Each student shall be assigned a specific project. He/she shall select most appropriate process from various available alternatives and design the plant. A cost analysis, plant layout etc. may also form part of the total exercise. The final report will be examined by a panel. Experimental projects with well defined aims may also be offered subject to the availability of the facilities.

The minimum number of credits to be earned for the award of the B.Tech degree should be 200 credits as per university's norms.
