PANJAB UNIVERSITY

Scheme and Syllabus of
B.E. (Biotechnology)
1ST to 8th semester

2021-2025

University Institute of Engineering and Technology,

Panjab University, Chandigarh

DEPARTMENT BIOTECHNOLOGY ENGINEERING

VISION

ASM 201	Differential Equations and Transforms	Theory	4	1	0	5	50	50	100
ESC X01 ESC X51	Programming for Problem Solving	Theory	3	0	0	3	50	50	100

SCHEME OF EXAMINATION OF B.E. BIOTECHNOLOGY

Second Year -

SCHEME OF EXAMINATION OF B.E. BIOTECHNOLOGY

Second Year - Fourth Semester

Sub Code	Subject	Scheme of Teaching					Scheme of Examination Theory/ Practical		
		L	T	P	Hrs	Credits	Sess.	Univ. Exam.	Total
BIO 411	Molecular Biology	4	0	0	4	4	50	50	100
BIO 461	Molecular Biology (Prac.)	0	0	2	2	1	50*	00	50
BIO 412	Thermodynamics	3	1	0	4	4	50	50	100
BIO 413	Chemical Reaction Engineering	3	1	0	4	4	50	50	100
BIO 463	Chemical Reaction Engineering (Prac.)	0	0	2	2	1	50*	00	50
BIO 414									

SCHEME OF EXAMINATION OF B.E. BIOTECHNOLOGY

Third Year – Fifth Semester

Sub Code	Subject	Scheme of Teaching				Scheme of Examination
						Theory/ Practical
		L	T	P	Hrs	

SCHEME OF EXAMINATION FOR B.E. BIOTECHNOLOGY

Fourth Year - Seventh Semester

Sub Code	Subject	Scheme of Teaching					Scheme of Examination Theory/ Practical		
		L	T	P	Hrs	Credits	Sess.	Univ. Exam.	Total
BIO711	Environmental Biotechnology	4	0	0	4	4	50	50	100
BIO761	Environmental Biotechnology (Prac.)	0	0	2	2	1	50*	00	50
BIO712	Food Biotechnology	4	0	0	4	4	50	50	100

* Cumulative marks for mid semester and end semester evaluation.

SCHEME OF EXAMINATION FOR B.E. BIOTECHNOLOGY

Fourth Year - Eight Semester

* Cumulative marks for mid semester and end semester evaluation.

Options in Elective I*

1. BIO: 815(a): Nanobiotechnology
2. BIO: 815(b):.1 (at)-1 (i)-1 (o)1 (n)1 (.)]TJ2..15

Conditions for choosing Option 2 in 8th Semester:

A student may opt for either Option 1 or one semester training (Option 2) in lieu of subjects of 8th Semester (option 1). The marks for six months training will be equal to the total marks of 8th Semester study. A student can opt for six month training under following conditions:

1. A student having any pending reappear in any subject (Theory or Practical) will not be allowed to go for training
2. Students scoring less than 6.0 CGPA up to 6th semester(if the result of 7th semester is not available) will not be allowed to go for training
3. A student will be allowed to pursue training:
    a. In a company in which he/she is placed irrespective of the stipend amount/CGPA/reappear
    b. In a reputed company registered with the Ministry of Corporate Affairs/MNC irrespective of stipend amount
    c. In government organizations/ R&D institutes/PSUs irrespective of the stipend amount, provided the student submits the application in the prescribed format
    d. In any company offering a minimum stipend of Rs 5000 per month, provided the company is approved by the concerned department.
    e. In a company/ institute for w2 (e)-1 (a)4 (p .D9b /LBod.n f)3for (nyhe)-1 (a)-1oved

B.E. (Biotechnology Engineering)

1st and 2nd Semesters

Course Code	ASP X01
Course Title	Applied Physics
Course Assessment Methods	
End Semester Assessment(University Exam)	50
Continuous Assessment (Minors, Assignment Quiz)	50

Note for the examiner: The semester question paper will be of 50 Marks having 7 questions of equal marks. Students are required to attempt 5 questions in all. First question, covering the whole syllabus and having questio of conceptual nature, will be compulsory. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt two questions from each section.

SECTION A

Oscillations
Complete mathematical treatment for mechanical as well as electrical free, damped and forced oscillators.4 ((en)-3

Course Code

Course Code	ASP X52
Course Title	Quantum Physics (P)
Course Assessment Methods Practical (Continuous and end semester evaluation)	50

List of Experiments

1. To study the quantized energy level of the first excited state in the Argon using the Franck-Hertz setup.
2. To find the value of Plank's constant and evaluate the work function of cathode material by used of photoelectric cell.
3. To study various characteristics of photo-voltaic cell: (a) Voltage-current characteristics, (b) loading characteristics, (c) power-resistance characteristics and (d) inverse square law behavior of the photo-current with distance of source of light from photo-voltaic cell
4. To study the response of a photo-resistor to varying intensity of light falling on it and deduce spectral sensitivity of its semiconductor material.
5. To study the Balmer Series of Hydrogen spectrum using diffraction grating and calculate Rydberg constant.
6. To evaluate charge on an oil drop using Millikan's oil drop method.
7. To verify Rutherford's alpha scattering formula using a mechanical model.
8. To calculate charge to mass ratio of an electron using Thompsoń method.
9. To determine Hall coefficient of a given semiconductor material and evaluate charge carrier type, density and mobility of charge carriers.
10. To study temperature dependence of resistivity of a semiconductor using four probe method and determine the energy band gap of a given semiconductor.
11. To determine the velocity of ultrasonic waves in different liquids using ultrasonic interferometer.
12. To study probability theory using coins.
13. To study probability and statistics using two dice.

Course Code	ASP X03
Course Title	Physics of Materials
Course Assessment Methods End Semester Assessment(University Exam) Continuous Assessment (Minors, Assignments Quiz)	 50 50

SYLLABUS

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SECTION - A

Crystal structure: Bonding forces and energies, Primary and Secondary boe

SECTION - B

Plastic Deformations and strengthening mechanisms : Tensile properties (Yield strength, Tensile Strength, Ductility, Resilience, Toughness), Dislocations and plastic deformation, characteristics of dislocations, slip systems, slip in single crystals and polycrystalline materials, mechanisms of strengthening in metals (grain siz reduction, solid solution strengthening, strain hardening), recovery, recrystallization and grain growth (5hours)

Fracture, Fatigue and Creep: Fracture (Ductile and brittle fractures), principles of fracture mechanics, fracture toughness, ductile to brittle transitions Cyclic stresses, S-N curve, crack initiation and propagation, factors that affect fatigue life, environmental effects, generalized creep behavior, stress and temperature effect
(5 hours)

Phase Diagrams : One-Component (or Unary) Phase Diagrams, Binary Isomorphous Systems, Interpretation of Phase Diagrams, Development of Microstructure in Isomorphous Alloys, Mechanical Properties of Isomorphous Alloys ,Binary Eutectic Systems, Development of Microstructure in Eutectic Alloy, Equilibrium Diagrams Having Intermediate Phases or Compounds, Eutectic and Peritectic Reactions, the Iron-Carbon syste
(6 hours)

Phase Transformations: Kinetics of phase transformation, kinetics of solid state reactions, Isothermal transformation diagrams, continuous cooling transformation, temper embrittlement
(4 hours)

RECOMMENDED BOOKS

S.No.	NAME	AUTHORS	PUBLISHER

Course Code	ASP X53
Course Title	Physics of Materials (P)
Course Assessment Methods Practical (Continuous and end semester evaluation)	 50

List of Experiments

1. To study the quantized energy of the first excited state in Argon using the Franck-Hertz Set-up.

2. To find the value of Planck's constant and evaluate the work function of cathode material by use of photoelectric cell.
3. To study various characteristics of photovoltaic cell: (a) Voltage-current characteristics (b) loading characteristics (c) power-resistance characteristics and (d) inverse squarelaw behavior of photocurrent with distance of source of light from photovoltaic cell.
4. To study the response of a photoresistor to varying intensity of light falling on it and deduce spectral sensitivity of its semiconductor material.
5. To determine Hall coefficient of a semiconductor material and then evaluate the type, density and mobili

Course Code	ASC X01
Course Title	Applied Chemistry
Course Assessment Methods End Semester Assessment(University Exam) Continuous Assessment (Mid Term Exams, Assignments, Quiz)	 50 50
Course Prerequisites	
Course Objectives (CO)	To teach the fundamentals of basic chemistry and allied sciences essential for the development of modern technologies to all branches of engineering.
Course Outcome	1. The geometry and bonding in homonuclear, heteronuclear molecules and coordination compounds. Splitting of d-orbital in octahedral, tetrahedral and square planar field along with different properties of the coordination compounds. 2. How the molecules are arranged in three dimensional structure and how it leads to the phenomena of various types of isomerism. 3. The basic principles of spectroscopy and its use to determine the chemical structure. 4. The different thermodynamic laws, heat changes and energy calculations. 5. The role and mechanism of various heterogeneous and homogeneous catalysts in increasing reactions rates of many synthetically important chemical reactions. 6. The sustainable technology in design and synthesis of polymers for its variety of applications.

Note for the examiner:The end semester question paper will be of 50 Marks having 7 questions of equal marks. Students are required to attempt 5 questions in all. First question, covering the whole syllabus and having questions of conceptual nature, will be compulsory. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt two questions from each section.

SYLLABUS

SECTION - A

Chemical Bonding (6 hrs)

Molecular orbital theory and its applications to the formation of homonuclear (F_2, N_2) and heteronuclear diatomic molecules (NO, CO, CN), Valence bond theory as applicable to coordination compounds and its limitations. Crystal Field Theory, Splitting of octahedral, tetrahedral and square planner complexes, crystal field stabilization energies of octahedral and tetrahedral complexes and its application.

Stereochemistry of Organic Compounds (8 hrs)

Concept of isomerism. Types of isomerism. Optical isomerism – enantiomers, optical activity, properrgi Í$ ˜ pÇ

Course Code	ASC X51
Course Title	Applied Chemistry (P)

[redacted]

FUNCTIONS OF ONE VARIABLE

Sequences and Series: Sequences, Limits of sequences, Infinite series, series of positive terms, Integral te
Comparison test, Ratio test, Root test. Alternating series, Absolute and Conditional Convergence, Leibnitz tes
Power series: radius of convergence of power series, Taylor's and Maclaurin's Series. (Scope as in Chapter 1
Sections 10.1 -10.9 of Reference 1).

Integral Calculus: Length of curves, Volume (disk and washer method) and surface area of revolution (Scope as
in Chapter 6, 6.1, 6.3, 6.4 of Reference 1).

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RECOMMENDED BOOKS			
S. No.	NAME	AUTHORS	PUBLISHER
1.	Calculus	Maurice D. Weir, Joel Hass, Frank R. Giordano, Thomas	12

RECOMMENDED BOOKS			
S.No.	**NAME**	**AUTHORS**	**PUBLISHER**
1.	Elements of Partial Differential Equations	Ian N. Sneedon	McGraw Hill,Singapore 1957.
2.	Advanced Engineering Mathematics	E. Kreyszig.	10th edition , John Wiley.
3.	Advanced Engineering Mathematics	Michael D. Greenberg	2nd edition, Pearson Education.
4.	Advanced Engineering Mathematics	Wylie and Barrett	Tata McGraw Hill
5.	Higher Engineering Mathematics	B.V.Ramana	Tata McGraw Hill.
6.	Advanced Engineering Mathematics	R. K. Jain, S. R. K. Iyenger	Narosa Publications
7.			

Course Code	**ESC X01**
Course Title	Programming for Problem Solving

Course Assessment Methods

End Semester Assessment(UnivEMCB T3 1 Tf-b4 (P)1.6 (r)2.7 (obl)2.3 (e)4.4 (m)101.8 (U6 rg297.216 Tm( )TjETEM

Concept of algorithm:

File handling: File I/O functions, standard C pre-processors, defining and calling macros, command-line arguments.

Text books:

1. Schaum's Outline of Programming with C by Byron Gottfried, McGraw-Hill
2. Programming in C: A practical approach by Ajay Mittal, Pearson Education, 2010
3. The C programming by Kernighan Brain W. and Ritchie Dennis M., Pearson Education.
4. Computer Basics and C Programming by V.Rajaraman , PHI Learning, 2015.
5. Computer Concepts and Programming in C, E Balaguruswamy, McGraw Hill
6. Computer Science- A Structured Programming Approach Using C, by Behrouz

Course Code	**ESC X51**
Course Title	Programming for Problem Solving (P)

Course Assessment Methods

Practical (Continuous and end semester evaluation)

Course Code	**ESC X53**
Course Title **Course Assessment Methods** Practical (Continuous and end semester evaluation)	**Workshop (P)** 50
Course Prerequisites	Basic Workshop Practices
Course Objectives (CO)	1. Know different machines, tools and [redacted] materials, metals and non-**M2EmmmmmFittjn (m)7lalet2**

Jobs:

Drawing and Upsetting Practice using Open Hearth Furnace, Cold working process practice, Heat Treatment \: Annealing and hardening process

Machine Shop

Application, Function and different parts, Operations of Lathe, Type of Cutting Tools and their materials, Drill machine Types, applications and Functions. Hacksaw machines and functions, Work Holding devices and tools, chucks, Vices, machine Vices, V Block, Measuring Instruments uses, Shaper and Milling machine Applications.

Jobs:

To perform Marking, Facing, Turning,taper Turing, Grooving, Knurling, parting, Drilling, Reaming operations on lathe machine,Hacksawing practice on Power hacksaw,Shaping operation practice on Shaper.

Carpentry Shop

Classification of Tree, Timber. Advantages and uses of Timber, Seasoning of Wood, Tools Used, Defects and Prevention of Wood,

Jobs:

Tee Joint, Cross Joint,Tenon Joint, L Shape Joint, Practice of Wood Working Lathe, Practice on multi-purpose Planer.

Foundry Shop

Introduction to Foundry, Advantages and Disadvantages of castings process, Introduction to pattern and various hand tools, Ingredients of Green sands, Various Hand Molding processes, Introduction to Casting Defects.

Jobs:

Identification and uses of hand tools, Preparation of Green sand in Muller, Preparation of Sand Mould of Single piece solid pattern, Split pattern, Preparation of Green sand Core, casting of a Mould and study its defects.

RECOMMENDED BOOKS

Course Code	**ESBT 101**
Course Title	Basic Biology

Course Assessment Methods

End Semester Assessment(University Exam)	50
Continuous Assessment (Minors, Assignments, Quiz)	50

Books Recommended:

1. Campbell, NA, Reece, JB, Urry, LA, Cain, ML, Wasserman, SA, Minorsky, PV and Jackson, RB: Biology, Pearson/Benjamin Cummings, 8th edition,2008

2. Singh BD: Biotechnology: Expanding Horizons, Kalyani Publishers, 4th edition,2012

3. Tortora GJ and Derrickson BH: Principles of Anatomy and Physiology, John Wiley & Sons, 13th edition,2011

4. Ratner, BD (Ed.), Hoffman, AS (Ed.), Schoen, FJ (Ed.) and Lemons, JE (Ed.). Biomaterials Science: An Introduction to Materials in Medicine, Academic Press, 3rd edition,2013

Application of Computers to Biology: concepts of bioinformatics, types ofdatabases,biochips 6

Introduction of nano-bioengineering: Introduction of nano-biotechnology and biological systems at nanoscale, applications of nano-biotechnology in med 4

Books Recommended:

1. Himmelblau, DM and Riggs, JB: Basic Principles and Calculations in Chemical Engineering, PHI Learning Private Limited, 8th edition,2013
2. Wilson K and Walker J: Principles and Techniques of Practical Biochemistry, Cambridge University Press, 5th edition,2000
3. Khandpur RS: Handbook of Biomedical Instrumentation, Tata McGraw Hill, 2nd edition, 2003
4. Attwood, TK, Parry-Smith, DJ and Phukan, S: Introduction to Bioinformatics, Pearson Education Ltd, 1st edition,2007
5. Vo-Dinh, T (Ed.): Nanotechnology in Biology and Medicine: Methods, Devices, and Applications, CRC Press, Taylor & Francis Group,2007

Course Code **Course Title**	**ESBT 252** Fundamentals of Biotechnology and Bioengineering (P)
Course Assessment Methods Practical (Continuous and end semester evaluation)	 50

List of experiments

1. To verify the validity of Beer Lambert law using aspectrophotometer
2. To prepare the standard curve of Bovine Serum Albumin(BSA)
3. To observe epithelial tissue under amicroscope
4. To study the working and components of a CO_2incubator
5. To study the working and components of anautoclave
6. Acquaintance to NCBIdatabase
7. To learn the preparation of glycerolstocks
8. Case study of *Bt*cotton

THIRD SEMESTER

Course Code	BIO 311
Course Title	Process Calculations
Type of Course	Core
L T P	3 1 0
Credits	4
Course Assessment Methods	
End Semester Assessment (University Exam.)	50
Continuous Assessment (Sessional)	50
Course Prerequisites	Fundamental course in physics, chemistry and mathematics.
Course Objectives (CO)	1. To develop a fundamental understanding of the basic principles of process calculations. 2. To introduce students to calculations involving material and energy balance for reaction and separation processes. 3. To learn about the PVT relations and gaseous mixtures. 4. To introduce students to the use of data sources for physical and chemical properties and the estimation of such data.
Course Outcome	1. Define and determine properties of process streams. 2. Analyze and solve elementary material balances on single and multiple unit processes with recycle and bypass for reactive and non-reactive processes. 3. Solve energy balance on reactive and non-reactive processes. 4. Use psychrometric charts and steam tables for estimating physical and thermodynamic properties of gas-vapour mixtures.

SYLLABUS

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will be divided into two parts having three questions each and the Students is required to attempt at least two questions from each section.

SECTION-A

Introduction to Engineering Calculations: Units and dimensions, mole concept, conventions in methods of analysis and measurement, basis, temperature, pressure, the chemical equations and stoichiometry. Composition of mixtures and solutions: mass fractions, mole fraction. (10)

Material Balance: Material balance with and without chemical reactions; Material balance involving multiple subsystems; recycle, bypass and purge. Concept of limiting and excess reactant, conversion and yield. Metabolic stoichiometry of growth and product formation. (15)

SECTION-B

P-V-T relations for gas and gas mixtures, calculations using ideal gas law, vander waal's equation of state. Liquid and liquid mixtures, vapor pressure, saturation, partial saturation and humidity. (10)

Enthalpy changes, energy balance for simple flow process, calculation of heat capacity, mean heat capacity, application of the energy balance to systems with and without reactions. Use of Hess's law for calculation of heats of formation, heats of combustion, heats of reaction. Kirchoff's equation for calculating heats of reaction at different temperatures. (10)

RECOMMENDED BOOKS

S.No	NAME	AUTHOR(s)	PUBLISHER
1.	Elementary Principles of Chemical Processes	R.M.Felder, R.W.Rousseau	John Wiley & Sons 3rd Edition 2011.
2.	Basic Principles and Calculations in Chemical Engineering	D.M.Himmelblau, D.M.Riggs	PHI Learning Private Limited 8th Edition 2012
3.	Stoichiometry	B.I.Bhatt, S.M.Vora	Tata McGraw Hill 4th Edition 2006
4.	Bioprocess Engineering- Basic Concepts	M.L.Shuler, F.Kargi	Prentice Hall 2nd Edition 2007

Course Code	BIO312
Course Title	Microbiology (Theory)
Type of Course	Core
L T P	4 0 0
Credits	4
Course Assessment Methods	
End Semester Assessment (University Exam.)	50
Continuous Assessment (Sessional)	50

Course Code	BIO 362
Course Title	Microbiology (Practical)
Type of Course	Core
L T P	0 0 3
Credits	2
Course Assessment Methods	
End Semester Assessment (University Exam)	00
Continuous Assessment (Sessional)	50
Course Prerequisites	Microbiology (Theory)
Course Objectives (CO)	1. To impart to students skills to work with microorganisms and familiarize them with different techniques used in a microbiology lab
Course Outcome	1. **S**tudents are able to isolate, grow, identify and maintain different microbial cultures 2. Students become proficient to use microbial techniques in different scenarios pertaining to biotechnology

SYLLABUS

List of Experiments

1. Awareness of good and safe practices in a microbiology laboratory
2. Preparation different culture media-broth and agar
3. Culturing of microorganisms by simple streaking and pure culture technique
4. Preservation of microorganisms on agar slants
5. Isolation of microorganisms from soil/ milk/food sample by dilution plate method.
6. Gram staining of a given microbial sample
7. Endospore staining of endospore forming microorganisms
8. Motility test on the given bacterial sample

Course	BIO 313
Course Title	Biochemistry (Theory)
Type of Course	Core
L T P	4 0 0
Credits	4
Course Assessment Methods	
End Semester Assessment (University Exam.)	50
Continuous Assessment (Sessional)	50
Course Prerequisites	Knowledge of cell structure and functions of different cell types, organ system. Knowledge of mammalian, plant and microbial systems in Biotechnology
Course Objectives (CO)	1. To study the structures and functions of various biomolecules like carbohydrates, lipids, nucleic acids, proteins and vitamins in biosystem 2. To understand the structure-function relationship in proteins, purification and sequencing of proteins/enzymes. 3. To study the anabolic and catabolic pathways of carbohydrates and fats and its significance. 4. To understand the biochemical pathways of nucleic acid biosynthesis and degradation. 5. To study the biochemical pathways of photosynthesis and nitrogen fixation in plants and microbes respectively.
Course Outcome	1. Students learn the basic concepts of biochemistry such as structural and functional aspects of biomolecules, necessary for biotechnology studies and applications. 2. Students understand how biomolecules function as a unit to build a complex multicellular organism, undergoing diverse functions and cellular metabolic pathways in mammals, plants and microorganisms. 3. Students learn the role of enzymes and other molecules in metabolic pathways and how regulation of biochemical pathways is attained in a cell. 4. To understand the biochemical pathways in plants and organisms.

Course Code	BIO 363
Course Title	Biochemistry (Practical)
Type of Course	Core
L T P	0 0 3
Credits	2
Course Assessment Methods	
End Semester Assessment (University Exam.)	00
Continuous Assessment (Sessional)	50
Course Prerequisites	Understanding of biomolecules and biochemistry.
Course Objectives (CO)	1. To give practical training of the analysis of various biochemical parameters having clinical and industrial relevance. 2. To have an understanding of the principle of each determination by biochemical reactions using UV –visible spectroscopy. 3. To resolve biomolecules by chromatographic technique.
Course Outcome	1. Students have hands on training of quantitations related to biomolecules in biochemistry. 2. Students learn quality control in clinical biochemistry by performing blood analysis.

SYLLABUS

List of Experiments:

1. To study Beer-Lambert Law and to determine λ max of a colored dye.
2. To estimate carbohydrate content in a given sample by Anthrone method.
3. To determine total amount of proteins in serum by Biuret method.
4. To estimate proteins by Lowry method.
5. To identify the amino acids in a mixture by ascending paper chromatography.
6. To determine the content of nucleic acids by UV method.
7. To quantitate RNA/DNA in the given sample by colorimetric method.
8. To determine cholesterol/ urea/uric acid in blood.

Course Code	BIO 314
Course Title	Cell Biology and Genetics (Theory)
Type of Course	Core
L T P	4 0 0
Credits	4
Course Assessment Methods	
End Semester Assessment (University Exam.)	50
Continuous Assessment (Sessional)	50

SECTION-A

Biological membranes: models, structure and function, membrane proteins (6)

Cytoskeletal elements: microtubules, intermediate filaments and microfilaments, their structure and functions (3)

Extracellular matrix interactions: Types of ECM, interaction of cell with the ECM, malfunctions in ECM signaling (3)

Chromosomes structure and organization: Chemical composition of DNA, structural organization of nucleosomes, chromosomal organization, polytene and lampbrush chrosmosomes, human chrosmosomes, centrosome, telomere (4)

Types of DNA sequence: unique and repetitive DNA, hetero chromatin (1)

Cell cycle: P(hr)-oTrn-1 (h c)-13 (y)1 (p)2 (esTt1 (te)1l c)1 (y)-1 (o10.47t)-2 6.81 0 Td[ )-870 ( )-2750 6oftinun

			(2007) 7th edition
6	Principles of Genetics	Gardner EJ, Simmons MJ, Snustad DP	John Wiley & Sons (1991) 8th edition
7	Genetics: Analysis of Genes and Genomes	Hartl DL and Jones EW	Jones and Bartlett Publication, 8th edition
8	Genetics	Strickberger	Prentice Hall, (2002) 3rd edition
9	Genetics	Weaver P and Hedrick R	McGraw Hill Publishers, (2002) 3rd edition

Online study material links-

1. https://ocw.mit.edu/courses/biology/7-012-introduction-to-biology-fall-2004/video-lectures/lecture-7-genetics-2/
2. https://ocw.mit.edu/courses/biology/7-012-introduction-to-biology-fall-2004/video-lectures/lecture-8-genetics-3/
3. https://ocw.mit.edu/courses/biology/7-012-introduction-to-biology-fall-2004/video-lectures/lecture-6-genetics-1/

Course Code	BIO 364
Course Title	

will be divided into two parts having three questions each and the Students is required to attempt at least two questions from each section.

SECTION-A

Unit-1: Ecosystem

• Structure of ecosystem, Biotic & Abiotic components.
• Food chain and food web.
• Aquatic (Lentic and Lotic) and terrestrial ecosystem.
• Carbon, Nitrogen, Sulphur, Phosphorus cycle.
• Global warming -Causes, effects, process, Green House Effect, Ozone depletion.

Unit–2: Air and Noise Pollution

• Definition of pollution and pollutant, Natural and man-made sources of air pollution (Refrigerants, I.C., Boiler).
• Air Pollutants: Types, Particulate Pollutants: Effects and control (Bag filter, Cyclone separator, Electrostatic Precipitator).
• Gaseous Pollution Control: Absorber, Catalytic Converter, Effects of air pollution due to Refrigerants, I.C., Boiler.
• Noise pollution: sources of pollution, measurement of pollution level, Effects of Noise pollution, Noise pollution (Regulation and Control) Rules, 2000.

Unit-3: Water and Soil Pollution

• Sources of water pollution, Types of water pollutants, Characteristics of water pollutants Turbidity, pH, total suspended solids, total solids BOD and COD: Definition, calculation.
• Wastewater Treatment: Primary methods: sedimentation, froth floatation, Secondary methods: Activated sludge treatment, Trickling filter, Bioreactor, Tertiary Method: Membrane separation technology, RO (reverse osmosis).

• Causes, Effects and Preventive measures of Soil Pollution: Causes-Excessive use of Fertilizers, Pesticides and Insecticides, Irrigation, E-Waste.

SECTION-B

Unit– 4: Renewable sources of Energy

• Solar Energy: Basics of Solar energy. Flat plate collector (Liquid & Air). Theory of flat plate collector. Importance of coating. Advanced collector. Solar pond. Solar water heater, solar dryer. Solar stills.
• Biomass: Overview of biomass as an energy source. Thermal characteristics of biomass as fuel. Anaerobic digestion. Biogas production mechanism. Utilization and storage of biogas.
• Wind energy: Current status and future prospects of wind energy. Wind energy in India. Environmental benefits and problem of wind energy.
• New Energy Sources: Need of new sources. Different types of new energy sources. Applications of (Hydrogen energy, Ocean energy resources, Tidal energy

SYLLABUS
B.E. BIOTECHNOLOGY
FOURTH SEMESTER

Course Code	BIO 411
Course Title	Molecular Biology (Theory)
Type of Course	Core
L T P	4 0 0
Credits	4
Course Assessment Methods	
End Semester Assessment (University Exam.)	50
Continuous Assessment (Sessional)	50
Course Prerequisites	Students should have prior knowledge of structure and functions of basic biomolecules such as DNA, RNA and proteins.
Course Objectives (CO)	1. Students will be able to describe DNA and RNA metabolism**.** 2.Students will be able to explain protein metabolism and its importance . 3. Students will be able understand about signal transduction process and its function. 4. Students will be able to explain various molecular techniques and their application in medicine.
Course Outcome	1. Students are able to explain DNA and RNA metabolism**.** 2. Students are able to explain protein metabolism and analyze its importance 3. Students are able to discuss about signal transduction process and its function. 4. Students are able to analyze various molecular techniques and their application in medicine.

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SYLLABUS

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will be divided into two parts having three questions each and the Students is required to attempt at least two questions from each section.

SECTION-A

Introduction-Chromosome, chromatin, gene for understanding molecular processes (1)

DNA replication-Unit of replication, enzymes involved, replication process (initiation, elongation and termination) in Prokaryotes and Eukaryotes, fidelity of replication, extrachromosomal replicons (6)

DNA repair and recombination mechanism-Importance of DNA repair and recombination, various types of DNA damages and repair mechanisms in Prokaryotes and Eukaryotes, homologous and site-specific recombination, DNA transposition (6)

RNA metabolism in eukaryotes and prokaryotes – structure, function and types of RNA, Transcription factors and machinery, formation of transcriptional initiation complex, elongation and termination (6)

Course Code	BIO 461
Course Title	Molecular Biology (Practical)
Type of Course	Core
L T P	0 0 2
Credits	1

Course Assessment Methods

End Semester Assessment (University Exam)

Course Code	BIO 412
Course Title	Thermodynamics (Theory)
Type of Course	Core
L T P	3 1 0
Credits	4
Course Assessment Methods	
End Semester Assessment (University Exam.)	50
Continuous Assessment (Sessional)	50
Course Prerequisites	Process Calculations, Physical Chemistry, Mathematics and Biochemistry
Course Objectives (CO)	1. To learn the fundamentals of thermodynamics, understand various forms of energy including heat and work.

Throttling process, Joule Thompson coefficient, liquefication of gases. (4)

Second law of thermodynamics, concept of entropy, Refrigeration cycle, refrigerants, vapor compression cycle, Absorption refrigeration, Third Law of thermodynamics. (7)

SECTION-B

Vapor liquid equilibrium: Duhem's theorem, Raoult's law, Henry's law. Estimation of vapor liquid equilibrium data. Solution thermodynamics: chemical potential, phase equilibria, partial properties, Gibbs/Duhem equation. Concept of fugacity and fugacity coefficient, activity and activity coefficient. (12)

Course Code	BIO 413
Course Title	Chemical Reaction Engineering (Theory)
Type of Course	Core
L T P	3 1 0
Credits	4
Course Assessment Methods	
End Semester Assessment (University Exam.)	50
Continuous Assessment (Sessional)	50
Course Prerequisites	Knowledge of material balance equation and mathematical equations.
Course Objectives (CO)	1. To understand the characteristics of

CoPLqPbuPBNÎQPßQÀSQsßQÂR¡ÆEßWPXàßÀQlÁBp?Ê

Biochemical reaction systems: Michaelis-Menten kinetics, Kinetic of competitive and Non-competitive inhibition, evaluation of M-M equation parameters, enzyme fermentation in batch, plug-flow and mixed flow fermenters. (4)

SECTION-B

Thermal Characteristic of Reactors: Optimum temperature progression, Adiabatic Operations. (6)

Design for Multiple Reactions: Qualitative and Quantitative Product distribution for Parallel and Series reaction. Qualitative product distribution of Series-Parallel reactions. (10)

Biochemical kinetics:

Course Code	BIO 414
Course Title	Industrial Biotechnology (Theory)
Type of Course	Core
L T P	4 0 0
Credits	4
Course Assessment Methods	
End Semester Assessment (University Exam.)	50
Continuous Assessment (Sessional)	50
Course Prerequisites	Students should have done basic courses in Microbiology and Biochemistry
Course Objectives (CO)	1.To make the students understand the role of diverse organisms in industrial productions, their growth requirements and culture preservation. 2. To learn the methods applied for strain development. 3. To understand the microbial production process for of a wide range of products sand .-K(4 Tn)-2 (o (e)-1 (d f)dge t)-21 ()4 (t) ()Tj.15 rts

Course Code	BIO 464
Course Title	Industrial Biotechnology (Practical)
Type of Course	Core
L T P	0 0 2
Credits	1
Course Assessment Methods	
End Semester Assessment (University Exam.)	00
Continuous Assessment (Sessional)	50
Course Prerequisites	Experience of handling microbial cultures and biochemical analysis.
Course Objectives (CO)	1.To have practical training of the concepts and topics done in theory. 2. To get practical training in studying the growth curve and utilization of carbon source in media by bacterial/ yeast cultures. 3. To get practical training in media preparation, cell counting and product formation in bacteria/yeast.
Course Outcome	1.Practical Exposure in handling/ culturing of microorganisms, cell counting, measurement of product formation with respect to time of growth and by biochemical assay of product formation. 2. Practical Experience of identification and preservation of microbial cultures.

SYLLABUS

List of Experiments:

1. To identify bacteria on the basis of Gram's Staining.
2. To study the growth of E.coli / bacillus in broth media and plot the growth curve.
3. To determine the cell count of S. cerevisiae using Neubauer chamber.
4. To determine the concentration of glucose by DNSA reagent and plot the standard curve for glucose.
5. To study the utilization of glucose by S. cerevisiae/ Bacillus subtilis.
6. To plot a standard curve of ethanol by using dichromate oxidation method.
7. To study the production of ethanol during the growth of S. cerevisiae.
8. To identify industrially important fungi from slides.
9. To perform cryopreservation of bacteria/ yeast.

Course Code	BIO 415
Course Title	Immunology and Immunotechnology (Theory)
Type of Course	Core

Antigens and Haptens:

Course Code	BIO 465
Course Title	Immunology and Immunotechnology (Practical)
Type of Course	Core
L T P	0 0 2
Credits	1
Course Assessment Methods	
End Semester Assessment (University Exam)	00
Continuous Assessment (Sessional)	50
Course Prerequisites	Immunology and Immunotechnology (Theory)
Course Objectives (CO)	1. Students will be able to demonstrate isolation, separation and quantification of various cells and biomolecules of immune system present in blood 2. Students will be able to illustrate various antigen and antibodies reactions
Course Outcome	1**.** Students are able to demonstrate isolation, separation and quantification of various cells and biomolecules of immune system present in blood 2. Students are able to illustrate the various antigen and antibodies reactions

SYLLABUS

List of Experiments

1. Separation of plasma and serum from given blood sample.
2. Determination of Total Leukocyte Count (TLC) of given blood sample.
3. Determination of Differential Leukocyte Count (DLC) of given blood sample.
4. Determination of blood group antigens by hemeagglutination assay for typing blood sample.
5. Estimation of antigen concentration in an unknown sample using simple radial immunodiffusion assay.
6. Estimation of antigen concentration in an unknown sample using Ouchterlony double diffusion assay.
7. Demonstration of ELISA for antigen diagnostics.

questions of conceptual nature, will have 10 sub parts and will be compulsory. Rest of the paper will be divided into two parts having three questions each and the Students is required to attempt at least two questions from each section.

SECTION-A

Introduction & Scope; General distinctive features and industrial applications. (4)

Enzyme kinetics; single, substrate steady state kinetics; King-Altman's method (8)

Inhibitors and activators; effect of pH and temperature. (7)

Multi-substrate systems and allosteric enzymes. (4)

SECTION-B

Immobilization of enzymes; advantages; carriers; adsorption; covalent coupling; cross linking and entrapment methods. (5)

Enzyme reactors; reactors for batch/continuous enzymatic processing, choice of reactor type; idealized enzyme reactor systems; mass transfer in enzyme reactors. (5)

Steady state analysis of mass transfer and biochemical reaction in enzyme reactors bio-process design. (7)

Physical parameters, reactor operational stability; operational strategies; a few case studies. (5)

RECOMMENDED BOOKS

S. No.	NAME	AUTHOR(S)	PUBLISHER
1	Biochemical Engineering Fundamentals	J.E. Bailey and P.F. Ollis	McGraw Hill (1986), 2nd ed.
2	Bioprocess Engineering Basic Concepts	P.H. M.L.Shuler, F.Kargi	Phi Learning Pvt Ltd (2002), 2nd ed.
3	*Enzymes:* Biochemistry, Biotechnology, Clinical Chemistry	T Palmer and P L Bonner	Horwood *Publishing* Ltd. (2007), 2nd ed.
4	Enzyme Kinetics: A Modern Approach	Alejandro g. Marangoni	John Wiley & Sons. (2003)

http://nptel.ac.in/courses/103105054/9

http://nptel.ac.in/courses/102102033/

Course Code	BIO 561
Course Title	Enzyme Engineering & Technology (Practical)
Type of Course	Core
L T P	0 0 2
Credits	1
Course Assessment Methods	
End Semester Assessment (University Exam.)	00
Continuous Assessment (Sessional)	50
Course Prerequisites	Enzyme Engineering & Technology (Theory)
Course Objectives (CO)	The course aims to provide the practical knowledge of enzymatic reactions.
Course Outcome	1. Student will know about enzyme kinetics. 2. Student will know procedure for enzyme immobilization

SYLLABUS

List of Experiments

1. To find out enzyme activity.
2. To study the effect of substrate concentration on enzyme.
3. To find out V_{max} and K_m of enzyme.
4. To study the effect of temperature on enzyme.
5. To study the effect of pH on enzyme.
6. To find out half life of enzyme.
7. To study the Enzyme immobilization by sodium alginate method and find out immobilized enzyme activity.

Course Code	BIO 512
Course Title	Bioprocess Engineering (Theory)

Introduction to modeling of growth kinetics: General structure for kinetic models, overview of structure and unstructured models. (8)

SECTION-B

Sterilization of media: design of heat sterilization processes; kinetics; Sterilization in place and Cleaning in place concepts. (6)

Sterilization of air: Filter sterilization and kinetics. (4)

Design of fermentation media and optimization (6)

Aeration and agitation: various correlations and mass-transfer aspects, k_La determination (6)

RECOMMENDED BOOKS

S. No.	NAME	AUTHORS	PUBLISHERS
1.	Principles of Fermentation Technology.	Stanbury P.F.,Whitakar A. & Hall S.	Elsevier 3

Course Code	BIO 562
Course Title	Bioprocess engineering (Practical)
Type of Course	Core
L T P	0 0 2
Credits	1
Course Assessment Methods	
End Semester Assessment (University Exam)	00
Continuous Assessment (Sessional)	50
Course Prerequisites	Bioprocess engineering (Theory)
Course Objectives (CO)	1. To impart the practical knowledge and skills to students how to analyze the biological mechanisms and reactions.
Course Outcome	1. Students will be able to perform biological reactions and understand the behavior of different enzymes to their substrates. 2. Students

Course Code	BIO 513
Course Title	Animal Cell Culture and Bio-Technology (Theory)
Type of Course	Core
L T P	4 0 0
Credits	4
Course Assessment Methods	
End Semester Assessment (University Exam.)	50
Continuous Assessment (Sessional)	50
Course Prerequisites	Students should have knowledge of animal cell structure, function and behavior
Course Objectives (CO)	1. Students will be able to explain the biology, groLn1 1 Tf0.00rse O.04 Tw -2750 (50)]TJEMC cel7(d) 7 ƀ(o)-5 (m)10 (7y, g)deL IDooscr ())]TJ0 bc 0 T scappTd[())]TJ0 ni750p T 7 ƀBDC /TT2 Td[(bi)-2 (ol)-2

will be divided into two parts having three questions each and the

	Culture		6th edition
3.	Animal Cell Culture and Technology	Michael Butler	Taylor & Francis, 2nd ed.

1. https://swayam.gov.in/course/3713-cell-culture-technologies
2. http://nptel.ac.in/courses/102104059/
3. http://nptel.ac.in/courses/102103012/pdf/mod6.pdf

Course Code	BIO 563
Course Title	

Course Code	BIO 514
Course Title	Transport Phenomena (Theory)
Type of Course	Core
L T P	3 1 0
Credits	4
Course Assessment methods	
End Semester Assessment (University Exam)	50
Continuous Assessment (Sessional)	50
Course Prerequisites	Mathematical ability to solve analytically simple first and second order differential equations, concepts of heat and mass transfer, fluid flow and Process Calculations
Course Objectives (CO)	To provide engineering students the fundamentals to solve problems involving transport of momentum, energy and mass in biological and other systems using a unified approach.
Course Outcome	1. The students will be able to define the fundamental law of viscosity, heat transfer and mass transfer. 2. The students will be able to write shell balance for conservation of momentum, energy and mass. 3. The students will be able to employ these equations to obtain desired profiles for velocity, temperature and concentration. 4. The students will be able to apply dimensional analysis for problem solving.

SYLLABUS

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SECTION-A

Transport of momentum, heat and mass by molecular motion-Newton's law of viscosity, Fourier's Law of heat conduction, Fick's Law of Diffusion. (4)

Transport properties-Viscosity, Thermal Conductivity and mass diffusivity. (2)

Development of mathematical models of transfer processes through shell momentum balance for

Course Code	BIO 564
Course Title	Transport Phenomena (Practical)
Type of Course	Core
L T P	0 0 2
Credits	1
Course Assesement methods	
End Semester Assesement (University Exam)	00
Continous Assesement (Sessional)	50
Course Prerequisites:	Transport Phenomena (Theory)
Course Objectives (CO):	To demonstrate and validate the theoretical concepts.
Course Outcome:	Application of the theoretical concepts.

SYLLABUS

List of Experiments:

1. Measurement of density of a liquid.
2. Measurement of viscosity of a liquid.
3. Determination of Thermal Conductivity of solid.
4. Determination of Heat transfer coefficient. (Natural convection)
5. Determination of heat Transfer coefficient (Forced convection).
6. Determination of mass transfer coefficient for vaporization of naphthalene in air.
7. Determination of mass transfer coefficient as a function of gas mass velocity in a wetted wall column.

Course Code	BIO 515

implantable, performance aspects, power source and electrodes (5)

Introduction to medical imaging: Ultrasound, magnetic resonance imaging and computed tomography (3)

RECOMMENDED BOOKS

S.No	NAME	AUTHOR(S)	PUBLISHER
1	Handbook of Biomedical Instrumentation	Khandpur, R.S.	Tata McGraw Hill(2003)2nd edition
2	Medical Instrumentation application & Designs	Webster, G. J.	John Wiley &Sons, Inc.(2009)4th edition
3	Principles of applied Biomedical Instrumentation	Geddes, L.A. and Baker, L.E.	A Wiley Interscience publication (2008) 3rd edition
4	Electrical and Electroill(n4Qw 12		

SYLLABUS
B.E. BIOTECHNOLOGY

SIXTH SEMESTER

Course Code	BIO 611
Course Title	Recombinant DNA Technology (Theory)
Type of Course	BIO 611

4. Students are able to analyze the applications of recombinant DNA technology in the fields of Medicine, Agriculture, Forensic and Environment

SYLLABUS

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SECTION-A

Gene cloning-concept and importance (1)

DNAase1 footprinting, modification interference assay), *in-vitro* mutagenesis, Concept of gene editing

Studying protein-protein interactions- Phage display and yeast two hybrid (1)

Expression studies of foreign genes in research- feature of expression vector, (3)

expression in *E. coli,* eukaryotic cells, animal cells and plant cells.

Safety measures and regulations for recombinant DNA work, ethical concerns with (2)

pharming

Applications of recombinant DNA technology in the fields of Medicine, Agriculture, (4)

Forensic and Environment2 (ic)1 (in)2 (e)1 (,)7 (A)f

Course Code	BIO 612
Course Title	Bioinformatics (Theory)
Type of Course	Core
L T P	4 0 0
Credits	4
Course Assessment Methods	
End Semester Assessment (University Exam.)	50
Continuous Assessment (Sessional)	50
Course Prerequisites	Knowledge of biomolecules like DNA, RNA, proteins and some fundamentals of computer.

Course Objectives (CO)

1. To introduce to the students objectives and applications of bioinformatics, genome sequencing projects and the basic concepts of different databases.
2. To make students understand the use of databases in protein and nucleic acid sequence analysis.
3.

Molecular mechanics and Molecular dynamics simulations: concept of force field, Energy Minimization and related methods for exploring the energy surface.
Use of molecular graphics packages: Rasmol, spdbviewer, Cn3D.

Computer aided drug design: (5)

Drug discovery process, Role of molecular recognition in drug design, concepts of docking and Quantitative structure activity relationships (QSAR) in drug design

RECOMMENDED BOOKS

S. No.	NAME	AUTHOR(S)	PUBLISHER
1.	Bioinformatics- A Beginners Guide	Claverie, J. M. and Notredame, C.	Wiley Publishing, Inc. (2007)2nd edition
2.	Bioinformatics Concepts, Skills and Applications	Rastogi, S. C., Mendiratla, N. and Rastogi, P.	CBS Publishers and Distributors, N

http://nptel.ac.in/courses/102106065/11

Course Code	BIO 662
Course Title	Bioinformatics (Practical)
Type of Course	Core
L T P	0 0 2
Credits	1
Course Assessment Methods	
End Semester Assessment (University Exam.)	00
Continuous Assessment (Sessional)	50
Course Prerequisites	Bioinformatics (Theory)
Course Objectives (CO)	1. To make students understand the use of various computational tools available online for retrieving DNA and protein sequences, similarity searches among them, phylogenetic analysis, gene prediction, 2D and 3D protein structure analysis.
Course Outcome	1. Students will be able to study and analyse various biological databases at NCBI, Expasy and RCSB 2. Students will be able to retrieve DNA and protein sequences from databases. 3. Students will be able to use various computational tools available online for similarity searches, phylogenetic analysis, gene prediction, 2D and 3D protein structure analysis for DNA and protein sequences.

SYLLABUS

List of Experiments:

1. To study and analyze various biological databases at NCBI, Expasy and RCSB
    a. Nucleic acid sequence databases like Gene Bank, EMBL etc.
    b. Protein sequence databases like UNIPROT.
    c. Structural databases- PDB, NBD.
2. To retrieve sequences from NCBI/EBI/ExPasy using ENTRZ, SRS.
3. Similarity searches using various tools like BLAST N, BLAST P, BLAST X.
4. Pairwise sequence alignment between the given two sequences using any two variants of BLOSUM in BLAST.

5. Multiple sequence alignment and phylogenetic analysis using CLUSTALW / T-Cofee.
6. To predict gene/ORF for genomic DNA sequences of prokaryotic and eukaryotic origin.
7. To analyze protein sequence using Secondary Structure prediction Methods:

   Chou-Fasman/GOR method, PSIPRED etc.
8. To down-load structures of proteins in software like RASMOL, SPDBV and analysis of structures in these software.
9. Energy minimization using SPDBV.

Course Code	BIO 613
Course Title	Bioreactor Design & Operation

Ideal Reactors: Batch reactor (Closed and fed-batch), continuous reactors; PFTR, CSTR design equations. Reactors for biomass growth; reactors in series; recycle reactors; overview of pneumatically agitated bioreactors; Membrane bioreactors and Photo bioreactors. (10)

RTD in reactors: Models for non-ideal reactors; Tanks in series and dispersion models. (6)

SECTION-B

Instrumentation and control of various parameters in bioreactors for Dissolved oxygen, foam,pH, temperature, flow, pressure, microbial biomass, CO_2 etc; Methods of measuring process variables and control systems: Proportional, Proportional integral and Proportional integral derivative. (10)

Bioreactor modeling and stability: Fermentation dynamics, Biomass production and dilution factor, Thermal stability concepts. (6)

Mechanical design Concepts: Application to continuous sterilizers, RTD concepts, Application of design principles. (6)

RECOMMENDED BOOKS

S. No.	NAME	AUTHORS	PUBLISHERS
1.	Bioprocess Engineering Basic Concepts	Shuler M.L & Kargi F. P.H	2nd edition, Prentice Hall.
2.	Bioreactor Sytem Design	Asenjo J.A. & Merchule J.C. Dekker.	C R C Pr. 1st edition, 1994. (Eds.) .
3.	Basic Bioreactor Design	Van't R et KK. & Tramper J. Marcel Decker	1991 C R C Pr.
4.	Bioprocess Engineering Principles	Pauline M. D.	Academic Press, An imprint of Elsevier.

Course Code	BIO 614
Course Title	Downstream Processing (Theory)
Type of Course	Core

Course Code	BIO 664
Course Title	Downstream Processing (Practical)
Type of Course	Core
L T P	0 0 2
Credits	1
Course Assessment Methods	
End Semester Assessment (University Exam)	00
Continuous Assessment (Sessional)	50
Course Prerequisites	Downstream Processing (Theory)
Course Objectives (CO)	1. To impart to students working knowledge of different methods and techniques used during different stages of downstream processing of bio-molecules
Course Outcome	1. The students are able to isolate and enrich bio-molecules using different techniques pertaining to downstream processing

SYLLABUS

List of Experiments:

1. Separation of microbial flora from the given sample by filtration method.
2. Cell lysis by ultrasonication.
3. Thin Layer Chromatography (TLC) of the given sample (sugars/ amino acids).
4. Determination of specific amylase activity.
5. Ammonium sulphate precipitation of the given protein.
6. Protein concentration by Dialysis.
7. Lyophilization of the given sample.

Course Code	BIO 615
Course Title	Open Elective (Biomaterials)
Type of Course	Core
L T P	4 0 0
Credits	4
Course Assessment Methods	
End Semester Assessment (University Exam.)	50
Continuous Assessment (Sessional)	50
Course Prerequisites	Knowledge of human anatomy and physiology and basics of immunology
Course Objectives (CO)	1. The course aims at introducing the students to properties of biomaterials 2. To make them aware of different types of tissue grafts 3. The students learn about the immunological response to the grafts 4. To explain to them about the utilization of different classes of synthetic polymers and biopolymers as implant material in various organ systems
Course Outcome	1. To students learn about the mechanical, thermal and surface properties of biomaterials 2. Learn about the application of synthetic and biopolymer as implant material for soft and hard tissues 3. The students learn about the interaction of implant material with the body tissues 4. The students are able to identify the approaches to prevent rejection of the implant

SYLLABUS

Note: *The question paper will be of 50 Marks having 7 questions of equal marks. Students are required to attempt 5 questions in all. First question, covering the whole syllabus and having questions of conceptual nature, will have 10 sub parts and will be compulsory. Rest of the paper*

Classes of biomaterials: Structure and characteristic feature

Metallic alloys: Stainless steel, cobalt- chromium alloys, titanium based alloys, metallic corrosion

Ceramics

SYLLABUS

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SECTION-A

Introduction: Environmental Pollution: Sources and effects, Environmental ethics -issues and possible solutions- population explosion, climatic change, ozone layer depletion, global
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Course Code	BIO 761
Course Title	Environmental Biotechnology (Practical)
Type of Course	Core
L T P	0 0 2
Credits	1
Course Assessment Methods	
End Semester Assessment (University Exam.)	00
Continuous Assessment (Sessional)	50
Course Prerequisites	Environmental Biotechnology (Theory)
Course Objectives (CO)	1. The course aims to provide the practical training of estimation of Environmental Pollutant such as aromatic compounds. 2. To perform the measurement in waste water treatment such as DO and COD.
Course Outcome	1. Learn about measurement in waste water treatment. 2. Learn about Environmental Pollutant such as aromatic compounds. 3. To understand about biochemical calculation in waste water treatment.

SYLLABUS

List of Experiments:

1. To estimate dissolved oxygen content of a given water sample.
2. Estimation of phenolic compounds in the drinking water and effluent sample.
3. Quantification of total detergents /surfactants content in drinking water.
4.

Course Code	BIO 712
Course Title	Food Biotechnology (Theory)
Type of Course	Core
L T P	4 0 0
Credits	4

Course Assessment Methods

End Semester Assessment (University Exam.) 50
Continuous Assessment (Sessional) 50

Course Prerequisites Knowledge of microbiology concepts

Course Objectives (CO)

1. To introduce students about history of microorganisms in food, primary sources of microorganisms in foods.
2. To familiarize students with synopsis of common food borne bacteria, fungi and yeasts.
3. To understand about Extrinsic & Intrinsic parameters of foods.
4. To make their understanding in relating above parameters with food spoilage, food borne diseases, food preservation.
5. To introduce about methods for diagnosis of microbial contents of food, food biosensors.

Course Outcome

1. Students will be able to describe history of microorganisms in food, primary sources of microorganisms in foods.
2. Students will be able to explain factors affecting food.
3.

SECTION-A

Introduction: History of Microorganisms in food, Primary sources of Microorganisms in foods, Synopsis of common food borne bacteria, fungi and yeasts. (9)

Microbial growth in food: Intrinsic and extrinsic factors affecting the growth of microorganisms in food; Microbiology of raw, processed and spoiled foods: Fruits and vegetables, meat and meat products, milk and milk products, eggs, canned foods, cereal and cereal products; Biochemical changes brought by microorganisms. (7)

Food Preservation with chemicals, modified atmospheres, low and high temperatures, radiations and drying methods. (6)

SECTION-B

Role and significance of microorganisms as Single cell proteins, Food value of mushroom, Production of Fermented foods: Bread, yoghurt, cheese, beverages, sauerkraut, soy sauce, miso, tempeh. (7)

Food borne pathogens and pathogenesis: *Staphylococcus aureus, Escherichia coli, Clostridium botulinum, Clostridium perfringens, Listeria monocytogenes, Salmonella enteritidis, Shigella dysenteriae, Vibrio cholera and Campylobacter jejuni,* Hepatitis virus, Rotaviruses, Giardiasis, Amoebiasis, Taeniasis and Trichinellosis, overview of food intoxication by mycotoxins. (10)

Applications of various microbial and molecular techniques in food technology. (4)

HACCP system and food safety. (2)

RECOMMENDED BOOKS

S. No.	NAME	AUTHOR(S)	PUBLISHER
1.	Introductory Food Microbiology	Modi, H. A.	Aavishkar Publishers and Distributors, Jaipur (India) (2007)
2.	Food Microbiology	Adams, M.R. and Moss, M.O	Turpin Distribution Service Ltd (1995)2nd edition
3.	Modern Food Microbiology	Jay, J.M.	

Course Code	BIO 713
Course Title	Plant Tissue Culture (Theory)
Type of Course	Core
L T P	4 0 0
Credits	4
Course Assessment Methods	
End Semester Assessment (University Exam.)	50
Continuous Assessment (Sessional)	50
Course Prerequisites	Knowledge of plant cell biology and physiology
Course Objectives (CO)	4. The course aims at familiarizing the students with fundamental aspects of plant tissue culture, 5. Explain the concept of totipotency to the students 6. Explain the utilization of tissue culture systems for plant improvement 7. Learn about the techniques for optimized production of metabolites.
Course Outcome	1. The students understand the basic concepts in plant tissue culture 2. Learn different methods and techniques utilized in plant tissue culture 3. Learn about recent advances in plant tissue culture and secondary metabolite production techniques 4. Implementation of plant tissue culture techniques for research and commercial application

SYLLABUS

Note: *The question paper will be of 50 Marks having 7 questions of equal marks. Students are required to attempt 5 questions in all. First question, covering the whole syllabus and having questions of conceptual nature, will have 10 sub parts and will be compulsory. Rest of the paper will be divided into two parts having three questions each and the Students is required to attempt at least two questions from each section.*

Introduction to Plant Tissue Culture: definition, history, set up of a plant tissue culture laboratory, requirements and general techniques, explant sterilization. (3)

Tissue Culture Media : preparation and composition of the nutrient media ,micronutrients, macronutrients , plant growth regulators and gelling agents. (3)

Introduction to Cell Culture :callus culture, isolation and culture of single cell , suspension cultures, protoplast isolation and culture. (6)

Cellular Totipotency :

Course Code	BIO 714
Course Title	Bioanalytical Techniques (Theory)
Type of Course	Core
L T P	4 0 0
Credits	4

Course Assessment Methods

End Semester Assessment (University Exam.)	50
Continuous Assessment (Sessional)	50

Course Prerequisites: Introductory knowledge about bioanalytical instruments and techniques

Course Objectives (CO):
1. To impart the knowledge to student about basic concepts behind biotechniques
2. To make the student understand importance of biotechniques

Course Outcome:
1. Student will know about the utilization of different techniques for different analytes

SYLLABUS

Note: *The question paper will be of 50 Marks having 7 questions of equal marks. Students are required to attempt 5 questions in all. First question, covering the whole syllabus and having questions of conceptual nature, will have 10 sub parts and will be compulsory. Rest of the paper will be divided into two parts having three questions each and the Students is required to attempt at least two questions from each section.*

SECTION-A

Spectrophotometry (UV and Visible): Principle, single beam and double beam spectrophotometer, factors influencing the absorption spectra, overview of empirical rules, Beer-

Atomic absorption Spectrophotometry: Principle, instrumentation details, various interferences in atomic absorption spectroscopy and applications. (4)

Infrared and Raman Spectroscopy: Principle, factors deciding the spectra, instrumentation, overview of different class of compounds and their IR spectra. Introduction to Raman scattering. (4)

Nuclear Magnetic resonance: Phenomena of resonance, instrumentation, diamagnetic shielding, anisotropy, chemical shift, free induction decay (FID), population distribution of nuclei, and prediction of NMR spectra on the basis of (n+ 1) rule for basic class of compounds. Overviews of electron spin resonance spectroscopy (ESR) and magnetic resonance imaging (MRI). (8)

SECTION-B

Electron Microscopy: Transmission and scanning electron microscopy, significance of vacuum, basic instrumentation for TEM and SEM, sample preparation for electron microscopy. Overview of Atomic force microscopy and tunneling microscopy with respect to their working principle and comparison with other scanning techniques. (5)

Crystallography and X-ray diffraction: Introduction to x-ray and general theory and instrumentation, Bragg's law, various techniques to determine crystal structure. (5)

Radioisotope techniques: Nature detection and measurements of radioactivity radiotracers, units of radioactivity measurement, proportional, GM counter and scintillation counters, introduction to autoradiography and nuclear medicine, pulse height analyser, isotope dilution analysis, application of radioisotopes in biological science, safety measures in handling isotopes. (6)

Mass Spectroscopic Techniques: Introduction tohani

Course Code	**:**BIO 764
Course Title	**:**Bioanalytical Techniques (Practical)
Type of Course	**:**core
L T P	**:** 0 0 2
Credits	**:** 1

Course Assessment Methods oE]TJn2 (s)]oes A1 (u)-1 (en9 (t)-1 (h)2)-1 (Tc 0 Tw ( )TjEMC /P <</MCID 6 >>BD

Course Code	BIO 715
Course Title	Minor Project (Practical)
Type of Course	Core
L T P	0 0 4
Credits	2
Course Assessment Methods	
End Semester Assessment (University Exam.)	00
Continuous Assessment (Sessional)	50

Course Code	BIO 716
Course Title	Training of 6 weeks after 6^{th} semester
Credits	1
Course Assessment Methods	
End Semester Assessment (University Exam.)	00
Continuous Assessment (Sessional)	50

SYLLABUS
B.E. BIOTECHNOLOGY

EIGHTH SEMESTER

Course Code	BIO 811
Course Title	Major project (Practical)
Credits	2
Course Assessment Methods	
End Semester Assessment (University Exam.)	00
Continuous Assessment (Sessional)	50

Course Code	BIO 812
Course Title	Enzyme Catalyzed Organic Synthesis (Theory)
Type of Course	Core
L T P	4 0 0
Credits	4

Course Assessment Methods

End Semester Assessment (University Exam.)	50
Continuous Assessment (Sessional)	50

Course Prerequisites Introductory Enzyme Technology.

SYLLABUS

Note: *The question paper will be of 50 Marks having 7 questions of equal marks. Students are required to attempt 5 questions in all. First question, covering the whole syllabus and having questions of conceptual nature, will have 10 sub parts and will be compulsory. Rest of the paper will be divided into two parts having three questions each and the Students is required to attempt at least two questions from each section.*

SECTION-A

Biocatalysis: Definition of Biocatalysis, advantages and disadvantages of Biocatalysis over chemical catalysis. Chirality and biological activity. (10)

Different types of Biocatalysis; microbial, enzymatic and immobilized system of Biocatalysis; current industrial Biocatalysis with different enzymes. (7)

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Course Code

Course Code	BIO 813
Course Title	

SECTION-A

Project Formulations and Planning ,Private commercial criteria for project choice, project cycle, feasibility, marketing feasibility (6)

Financing for Projects and financial feasibility (6)

Project Implementation. Brief outline of social cost benefit analysis: rationale. (4)

UNIDO and little Mirrlees approaches, UNIDO-IDCAS manual, shadow prices and conversion factors, applications in India. Planning and scheduling networks (6)

Critical path, PERT model, CPM model, PERT/cost, resource leveling and allocation. (3)

SECTION-B

Entrepreneur- Concept on percent - Functions and clarifications of entrepreneurs - Characteristics of entrepreneur - Nature and importance of ,entrepreneur (6)

Entrepreneur vs. professional manager - Women entrepreneurs. Concept of Entrepreneurship - Entrepreneurship and environment-Policies governing entrepreneurs, entrepreneurial development programmes (6)

Institutions for - entrepreneurship development, entrepreneurship. (2)

Entrepreneurship -Entrepreneurship development in other countries. (2)

Institutions for Entrepreneurial Development - Role of constancy organizations - Role of financial institutions -Bank finance to entrepreneurs Entrepreneurship development: Role of development financial institutions. (4)

RECOMMENDED BOOKS

S.No	NAME	AUTHOR(s)	PUBLISHER
1.	Fundamentals of Entrepreneurship and Small business Management	Vasant Desai	Himalya Publishing House
2.	Entrepreneurship	Hisrich,Peters and Shepherd	Tata McGrawHill
3.	UNIDO: Guidelines for Project Evaluation, United Nations	UNIDO	UNIDO
4.	Manual for the preparation of Industrial Feasibility Studies, United Nations		United Nations, 1978.

Course Code	BIO 814
Course Title	Modeling and Simulation of Bioprocesses (Theory)
Type of Course	Core
L T P	4 0 0
Credits	4

Course Assessment Methods

End Semester Assessment (University Exam.)	50
Continuous Assessment (Sessional)	50

Course Prerequisites Introductory Bioprocess Engineering and Mathematical Calculation.

Course Objectives

1. To introduce the Basic concepts about kinetic models.
2. To understand the Mathematical representation of bioprocess.
3. To understand the Development of compartment and metabolic pathway models.
4. To introduce the Dynamic simulation of batch, fed-batch, CSTR and transient culture metabolism.
5. To introduce the Numerical optimization.

Course Outcome

1. Students will learn about basic concepts of Kinetic Models.
2. Students will be able to explain about bioprocess design in a various systems solve model equation.
3. Students will be able to explain about dynamic simulation of metabolic pathway models.
4. Students will be able to explain to study the mathematical modeling of batch, Continuous & Fed·Batch Reactors.
5. Students will be able to solve numerical integration techniques for model validation.

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SECTION-A

Types of kinetic models. Data smoothing and analysis. (9)

Mathematical representation of bioprocess; parameter estimation; numerical integration techniques; parameter sensitivity analysis; statistical validity. (8)

Discrimination between two models. Physiological state markers and its use in the formulation of a structured model. (6)

SECTION-B

Development of compartment and metabolic pathway models for intracellular state estimation. (8)

Dynamic simulation of batch, fed-batch steady and transient culture metabolism; Numerical optimization of Bioprocesses using Mathematical models. (14)

RECOMMENDED BOOKS

S.No	NAME	AUTHOR(s)	PUBLISHER
1.	Chemical Engineering Dynamics: Modeling and computer Simulation	John Ingham, Irving J. Dunn, Elmar Heinzle & J.E. Prenosil	

Course Code	BIO 815 (a)
Course Title	Nanobiotechnology

be divided into two parts having three questions each and the Students is required to attempt at least two questions from each section.

SECTION-A

Cell nanostructure interactions: Surface patterning to control the adhesion of cells

Course Code	BIO 815 (b)
Course Title	Microbial Biodiversity
Type of Course	Elective
L T P	

Course Code	**:**	**HSS 301a**
Credits	**:**	**3**
L T P	**:**	**3-0-0**

Total No. of Lectures – 42

Lecture wise breakup		**No. of Lectures**
	Introduction to Economics	**(5)**
1	Nature of Economics, Economic Thoughts, Economic Activities, Relationship of Economics with other Social Sciences and Engineering	
	Theory of Consumer Behaviour	
2	Demand: Types, Law of Demand, Determinants of Demand and Change in Demand Elasticity of Demand: Nature, Degrees,	

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2 Jhingan M.L., “Macro Economic Theory”, Konark Publisher Pvt. Ltd.

3

Course Name : Introduction to Psychology
Course Code : HSS 301b
Credits : 3
L T P : 3-0-0
Total No. of Lectures – 42

Course Objectives:

1 To provide knowledge and understanding about important concepts in Psychology.

2 To make students learn the application of principles of psychology in working life.

Lecture wise breakup		**No. of Lectures**
1	Understanding Human Behaviour: Definition, methods, branches and application of psychology for engineers	**(5)**
2	Measuring Human abilities: Intelligence, theories and assessment	**(6)**
3	The individual working life: Personality, approaches and trait theories	**(6)**
4	Psychological problems of everyday life: Stress and coping	**(6)**
5	Work and mental health, y(o)-3.7 (b)-3.23.87 0 Td(1 T0 Td[(CP /MCIn /MCIn3 ( )]T301 Tc 0.07DC T7Tc 0 Tw/M	

Course Name	**:**	**Sociology**
Course Code	**:**	**HSS 301c**
Credits	**:**	**3**
L T P	**:**	**3-0-0**

Total No. of Lectures – 42

Course Objectives:

1	To make the students understand the role of theory in social sciences.
2	To explain students how social problems interact and react with the larger society.
3	To make students learn whether the problem is evaluated on the macro or micro perspective and their cause and effect patterns.

Lecture wise breakup		No. of Lectures
1	**Sociology – The Discipline** Sociology as a Science, Impact of Industrial and French Revolution on the Emergence of Sociology, Relevance of Sociology for Engineering	**(3)**
2	**Basic Concepts** Society, Association, Institution, Culture Relativism, Social Structure, Social System, Socialisation, Competition, Conflict, Accommodation, Social Mobility	**(4)**
3	**Pioneering Contributions to Sociology** Seminal Views of Karl Marx, Emile Durkheim, Max Weber, Alwin Toeffler	**(4)**
4	**Evolution of Society** Primitive, Agrarian, Industrial and Post-Industrial, Features of Industrial and Post-Industrial Society, Impact of Automation and Industrialization on Society	**(4)**
5	**Economy and Society** Economic Systems of Simple and Complex Societies, Sociological Dimensions of Economic Life, Market (free) Economy and Controlled (planned) Economy	**(4)**
6	**Industrial Sociology** Nature and Scope of Industrial Sociology, Pre-Conditions and Consequences of Industrialization	**(4)**
7	**Science and Technology** Ethos of Science and Social Responsibility of Science	**(4)**
8	**Social Change** Theories of Change, Factors of Change, Directed Social Change, Social Policy and Social Development, Social Cost Benefit Analysis, Role of Engineers in Development	**(5)**
9	**Understanding Indian Society** Traditional Hindu Social Organization, Caste System, Agrarian Society in India, Social Consequences of Land Reforms and Green Revolution, Working of the Democratic Political System in a Traditional Society, Problem of Education in India, Gender Discrimination, Economic Reforms: Liberalization, Privatization and Globalization, Strategies for Development in India	**(7)**

10	**Social Problems** AIDS, Alcoholism, Drug Addiction, Corruption	**(3)**

Course Outcomes:

1	The students will be able to identify the function and application of sociology theory in social sciences.
2	The students will be able to understand how social class affects individual life chances.
3	The students will learn about social structure and how it shapes and influences social interactions.

Text Books:

1 Vardhan R4 (act)-1.7 (i)-1.7 (i)-1.27 (en)-3.8 (ces so)-3.7 (ci)-1qTJ0 Tni..5 664./w/oD2 1 Tf-s.4 (ohc