

## B.TECH BIOTECHNOLOGY

### SEMESTER - 1

#### 19B101 CALCULUS AND GEOMETRY

3 1 0 4

**THREE-DIMENSIONAL ANALYTICAL GEOMETRY** : Direction cosines and ratio's, angle between two lines, equation of a plane, equation of a straight line, shortest distance between two lines. Equation of a sphere, plane section of a sphere. (9 + 3)

**DIFFERENTIAL CALCULUS** : Functions of two variables, limits and continuity, partial derivatives, the chain rule, extreme values and saddle points, Taylor's formula for two variables. (9 + 3)

**INTEGRAL CALCULUS** : Double integrals, double and iterated integrals over rectangles, double integrals over general regions, Fubini's theorem, area and volume by double integration, reversing the order of integration. (9 + 3)

**ORDINARY DIFFERENTIAL EQUATIONS OF FIRST ORDER** : Basic concepts, separable differential equations, exact differential equations, integrating factors, linear differential equations, modeling - mixing problems, decay and growth problems, Newton's law of cooling. (9 + 3)

**LINEAR DIFFERENTIAL EQUATIONS OF SECOND ORDER** : Homogeneous linear equations of second order, homogeneous linear ODEs with constant coefficients, finding a basis if one solution is known, Euler — Cauchy equation, solution by variation of parameters. (9 + 3)

**Total L: 45 +T: 15 = 60**

#### TEXT BOOKS:

1. Joel Hass, Christopher Heil, Maurice D. Weir "Thomas' Calculus", Pearson Education., New Delhi, 2018
2. Erwin Kreyszig "Advanced Engineering Mathematics", Wiley India Pvt Ltd., New Delhi, 2015

#### REFERENCES:

1. Howard Anton, Irl Bivens, Stephen Davis "Calculus", John Wiley & Sons, INC., USA, 2016
2. Wylie C R and Barrett L C "Advanced Engineering Mathematics", Tata McGraw-Hill., New Delhi, 2019
3. Vittal. P.R "Analytical Geometry 2D and 3D", Pearson Education., Chennai, 2013
4. Gilbert Strang "Calculus", Wellesley Cambridge Press., USA, 2017

#### 19B102 PHYSICS

3 0 0 3

**OSCILLATORY MOTION** : Review of simple harmonic motion- Differential equation of SHM- Velocity and acceleration- Restoring force- Vibration of a spring and mass system. Frequency response, phase response and resonance- Analogy with LCR circuits and oscillators- Energy and energy loss- Damped oscillations- Significance in control systems, vibration and vibration isolation. (9)

**WAVE MOTION** : Definition of a plane progressive wave- Attenuation of waves- Representation of waves using complex numbers- Differential equation of a plane progressive wave- Phase velocity- Phase and phase difference- Solution of the differential equation of a plane progressive waveform of differential equation of 3-dimensional wave motion (no detailed solution)- Introduction to numerical methods for solution of wave equation- Importance of spherical and plane wave fronts. (9)

**CRYSTALLOGRAPHY AND ENGINEERING MATERIALS** : Lattice parameters. Crystal systems. Packing factors of cubic and HCP crystal systems. Miller indices. Linear and planar density of atoms. Debye-Scherrer method of crystal structure determination, Crystal imperfections - point, line and surface defects and their role in electrical, mechanical and optical properties of materials, Growth of crystal of biological molecules. Factors affecting crystallization of organic molecules. XRD of molecules and proteins. (9)

**SEMICONDUCTING MATERIALS AND DEVICES** : Elemental and compound semiconductors. Intrinsic and extrinsic semiconductors - Properties. Carrier concentration in intrinsic, n-type and p-type semiconductors. Hall effect - experimental determination of Hall coefficient. Application- Hall and peltier devices, LDR, LED, and LCD. (9)

**SENSORS** : Proximity detectors — inductive and capacitive, ultrasonic, photo beam detectors reed switch, magnet and hall-effect units, doppler detectors, liquid level detectors, flow sensors, smoke sensors. **STRAIN AND PRESSURE SENSORS**: Resistance strain gauge, piezoelectric pressure gauge, characteristics. Electronic circuits for strain gauge, load cells. Interferometer, fibre-optic methods. Pressure gauges aneroid capacitance pressure gauge, ionization gauge, using the transducers for applications (9)

**Total L: 45**

#### TEXT BOOKS:

1. Richard Wolfson "Essential University Physics", Pearson Education., Singapore, 2016 ,3rd
2. Gupta S L, Gaur R K "Engineering Physics", Dhanpat Rai Publications., 2016

**REFERENCES:**

1. Resnick R. and Walker J., Halliday D "Fundamentals of Physics", Wiley Publications., 2011
2. Purcell E. M. "Electricity and Magnetism – Berkeley Physics Course", Tata McGraw-Hill., 2017
3. Paul A. Tipler and Gene Mosca "Physics for Scientists and Engineers", W.H. Freeman and Company., New York, 2017, 6th
4. Ian R Sinclair "Sensors and Transducers", Newnes publishers., 2001

**19B103 CHEMISTRY****3 0 0 3**

**THERMODYNAMICS AND BIOENERGETICS** : Review of first law, flow of energy in living organisms, bond enthalpy - thermochemical properties of biological fuels, Kirchoff's equation. Entropy and second law, Free energy and spontaneity, bioenergetics - energy coupling links and activation energy of reactions, assembly of proteins and biomembranes. The ATP cycle. (9)

**KINETICS AND CATALYSIS** : Integrated rate laws-review, complex reactions, chain reactions, kinetics of combustions. Catalysis - general characteristics, types of catalysis, acid-base catalysis, enzyme catalysis - Michaelis - Menton equation and its characteristic features. (9)

**SURFACE CHEMISTRY** : Adsorption - types of adsorption. Freundlich and Langmuir adsorption isotherms. Langmuir-Hinshelwood mechanism for heterogeneous catalysis, applications of adsorption. Surface active agents — surfactants, detergents, emulsifiers, critical micellar concentration, bio-colloids, properties — contact angle and wetting, water repellency, super hydrophobicity. (9)

**WATER AND SOLUTION CHEMISTRY**: Estimation of Hardness and alkalinity of water. Softening - demineralization, Phase rule — water system and ethanol — water system. Distribution law - principle of extraction. Ionic equilibrium - weak and strong electrolytes, ionization of electrolytes, ionization of water, pH scale, common ion effect, hydrolysis of salts, solubility of sparingly soluble salts and solubility product principles, buffer solutions. (9)

**ELECTROCHEMISTRY AND CORROSION** : Single electrode potential, standard and reference electrodes, emf series, Nernst equation, emf of a cell, galvanic and concentration cells. Glass electrode- applications. Potentiometric and conductometric titrations. Forms of corrosion and their mechanisms- atmospheric corrosion, pitting corrosion, stress corrosion, bio corrosion. Corrosion protection by design, cathodic protection- protective coatings, corrosion inhibitors. (9)

**Total L: 45****TEXT BOOKS:**

1. Atkins P. and Paula J "Physical Chemistry for the Life Sciences", Oxford University Press., London, 2011, 2nd ed
2. Cox M. M. and Nelson D. L "Lehninger Principles of Biochemistry", W H Freeman and Co., New York, 2011, 5th ed

**REFERENCES:**

1. Shaw D "Introduction to Colloid and Surface Chemistry (Colloid & Surface Engineering S)", Butterworth- Heinemann., California, 1992, 4th ed
2. Atkins P and, de Paula J. D "Elements of Physical Chemistry", Oxford University Press., London, 2017, 7th ed
3. Benjamin M. M "Water Chemistry", Waveland Press., Long Grove, 2015, 2nd ed

**19B104 BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING****3 0 0 3**

**ELECTRICAL CIRCUITS** : Ohm's law, Kirchoff's law-simple problems in DC circuits. Introduction to AC circuits- RMS Value, Power and Power factor, 1-phase and 3-phase balanced circuits (9)

**ELECTRONIC DEVICES AND CIRCUITS** : P-N junction-VI Characteristics of PN junction diode and zener diode. Rectifiers-Half wave and Full wave. Bipolar junction transistors-Configuration and Characteristics. Field Effect Transistors — FET amplifier. UJT-Construction and Characteristics. RC coupled amplifier — Concept of Positive and Negative feedback—Wien Bridge Oscillator. (9)

**OPERATIONAL AMPLIFIER AND DIGITAL ELECTRONICS** : Block diagram of LM741 Operational Amplifier, Application as Adder, Subtractor, Integrator, Differentiator. Digital Electronics : Binary number system and conversion—Basic gates—Boolean Algebra—Adder, Subtractor. Flip Flops—Universal Shift Register—Counters (9)

**SENSORS AND FEEDBACK DEVICES** : Importance of sensors in biotechnology. Accuracy, repeatability, sensitivity, resolution, stability, errors and output Impedance of sensors. Static and Dynamic characteristics of sensors (9)

**ELECTRODES AND TRANSDUCERS** : Basic electrode theory in biological : Ionic conduction, Metal electrolyte double layer, models of the cell membrane. Electrical signal detection in biological systems : Silicon, glass and metal electrodes, Micro electrode-skin surface electrode; Electrode materials — Blood gas electrode; Active transducer and passive transducers — Thermistor — Example of Industrial biosensors : glucose monitoring and DNA analysis (9)

**Total L: 45**

**TEXT BOOKS:**

1. Boylestad R. L., Nashelsky L "Electronic Devices And Circuits Theory", Pearson Education., New York, 2010
2. Muthusubramanian R, Salivahanan S, Muraleedharan K "Basic Electrical, Electronics and Computer Engineering", Tata McGraw Hill Publishers., 2006

**REFERENCES:**

1. Mehta V. K, Rohit Mehta "Principles of Electrical Engineering and Electronics", S.Chand & Co., New Delhi, 2006
2. Roy Choudhury, Shail Jain "Linear Integrated Circuits", New Age International Limited., New Delhi, 2003
3. Khandpur R. S "Handbook of Biomedical Instrumentation", Tata McGraw Hill Publishers., New Delhi, 2008

**19G105 ENGLISH LANGUAGE PROFICIENCY****2 1 0 3**

**LEARNING LANGUAGE THROUGH STANDARD LITERARY AND GENERAL TEXTS** : Integrated tasks focusing on language skills ; Training based on Text based vocabulary, tone, register and Syntax features (12 + 0)

**GRAMMAR IN CONTEXT** : Word Order ; Subject Verb Concord ; Style features - Tenses, Conditionals, Prepositions, Active and Passive Voice, Modals, Cloze and Spotting Error exercises (10 + 0)

**GUIDELINES FOR WRITTEN COMMUNICATION** : Principles of clear writing, Paragraph writing, Essay writing, Emphasis Techniques, Summarizing and Paraphrasing, Analytical writing (8 + 0)

**FOCUS ON SPOKEN ENGLISH** : Task — based activities: Graded levels of difficulty and with focus on language functions - Level 1: Self — expression — Greetings in Conversation, Hobbies, Special interests, Daily routine - Level 2: General Awareness — Expression of Concepts, Opinions, Social Issues, Description of a process / picture/chart, news presentation / review - Level 3: Advanced Skills — Making Short Speeches and Participating in Role Plays (0 + 10)

**LISTENING ACTIVITY** : Task based activities using Language Laboratory (0 + 5)

**Total L: 30 +T: 15 = 45****TEXT BOOKS:**

1. Faculty Incharge "Course Material on "English Language Proficiency", PSG College of Technology., Coimbatore, 2019

**REFERENCES:**

1. Jill Singleton "Writers at Work: The Paragraph", Cambridge University Press., New York, 2012
2. Simon Haines, Mark Nettle and Martin Hewings "Advanced Grammar In Use", Cambridge University Press., New Delhi, 2008
3. Anne Laws "Writing Skills", Orient Black Swan., Hyderabad, 2011
4. Sinha DK "Specimens of English Prose", Orient Black Swan., Hyderabad, 2012

**19B110 ENGINEERING GRAPHICS****0 0 4 2****INTRODUCTION :**

1. Introduction to Engineering Drawing;
2. BIS
3. Principles of dimensioning(12)

**ORTHOGRAPHIC PROJECTION :**

1. Principles of orthographic projection-projection of points, straight lines, planes and solids
2. Orthographic projection of simple engineering components , missing view exercises
3. Drawing orthographic projections of computer components (16)

**PICTORIAL PROJECTIONS :**

1. Principles of pictorial views, isometric view of simple engineering components
2. Orthographic views from given pictorial views
3. Isometric views from given two or three views
4. Drawing isometric views of typical electronic components (16)

**SECTION OF SOLIDS & DEVELOPMENT OF SURFACES :**

1. Section of regular solids, types of sections, selection of section views
2. Sectional views of simple engineering components
3. Drawing sectional views of assemblies like electric motor, mobile phone
4. Development of lateral surfaces of regular solids and truncated solids (16)

**Total P: 60****TEXT BOOKS:**

1. Natarajan K. V "Engineering Drawing and Graphics", Dhanalakshmi Publishers., Chennai, 2007
2. Venugopal K. and Prabhu Raja V. "Engineering Graphics", New Age International Publishers., 2007

**REFERENCES:**

1. Luzadder and Duff "Fundamentals of Engineering Drawing", Prentice Hall of India Pvt. Ltd., New Delhi, 2009
2. Bureau of Indian Standards "Engineering Drawing Practices for Schools and Colleges SP 46-2003", BIS., New Delhi, 2004

**19B111 PHYSICS LABORATORY****0 0 2 1****PHYSICS LABORATORY ( ANY EIGHT) :**

1. Determination of thermal conductivity of bad conductor using Lee's Discmethod
2. Determination of fibre thickness — air wedge method
3. Measurement of vibration frequency of electrically maintained tuning fork using Melde's apparatus
4. Determination of velocity of sound — Helmholtz resonator
5. Determination of lattice constant using X-ray powder photograph
6. Study of reverse bias characteristics of Germanium diode and determination of its bandgap
7. Hall effect - Determination of Hall coefficient
8. Measurement of temperature using LM35
9. Study of characteristics of PhotoDiode
10. Phototransistor — Characteristics

**Total P: 30****REFERENCES:**

1. Department of Physics "1. Physics Practicals", PSG College of Technology., Coimbatore, 2015
2. Wilson J. D. and Hernandez C. A "Physics Laboratory Experiments", Houghton Mifflin Company., New York, 2005

**19B112 C PROGRAMMING LABORATORY****0 0 4 2**

1. Working with RAPTOR Tool — Flowchart Interpreter
2. Simple programs to understand Operators and expressions.
3. Decision making Statements :simple if, if..else, nested if .. else,elseifladder, switch case
4. Loops : while , do..while, for
5. Implementation of one dimensional array
6. Implementation of two dimensional array
7. Working with Strings
8. Functions
9. Recursive functions
10. Structures: Arrays and Structures,Nested Structures
11. Structures and functions
12. Implementation of pointer and pointer arithmetic
13. Types of pointer:const pointer, pointer to a constant, void pointer, null pointer

**Total P: 60****REFERENCES:**

1. Deitel H. M. and Deitel P. J "C: How To Program", Prentice Hall of India., New Delhi, 2015
2. Ajay Mittal "Programming in C - A Practical approach", Pearson., New Delhi, 2010
3. Gottfried B "Programming with C", McGraw Hill Education., New Delhi, 2018
4. Herbert Schildt "C: The Complete Reference", McGraw Hill., New Delhi, 2017

**19IP15 INDUCTION PROGRAMME****0 0 0 0**

As per AICTE guidelines

**SEMESTER - 2****19B201 LINEAR ALGEBRA AND TRANSFORMS****3 1 0 4**

**LINEAR EQUATIONS** : Systems of linear equations, solving a linear system, existence and uniqueness of solutions, solutions of homogeneous and non homogeneous linear systems, applications of linear systems in economics and network flow, linear independence. (9 + 3)

**EIGENVALUES AND EIGENVECTORS** : Eigenvalues and eigenvectors of a real matrix — characteristic equation, properties of eigenvalues and eigenvectors, diagonalization, quadratic forms, reduction to canonical form by

orthogonal reduction, applications of eigenvalues in population models and a predator-prey system. (9 + 3)

**Z TRANSFORMS** : Z transform, inverse transform, shifting theorem, convolution, initial and final value theorem, application of Z transform to solve difference equations. (9 + 3)

**LAPLACE TRANSFORMS** : Laplace transform, linearity, first shifting theorem, transforms of derivatives and integrals, ODEs, unit step function, second shifting theorem, Dirac's delta function, periodic functions. (9 + 3)

**FOURIER TRANSFORMS** : Fourier transform, Fourier cosine and sine transforms, discrete Fourier transform, Fast Fouriertransform—DIT algorithm. (9 + 3)

**Total L: 45 +T: 15 = 60**

**TEXT BOOKS:**

1. Erwin Kreyszig "Advanced Engineering Mathematics", John Wiley & Sons., New Delhi, 2015
2. David C. Lay "Linear Algebra and its Applications", Pearson Education, Inc., Chennai, 2016

**REFERENCES:**

1. Wylie C R and Barrett L C "Advanced Engineering Mathematics", Tata McGraw-Hill., New Delhi, 2019
2. Jain. R. K., Iyenger, S. R. K. "Advanced Engineering Mathematics", Narosa Publishing House., New Delhi, 2018
3. Alexander D. Poularikas "Transforms and Applications Primer for Engineers with Examples and MATLAB®", CRC Press., 2010
4. Howard Anton and Chris Rorres "Elementary Linear Algebra", John Wiley and Sons., New Delhi, 2018

### 19B202 APPLIED PHYSICS

**3 0 0 3**

**HEAT** : Review of thermal properties: Specific heat capacity, thermal capacity and coefficient of linear thermal expansion- Methods of measurement of thermal expansion- Thermal stresses in composite structures due to non-homogeneous thermal expansion- Applications -The bimetallic strip- Differential equation of one-dimensional heat flow- Searle's apparatus and Lee's disc apparatus for determination of thermal conductivity- Thermal Insulation- Convection and radiation- Heat dissipation and heat sinking of electronic devices. (9)

**OPTICS** : Review of image formation in lenses and mirrors- Spherical and chromatic aberration- Methods of reducing aberrations (no derivations)- aspherical components, aperture control, multiple elements- Principle of adaptive optics- Role of actuators in adaptive optics- Fresnel mirrors- principle and applications for solar energy- Tracking of Fresnel mirrors- Interference and diffraction: Principle of Fabry-Perot interferometer- Diffraction due to circular apertures- Applications- Spectral distribution: emission, transmission and absorption spectra- Examples. (5)

**THERMAL AND LIGHT SENSORS** : Bimetallic strip, Bourdon temperature gauge, Thermocouples, Resistance thermometers, thermistors, PTC thermistors, bolometer, Pyroelectric detector. Color temperature, light flux, photo sensors, photomultiplier, photo resistor and photoconductors, photodiodes, phototransistors, photovoltaic devices, fiber-optic applications, light transducer, solid-state transducers liquid crystal devices. (9)

**UV-VISIBLE AND LUMINESCENCE SPECTROMETRY** : Measurement of Transmittance and Absorbance, Beer's Law, Instrumentation and components of UV-Visible spectrometry. Applications — qualitative analysis of organic solvents. Photo Luminescence - theory of Fluorescence and Phosphorescence – Instrumentation – components of photoluminescence spectrometry – Emission and excitation spectra. Applications – Determination of organic species (9)

**FTIR AND RAMAN SPECTROMETRY** : Theory of Infrared absorption spectrometry — Quantum treatment— Instrumentation — Infrared sources and detectors. Applications — functional group of organic molecules identification. Theory of Raman spectroscopy – excitation mechanism. Instrumentation – Sources and detectors. Applications—organic material analysis.—Introduction to NMR and Mass spectrometry. (9)

**Total L: 45**

**TEXT BOOKS:**

1. Skoog D A, Holler FJ, Nieman T A "Principles of Instrumental Analysis", Harcourt College Publishers., Florida, 2017 , 7th
2. Gaur R K, Gupta S L "Engineering Physics", Dhanpat Rai and Sons., New delhi, 2013

**REFERENCES:**

1. Willard H H, Meritt L L, Dean J A, Settle F A "Instrumental Methods of Analysis", CBS Publishers and Distributions., New delhi, 2001
2. Vasantha Pattabi, Gautham N "Biophysics", Narosa Publishing House., New delhi, 2003
3. Ian R Sinclair "Sensors and Transducers", Newnes publishers., 2001
4. Raymond A Serway, John W Jewell "Physics for Scientists and Engineers", Cengage Learning., 2010

## 19B203 ORGANIC CHEMISTRY

3 0 0 3

**STEREOCHEMISTRY** : Structural and stereoisomerism - conformational isomerism. Fischer, Sawhorse and Newmann projection, Geometrical isomerism - E and Z nomenclature. Chiral carbon, optical isomerism, enantiomers and diastereomers. Asymmetric molecule - absolute and relative configuration, D-L and R-S notations, specific rotation, determination of optical activity. Chiral resolution, asymmetric synthesis. (9)

**COMMON REACTIONS AND REAGENTS** : Inductive, hyper conjugative, and resonance effects. Reactive species - carbocations, carbanions, free radicals - generations, structure and stabilities. Classification of organic reactions - nucleophilic, electrophilic addition, substitution, elimination, free radical reactions, general mechanisms, oxidation and reduction processes. Derivatization of functional groups - Alcohols, thiols, aldehydes, ketones, carboxylic acids, esters, amines and amides. (9)

**ROLE OF METAL IONS IN BIOMOLECULES** : Role of iron, calcium, magnesium, manganese, cobalt, zinc and molybdenum in biology. Oxygen transport, electron-transport and enzymatic functions. (9)

**CHEMICAL SYNTHESIS OF BIOLOGICAL MOLECULES** : Amino acids - properties and reactions, peptide synthesis, reagents for protection and de-protection, end group analysis, solid phase synthesis - oligonucleotide synthesis. (9)

**SPECTRAL ANALYSES OF ORGANIC COMPOUNDS** : Ultraviolet-visible spectrophotometry - Beer-Lambert law, applications. Infrared spectrophotometry-selection rules, finger print regions, common functional group frequencies. Nuclear magnetic resonance spectroscopy - chemical shifts, spin-spin splitting pattern in small molecules. Mass spectrometry - base peaks, fragmentations types. (9)

**Total L: 45**

### TEXT BOOKS:

1. Morrison R. T and Boyd R. N "Organic Chemistry", Pearson Education., Singapore, 2012 , 7th ed
2. Bahl B.S and ArunBahl "A Textbook of Organic Chemistry", S. Chand., New Delhi, 2016 , 22nd ed

### REFERENCES:

1. Chatwal G. R "Organic Chemistry of Natural products, Vol. I & II", Himalaya Publishing House., New Delhi, 2011 , 1st ed
2. Finar I. L "Organic Chemistry, Vol I & II.", Pearson., New Delhi, 2009 , 7th ed
3. Kemp W "Organic Spectroscopy", Palgrave., New York, 2002 , 3rd ed

## 19B204 PROCESS CALCULATIONS

2 1 0 3

**UNITS AND DIMENSIONS** : Systems of Units- SI, CGS, FPS, Conversion between different metric systems. - Dimensional homogeneity, Dimensionless numbers and application. (4 + 2)

**STOICHIOMETRY** : Stoichiometry principles: composition relations, density, specific gravity and basis of calculation (5 + 2)

**FLOW DIAGRAMS** : Symbols, P&I diagrams. - Process flow sheets for different processes: Organic acid production, Enzyme production processes. (3 + 1)

**MATERIAL BALANCE** : Material Balance without Chemical Reaction - Material Balance with Chemical Reaction, Limiting and excess reactants - Material balance for Single and Multiple Reactions (9 + 5)

**ENERGY BALANCE** : Steady state concept, Concept of latent heat, internal energy, enthalpy. - Energy balance for systems with and without chemical reaction: Distillation, Extraction, Metabolic reactions. (9 + 5)

**Total L: 30 +T: 15 = 45**

### TEXT BOOKS:

1. B I Bhatt, S B Thakore "Stoichiometry", Tata McGraw Hill., New Delhi, 2010 , 5th
2. David M Himmelblau, James B Riggs "Basic Principles and Calculations in Chemical Engineering", Prentice Hall of India Ltd., New Delhi, 2012 , 8th

### REFERENCES:

1. Richard M Felder, Ronald W Rousseau "Elementary Principles of Chemical Processes", Wiley., New Delhi, 2008 , 3rd
2. Warren L McCabe, Julian C Smith, Peter Harriot "Unit Operations of Chemical Engineering", McGraw Hill., New Delhi, 2017, 7th

## 19B210 CHEMICAL ENGINEERING LABORATORY

0 0 4 2

### CHEMICAL ENGINEERING LABORATORY :

1. Flow measurement through pipes: Venturimeter, orificemeter and rotameter
2. Determination of power requirement for the operation of different equipment
3. Material/Mass balance for various processes: Filtration, Solvent extraction, Bio-transformation reactions

4. Mass and energy balance analysis for different unit operations: a. Simple Distillation b. Tray Drying c. Trans-esterification process d. Soxhlet extraction
5. Process flow sheet preparation for different processes using online software

**Total P: 60**

### **19B211 CHEMISTRY LABORATORY**

**0 0 2 1**

#### **CHEMISTRY (ANY EIGHT EXPERIMENTS) :**

1. Determination of the Fe<sup>2+</sup> by potentiometry
2. Estimation of Fe<sup>3+</sup> by photocolourimetry.
3. Determination of isoelectric point of an amino acid by pH metry
4. Estimation of acids in a mixture by conductometry.
5. Determination of rate constant of acid hydrolysis of ester.
6. Determination of total, temporary, and permanent, hardness of water by EDTA method.
7. Estimation of amino acid by formal titration method
8. Determination of saponification and iodine value of lipids.
9. Determination of distribution coefficient (I<sub>2</sub> in water / CCl<sub>4</sub> system) and equilibrium constant (I<sub>2</sub>, KI and KI<sub>3</sub>)
10. Adsorption of oxalic acid on carbon — verification of Freundlich adsorption isotherm.

**Total P: 30**

#### **REFERENCES:**

1. Department of Chemistry "Chemistry Laboratory Manual", ., 2019

### **19B212 PYTHON PROGRAMMING LABORATORY**

**0 0 4 2**

#### **PROBLEM SOLVING RELATED TO THE FOLLOWING TOPICS: :**

1. Programs related to integers, float, complex, Boolean data types in the shell
2. Input/output and conditional statements in scripts
3. Different operator and conversion functions
4. Loops : for and while
5. String datatype: Creation, Operations, Methods
6. Tuple data type: Creation, Operations, Methods
7. Set and frozenset datatypes: Creation, Operations, Methods
8. Dictionary datatype: Creation, Operations, Methods
9. Functions: definitions , parameter passing, returning data types
10. Lambda and recursive functions
11. Creating modules and packages
12. Handling exceptions
13. File handling

**Total P: 60**

#### **REFERENCES:**

1. Mark Summerfield "Programming in Python 3: A Complete introduction to the Python Language", Addison- Wesley Professional., 2009
2. Reema Thareja "Python Programming : Using Problem Solving Approach", Oxford university Press., 2017
3. Paul Barry "Head First Python: A Brain-Friendly Guide", O'Reilly Media., 2016

### **19B213 INTERNSHIP**

**0 0 0 2**

Training in Good Laboratory practices: Laboratory Discipline & Procedures, Material handling and lab safety, Lab waste disposal, SoP for Lab Equipments  
Field Visit: Visit to biotech related industries and research institutions, Report preparation: Preparation of comprehensive report by the students

### **SEMESTER - 3**

### **19B301 NUMERICAL METHODS**

**2 1 0 3**

**SYSTEM OF LINEAR EQUATIONS, EIGENVALUES AND EIGENVECTORS :** Errors - approximations and round-off errors - truncation errors. system of linear equations, Gauss elimination method, Crout's method, Gauss - Seidel method, eigenvalues and eigenvectors - power method. (6 + 3)

**NONLINEAR EQUATIONS** : False- position method, Newton-Raphson method, Graeffe's root squaring method. (6 + 3)

**INTERPOLATION AND CURVE FITTING** : Newton's forward and backward interpolating polynomials, Newton's divided-difference interpolating polynomials, Lagrange interpolating polynomials. Straight line fitting using least squares method. (6 + 3)

**DIFFERENTIATION AND INTEGRATION** : Numerical differentiation - equally spaced and unequally spaced data. Numerical integration - Newton-Cotes formulae, Trapezoidal rule, Simpson's 1/3 rule. Gaussian quadratures. (6 + 3)

**NUMERICAL SOLUTION TO ORDINARY DIFFERENTIAL EQUATIONS** : Taylor-series method, Euler method, modified Euler method, 4th order Runge-Kutta method, multi-step method — Milne's method. (6 + 3)

**Total L: 30 +T: 15 = 45**

**TEXT BOOKS:**

1. Steven C Chapra and Raymond P Canale , "Numerical Methods for Engineers", Tata McGraw Hill, New Delhi, 2017.
2. Curtis F Gerald and Patrick O Wheatly , "Applied Numerical Analysis", Pearson, New Delhi, 2017.

**REFERENCES:**

1. Richard L Burden and Douglas J Faires , "Numerical Analysis", Thomas Learning, New York, 2017.
2. G. Miller , "Numerical Analysis for Engineers and Scientists", Cambridge University Press, UK, 2014.
3. Amos Gilat and Vish Subramaniam , "Numerical Methods for Engineers and Scientists", Wiley India, New Delhi, 2014.
4. Uri M Ascher and Chen Greif , "A first course in numerical methods", Prentice Hall, New Delhi, 2013.

## **19B302 BIOCHEMISTRY**

**4 0 0 4**

**STRUCTURE AND FUNCTIONS OF CARBOHYDRATES AND PROTEINS** : Monosaccharides - mutarotation, reactions of monosaccharides; glycosidic bond- di, oligo & polysaccharides- Starch, glycogen, cellulose and chitin; peptidoglycans, glucosaminoglycans, Proteoglycans Proteins- Amino Acids, Peptides, Proteins, measurement, structures, hierarchy of organization- primary, secondary, tertiary and quaternary structures, glycoproteins, lipoproteins. (13)

**STRUCTURE AND FUNCTIONS OF LIPIDS AND NUCLEIC ACIDS** : Lipids: fatty acids, triacyl glycerol, phospholipids, glycolipids, sphingolipids, cholesterol, steroids, prostaglandins. Biological membranes — structure, action potential and transport process. Nucleic acids: purines, pyrimidines, nucleoside, nucleotide, RNA, DNA- structure, properties and measurements, Vitamins- coenzymic functions of water soluble vitamins (13)

**CONCEPTS OF METABOLISM AND CARBOHYDRATE METABOLISM** : Enzymes as biocatalysts, primary and secondary metabolites. Inter connection of pathways and metabolic regulation. Carbohydrate metabolism - Glycolysis, TCA cycle, gluconeogenesis, pentose phosphate shunt & glyoxalate shunt, Bioenergetics - High energy compounds, electronegative potential of compounds, respiratory chain, Photosynthesis, ATP cycle (13)

**METABOLISM OF LIPIDS AND NUCLEIC ACIDS** : Fatty acid synthesis and oxidation, TAG and phospholipid metabolism, Metabolism of nucleic acids — degradation of nucleic acids, salvage and denovo synthesis of purines and pyrimidines and their regulation (11)

**METABOLISM OF PROTEINS** : Amino acids - deamination, transamination and decarboxylation, urea cycle, Inborn errors of amino acid metabolism with an example of aromatic amino acids, amino acid biosynthesis - overview with an example of branched chain amino acids (10)

**Total L: 60**

**TEXT BOOKS:**

1. Nelson D. L. and Cox M. M. , ""Lehninger's Principles of Biochemistry"" , 7th Edition, Freeman W.H & Company, New York, 2017.
2. McKee T. and McKee J. R. , ""Biochemistry- The Molecular Basis of Life"" , 6th Edition, Oxford University, London, 2016.

**REFERENCES:**

1. Berg J. M., Tymoczko J. L. Gatto G and Lubert Stryer , "Biochemistry", 9th Edition, W H Freeman and Company, New York, 2018.
2. Voet D., Voet J. G. and Pratt C. W. , "Fundamentals of Biochemistry- Life at the Molecular level"" , 5th Edition, John Wiley & Sons, New Jersey, 2016.
3. Rodwell V.W, Bender D. A, Botham K.M, Kennelly P.J. and Anthony Weil. P , ""Harper's Illustrated Biochemistry"" , 31th Edition, WCB/McGraw-Hill publishers, Iowa, 2018.

## **19B303 CELL BIOLOGY**

**3 0 0 3**

**CELLULAR ORGANIZATION** : Sub cellular structures - chromatin organization - biogenesis of nucleus - mitochondria and chloroplast - cytoskeleton - endoplasmic reticulum - golgi body - ribosomes -lysosomes; cell junctions; extracellular matrix; cell movement. (10)

**TECHNIQUES TO STUDY CELLS** : Cell fractionation, microscopy, flow cytometry, Immunostaining. animal cell culture basics: Cell lines - types, growth requirements, freezing, thawing and basic cell staining protocols. (5)

**CELL CYCLE AND REGULATION** : Mitosis - meiosis - cell cycle regulation - checkpoints - mitosis promoting factors - cyclins



and cyclin dependent kinases (10)

**MEMBRANE ARCHITECTURE AND FUNCTION** : Membrane synthesis; Membrane proteins - pumps - channels transporters and receptors; types of membrane transport; Osmosis and cell volume; Endocytosis -Exocytosis; Intracellular Compartments; protein Trafficking and secretion (10)

**INTERCELLULAR INTERACTION** : Cell signaling- autocrine - paracrine - juxtacrine - endocrine and synaptic signaling; Types of cell membrane receptors - GPCR - RTKs and voltage gated ion channel receptors; Signal transduction - Cellular response mechanisms to primary messengers; secondary signaling molecules - adenylatecyclase - calcium flux - phospholipases - protein kinases (10)

**Total L: 45**

**TEXT BOOKS:**

1. Lodish, Harvey , "Molecular Cell Biology", 6th Edition, W.H.Freeman, US, 2008.
2. Alberts, Bruce , "Essential Cell Biology", 2nd Edition, Garland science, Oxford, 2004.

**REFERENCES:**

1. Cooper , "The Cell: A Molecular Approach", 4th Edition, ASM Press, US, 2007.

### 19B304 GENERAL MICROBIOLOGY

**3 0 0 3**

**HISTORY AND BACKGROUND** : History. Microscopy- Light - dark field - phase contrast - Fluorescence and Electron Microscopes. Stains- Simple - Differential and Special stains. (6)

**MICROBIAL DIVERSITY** : Taxonomy and classification systems - Structure and functions of cellular components of bacteria. fungi - algae and virus. (8)

**MICROBIAL GROWTH** : Factors affecting growth. Types of Culture Media. Growth Curve - Methods of enumeration of microorganisms. Preservation techniques. (8)

**MICROBIAL CONTROL** : Sterilization and Disinfectants. Antimicrobial Chemotherapy- Antibiotics - Source and mode of action. (8)

**MICROBIAL METABOLISM** : Nutritional types ,Bacterial metabolism- Respiration, anaerobic respiration – fermentation and bacterial photosynthesis. - Role of microbes in nitrogen, phosphorus and sulfur cycle. - Bioleaching, Bioremediation (15)

**Total L: 45**

**TEXT BOOKS:**

1. Pelczar Jr M J., Chan, ECS., , Krieg R. , " Microbiology", New York, 2008.
2. Joanne M. Willey, Kathleen M. Sandman, Dorothy H. Wood , "Prescott's Microbiology", 11th Edition, MCGRAW- HILL, INC, New York, 2019.

**REFERENCES:**

1. Prescott, L.M., Harley JP , Klein DA. , "Microbiology", McGraw Hill , 2005.
2. Jefferey C pommerville , "Alcamos Fundamentals of Microbiology", 10th Edition, Jones and Bartlett, Burlington, 2014.

### 19B305 FLUID MECHANICS AND HEAT TRANSFER

**3 1 0 4**

**FLUID PROPERTIES AND FLUID STATICS** : Properties of fluids, fluid statics, concept of shear stress, Newton's law of viscosity , Fluid behavior under shear, Newtonian and Non-Newtonian fluids, Types of flow–laminar, turbulent, Steady, unsteady, non uniform and uniform flows, Compressible and incompressible fluids (9 + 3)

**FLUID DYNAMICS:** : Continuity equation, Bernoulli's equation, boundary layer condition, form drag, skin drag, drag coefficient— laminar and turbulent flow through closed conduit velocity profiles, pipes, tubes, fittings, valves, friction factor for smooth and rough pipes, head losses due to friction in pipes and fittings (10 + 4)

**FLUID FLOW MEASUREMENT AND FLOW THROUGH SOLIDS** : Orifice meter, Venturimeter, Pitot tube, Rotameter, pressure measurement by manometers,Flow through packed beds and fluidised beds; Ergun equation, Kozeny- Carman equation, Burke-Plummer equation and its applications, Types of fluidisation, Minimum fluidization velocity determination, Classification of pumps. (9 + 3)

**MIXING AND AGITATION** : Types of agitators, Mechanism of mixing, Cavity formation and types of cavity formation in impeller, flow patterns and power consumption in agitated vessels for gassed and ungassed system (8 + 2)

**HEAT TRANSFER:** Basics of conductive, convective and radiation heat transfer, Application of heat exchangers in process industries (9 + 3)

Total L: 45 +T: 15 = 60

**TEXT BOOKS:**

1. Warren McCabe, Julian Smith, Peter Harriott, "Unit Operations of Chemical Engineering", 7th Edition, McGraw- Hill company, 2017.
2. Geankoplis C.J, A. Allen Hersel, Daniel H. Lepek, "Transport Processes and Separation Process Principles", 5th Edition, Prentice Hall, International Series, 2018.

**REFERENCES:**

1. J.M. Coulson and J. F. Richardson J. R. Backhurst and J.H.Harker, "Chemical Engineering, Fluid Flow, Heat Transfer and Mass Transfer", 6th Edition, Butterworth Heinemann, 1999.
2. Frank M. White, "Fluid Mechanics", 6th Edition, Tata McGraw-Hill, NewDelhi, 2008.

**19B310 BIOCHEMISTRY LABORATORY**

**0 0 4 2**

**IDENTIFICATION, QUANTIFICATION AND CHARACTERIZATION OF BIOLOGICAL COMPOUNDS:**

1. Qualitative analysis of carbohydrates
2. Extraction and estimation of reducing sugar by Dinitrosalicylate acid (DNS) method
3. Extraction and estimation of starch by anthrone method
4. Qualitative analysis of aminoacids
5. Total protein extraction by kjeldahl method
6. Extraction and estimation of proteins by Lowry's method
7. Extraction and analyses of lipids by titrimetry
8. Estimation and purity analysis of nucleic acid by UV-VIS spectrometer
9. Elemental analysis using flame photometry

**Total P: 60**

**TEXT BOOKS:**

1. B. Sashidhar Rao and Vijay M. Deshpande , "Experimental Biochemistry: A student companion", , 2007.

**REFERENCES:**

1. David T Plummer , "An Introduction to Practical Biochemistry", Tata McGraw Hill Education Pvt. Ltd., 2009.

**19B311 MICROBIAL AND CELL BIOLOGY LABORATORY**

**0 0 4 2**

1. Sterilization Techniques; Preparation of Culture Media
2. Culturing of Microorganism-Streak & spread plate
3. Isolation and preservation of bacterial Culture
4. Identification of Micro organisms- Staining, Motility, Biochemical Methods.
5. Microbial enumeration
6. Cell Cycle Experiments

**Total P: 60**

**REFERENCES:**

1. James G Cappuccino and Natalie Sherman , "Microbiology - A Laboratory Manual", 6<sup>th</sup> Edition, Pearson, India, 2005.

**19K312 ENVIRONMENTAL SCIENCE**

**2 0 0 0**

**INTRODUCTION TO ENVIRONMENT :** Environment - Definition, scope and importance. Types and composition of atmospheres - particles, ions and radicals. Ozonolayer- significance, formation and depletion. Ecosystems- Structure and functions, components, energy flow, food chains, food web, Biodiversity-levels, values and threats - India as a mega-diversity nation - hotspots of biodiversity - endangered and endemic species of India - conservation of biodiversity. (6)

**ENERGY RESOURCES :** Introduction -National and International status- exploitation - sustainable strategies - Fossil fuels- classification, composition, physico-chemical characteristics and energy content of coal, petroleum and natural gas; solar energy - introduction, harnessing strategies. Wind energy - availability, wind power plants, wind energy conversion systems, site characteristics, and types of wind turbines. Supporting renewable energy resources - tidal -geothermal - hydroelectric. (6)

**ENVIRONMENTAL POLLUTION :** Definition -Sources, causes, impacts and control measures of (a) Air pollution (b) Water pollution (c) Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards (h) RF hazards - Role of an individual in prevention of pollution. **DISASTER MANAGEMENT:** Floods, earthquake, cyclone and landslides - Case studies, consequences and rescue measures (6)

**WASTE MANAGEMENT :** Wastewater - Characteristics of domestic and industrial wastewater - COD and BOD -Various stages of treatment - primary, secondary, tertiary treatment- Biological and advanced oxidation processes. Solid waste

management – Characteristics of municipal solid waste(MSW), biomedical, automobile and e-wastes and their management -landfills, incineration, pyrolysis, gasification and composting. (6)

**SOCIAL ISSUES AND THE ENVIRONMENT** : Environmentally Sustainable work practices- Rain water harvesting – Role of non-governmental organizations. Human ethics and rights- impact on environment and human health – role of information technology on environment and human kind. Green IT policies Process of EIA - ISO 14000. Legislation- Environment protection act – Air (Prevention and Control of Pollution) act – Water (Prevention and control of Pollution) act–Wildlife protection act–Forest conservation act. (6)

**Total L: 30**

**TEXT BOOKS:**

1. Gilbert M. Masters, "Introduction to Environmental Engineering and Science", Pearson Education, New Delhi, 2004.
2. De A K, "Environmental Chemistry", New Age International P Ltd, New Delhi, 2006.

**REFERENCES:**

1. Benny Joseph, "Environmental Science and Engineering", Tata McGraw-Hill, New Delhi, 2006.
2. Koteswara Rao MVR, "Energy Resources: Conventional & Non-Conventional", BSP Publications, New Delhi, 2006.
3. Deswal S and Deswal A, "A Basic Course in Environmental Studies", Dhanpat Rai and Co, New Delhi, 2004.

### **190306 ECONOMICS FOR ENGINEERS**

**3 0 0 3**

**INTRODUCTION** : Definition – Nature and Scope – Central Problems of an Economy – Positive and Normative Economics - Micro Economics and Macro Economics, Significance of Economics, Economic Assumptions. (9)

**THEORY OF CONSUMER BEHAVIOR** : Utility – Indifference Curve Analysis - Properties, Consumer's Budget Line - Demand Analysis: Demand Function and Law of Demand, Elasticity of Demand. Demand forecasting using Econometric Techniques. Supply – Factors Affecting Supply, Market Equilibrium Price, Consumer Surplus. (9)

**PRODUCTION, COST AND REVENUE** : Production Function, Total Product, Average Product and Marginal Product, Returns to Scale. Costs, Nature of Costs, Short-run and Long-run Cost Curves, Revenue concepts. (9)

**MARKET STRUCTURE** : Types of Markets - Perfect Competition – Characteristics – Imperfect Competition: Monopoly - Monopolistic Competition - Oligopoly and Duopoly - Price Discrimination and Product Differentiation under Different Markets – Price and Output Determination in Short run and Long run and profit maximization. (9)

**PERFORMANCE OF AN ECONOMY (MACRO ECONOMICS)** : Demand and Supply of Money - Quantity Theory of Money, Banking – Functions of Commercial Banks and Central Bank – Inflation – Causes – Control Measures – National Income – Concepts – Methods of Calculating National Income – Problems in Calculating National Income. (9)

**Total L: 45**

**TEXT BOOKS:**

1. Varian H.R., "Intermediate Microeconomics", East– West Press, New Delhi, 2014.
2. Dewett. K.K, Navalur. M.H., "Modern Economic Theory", S. Chand, New Delhi, 2015.

**REFERENCES:**

1. William A, McEachern, Simrit Kaur, "Micro ECON", Cengage Learning, Noida, 2013.
2. William A, McEachern, Indira A., "Macro ECON", Cengage Learning, Noida, 2014.
3. Deepashree, "Principles of Economics", Ane Books Pvt Ltd, New Delhi, 2010.
4. Dwivedi, "Essentials of Business Economics", Vikas Publishing House Pvt Ltd, New Delhi, 2010.

### **SEMESTER – 4**

#### **19B401 BIostatistics**

**2 1 0 3**

**DESCRIPTIVE STATISTICS AND BASICS OF PROBABILITY** : Measure of location, measure of spread, coefficient of variation, grouped data, graphic methods, Probability - definition of probability, multiplication law, addition law, conditional probability, Baye's rule and screening tests. (6 + 3)

**PROBABILITY DISTRIBUTIONS** : Discrete probability distribution - Random variables, probability mass function, expected value, variance, cumulative distribution function, binomial and Poisson distributions, continuous probability distribution - Probability density function, and normal distribution. (6 + 3)

**ESTIMATION AND HYPOTHESIS TESTING-ONE SAMPLE INFERENCE** : Relationship between population and sample, sampling distribution, point and interval estimation of mean and variance, one-sample inference- general concepts, test for mean of a normal distribution - one sided and two sided alternatives, one sample chi-square test for variance of a normal distribution. (6 + 3)

**HYPOTHESIS TESTING-TWO-SAMPLE INFERENCE** : The paired t- test, testing for equality of two variances, t-test for two independent samples for mean with equal and unequal variances, categorical data - R x C contingency table, Chi-square goodness of fit. (6 + 3)

**REGRESSION METHODS AND ANOVA** : General concepts, fitting regression lines - method of least squares, inferences about parameters from regression lines, goodness of fit of regression lines, analysis of variance-One way ANOVA-fixed effects model, random effect model. (6 + 3)

**Total L: 30 +T: 15 = 45**

**TEXT BOOKS:**

1. Bernard Rosner , "Fundamental of Biostatistics", Duxbury Thomson Learning, New York, 2015.
2. Ronald N Forthofer and Eun Sul Lee , "Introduction to Biostatistics – A Guide to Design, Analysis and Discovery", Academic Press, New York, 2016.

**REFERENCES:**

1. Vee Bala and Rastogi , "Biostatistics", Scientific International, New Delhi, 2017.
2. Wayne W Daniel and Chad L Cross , "Biostatistics: Basic concepts and methodology for Health Sciences", Wiley, USA, 2017.
3. Sundar Rao PSS and Richard J , "An introduction to Biostatistics- A model for students in health sciences", Prentice Hall, New Delhi, 2012.
4. Manju Pandey , "Biostatistics, Basics and Advances", MyLearning, London, 2015.

## 19B402 CHEMICAL AND BIOCHEMICAL THERMODYNAMICS

**2 1 0 3**

**BASIC CONCEPTS:** Concepts of system, surrounding, boundary, process, equilibrium and energy. - Laws of Thermodynamics. Hess's law. - Concept of Entropy, Spontaneity and Irreversibility. - Thermodynamic properties of ideal fluids. Equation of state: Ideal and real fluids (Ideal law, VDW, RK, RKS equations). - Refrigeration cycles and Calorimeter. (8 + 4)

**PROPERTIES OF SOLUTION:** Ideal and non-ideal solutions,- Thermodynamic properties of solutions – Gibbs energy, Chemical potential, activity and activity coefficient. - Partial molar properties, Gibbs-Duhem equation. (4 + 2)

**CHEMICAL REACTION EQUILIBRIA** : Criteria for equilibrium, equilibrium constants; Effect of temperature and pressure, evaluation of equilibrium constants. - Equilibrium conversion – single and multiple reactions. (6 + 3)

**BIOCHEMICAL THERMODYNAMICS:** Thermodynamics of open system – biological system. - Thermodynamics of affinity based process: Ligand-substrate binding, Hemoglobin and oxygen binding, Affinity chromatography Gibbs Donnan equilibrium: Membrane transport, Osmosis and electrostatic potential. (5 + 2)

**BIOLOGICAL THERMODYNAMICS:** Energy coupling reactions: Thermodynamics and feasibility. Thermodynamic analysis of metabolic pathways: Glucose metabolism, Photosynthesis. - Thermodynamics of Protein folding and unfolding: Gibbs energy, entropy and melting temperature. - Thermodynamic analysis of fermentation process: Degree of reduction, Feasibility analysis of process. (7 + 4)

**Total L: 30 +T: 15 = 45**

**TEXT BOOKS:**

1. Smith JM, Van Ness HC, Abbott MM , "Introduction to chemical Engineering Thermodynamics", 7<sup>th</sup> Edition, Tata McGraw Hill, New Delhi, 2009.
2. Stanley I Sandler, "Chemical Biochemical and Engineering Thermodynamics", 4<sup>th</sup> Edition, Wiley, New Delhi, 2006.

**REFERENCES:**

1. Donald T Haynie , "Biological Thermodynamics", 2<sup>nd</sup> Edition, Cambridge University press, 2013.
2. Robert T Balmer , "Modern Engineering Thermodynamics", 1<sup>st</sup> Edition, Academic Press, 2011.

## 19B403 INDUSTRIAL BIOTECHNOLOGY

**3 0 0 3**

**INTRODUCTION TO INDUSTRIAL BIOTECHNOLOGY:** Overview of Industrial fermentation process, Classification of Bioproducts, Microbes and enzymes of industrial importance, Development of Industrial strain, Characteristics of fermentation media. (8)

**BIOREACTOR INSTRUMENTATION, MODES OF CULTIVATION AND RECOVERY:** Basic configuration of a bioreactor, Reactor classification and their mode of operation, Sterilization of air (Filtration), Medium sterilization. Reaction kinetics, Microbial growth, Substrate utilization, Product formation kinetics. Steps in product recovery – Solid liquid separation, Liquid - liquid separation, Chromatography (Ion exchange , Affinity) (10)

**PRODUCTION OF PRIMARY METABOLITES** : Industrial production of organic acids (Citric acid, Lactic acid, acetic acid ) . Bioenergy ( Ethanol fermentation, Biobutanol) , Amino acids (Glutamic acid, Aspartic acid) (8)

**PRODUCTION OF SECONDARY METABOLITES, ENZYMES AND OTHER BIOPRODUCTS** : Antibiotic fermentation (Penicillin, Streptomycin), Steroid biotransformation. Enzymes (Amylase, Protease), High fructose corn syrups, Biopolymer (Xanthum gum), Biopreservative (Nisin). (10)

**BIOTECHNOLOGICAL PRODUCTS FOR AGRICULTURE AND HEALTH CARE** : Basic overview and significance of tissue culture

for industrial crops, Biopesticide (*Bacillus thuringiensis*), recombinant proteins, Insulin, erythropoietin, Monoclonal antibodies. (9)

**Total L: 45**

**TEXT BOOKS:**

1. Cruegar W , Cruegar A , "Biotechnology: A text book of Industrial Microbiology", Panima Publications, 2005.
2. Ratledge C, Kristiansen B , "Basic Biotechnology", 3<sup>rd</sup> Edition, , Cambridge University Press, Cambridge, 2008.

**REFERENCES:**

1. Glazer A.N, Nikadio H , "Microbial Biotechnology : Fundamentals of applied microbiology", Cambridge University Press, New York, 2008.
2. Shuler.M, Kargi. F , "Principles of Bioprocess Engineering", Prentice Hall, New Delhi, 2013.

## **19B404 MOLECULAR BIOLOGY**

**3 0 0 3**

**GENETIC MATERIAL** : Evidence of DNA as genetic material - Physical structure - Nucleosomes - Forms of DNA - Gene structure. (7)

**DNA REPLICATION** : Replication mechanism and machinery - plasmid and phage replication. (10)

**TRANSCRIPTION** : In Prokaryotes and Eukaryotes - Inhibitors of Transcription - Processing of mRNA - rRNA and tRNA - splicing and post transcriptional modification - miRNA - siRNA - ncRNA. (9)

**TRANSLATION** : Genetic code - Initiation - elongation and termination - Inhibitors of translation - Post translational modification - targeting. (9)

**REGULATION OF GENE EXPRESSION** : Negative control (Lac operon) - Positive control (arabinose operon) - attenuation - Recombination and repair - Transposable elements - mutation - oncogene - Epigenetics. (10)

**Total L: 45**

**TEXT BOOKS:**

1. Jocelyn E Krebs Elliotts S Goldstein Stephen T Kilpatrick , "Lewin's Genes XII", Jones & Bartlett, Burlington, 2018.
2. George M Malacinski , "Freifelder's Essentials of Molecular Biology", 4<sup>th</sup> Edition, Narosa Book Distributors (P) Ltd, New Delhi, 2006.

**REFERENCES:**

1. Lodish H, Berk A, Zipursky L, Matsudaria P, Baltimore D , Damell J , "Molecular Cell Biology", WH Freeman & Co, 2000.

## **19B405 ANALYTICAL METHODS AND INSTRUMENTATION**

**3 0 0 3**

**SPECTROSCOPY AND SPECTROMETRY** : Concepts of chromophores, auxochromes, energy bands; Working Principle, Instrumentation and Applications- Absorption and Emission Spectroscopy, UV-Visible, Infrared, Raman, NMR; Mass Spectrometry - Single and Double Focusing, ToF - (10)

**IMAGING** : Working Principle, Instrumentation and Applications- Confocal Laser Scanning Microscopy, Scanning electron Microscopy, Transmission Electron Microscopy, Atomic Force Microscopy, Fluorescence Microscopy (8)

**CHROMATOGRAPHY** : Classification of chromatographic methods, Concepts- Partition Ratio, Theoretical Plate Number, Plate Height, Resolution, Selectivity Ratio, Retention Behaviour, Van Deemter Parameters, Band Broadening; Working Principle, Instrumentation and Applications - Ion Exchange, Size Exclusion, Adsorption, Reverse Phase, Affinity, HPLC, TLC, Gas Chromatography (10)

**CENTRIFUGATION** : Concepts - Centrifugal Field, Density Gradient Centrifugation, Differential Centrifugation, Types of Centrifuges, Types of Rotors, Analytical Centrifugation - Principal, Instrumentation, molecular weight determination, subcellular fractionation, decantation (8)

**ELECTROPHORESIS AND ELECTROCHEMISTRY** : Concept and Application - Agarose, SDS and Native PAGE, Isoelectric Focusing, Isotachopheresis, Pulsed Field Gel Electrophoresis, Capillary Electrophoresis; Case studies on qualitative detection of analytes in human serum, Electrochemical Cells, Ion Selective Electrodes, Patch Clamp Techniques (9)

**Total L: 45**

**TEXT BOOKS:**

1. Wilson and Walker , "Principle and Techniques of Practical Biochemistry", Cambridge University Press, Oxford, 2000.
2. Sherley Benson , "Handbook of Analytical Science and Instrumentation: Volume I: 1", 2<sup>nd</sup> Edition, NY Research Press, NY, 2015.

**REFERENCES:**

1. Willar HH, Merritt LL, Dean JA, Settle FA, "Instrumental Methods of Analysis", CBS Publishers, 2004.
2. Skoog DA, Holler FJ, Nieman TA, "Principles of Instrumental Analysis", Barace College Publishing, 2006.

### 19B406 MASS TRANSFER OPERATIONS

3 1 0 4

**INTRODUCTION TO MASS TRANSFER AND DIFFUSION** : Ficks law, Molecular and eddy diffusion, Theories of mass transfer, Diffusion in gaseous mixtures, liquid mixtures and solids, Pseudo steady state diffusion, measurement and calculation of diffusivities, Individual and overall mass transfer coefficient (8 + 3)

**ADSORPTION** : Types and choice of adsorbents, nature of adsorbents, Adsorption isotherm, Mechanism of adsorption, Operation of adsorption columns-Cross current and counter current operations, stage determination, Batch and continuous operations, Performance characteristics of fixed bed adsorbers, Concept of breakthrough curve, Industrial application of adsorption process (9 + 3)

**ABSORPTION** : Principles of gas absorption; Single and Multi component absorption; Absorption with chemical reaction; Design principles of absorbers; Industrial absorption equipments; HTU, NTU concepts (9 + 3)

**DISTILLATION** : Basic concepts of distillation- principle, theory, vapor liquid equilibria calculations, Methods of distillation- simple, flash, steam, azeotropic, extractive, molecular distillation, Design of single stage flash and simple distillation, Stage wise and continuous differential contact operations, Design calculations using McCabe thiele method. (10 + 4)

**EXTRACTION AND LEACHING** : Liquid liquid extraction- Liquid liquid equilibria for different systems, Effect of pressure and temperature on LLE, Solubility criteria, Solvent selection, Liquid liquid extraction equipment. Leaching (Solid-liquid extraction)- Theory, mechanism, equipments and applications (9 + 2)

**Total L: 45 +T: 15 = 60**

#### TEXT BOOKS:

1. R. E. Treybal, "Mass Transfer Operations", 3<sup>rd</sup> Edition, McGraw Hill, New York, 2012.
2. N. Anantharaman, K.M Meera Sheriffa Begum, "Mass Transfer: Theory and practice", 1<sup>st</sup> Edition, Prentice Hall of India, India, 2011.

#### REFERENCES:

1. Warren McCabe, McCabe Julian Smith, Peter Harriott, "Unit Operations of Chemical Engineering", 7<sup>th</sup> Edition, McGraw-Hill Company, 2017.
2. B K Dutta, "Principles of Mass transfer and Separation Processes", 1<sup>st</sup> Edition, Prentice-Hall of India, NewDelhi, 2007.

### 19B410 MOLECULAR BIOLOGY LABORATORY

0 0 4 2

1. DNA Extraction from plant and animal cells.
2. Isolation of Bacterial plasmid and genomic DNA
3. Agarose gel electrophoresis for quality and quantity assessment
4. DNA quantification by UV spectroscopy
5. RNA extraction and denaturing gel electrophoresis
6. Protein isolation and SDS PAGE analysis
7. Protein detection by silver staining and Coomassie staining

**Total P: 60**

#### REFERENCES:

1. Joseph Sambrook, David W Russel, "Molecular Cloning: A Laboratory Manual Vol -1,2,3", 3rd Edition, Cold Spring Harbor Laboratory Press, New York, 2001.

### 19B411 ANALYTICAL METHODS AND INSTRUMENTATION LABORATORY

0 0 4 2

#### FLAME PHOTOMETER :

1. Equipment calibration and Elemental Analysis
2. Sample Analyses and Interpretation

#### UV-VIS SPECTROPHOTOMETRY :

1. Verification of Beer's Law for Quantitative Analyses
2. Wavelength Scanning and Chromogenic Shift Analyses

#### ELECTROPHORESIS :

1. Molecular Weight Determination using Native PAGE, Isozyme Analyses

#### CHROMATOGRAPHY :

1. TLC, Paper Chromatograph

#### POTENTIOMETRIC MEASUREMENT OF AMINO ACID TITRATION :

**POLAROGRAPHY :**

1. Dissolved oxygen measurement

**Total P: 60****TEXT BOOKS:**

1. Wilson Walker , "Principles and techniques of Molecular Biology and Biochemistry", Cambridge University Press, 2010.

**19O412 INDIAN CONSTITUTION****2 0 0 0****INTRODUCTION :** Evolution of Indian Constitution; Significance of Constitution; Composition; Preamble and its Philosophy. (4)**RIGHTS, DUTIES AND DIRECTIVE PRINCIPLES :** Fundamental Rights- Writs and Duties, Directive Principles of State Policy. (6)**COMPOSITION OF PARLIAMENT AND FEDERALISM :** Union Government, President and Vice President, Houses of the Parliament and their functions; Composition of State Legislature; Powers, Functions and Position of Governor, Function of Chief Ministers, Council of Ministers; The Indian Federal System, Administrative Relationship between Union and States. (8)**BILLS AND CONSTITUTION AMENDMENT PROCEDURE :** Types of Bills, Stages of passing of Bill into an Act, Veto Power, Constitution Amendment Procedure, Various Amendments made and their significance for India. (6)**JUDICIARY :** Supreme Court and High Court; Functions and powers, Judicial Review. (6)**Total L: 30****TEXT BOOKS:**

1. Subash C. Kashyap , "Our Constitution", 5<sup>th</sup> Edition, NBT, India, New Delhi, 2015.
2. Basu D D , "Introduction to the Constution of India", 20<sup>th</sup> Edition, Prentice Hall of India, New Delhi, 2011.

**REFERENCES:**

1. Brijji Kishore Sharma , "Intrdouction to the Consitution of India", 8<sup>th</sup> Edition, Prentice Hall of India, New Delhi, 2017.
2. Hoshiar Singh , "Indian Adminstration", 1<sup>st</sup> Edition, Pearson Education, New Delhi, 2011.
3. Jain M C , "The Consitution of India", 5<sup>th</sup> Edition, State Mutual Book & Periodical Service, Limited, New Delhi, 1988.
4. Shukla V N , "Consitution of India", 13<sup>th</sup> Edition, Eastern Book Company Limited, New Delhi, 2017.

**19Q413 SOFT SKILLS DEVELOPMENT****0 0 2 1****SOFT SKILLS DEVELOPMENT :**

Body Language and Professionalism Interpersonal skills Goal setting Impression Management, Team Building Time management. Stress Management Convincing Skills Motivation Change Management Communication Confidence Group discussion basics Personal Interview basics Resume writing (30)

**Total P: 30****REFERENCES:**

1. Jeff Butterfield , "Soft Skills for Everyone", 6<sup>th</sup> Edition, Cengage Learning, Delhi, 2015.
2. Rao M S , "Soft Skills - Enhancing Empolyability", LK International Publishing House, New Delhi, 2011.

**SEMESTER - 5****19B501 IMMUNOLOGY****3 0 0 3****INTRODUCTION TO IMMUNOLOGY :** Historic aspects; Innate immunity, humoral and cell mediated immunity. Primary and secondary lymphoid organs, production of blood cells, B cell, T cell and macrophages, Antigen and antigenicity, lymphocyte ontology (10)**HUMORAL IMMUNITY :** Molecular basis of antibody diversity, polyclonal and monoclonal antibody, complement system, antigen-antibody reaction (10)**CELLULAR IMMUNITY :** Antigen processing cells; T cells, killer cells; major histocompatibility complex (MHC) : antigen processing and presentation (10)**IMMUNE RESPONSE AND TOLERANCE :** Regulation of immune response, immune tolerance; hyper sensitivity, autoimmunity; Transplantation (8)**IMMUNOTHERAPEUTICS :** Antisera, Monoclonal antibody- production and its application; vaccines - types and production. (7)

**TEXT BOOKS:**

- 1.Coico R, and Sunshine G , "Immunology – a short course", 7<sup>th</sup> Edition, Wiley-Blackwell, New York, 2015.
- 2.Richard A, Goldsby R A, Kindt T J, Kuby J and Osborne B A , "Immunology", 6<sup>th</sup> Edition, W.H. Freeman and Company, New York, 2006.

**REFERENCES:**

- 1.Abbas. A., Lichtman. A.H. and Pillai , "Cellular and Molecular Immunology", 9<sup>th</sup> Edition, Elsevier, 2017.
- 2.Sell S, and Max E E , "Immunology, Immunopathology and Immunity", ASM international, Washington, DC., 2001.

**19B502 BIOPROCESS ENGINEERING****3 1 0 4**

**MEDIA DESIGN AND OPTIMIZATION:** Medium components: Carbon and nitrogen source, supplements and trace elements. Optimization methods: OFAT, PBD, FFD, CCD and BBD. - Simplex method and RSM for medium and process optimization. (6 + 2)

**GROWTH AND PRODUCT KINETICS :** Kinetics and models of growth: Structured, Unstructured, Segregated and Non-Segregated kinetic models. Monod kinetic model, Model for Recombinant cells and filamentous organism. Models for Product formation – Leudeking-Piret model, Growth and non-growth associated products. (9 + 3)

**HEAT AND MASS TRANSFER IN BIOPROCESSING :** Mass transfer, oxygen transfer in different fermentation systems; determination of oxygen uptake rates. Transfer coefficients; mechanisms that affect oxygen transfer; Heat transfer in bioprocessing; Design of cooling coils for fermentation process. - Sterilization operations; Design of batch and continuous sterilizers. (9 + 4)

**BIOREACTORS :** Stir tank reactors: Operation and Application; Batch, Fed-batch, Continuous; Recycle reactors, Reactors in series. - Non-conventional reactors: Operation and Application; Packed bed (Immobilized cell reactor) Membrane reactors, Air lift reactor, Bubble column reactor, Trickle bed reactor (12 + 4)

**SCALE UP AND BIOPROCESS MONITORING :** Scale up: Fundamental approach, Rule of thumb, Geometric similarity approach. Scale up using kLa, PV, Re with case study. - Sensors in bioreactors. Online analysis of biomass, substrate and product. Control loops; Feedforward and feedback control system, PID controllers. - PAT system: Online monitoring and control system. (9 + 2)

**Total L: 45 +T: 15 = 60****TEXT BOOKS:**

- 1.Michael L. Shuler, Fikret Kargi, Matthew DeLisa , "Bioprocess Engineering - Basic Concepts", 3<sup>rd</sup> Edition, Prentice Hall, 2017.
- 2.Pauline M Doran , "Bioprocess Engineering Principles", 2<sup>nd</sup> Edition, Academic Press, 2012.

**REFERENCES:**

- 1.Mukhopadhyay , "Process Biotechnology Fundamentals", Viva Books Pvt Ltd, New Delhi, 2001.
- 2.Bailey JE, Ollis DF , "Biochemical Engineering Fundamentals", 2<sup>nd</sup> Edition, McGraw Hill, New York, 1986.

**19B503 GENETIC ENGINEERING****3 0 0 3**

**TOOLS OF GENETIC ENGINEERING :** DNA Exonucleases and Endonucleases- Restriction Enzymes - Type I - II - III - Restriction analysis of DNA - RNases - Ligase - Polymerases - DNA Modifying enzymes. DNA - RNA - and Protein blotting techniques - CRISPR CAS , TALEN, ZNF (10)

**VECTORS FOR CLONING AND EXPRESSION :** Plasmids - lambda phage - Ti plasmids - Bacterial expression vectors - Yeast vectors - Baculoviruses - Plant - animal viral vectors. (8)

**DNA MANIPULATIONS :** Tailing - cohesive end - use of linkers - blunt end methods; Labeling and detection techniques PCR and its application - DNA Synthesis and Sequencing - site directed Mutagenesis – protein engineering. - Ligation independent cloning (10)

**EXPRESSION OF TRANSGENES :** In vitro transcription and translation systems - Reporters for various expression systems - Preparation of cDNA - cDNA and genomic libraries - Transformation methods - Fusion proteins - Protein targeting and secretion. (12)

**APPLICATIONS OF TRANSGENICS :** Transgenic plants - animals and gene therapy - Si RNA - Targeted drug delivery - Ethics - biosafety regulations - and GMOs status in India. - Genome engineering Applications (5)

**Total L: 45**



**TEXT BOOKS:**

1. Glick B , Pasternak JJ , "Molecular Biotechnology principles and applications of Recombinant DNA", ASM Press, 2001.
2. Desmont St, Nicholl , "Introduction to Genetic Engineering", 3<sup>rd</sup> Edition, Cambridge University, 2010.

**REFERENCES:**

1. Bernard R Glick, Cheryl L Patten , "Molecular Biotechnology: Principles And Applications Of Recombinant Dna", 5<sup>th</sup> Edition, Asm Press, Washington, 2018.
2. Brown T A , "Gene Cloning And Dna Analysis: An Introduction", 6<sup>th</sup> Edition, Wiley Blackwell, Oxford, 2010.

**19B504 ENZYME ENGINEERING AND TECHNOLOGY****2 0 0 2**

**ENZYMES AND THEIR USES** : Sources; Commercial production and characterization; Application in pharmaceutical, food industries; Diagnostics and Research. (5)

**KINETICS OF ENZYME ACTION** : Single, Bi substrate kinetics; Inhibition Kinetics; Simple and complex interaction. (6)

**IMMOBILIZATION** : Immobilization of enzymes and coenzymes — different methods of immobilization, chemistry, carriers, advantages and disadvantages; Diffusion barriers, kinetics and effectiveness in Surface immobilization; Applications – Antibiotic production, amino acid production. (7)

**BIOSENSORS** : Sensing systems; Optical, Potentiometric, Amperometric and thermal sensors; Types of analytes and analysis (6)

**ENZYME ENGINEERING** : Property alteration, Applications - Extreme conditions; Reactions in organic solvents. (6)

**Total L: 30****TEXT BOOKS:**

1. Chaplin and Bucke , "Enzyme Technology", Cambridge University Press, Cambridge, 1990.
2. Walsh G , "Proteins: Biochemistry and Biotechnology", John Wiley & Sons Inc., Chichester, 2014.

**REFERENCES:**

1. Price & Stevens , "Fundamentals of Enzymology", Oxford University Press, Oxford, 2001.
2. Palmer T , "Enzymes: Biochemistry, Biotechnology and Clinical Chemistry", East West Press, New York, 2008.
3. Vladimir Leskovac , "Comprehensive Enzyme Kinetics", Kluwer Academic Publishers, New York, 2004.
4. Michael L. Shuler, Fikret Kargi, Matthew DeLisa , "Bioprocess Engineering: Basic Concepts", 3<sup>rd</sup> Edition, Prentice Hall, 2017.

## 19B505 BIOREACTION ENGINEERING

**3 1 0 4**

**REACTION KINETICS:** Basic reaction theory; Order and molecularity of reaction; Homogeneous and heterogeneous reactions; Elementary and non-elementary reactions; Reaction yield and reaction rate; Calculation of reaction rates from experimental data. (10 + 4)

**SINGLE REACTIONS :** Ideal batch reactor; Steady state continuous stirred tank reactor; Steady state plug flow reactor; Size comparison of single reactions; Multiple reactor systems; Recycle reactor - Autocatalytic reactions. (8 + 4)

**MULTIPLE REACTIONS AND STEADY STATE NONISOTHERMAL REACTIONS :** Series reactions, parallel reactions, combination reactions, reactor set up and design for multiple reactions; Energy balance in nonisothermal reactions, Adiabatic operation, Equilibrium conversion, CSTR with heat effects, Nonisothermal multiple reactions. (10 + 2)

**HETEROGENEOUS REACTIONS IN BIOPROCESSING :** Concentration gradients and reaction rates in solid catalysts, Internal mass transfer and reactions, Thiele modulus and effectiveness factor, Solid-liquid mass transfer correlations, Minimizing mass transfer effects. (8 + 2)

**RESIDENCE TIME AND MODELS FOR NON IDEAL REACTORS :** Measurement of RTD, Characteristics of the RTD, RTD in Ideal Reactors, Diagnostics and Troubleshooting. Non ideal reactor models: Segregation model, Tanks in series model, Dispersion model. (9 + 3)

**Total L: 45 +T: 15 = 60**

### TEXT BOOKS:

1. O. Levenspiel, "Chemical Reaction Engineering", John Wiley, 2004.
2. H Scott Fogler, "Elements of Chemical reaction engineering", PHI Learning Private Limited, India, 2006.

### REFERENCES:

1. James E. Bailey and David F. Ollis, "Biochemical Engineering Fundamentals", McGraw-Hill, 1986.
2. Blanch HW and Clark DS, "Biochemical Engineering", CRC Press, 1997.
3. Pauline Doran, "Bioprocess Engineering Principles", 2<sup>nd</sup> Edition, Academic Press, 2012.

## 19B510 GENETIC ENGINEERING LABORATORY

**0 0 4 2**

1. Laboratory DNA extraction, for Cloning.
2. Restriction digestion and ligation in plasmid vector
3. Bacterial transformation and blue white selection.
4. Gene isolation (confirmation) by PCR, ligation independent cloning.
5. Southern and northern blotting and hybridization.
6. Protein expression analysis.
7. Agrobacterium mediated transformation and expression analysis.
8. Electroporation.

**Total P: 60**

### REFERENCES:

1. Joseph Sambrook, David W. Russell, "Molecular Cloning: A Laboratory Manual Vol -1,2, and 3", CSHL Press., 2001.

## 19B511 BIOPROCESS LABORATORY

**0 0 4 2**

### BIOPROCESS LABORATORY :

1. Enzyme kinetics - Determination of MM constants, total activity and specific activity. Effect of pH and temperature on enzyme activity
2. Growth media optimization by Response Surface methods - PBD, CCD, BBD, FFD
3. Microbial growth kinetics (Batch culture)-estimation of Monod parameters, Yield coefficients, maintenance coefficients
4. Substrate/product kinetics in Immobilization system-Enzyme and microbial cells
5. Mass transfer studies in immobilized system: comparison of mass transfer effects in different operation modes - Packed bed and agitator system
6. Comparison of reaction kinetics in batch reactor, plug flow reactor and packed bed reactor.
7. RTD studies in stir tank and tubular reactors
8. Sterilization and operation of Batch reactor
9. Mass transfer rate determination in bioreactors -dynamic gassing out method- KLa determination

**Total P: 60**

### REFERENCES:

1. Mukhopadhyay, "Process Biotechnology Fundamentals", 3<sup>rd</sup> Edition, Viva Books Pvt Ltd, New Delhi, 2010.
2. Pauline M Doran, "Bioprocess Engineering Principles", 2<sup>nd</sup> Edition, Academic Press, New Delhi, 2012.

## 19B520 INDUSTRIAL VISIT CUM LECTURE

0 0 4 2

**INDUSTRIAL LECTURE** : Faculty will arrange for lectures by experts preferably from industries to highlight the recent technical and soft skill trends.

**VISIT TO INDUSTRIES** : study tour / industrial visit. Reports are to represent the observations of the students after the visits with their personal comments / suggestions.

**Total P: 60**

## 19Q513 BUSINESS AND MANAGERIAL COMMUNICATIONS

0 0 2 1

### **BUSINESS AND MANAGERIAL COMMUNICATIONS:**

1. Advanced Group discussion
2. Advanced Resume writing
3. Mock Group discussion
4. Advanced Personal Interview
5. Mock Personal Interview
6. Cracking special Interviews
7. Essential Grammar for Placements
8. Vocabulary for Placements
9. Email writing
10. Paragraph writing
11. Essay writing

(30)

**Total P: 30**

### **REFERENCES:**

1. Priyadarshi Patnaik , "Group Discussion and Interview Skills", Cambridge, New Delhi, 2011.
2. Hari Mohan Prasad, Rajnish Mohan , "How to Prepare for Group Discussion and Interview", 2<sup>nd</sup> Edition, Tata McGrawhill, New Delhi, 2009.

## SEMESTER - 6

### 19B601 BIOINFORMATICS

3 0 0 3

**DATABASES** : Biological data: types, mode of collection, documentation & submission; Biological databases- sequence databases & structure databases; File formats; Information retrieval systems. (7)

**DATABASE SEARCH** : BLAST: Algorithm; types of BLAST; Interpretation of BLAST results; FASTA: algorithm; MOTIF and Pattern search; Structural database: DALI. (8)

**SEQUENCE ALIGNMENT** : Dot Matrix; Dynamic Programming; substitution matrices; gap penalty; statistical significance of alignment; multiple sequence alignment- Global vs Local; HMM; Molecular phylogeny (10)

**GENOME ANNOTATION** : Structural annotation: ORFs, Gene Structure, Motifs and Coding regions, Functional annotation: Biochemical functions, Gene regulation and gene interaction, Gene expression (10)

**PREDICTION TOOLS** : Eukaryotic gene prediction: Neural networks- GRAIL; Pattern discrimination methods; RNA structure prediction: Minimum free energy methods and co-variation site analysis; Protein structure Prediction: two dimensional structures- Neural networks, three dimensional structures- Rosetta Method (10)

**Total L: 45**

### **TEXT BOOKS:**

1. Jonathan Pevsner , "Bioinformatics and Functional Genomics", 2<sup>nd</sup> Edition, Wiley Blackwell, New York, 2016.
2. Marketa Zvelebil, Jeremy O. Baum , "Understanding Bioinformatics", 1<sup>st</sup> Edition, Garland Science, New York, 2008.

### **REFERENCES:**

1. Jin Xiong , "Essential Bioinformatics", 1<sup>st</sup> Edition, Cambridge University Press, New York, 2006.
2. Bosu Orpita, Simminder Kaur Thukral , "Bioinformatics: Databases, Tools, Algorithms", 1<sup>st</sup> Edition, Oxford University Press, New Delhi, 2007.
3. David Mount , "Bioinformatics: Sequence and Genome Analysis", 2<sup>nd</sup> Edition, CBS publishers, New York, 2004.

### 19B602 GENOMICS

3 0 0 3

**GENOME STRUCTURE AND GENOME PROJECTS** : Importance and strategies, Organization and structure of genomes. Genome Data Visualization (With emphasis on Human Genome) Ensembl, MapViewer. Genome databases of the following (To be explored by the students for presentation in seminars) E. coli, M. tuberculosis, Yeast, Plasmodium, C. elegans, Drosophila, Zebra fish, Human, Mouse, Arabidopsis thaliana and Rice. (10)

**GENOME MARKERS AND MAPPING** : Genetic maps and Physical maps STS, EST, RFLP, SNP, radiation hybrid mapping, Optical mapping. Chromosome walking, SNPs and genome wide association studies. (10)

**GENOME SEQUENCING** : Genome sequencing strategies. First, second and Next generation methods, Comparison of NGS methods. (8)

**FUNCTIONAL GENOMICS** : Transcriptomics: Types of transcriptome studies: Microarray and RNA- seq methods, Yeast Two hybrid System, Gene Expression Analysis from Gene expression omnibus. Identification of Disease Genes & Drug Targets (in hecontext of Human Genetics and Genetics of Model organisms) OMIM Metabolic diseases and Pathogenic diseases (8)

**EPIGENETICS AND METAGENOMICS** : Methylation of DNA and genetics; histone modifications, HATs and HDACs in the context of gene expression regulation. ChIPchip and ChIPseq techniques. Overview of metagenomics principles, microbial and ecological aspects underlying metagenomic experiments, applications and limitations of metagenomics (9)

**Total L: 45**

**TEXT BOOKS:**

1. Primrose Sandy B., Twyman Richard. , "Principles of Gene Manipulation and• Genomics.", 7<sup>th</sup> Edition, Wiley- Blackwell, 2006.
2. Brown, T.A, "Genomes", 3<sup>rd</sup> Edition, Garland Science publishers, 2006.

**REFERENCES:**

1. Primrose Sandy B., Twyman Richard. , "Principles of Genome Analysis and Genomics", 6<sup>th</sup> Edition, Wiley- Blackwell, 2003.

## 19B603 DOWNSTREAM PROCESSING

**3 0 0 3**

**BIOPRODUCTS AND CELL DISRUPTION** : Type of bio-products, Separation strategies to recover and purify bio- products - RIPP scheme. - Intracellular products - Cell disruption techniques - Principle and operation: mechanical disruption (High speed homogenizers, French press, and ultrasonication), enzyme disruption, chemical disruption, Thermal disruption. (8)

**BIOMASS SEPARATION AND RECOVERY PROCESSES** : Filtration process: Batch filtration, continuous filtration and centrifugal filtration; operation and application. - Pretreatment process: Precipitation, Flocculation and Coagulation; principle, operation and application. - Centrifugation - Operation and application of tubular, disc stack and basket centrifuges. (9)

**ENRICHMENT PROCESSES** : Extraction: Liquid-liquid extraction and solid-liquid extraction, principle and application. - Aqueous two-phase extraction, super critical fluid extraction and reverse micelle extraction - principle, operation and application. - Adsorption: Adsorption isotherms, Types of adsorption process and application. High Gradient magnetic Fishing-principle and application. (9)

**PRODUCT RESOLUTION** : Membrane separation techniques: Membrane materials and modules for different purification applications. Microfiltration, Ultrafiltration, nanofiltration, Reverse osmosis, Dialysis, Electrodialysis, Pervaporation, Submerged membranes; operation and application.- Preparative Chromatography: Ion exchange, Gel filtration and permeation, Affinity chromatography, hydrophobic interaction chromatography- operation, design and application. (12)

**PRODUCT FORMULATION** : Crystallization: Principles, operation and application. - Drying: Drying curve- Bound and unbound moisture. Types of dryer: Vacuum dryer, spray dryer and freeze dryer; Principle, operation and application. Product appearance, Product stabilization. (7)

**Total L: 45**

**TEXT BOOKS:**

1. Roger G Harrison, Paul W Todd, Scott R Rudge, Demetri Petreides , "Bioseparations Science and Engineering", 2<sup>nd</sup> Edition, Oxford University Press, 2015.
2. Juan A Asenjo , "Separation processes in biotechnology", 1<sup>st</sup> Edition, CRC Press, 1993.

**REFERENCES:**

1. Seader J, Henley J , "Separation process principles", 1<sup>st</sup> Edition, Wiley Interscience, New York, 2006.
2. Richardson JF, Harker JF, Backhurst JR, "Chemical Engineering, Volume 2 – Particle Technology and separation processes", 1<sup>st</sup> Edition, Butterworth Heinemann, 2002.
3. Van Dam Mieras M C E, Currell B R , "Product recovery in Bioprocess Technology- BIOTOL series", 1<sup>st</sup> Edition, VCH, Netherlands, 1995.

## 19B604 BIOPROCESS DESIGN AND ECONOMICS

2 0 0 2

**OVERVIEW OF BIOPRODUCTS (5)** : Categorization of bioproducts. Upstream and downstream process design principles. Economic impact analyses. (5)

**KARANJA BIODIESEL** : Product requirement. Viscosity management. Process selection. Role of mixing. (5)

**SUCCINIC ACID** : Fermentative production with *Anaerobiospirillum succiniciproducens*. Electrodialysis and acidogenesis. Ion exchange. (5)

**INSULIN** : Market analysis. Process description. Process design. Capital cost analysis. Operating cost estimation. (5)

**PRINCIPLES OF COST ANALYSES** : Stages and methods of cost analyses; Demand forecasting; Laws of supply; Theory of production; Cost of output. (10)

**Total L: 30**

### TEXT BOOKS:

1. K.Watson , "Industrial Biotechnology", CBS Publications, New Delhi, 2016.
2. A.R. Aryasri, V.V.R. Murthy , "Engineering Economics and Financial Accounting", Tata McGraw Hill, New Delhi, 2006.

### REFERENCES:

1. J.A. Asenyo , "Separation Processes in Biotechnology", Taylor & Francis, New York, 2008.
2. P.A. Belter, E.L. Cussler, W.S. Hu , "Bioseparations", Wiley India, New Delhi, 2011.
3. R.Ghosh, "Principles of Bioseparations Engineering", World Scientific Publishing Co, New York, 2006.

## 19B610 BIOINFORMATICS LABORATORY

0 0 4 2

### SEQUENCE RETRIEVAL AND ANALYSIS :

Databases and Data retrieval  
Genome Browser- Ensembl  
In silico analysis of 16S rRNA Sequence (10)

### BLAST :

Pairwise Sequence Alignment using various BLAST programs  
Protein sequence alignment by Blastp, PSI-BLAST, PHI-BLAST and Delta-BLAST (10)

### GENOME ANNOTATION :

Gene finding using NCBI ORF Finder  
Viral Genome Annotation using FGENESV (10)

### PHYLOGENY :

1. Multiple Sequence Alignment and Phylogenetic Tree Construction (10)

### PROTEIN STRUCTURE PREDICTION :

1. Protein Structure prediction through threading and homology modelling (10)

### RNA SEQUENCE ANALYSIS :

miRNA Target Prediction  
RNA structure Prediction (10)

**Total P: 60**

### REFERENCES:

1. Agastino M , "Practical Bioinformatics", 1<sup>st</sup> Edition, Garland Science, New York, 2013.
2. Jonathan Pevsner , "Bioinformatics and Functional Genomics", 2<sup>nd</sup> Edition, Wiley Blackwell, New York, 2016.

## 19B611 DOWNSTREAM PROCESSING LABORATORY

0 0 4 2

### DOWNSTREAM PROCESS LABORATORY :

1. Isolation of intracellular products from cells using disruption techniques (Ultrasonication, High speed Homogenization, Bead disruption, solvent methods, Free thaw)
2. Solid liquid separation by filtration process- (i). Separation of biomass and (ii). Separation of proteins based on size
3. Extraction of active components from given source by solvent extraction techniques – Liquid-liquid extraction and solid liquid extraction
4. Aqueous two-phase extraction of proteins
5. Isolation of desired component from sample using chromatographic technique – Gel filtration chromatography
6. Drying kinetics for given sample
7. Drying of samples using fluidized bed dryer

8. Evaluation of purity of isolated component using HPLC
9. Mini project: Purification process for proteins from microbial or plant source

**Total P: 60**

**REFERENCES:**

1. Simon Roe, "Protein purification techniques -A practical approach", 2<sup>nd</sup> Edition, Oxford University Press, New York, 2001.
2. Forciniti D, "Industrial Bioseparations: Principles and Practice", 1<sup>st</sup> Edition, Blackwell Publishing, 2008.

**19B620 INNOVATION PRACTICES**

**0 0 4 2**

1. Problem Identification and Innovative Solutions
2. Preparing a Project Proposal highlighting the Specifications of the Product/Process and Standards
3. Re-Engineering, Development of Biotechnological Products/Process of Commercial Importance
4. Analysis of the Product/Process
5. Consolidated Project Report Preparation

**Total P: 60**

**19Q613 QUANTITATIVE AND REASONING SKILLS**

**1 0 0 2**

**QUANTITATIVE AND REASONING SKILLS :**

1. Number System, Time and Work
2. Percentages, Simple and Compound Interests
3. Time, Speed and Distance
4. Permutation, Combination and Probability
5. Ratio and Proportion
6. Profit, Loss and Partnership
7. Logarithms, Progressions, Geometry and Quadratic Equations
8. Coding and Decoding
9. Series, Analogy and Odd Man Out
10. Visual Reasoning
11. Data Arrangements
12. Blood Relations
13. Clocks, Calendars and Direction Sense
14. Cubes, Logical Connectives and Syllogisms
15. Venn Diagrams, Interpretations and solving

**Total P: 30**

**REFERENCES:**

1. Aggarwal R S, "Quantitative Aptitude for Competitive Examinations", 3<sup>rd</sup> Edition, S Chand Publishing, New Delhi, 2017.
2. ETHNUS, "Aptimithra", 1<sup>st</sup> Edition, McGraw-Hill Education Pvt Ltd, 2013.
3. FACE, "Aptipedia Aptitude Encyclopedia", 1<sup>st</sup> Edition, Wiley Publications, Delhi, 2016.

**SEMESTER - 7**

**19B701 IPR, BIOSAFETY AND BIOETHICS**

**3 0 0 3**

**BIOETHICS** : Professional conducts and responsibility, Professional Ethics, Disease prevention Vs right to privacy, genetic tests in diagnostics and therapy, patentability of DNA, Case Study (7)

**PATENTS AND DESIGNS** : Patents and Utility models, Industrial designs, Patent search, Patent drafting, Patent Application, PCT, Indian IPR legislations, Case study (10)

**IPR FOR INDIGENOUS RESOURCES** : Protection of Plant varieties and Farmer's rights, Geographical Indicators, Traditional Knowledge and Folklore (8)

**TRADE RELATED IP SAFEGUARDS** : Copy rights: Trade secrets, WTO, TRIPS, Trade Barriers (8)

**BIOPROSPECTING AND BIOSAFETY** : Biodiversity, Bio-piracy, CBD, Cartagena protocol, Release of GMO into environment, safety assessment of biotechnology products, Case Study (12)

**Total L: 45**

**TEXT BOOKS:**

1. Krishna V, "Bioethics And Biosafety In Biotechnology", 1<sup>st</sup> Edition, New Age International P Ltd, New Delhi, 2017.
2. Goel D and Parashar S, "IPR, Biosafety and Bioethics", 1<sup>st</sup> Edition, Pearson, New Dehi, 2013.

**REFERENCES:**

1. Ma M , "Fundamentals Of Patenting And Licensing For Scientists And Engineers", 1<sup>S</sup> Edition, Wrlid Scientific, New Jersey, 2015.
2. Gordon T T et al , "Patent Fundamentals for Scientists and Engineers 3rd Edition Canada", CRC Press, CANADA, 2012.

**19B720 PROJECT WORK I****0 0 4 2**

1. Identification of real life problem in thrust areas
2. Developing a mathematical model for solving the above problem Finalisation of system requirements and specification
3. Proposing different solutions for the problem based on literature survey Future trends in providing alternate solutions
4. Consolidated report preparations on the above

**Total P:60****SEMESTER - 8****19B820 PROJECT WORK II****0 0 8 4****The Project involves the following:**

1. Preparing a project - Brief proposal including the following
  - a. Problem Identification
  - b. A statement of system/process specifications proposed to be developed ( Block Diagram/Concept tree)
2. List of possible solutions including alternatives and constraints
3. Cost benefit Analysis
4. Time line of activities
5. A Report highlighting the design finalization ( Based on functional requirements and standards (if any)) A Presentation including the following:
6. Plan implementation and progress made
7. Testing and validation of the developed system/hypothesis
8. Learning from the project
9. Consolidated Report Preparation

**Total P:120****PROFESSIONAL ELECTIVES****19B001 PLANT BIOTECHNOLOGY****3 0 0 3**

**INTRODUCTION :** Plant evolution and breeding - Marker Assisted selection - Organization and Expression of Plant Genes - Mitochondrial and chloroplast genomes - plant molecular genetics of photosynthesis and development. (8)

**PLANT TISSUE CULTURE :** methods - types - application - secondary metabolite production – Agrobacterium rhizogenes and hairyroot induction. (6)

**GENETIC ENGINEERING TECHNIQUES :** Agrobacterium mediated transformation - protoplast fusion - direct gene delivery methods - Plant viruses as vectors and chloroplast transformation. (6)

**STRATEGIES FOR PLANT MODIFICATIONS:** introducing biotic and abiotic stress resistance/tolerance - phytoremediation - herbicide resistance. (13)

**APPLICATIONS :** Molecular farming/pharming - symbiotic microorganism and their role in enhancing plant growth - cyanobacterial and algal modifications. Growing of GM crops - their regulations - Case studies pertinent to Indian scenario. (12)

**Total L: 45****TEXT BOOKS:**

1. Slater A, Scott N , Fowler M , "Plant biotechnology- the genetic manipulation of plants", Oxford press, 2008.
2. Kirakosyan A, Kaufman P , Cseke L , "Recent advances in plant biotechnology", Springer, 2009.

**REFERENCES:**

1. Trigiano, R N , Gray J D , "Plant Tissue Culture, Development and Biotechnology", CRC Press, 2010.
2. Sane, Mahajan, Khairnar, Saler & Thakur , "Fundamentals of Plant Biotechnology", Vision Publications, 2010.
3. Razdan MK , "Introduction to plant tissue culture", Science publishers, 2003.
4. Oksman , Caldente , "Plant biotechnology and transgenic plants", Marcel Dekker, 2002.

**19B002 ENVIRONMENTAL BIOTECHNOLOGY****3 0 0 3**

**STATUS OF THE ENVIRONMENT :** Global environmental issues - challenges to sustainability; anthropogenic activities and their environmental impacts; climate change; feeding a growing population. (5)

**BIOENERGY** : Current energy scenario and its impacts; biogas from waste; - biofuel from biomass, algae; hydrogen from bacteria; - biotechnological approaches to improve feedstock for biofuel production (12)

**BIOREMEDIATION** : Ecological principles; capability of microbial process for pollutant management. Bioremediation processes; Factors affecting the bioremediation processes; In situ and ex-situ bioremediation; Microbial degradation of contaminants in gas phase; biofiltration - biotrickling filtration - bioscrubbers; Phytoremediation of organic - metals and inorganic contaminants; transgenics in bioremediation. (15)

**BIODIVERSITY AND ITS CONSERVATION** : Biodiversity analysis: molecular methods to analyse biodiversity - gene sequencing - phylogenetic trees - ISSR - RAPDs - isozymes. DNA Barcoding - Metagenomics - Conservation of endangered species: micropropagation - cryopreservation - ART - DNA and tissue banking. (5)

**BIOFERTILIZERS AND BIOPESTICIDES** : Nitrogen fixers - phosphorous solubilising bacteria - phosphorous mobilizing bacteria - plant growth promoting microorganisms - Baculoviruses - entomopathogenic fungi – Bacillus thuringiensis. (8)

**Total L: 45**

#### TEXT BOOKS:

1. Thakur I S , "Environmental Biotechnology: Basic Concepts and Applications", 1<sup>st</sup> Edition, I K International Pvt Ltd, New Delhi, 2006.
2. Bruce E Rittmann, Perry L Mc Cathy , "Environmental Biotechnology: Principles and Applications", McGraw-Hill, Inc New Delhi, 2001.

#### REFERENCES:

1. NIIR Board , "The Complete Technology Book on Biofertilizer and Organic Farming National Institute of Industrial Research", New Delhi, 2004.
2. Vincent Savolainen , "DNA and tissue banking for biodiversity and conservation: theory, practice and uses", 2006., 2006.
3. David M. Mousdale , "Introduction to Biofuels", CRC Press, London, 2011.

### 19B003 PHARMACEUTICAL TECHNOLOGY

**3 0 0 3**

**INTRODUCTION TO BIOPHARMACEUTICS** : Histry of biologics, Basic definitions: Biogenerics, Biosimilars, Reference drugs, Small molecules, Complexity of biologics, Drug discovery and development phases of biologics and small molecules., Different therapeutic classes of biologics ( Recombinant proteins, Monoclonal Antibodies , Vaccines, Immunomodulators, cytokines, Interferons , Erythropoiesis stimulating factors), Approval process of generic drug and biosimilar. - (8)

**PHARMACOLOGY OF THERAPEUTIC PROTEINS** : Pharmacokinetics - ADME , factors affecting ADME , Pharmacodynamics - mode of transport, drug receptors , Clinical Pharmacology of therapeutic proteins, PKPD analyses (Special population trials for biologics, drug- drug interaction studies , Bioequivalence studies, Bioavailability) (10)

**BIOLOGIC MANUFACTURING PROCESS** : Expression hosts for producing biologics , Selection and characterization of high yielding strains and cell lines ( WCB and MCB generation), Media selection and optimization., Stages of process development for biologics , Different types of bioreactors for mAb production.Stages of biologic product purification (10)

**CHARACTERIZATION OF BIOGENERICS AND BIOSIMILARS** : Structural characteristics of biologics, Characterization of biosimilars ( LC- MS/MS and affinity capture techniques ), Problems in characterization of biologics ( peptides, Non - glycosylated proteins, Glycosylated proteins, Monoclonal antibodies ) Post translational modifications, protein aggregates, Equivalence issues (9)

**DRUG REGULATIONS AND CASE STUDIES OF BIOPHARMACEUTICAL PRODUCTS** : Biologic drug regulatory process ( CDSCO regulation , FDA regulation ), cGMP practices in the manufacture of biologics . - Case studies on different biologic products : Insulin and its analogues, Trantuzumab, cetuximab, Infliximab, L-Asparaginase, Streptokinase. (8)

**Total L: 45**

#### TEXT BOOKS:

1. Lachman L Lieberman, HA, Kanig, J , "Theory and Practice of Industrial pharmacy", Varghese Publishing & Co, 2009.
2. Sarfaraz K. Niazi , "Handbook of Biogeneric Therapeutic Proteins: Regulatory, Manufacturing, Testing, and Patent Issues", 2<sup>nd</sup> Edition, CRC Press, 2006.
3. Rodney J Y Ho, Milo gibaldi , "Biotechnology and Biopharmaceuticals transforming proteins and genes into drugs", 1<sup>st</sup> Edition, Wiley Liss, 2003.

#### REFERENCES:

1. Wei Wang, Manmohan singh , "Biological Drug Products: Development and Strategies", 1<sup>st</sup> Edition, Wiley, 2013.
2. Goodman & Gilman's , "The Pharmacological Basis of Therapeutics", 11<sup>th</sup> Edition, Mc GrawHill Medical Publishing Division, 2006.

### 19B004 FOOD SCIENCE AND TECHNOLOGY

**3 0 0 3**

**INTRODUCTION TO FOOD SCIENCE AND TECHNOLOGY** : Dimension of food science - food processing industry- current status. Major classes of food components. Food categorization & composition. Probiotics and prebiotics, Nutraceutical compounds- scope and future prospects, Human nutrition and food. (9)



**FOOD CHEMISTRY** : Functional groups and properties - Water and acids - Carbohydrates - lipids - Proteins - color - flavor & texture - food additives. (8)

**FOOD PROCESSING AND PRESERVATION** : Food preservation - Manufacturing or processing in Dairy products - egg - meat - sugar - fat & oils - Beverages - cereal grains - fruits and vegetables.,SCP (8)

**MICROBIOLOGY AND FERMENTED FOODS** : Factors affecting microbial growth - food borne microorganism, food borne illness - food spoilage quality control; preservation techniques. Fermented Foods - Food safety – Food toxicology. (8)

**FOOD ENGINEERING AND FOOD BIOTECHNOLOGY** : Food material science - food micro structure - Psychometrics - Rheology - Extrusion technology, Improving plant products, Animal products, Food processing aids through biotechnology. Safety in Biotechnology derived foods. Major concerns. (12)

**Total L:45**

**TEXT BOOKS:**

1. Murano PS, "Understanding Food Science and Technology", Thomson Wadsworth, 2009.
2. James MJ, "Modern Food Microbiology", CBS Publishers, New Delhi, 2012.

**REFERENCES:**

1. Campbell -patt Edited, "Food Science and Technology", Blackwell publishing Ltd, 2009.

**19B005 ANIMAL BIOTECHNOLOGY**

**3 0 0 3**

**ANIMAL CELL CULTURE** : Cell culture - Cell lines - Characterization and preservation of animal cells - chemically defined and serum free media for cell culture - scaling up of animal cell cultures - organ culture - insect cell lines - Products from animal cell culture. (12)

**ARTIFICIAL REPRODUCTIVE TECHNOLOGIES** : Hormones in animal development - superovulation – Artificial insemination - invitro fertilization, embryo manipulation - embryo splitting and sexing. (9)

**TRANSGENIC ANIMALS** : Transgenic mice - generation and applications of oncomice - knock out mice - cattle & other farm animals - transgenic fish- methodology & application. Production of spider silk - improvement of wool quality. (8)

**GENE THERAPY** : - ex vivo gene therapy - in vivo gene therapy - viral gene delivery systems - nonviral gene delivery systems - Pros and cons of the various methods (8)

**PRODUCTS FROM ANIMAL CELL CULTURE** : Commercially viable products from mammalian cell culture: Selected examples in monoclonal antibodies, (Humira, Mylotarg) vaccines (Hepatitis vaccine) and therapeutics (blood clotting factors, cytokines, hormones). Quality control practices and safety for cell culture based products (8)

**Total L: 45**

**TEXT BOOKS:**

1. Glick and Pasternak, "Molecular Biotechnology", ASM Press, Washington DC, 2010.
2. Freshney IR, "Culture of Animal Cells: A Manual of Basic Technique", Wiley-Liss Inc., New York, 2000.

**REFERENCES:**

1. Primrose S B and Twyman R, "Principles of Gene Manipulation and Genomics", John Wiley & Sons, USA, 2013.
2. Alcamo, "DNA Technology the awesome skill", Wm, C, Brown Publishers, , Dubuque, Iowa, 2000.

**19B006 BIOPROCESS PLANT DESIGN, ECONOMICS AND BIOSAFETY**

**3 0 0 3**

**TISSUE CULTURE SYSTEM DESIGN** : Engineering aspects for design of plant tissue culture system, components of plant tissue culture system –HEPA filter, Incubator, Illumination; Air flow and operational area; Movement materials; Field area, hardening facilities; (9)

**DESIGN OF EQUIPMENT FOR BIOWASTE DEACTIVATION** : Aerobic and anaerobic biological waste treatment systems, hold-up and discharge area; design of biological waste water treatment system –Dairy industry as a case study. (9)

**PROCESS DIAGRAMS** : Flow sheeting: Process flow diagram computer aided flow sheeting for production of enzymes, antibiotics, solvents; P&I Diagrams: Symbols and layout, mechanical design of piping systems –pipe size selection—control and instrumentation. (9)

**CONSTRUCTION MATERIALS** : materials properties, common materials used for bioprocess equipment construction. (9)

**PROCESS EQUIPMENT** : Pressure vessel: Pressure vessel codes and standards, mechanical design of pressure vessels, pressure vessel supports, Design of storage vessels. Bioreactor vessel: Laboratory and industrial bioreactors, components of bioreactor, selection of materials, General design consideration of bioreactor, bioreactor design using CAD, bioreactor safety, Process utilities: Design of bioprocess plant utilities. (9)

**Total L: 45**

**TEXT BOOKS:**

1. Brownell L E and Young E H , "Process Equipment Design", John-Wiley & Sons, New York, 2004.
2. Mahajani VV and Umarji SB , "Process Equipment Design", McMillan Co, New Delhi, 2011.

**19B007 MEDICAL GENETICS****3 0 0 3**

**INHERITANCE PATTERN :** Mendels law, Chromosome theory of inheritance, Autosomal/sex linked - mitochondrial - genetic expressivity - penetrance - pleiotropy - anticipation - genomic imprinting. (10)

**POPULATION GENETICS :** Hardy-Weinberg principle - mutation - migration - gene flow - genetic drift, Linkage –gene mapping in eukaryotes - QTL mapping. (9)

**CYTOGENETICS AND CHROMOSOMAL DISORDERS :** Karotyping - ideogram for G-banding - FISH - C C G - Aneuploidy and Deletions - Translocation - Mosaicism and Chimerism. (9)

**MOLECULAR ASPECTS OF DISEASES :** Triplet-Repeat Diseases - Tay Sachs disease - cystic fibrosis - Thalasemia - DMD - - (8)

**DIAGNOSIS AND THERAPY OF GENETIC DISORDERS :** Genetic diseases in prenatal - the neonatal period - childhood and adulthood - screening of diseases - gene therapy. (9)

**Total L: 45****TEXT BOOKS:**

1. Lynn B, C Carey , "Medical Genetics", 5<sup>th</sup> Edition, Mosby publications, 2016.
2. Klug WS, Cummings MR, "Concepts of Genetics", 10<sup>th</sup> Edition, Prentice Hall International Inc., New Jersey, 2011.

**REFERENCES:**

1. Micheal J Simmons, Eldon John Gardener , "Principles of Genetics", 8<sup>th</sup> Edition, John-Wiley & Sons, Newyork, 2005.

**19B008 NANOMATERIALS FOR BIOAPPLICATONS****3 0 0 3**

**NANOTECHNOLOGY :** Introduction-scientific evolution-history of nanotechnology-nanoparticles –surface –to- volume ratio- Nanoparticles for live cell dynamics (9)

**NANOMATERIALS FOR CELL ENGINEERING :** Nanoscale Biological Recognition and the cellular environments- Materials with controlled nanogeometry, nanochemistry& nanomechanics. Nanostructured Extracellular matrix (9)

**STEALTH AND BIOMIMETIC CORE-CORONA NANOPARTICLES :** Biodistribution of intravenously administered particles- Protein-rejecting abilities Polyethylene glycol coatings-stealth PEG coated Drug carriers-detection and characterization of the PEG corona (9)

**NANOBIOMOTORS :** General classification of bionanomotors - kinesin motor and nanoactuators, F0-F1 ATPase motor -viral DNA packaging motor-helicase (9)

**SELF ASSEMBLED NANOBIOMATERIALS :** Peptide systems-peptide for biomineralization-short amphiphilic peptides-cyclic peptides with alternating D & L-amino acids-bioamphiphilic peptides-peptides that form 3D scaffold hydrogels (9)

**Total L: 45****TEXT BOOKS:**

1. Niemeyer C M, Mirkin C A , "Nanobiotechnology, Concepts, Applications and Perspectives", Wiley-Vch., Germany, 2006.
2. Yubing Xie , "The nanobiotechnology Handbook", CRC press., London, 2013.

**REFERENCES:**

1. H.S.Nalwa , "Encyclopaedia of Nanoscience & nanotechnology", Vol 6 & 7, American scientific publisher, 2004.
2. Stergios Logothetidis , "Nanomedicine and Nanobiotechnology", Springer, New York, 2012.
3. Boisseau P, Houdy P, Lahmani M , "Nanoscience: Nanobiotechnology and Nanobiology", Springer, New York, 2010.

**19B009 SMART NANO PARTICLES IN CANCER THERAPY****3 0 0 3**

**INTRODUCTION TO CANCER BIOLOGY & NANOCARRIERS :** Causes of cancer, p53 pathway, tumors-benign-malignancies-Enhanced Permeation and Retention effect, definition of nanomaterials& nanomedicine, need for nanomedicine & nanocarrier, factors affecting nanocarrier properties, Homing device challenge, active & passive targeting with nanoparticles(9)

**MAGNETIC MICRO AND NANOPARTICLES** : Introduction-history of magnetic drug targeting-embolotherapy- hyperthermic therapy-magnetic particles for delivery of chemotherapeutic drugs-brachy therapy-magnetic particles for gene therapy (9)

**THERMORESPONSIVE LIPOSOMES FOR HYPERTHERMIC CHEMOTHERAPY** : Introduction-liposomal formulation for drug delivery-membrane transition and permeability-modeling of interfacial gel-liquid regions-phospholipid selection-liposome preparation & characterization. (9)

**ULTRASOUND IN DRUG DELIVERY** : Ultrasound energy deposition in body-modes of ultrasound applications in drug delivery-ultrasound cavitation-effect of doxorubicin on transient cavitation- interaction with cells-ultrasound induced drug delivery from micelles (9)

**VIRUS LIKE NANOPARTICLES:** : Introduction-polycations, surfactants & Gemini lipids for gene delivery in Vitro, morphology of DNA-surfactant complexes-stability , surface modification strategies and targeting effects. (9)

**Total L: 45**

**TEXT BOOKS:**

1. Reza Arshady and Kenji Kono , "Smart Nanoparticles in Nanomedicine", 8<sup>th</sup> Edition, Knetus Books, London, 2006.
2. Thomas Vorup-Jensen, Dan peer, Kenneth A. Howard , "Nanomedicine", CRC press , Newyork, 2016.

**REFERENCES:**

1. Mingjun Zhang and Ning Xi , "Nanomedicine: A Systems Engineering Approach", Pan Stanford Publishing, Singapore, 2019.
2. Alf Lamprecht , "Nanotherapeutics Drug Delivery Concepts in Nanoscience", Pan Stanford Publishing,, Singapore, 2016.

### **19B021 RESEARCH TOPICS IN CANCER BIOLOGY**

**3 0 0 3**

**INTRODUCTION** : Molecular Biology -Cancer overview. (4)

**CELL CYCLE** : Mitotic spindle; MPF and cell cycle control; yeast model; complex genetic diseases; cyclins and kinases. (7)

**SIGNALS AND REGULATION** : TGF-; CiP1; G2 cyclins; differentiation and reversal; disease mechanisms in acute promyelocytic leukemia. (8)

**APOPTOSIS** : c-rel and cell death; Bcl2 interactions in cell survival; DNA replication control; growth factor dependence and apoptosis suppression. (7)

**ONCOGENE** : ATC - Tcf-4 - -catenins and c-myc; Waf1 and p53; phosphatase 2A. (7)

**TUMORIGENESIS** : Anticancer agents and p53; dosage effects of tumor suppressor; colon cancer; breast cancer metastasis. (7)

**THERAPY** : Control of vasculogenesis; stem cell and CML dynamics; temporal targeting. (5)

**Total L: 45**

**TEXT BOOKS:**

1. Rudden RW , "Cancer Biology", Oxford University Press, 2007.

### **19B022 MOLECULAR PATHOGENESIS**

**3 0 0 3**

**PATHOGENESIS** : Bacterial flora of humans; Endogenous and Exogenous infection - Noninvasive and invasive pathogens.(8)

**VIRULENCE** : Virulence factors - toxins; Genetic basis of virulence; virulence genes and their regulation. Virulence protein secretion pathways. Microbial evasion strategies of host defense; Regulation of virulence associated genes - Methods to identify bacterial pathogenecity factors. (16)

**PARADIGMS OF PATHOGENESIS** : E.coli - Mycobacterium tuberculosis - Candida - Hepatitis B virus- Plasmodium. (15)

**THERAPEUTIC CHALLENGES** : Antibiotic resistance-molecular mechanisms - transposon mediation. Vaccine development in Malaria. (6)

**Total L: 45**

**TEXT BOOKS:**

1. Eduardo A Groisman , "Principles of bacterial pathogenesis", FL, 2001.
2. Hacker J , " Molecular Infection Biology: interaction between microorganisms and cells", Berlin 2002, 2002.

**REFERENCES:**

1. Wilson M, McNab R , Henderson B , "Bacterial disease mechanisms- An introduction to cellular microbiology", 2002.

## 19B023 DEVELOPMENTAL BIOLOGY

3 0 0 3

**INTRODUCTION TO DEVELOPMENTAL BIOLOGY** : Development among unicellular eukaryotes. Development pattern among the metazoans. Differential cell affinity. (5)

**PATTERNS OF DEVELOPMENT** : Gametogenesis - Fertilization - Cleavage - Gastrulation - Neurulation and the ectoderm - Axonal specificity - Mesoderm and endoderm. (10)

**MECHANISM OF CELLULAR DIFFERENTIATION** : Transcription factors - activation of specific promoters - chromatin. Control of development by differential RNA processing and translation. (6)

**SPECIFICATION OF CELL FATE AND THE EMBRYONIC AXES** : Autonomous - conditional and syncytial specification; Genetics of axis specification in *Drosophila* - Specificity of cell fate by progressive cell-cell interactions - Establishment of body axes in mammals and birds. (10)

**CELLULAR INTERACTION DURING ORGAN FORMATION** : Proximate tissue interaction - Development of the tetrapod limb. Cell interaction at a distance: Hormones as mediators of development. Sex determination. Environmental regulation of animal development. Metamorphosis - Developmental mechanisms of evolutionary (14)

**Total L: 45**

### TEXT BOOKS:

- 1.Scott F Gilbert , "Developmental Biology", Sinauer Associates Inc.,2003.
- 2.SLACK J M W , "ESSENTIAL DEVELOPMENTAL BIOLOGY", 3<sup>rd</sup> Edition, Wiley-Blackwell, OXFORD, 2012.

### REFERENCES:

1. Wolpert L, Jessell T , Lawrence P , "Principles of Development", Oxford University Press, 2010.

## 19B024 PROTEIN ENGINEERING

3 0 0 3

**PROTEIN STRUCTURE** : Primary structure and peptide bond; secondary structures and supersecondary structures; folding pathways; tertiary structure; quaternary structure; post translational modifications - - - - - (12)

**PROTEIN STRUCTURE ANALYSIS** : Protein sequencing, Circular dichroism and X ray crystallography for protein structure determination, Techniques for studying post translational modifications (9)

**STRUCTURE FUNCTION RELATIONSHIP** : DNA binding proteins- lac repressor; membrane proteins- bacteriorhodopsin, hormones receptors - estrogen receptors; serine proteases, Protease inhibitors - HIV protease (9)

**PROTEIN ENGINEERING METHODS** : Site directed and random mutagenesis, approaches for Protein Engineering, rational design and directed evolution, de novo protein design (8)

**ENGINEERED PROTEINS** : Engineering thermal stability and other properties; Antibody engineering; Therapeutic insulin; Engineering Subtilisin (7)

**Total L: 45**

### TEXT BOOKS:

1. Creighton TE , "Protein Structure- A practical approach,", IRL Press, 1998.
2. Carl Branden and John Tooze , "Introduction to protein structure", 2<sup>nd</sup> Edition, Garland Publishing, 1998.

### REFERENCES:

1. Alberghina L , "Protein engineering in Industrial Biotechnology", Chur, 2003.
2. Schulz G E, , Schirmer R H , "Principles of Protein structure", Springer-Verlag, 2003.
3. Glick B, , Pasternak J J , "Molecular Biotechnology principles and applications of Recombinant DNA", ASM Press, 2001.

## 19B025 IMMUNOTECHNOLOGY

3 0 0 3

**ANTIGENS AND EXPERIMENTAL ANIMAL MODELS** : Antigens: Epitopes - B cell & T cell epitopes - Types of antigen - factors affecting immunogenicity - Haptens - preparation of antigens for raising antibodies - adjuvants and their mode of action. Handling experimental animals - Inbred strains - SCID mice - Nude mice - knock out mice. (8)

**ANTIBODIES & IMMUNODIAGNOSIS** : Monoclonal and polyclonal antibodies - their production and characterization - western blot analysis - SDS - PAGE - precipitation and agglutination reactions - immunoelectrophoresis - ELISA- principle and applications - radio immuno assay (RIA) - principle and applications - nonisotopic assay methods for the detection of antigens- enhanced chemiluminescence assay. (8)

**ASSESSMENT OF CELL MEDIATED IMMUNITY** : Identification of lymphocytes and their subsets in blood - T cell activation parameters - estimation of cytokines - macrophages activation - macrophage microbicidal assays - in- vitro experimentation- application of the above technology to understand the pathogenesis of infectious disease. (9)

**IMMUNOPATHOLOGY** : Preparation and storage of tissues - identification of various cell types and antigens in tissues - isolation and characterisation of cell types from inflammatory sites and infected tissues - functional studies on isolated cells - immunocytochemistry- immunofluorescence - immunoenzymatic and immunoferritin techniques - immunoelectron microscopy. (9)

**MOLECULAR IMMUNOLOGY** : Preparation of vaccines - recombinant vector vaccines - application of recombinant DNA technology for the study of immune systems - Antibody engineering - antiidiotypic antibodies – catalytic antibodies. (11)

**Total L: 45**

**TEXT BOOKS:**

1. Richard A, Goldsby R A, Kindt T J, Kuby J, , Osborne B A, "Immunology", W.H. Freeman and Company, 2006.
2. Chakravarty A K , "Immunology and Immunotechnology", Oxford University Press, 2006

**REFERENCES:**

1. Talwar G P, , Gupta S K , "A handbook of practical and clinical immunology", Vol 1 & 2, 2005.
2. Burakoff J S, , Frank Austen K , "Therapeutic Immunology", Blackwell Publications,2001.

## **19B026 BIOFUEL TECHNOLOGY**

**3 0 0 3**

**INTRODUCTION** : Current energy scenario and the need for alternative fuels - overview of biofuel - bioenergy and biorefinery concepts - Biomass sources and classification - Physical and chemical characteristics and potential of different biomass materials - First - second and third generation biofuels. (7)

**BIODIESEL** : Transesterification reaction mechanism - Basics and chemistry of fats and oil - Oil resources and feedstock - Methods for biodiesel production - Types of catalysts employed; heterogeneous catalysis, enzyme based biodiesel - Microalgae based biodiesel - Microalgae cultivation and harvesting methods; Photobioreactor and raceway pond (10)

**BIOETHANOL** : Different feedstock for Bioethanol production - Fermentation process - Sugarcane molasses and other sources for fermentation process. - Lignocellulosic pretreatment methods - Hydrolysis - Hydration – Lignin upgradation - Economics of bioethanol production (10)

**BIO-OIL AND BIOHYDROGEN** : Thermo-chemical conversion of lignocellulose biomass - Biomass processing for liquid fuel production - Biohydrogen production process: Chemical & Biological method; Factors affecting biohydrogen production; Microbial fuel cell & Electrolysis cell - Thermo chemical gasification principles and its application for different biomass treatment. (9)

**BIOGAS TECHNOLOGY** : Feedstock for biogas production - Aqueous wastes containing biodegradable organic matter - animal residues; Microbial and biochemical aspects; Operating parameters for biogas production - Kinetics and mechanism - Dry and wet fermentation (9)

**Total L: 45**

**TEXT BOOKS:**

1. Caye M Drapcho, Nhuan Phu Nghiem , Terry Walker , "Biofuels Engineering Process Technology", McGraw Hill Professional, 2008.
2. David M Mousdale , "Introduction to Biofuels", CRC Press,2010.

**REFERENCES:**

1. Rezaiyan. J , N. P. Cheremisinoff , "Gasification Technologies, A Primer for Engineers and Scientists", Taylor & Francis, 2005.
2. Venkata Ramana P , Srinivas S.N , "Biomass Energy Systems", Tata Energy Research Institute, 1996.
3. Chakraverthy A , "Biotechnology and Alternative Technologies for Utilization of Biomass or Agricultural Wastes", Oxford & IBH publishing Co, 1989.

## **19B027 STUDIES IN PARADIGMATIC DEVELOPMENTS IN BIOLOGY**

**3 0 0 3**

**BIRTH OF MOLECULAR GENETICS** : Reviving the contributions of Mendel; identifying the chromosomal location of the hereditary material; developing facile models to study and experiment: microbial systems, the phage group; Contributions of Morgan, Beadle, Luria and Delbruck. (13)

**BEHAVIORAL GENETICS** : Study of individual and social behavior has always puzzled and promoted learning: vitalists and reflexologists models; inspiring experimental design case studies; insect, bird and fish behavior; Contributions of Lorenz, von Frisch. (8)

**DECODING THE CODE** : Protein synthesis and nucleic acid synthesis; manipulation of genetic material, and extracting the information; deliberations at Asilomar; Contributions of Holley, Nirenberg, Khorana. (12)

**EVOLUTION OF THE GENOME** : Public health and parasite diversity; Unique viral enzymes and pathogenesis discovery. Central role of RNA in biological processes. Contributions of Baltimore, Temin, Altman, Cech. (12)

**Total L: 45**

**TEXT BOOKS:**

1. Lodish, Beck, Kaiser , "Molecular Cell Biology", WH Freeman and Co, New York, 2008.
2. Bruce Alberts , "Molecular Biology of the Cell", Garland Science, Chicago, 2008.

**REFERENCES:**

1. Nobel Lectures , "Articles, Talks, Multimedia", Nobelprize.org, .

**19B028 ADVANCES IN GENOMICS****3 0 0 3**

**RECENT TRENDS IN GENOME SEQUENCING TECHNIQUES** : Next Generation Sequencing, R e and deep sequencing, analysis of deep sequencing data for SNP and miRNA identification and differential expression (7)

**METAGENOMICS** : Techniques and Strategies for metagenomics analysis, use of metagenomic analysis for agriculture, environment and clinical applications -case studies (8)

**EPIGENETICS AND EPIGENOMICS** : Epigenetic and Epigenomic regulation - Techniques used in Epigenomic analysis, ChIP, ChIP on chip,ChIP sequence, ChIP- PCR, bisulfate sequencing, enzyme based methods, NGS based sequencing of the pigenome. Epigenome systems - Human epigenome, epigenomics in plants, fungi, Applications of Epigenomics (12)

**PHARMACOGENOMICS** : Polymorphisms in metabolizers, transporters and receptors and their consequences in drug efficacy and drug discovery -case studies (9)

**CLINICAL GENOMICS** : Databases of diseases namely cancer and Alzheimer's diseases and workflow approaches for data analysis (9)

**Total L: 45****TEXT BOOKS:**

1. Diana Marco , "Metagenomics: Theory, methods, and applications", 1<sup>st</sup> Edition, Caister Academic Press, Norfolk, UK, 2010.
2. Nessa Carey , "The epigenetic regulation", 1<sup>st</sup> Edition, Columbia University Press, UK, 2011.

**REFERENCES:**

1. Robert A Myers , "Epigenetic regulation and epigenomics", Wiley- Blackwell, 2012.
- Allen , "Pharmacogenomics: Applications to Patient Care", American College of Clinical Pharmacy, USA, 2004.

**19B029 SYSTEMS BIOLOGY****3 0 0 3**

**INTRODUCTION TO SYSTEMS BIOLOGY** : Biological Systems, Processes and Techniques - Models and Modelling  
What is Systems Biology? - Basic concepts – Applications - Scope and Future. (3)

**MODELLING THEORY** : Model building - Parameter Estimation - Model testing and Selection - Local & Global Sensitivity Analysis - Model Reduction - Model Combination - Optimisation of Model Output and Structure (10)

**MODELLING AND ANALYSIS OF BIOLOGICAL SYSTEMS AND PROCESSES - I** : Network Modelling: Basics of network and graph theory - Properties and types of Network Structural/Stoichiometric analysis of biochemical systems: Construction of stoichiometric matrices, Flux Balance Analysis, Constraint based models (14)

**MODELLING, AND ANALYSIS OF BIOLOGICAL SYSTEMS AND PROCESSES – II** : Kinetic modeling of biochemical reactions – Construction, simulation and Analysis of ODE Models using rate equations — Case Studies. Other modeling techniques: Stochastic models - Rule based models — Statistical models. (14)

**DATABASES, DATA FORMATS, STANDARDS AND SIMULATION TOOLS** : Internet Databases for Modelling - Systems Biology Markup Language - BioPAX — Systems Biology Graphical Notation — Other standards – Simulation Tools and Software. (4)

**Total L: 45****TEXT BOOKS:**

1. Wolfram Liebermeister, Christoph Wierling, Axel Kowald, Edda Klipp , "Systems Biology: A Text Book", Wiley- Blackwell Publishing., 2016.
2. Eberhard Voit , "A First Course in Systems Biology", Garland Science, 2012.

**REFERENCES:**

1. Brian P Ingalls , "Mathematical Modelling in Systems Biology", MIT press, 2013.
2. Urion Alon , "Introduction to Systems Biology – Design Principles of Biological Systems", CRC press, 2003.

## 19B030 INTRODUCTION TO BIOPOLYMERS

3 0 0 3

**INTRODUCTION:** Classification of biopolymers (natural and mineral origin), Structure and dimensions, Biopolymers of commercial value (Polysaccharides, Poly-esters, Poly-nucleotides), Bottlenecks of synthetic polymers, Biorefinery perspective of Biopolymer Production (4)

**PROPERTIES AND POLYMERIZATION TECHNIQUES :** Physicochemical Properties (Solubility and Viscosity, Emulsifying Properties, Molecular Association, Pharmacological Action, Antioxidant Properties, Antimicrobial action, Surface Functional Properties, Hydrodynamic Properties; Types of Polymerization – Step-Growth, Free Radical, Chain Co-polymerization, Ionic Chain, Coordination Addition (10)

**PRODUCTION AND MECHANISM OF DEGRADATION :** Methods of Production (Coacervation, Interfacial Crosslinking Polymerization, Spray Drying), Types of Sources (Bacteria, Fungi, Algae, Agricultural Waste), Types of Fermentation, Factors affecting fermentation, Pathway of Synthesis, Commercially Viable Types: Starch, Gum Arabica, Gluten, Natural Rubber; Mechanism of Degradation for naturally occurring polymers (12)

**CHARACTERIZATION TECHNIQUES :** Physical and Structural — X-Ray diffraction, Scanning Electron Microscopy, transmission Electron Microscopy, Thermogravimetry, Viscometry, Turbidometry; Electrical Properties — Zeta Potential Analyzer; Elemental - Energy Dispersive X-ray Analysis (EDX), Functional - Fourier Transform Infrared Spectroscopy, Purification and Molecular Weight Analysis - Chromatography (7)

**APPLICATION AND REGULATORY ASSAYS :** Areas of Applications: Drug Delivery, Fuel Cell Applications, Biocontrol of Plant diseases, Tissue Engineering, Biomedical Applications, Wastewater Treatment, Textile Finishing, Green Synthesis of nanoparticles; Regulatory assays: Biodegradation Assays (Die-Away Test, CO<sub>2</sub> Evolution Test, Modified M1T1 Test, Closed Bottle Test, Modified OECD Screening Test, Manometric Respirometry Test) (12)

**Total L: 45**

### TEXT BOOKS:

1. Steinbuechel A Matsumura S , "Biopolymers: Miscellaneous Biopolymers and Biodegradation of Polymers POLYMERS AND BIODEGRADATION OF POLYMERS", Wiley-VCH Verlag GMBH, 2003 Newyork, 2003.
2. Michael Niaounakis , "Biopolymers: Processing and Products (Plastics Design Library)", 1<sup>st</sup> Edition, William Andrew, Norwich, 2014.

### REFERENCES:

1. Schmidtchen F P , "Implementation And Redesign Of Catalytic Function In Biopolymers", Springer-Verlag, New York, 1999.
2. Steven T Case , "Structure, Cellular Synthesis And Assembly Of Biopolymers", Springer-Verlag, Newyork, 1992.

## 19B031 MICROBIAL ECOGENOMICS

3 0 0 3

**INTRODUCTION TO ECOSYSTEMS :** Ecosystems – components, organization and interactions; Factors affecting ecosystems — environmental, physical and chemical; energy flow in ecosystem; Microbial ecology — role of microbes in ecosystems; Interactions of microbes with other organisms and within (6)

**APPLICATION OF GENOMIC TOOLS IN ECOGENOMICS :** Culturable and non-culturable approaches in studying microbial diversity; molecular fingerprinting techniques — ARISA, T-RFLP, DGGE; DNA microarrays — Phylochip, Geochip; next generation sequencing techniques (8)

**ECOGENOMICS OF MARINE ECOSYSTEMS :** Drivers and patterns of marine microbial diversity; Marine food web; Life strategies and adaptation mechanisms of marine microbes — environmental conditions, spatial heterogeneity and nutrient concentrations; Microbial networks in sea; Screening, production and enhancement of bioactive compounds of microbial origin from marine ecosystems (10)

**ECOGENOMICS OF HUMAN GUT MICROBIOME :** Hologenome concept — Microbiota of vertebrates, invertebrates and plants; Transmission of holobionts; Community structure of microbiota in GI; Influence of gut microbiome on human health; Manipulation of human gut microbiota — Prebiotics, Probiotics and Symbionts (9)

**ECOGENOMICS OF EXTREME ENVIRONMENTS :** Extreme environments and their characteristics; Physiology, metabolism and adaptations of extremophilic microorganisms; Case studies on the nucleic acids and thermolabile metabolites in thermophiles, membrane adaptations in psychrophiles, genome and proteome level adaptations in halophiles and ionoenergetic adaptations in alkaliphiles and acidophiles; Commercial production of extremolytes – Compatible solutes, xopolysaccharides and enzymes (12)

**Total L: 45**

### TEXT BOOKS:

1. Diana Marco , "Metagenomics: Current Innovations and Future Trends", 1<sup>st</sup> Edition, Caister Academic Press, London, 2011.
2. Lucas J Stal, Mariana S Cretoiu , "The Marine Microbiome; An Untapped Source of Biodiversity and Biotechnological Potential", 1<sup>st</sup> Edition, Springer International Publishing, Switzerland, 2016.

## REFERENCES:

1. David N Fredricks , "The Human Microbiota", 1<sup>st</sup> Edition, Wiley Blackwell, New Jersey, 2013.
2. Charles Gerday, Nicolas Glansdorff , "Physiology and Biochemistry of Extremophiles", 1<sup>st</sup> Edition, ASM Press, Washington, 2007.
3. Larry L Barton, Diana E Northup , "Microbial Ecology", 1<sup>st</sup> Edition, Wiley and Sons, New Jersey, 2011.

## 19B032 BIOTRANSFORMATION IN DRUG SYNTHESIS

3 0 0 3

**SCOPE OF ENZYMES IN BIOTRANSFORMATION** : Biocatalysts versus chemical catalysis; Understanding when to use a biocatalyst for a chemical problem; Advantages/disadvantages of biocatalysts compared to traditional chemical reactions and heterogeneous/ homogeneous catalysis; Mild reaction conditions, excellent stereo- chemo- and regio- selectivity versus substrate specificity, product inhibition, cofactor recycling; Isolated enzyme systems and whole cell systems; Cell free extract system. (7)

**TYPES OF BIOTRANSFORMATION REACTIONS** : Types of microbial and enzymatic biotransformation reactions: Oxidation, Reduction, Hydrolysis, Condensation, Isomerization, Formation of New C-C Bonds, Synthesis of Chiral Compounds and Reversal of Hydrolytic Reactions. (8)

**BIOTRANSFORMATION OF VITAMINS** : Microbial and Enzymatic biotransformation of vitamins A, B, C, D, E, H and K by various reaction mechanisms. (9)

**BIOTRANSFORMATION OF STEROIDS** : Microbial and Enzymatic biotransformation of steroids by various reaction mechanisms. (8)

**BIOTRANSFORMATION OF ANTIBIOTICS AND XENOBIOTICS** : Xenobiotic biotransformation by phase I enzymes - Biotransformation of drugs. Activation of xenobiotics by cytochrome P450. P450 knockout mice. Inhibition of cytochrome P450. Induction of cytochrome P450. Phase II enzyme reactions. (13)

Total L: 45

## TEXT BOOKS:

1. Klaus Buchholz, Volker Kasche, Uwe Theo Bornscheuer , "Biocatalysts and Enzyme technology", 2<sup>nd</sup> Edition, Wiley-Blackwell, 2012.
2. Kurt Faber , "Biotransformations in Organic Chemistry", 6<sup>th</sup> Edition, Springer-Verlag Berlin Heidelberg, 2011.

## REFERENCES:

1. Faber and Kurt , "Biotransformations in organic chemistry: A Textbook", Springer, 2008.
2. Drauz K, Groger H and May O , "Enzyme catalysis in organic synthesis", 3<sup>rd</sup> Edition, Willey-VCH, 2012.
3. Wolf dieter Fessner and Thorleif Anthonson , "Modern Biocatalysis: Stereoselective and environmental friendly reactions", Willey-VCH, 2009.

## 19B033SYNTHETIC BIOLOGY

3 0 0 3

**INTRODUCTION TO SYNTHETIC BIOLOGY**: Structure, expression and regulation of prokaryotic and eukaryotic systems. Recombinant DNA Technology. Genomics, proteomics, transcriptomics (6)

**COMPONENTS OF SYNTHETIC BIOLOGY**: Design - build – test. Design - Engineering biological components, metabolic engineering - pathway design, phenotype engineering, Xeno biologyBuild – DNA, Oligonucleotides, genes, genetic systems, gene/genome editing. Test – High throughput screening. Designing and encoding models for synthetic biology (12)

**BIOLOGICAL COMPONENTS AND CIRCUITS**: bacterial chemotaxis, noise in development, Circadian oscillation, RNA and Protein circuits, autoregulatory feedback, cascades, Gene circuit design and engineering: Biobricks/BioFAB and designing software , Synthetic circuits beyond bacteria: Phage, virus, and eukaryotes. In vitro/cell-free systems. (12)

**APPLICATIONS OF SYNTHETIC BIOLOGY**: Bio-remediation and microbial biotechnology, Plant and marine biotechnology, Animal biotechnology, Biomedicine and Biomaterials, Biofuels, Medical biotechnology and gene therapy (8)

**REGULATIONS, ETHICS AND IP**: Governance, risk culture, transparency, biosafety, machine metaphors, manipulation Vs creation, Biocontainment , IP -economic viability, legal frame work, iGEM (7)

Total 45

## TEXT BOOKS

1. Primrose and Twyman, Principles of Gene manipulation and Genomics, 7th Edition, Wiley-Blackwel, 2006
2. Freemont, P.S and Kitney, R.I.Synthetic Biology – a Primer. World Scientific Publishing Co pte Ltd., 2012
3. Board on Chemical Sciences and Technology; Board on Life Sciences; Division on Earth and Life Studies; National Academies of Sciences, Engineering, and Medicine, Biodefense in the Age of Synthetic Biology, The National Academies Press, 2018



## REFERENCE

1. Church, G and Regis, E, Regenesi: How Synthetic Biology will Reinvent Nature and Ourselves. Basic Books, 2012.

## LANGUAGE ELECTIVES

### 19G001 COMMUNICATION SKILLS FOR ENGINEERS

0 0 4 2

#### COMMUNICATION CONCEPTS :

Process of Communication  
Inter and Intrapersonal Communication  
Inter and Intrapersonal Communication Activities

(9)

#### FOCUS ON SOFT SKILLS :

Etiquette — Work Place etiquette — Telephone etiquette  
Body Language  
Persuasive Communication  
Public Speaking  
Critical Reasoning and Conflict Management based on Case Studies  
Group Communication  
Meetings  
Interview Techniques

(14)

#### TECHNICAL WRITING :

Technical Writing Principles  
Style and Mechanics  
Technical Definitions – Physical, Functional and Process Descriptions  
Technical Report Writing  
Preparing Instructions and Manuals  
Interpretation of Technical Data

(15)

#### BUSINESS CORRESPONDENCE :

Writing Emails  
Preparing Resumes  
Memos  
Technical and Business Proposals

(7)

#### TECHNICAL COMMUNICATION :

Seminars  
Process Description and Group Discussions  
Use of Visual Aids

(15)

**Total P: 60**

#### TEXT BOOKS:

1. Faculty Incharge "Course Material on "Communication Skills for Engineers"", PSG College of Technology., Coimbatore, 2019

#### REFERENCES:

1. Jeff Butterfield "Soft Skills for Everyone", Cengage Learning., New Delhi, 2013
2. Jean Naterop B and Rod Revell "Telephoning in English", Cambridge University Press., Cambridge, 2011
3. David A Mc Murrey and Joanne Buckley "Handbook for Technical Writing", Cengage Learning., New Delhi, 2011
4. Simon Sweeney "English for Business Communication", Cambridge University Press., New Delhi, 2012

### 19G002 GERMAN- LEVEL A1.1

0 0 4 2

#### GUTEN TAG! :

1. To greet, learn numbers till 20, practice telephone numbers & e mail address, learn alphabet, speak about countries & languages
2. Vocabulary: related to the topic
3. Grammar: W — Questions, Verbs & Personal pronouns I.

(10)

#### FREUNDE, KOLLEGEN UND ICH :

1. To speak about hobbies, jobs, learn numbers from 20; build dialogues and frame simple questions & answers

2. Vocabulary: related to the topic
  3. Grammar: Articles, Verbs & Personal pronouns II, sein & haben verbs, ja/nein Frage, singular/plural
- (10)

**IN DER STADT :**

1. To know places, buildings, question, know transport systems, understand international words; build dialogues and write short sentences
  2. Vocabulary: related to the topic
  3. Grammar: Definite & indefinite articles, Negotiation, Imperative with Sien verbs
- (12)

**GUTEN APPETIT! :**

1. To speak about food, shop, converse; Vocabulary: related to the topic; build dialogues and write short sentences
  2. Grammar: Sentence position, Accusative, Accusative with verbs, personal pronouns & prepositions, Past tense of haben & sein verbs
- (13)

**TAG FÜR TAG/ZEIT MIT FREUNDEN :**

1. To learn time related expressions, speak about family, about birthdays, understand & write invitations, converse in the restaurant; ask excuse, fix appointments on phone
  2. Vocabulary: related to the topic
  3. Grammar: Time related prepositions, Possessive articles, Modalverbs
- (15)

**Total P: 60**

**TEXT BOOKS:**

1. Dengler Stefanie "Netzwerk A1.1", Klett-Langenscheidt GmbH., München, 2013
2. Sandra Evans, Angela Pude "Menschen A1", Hueber Verlag., Germany, 2012

**REFERENCES:**

1. Stefanie Dengler "Netzwerk A1", Klett-Langenscheidt GmbH., München, 2013
2. Hermann Funk, Christina Kuhn "Studio d A1", Goyal Publishers & Distributors Pvt. Ltd., New Delhi, 2009
3. Rosa-Maria Dallapiazza "Tangram Aktuell 1 (Deutsch als Fremdsprache)", Max Hueber Verlag., Munchen, 2004
4. Christiane Lemcke und Lutz Rohrmann "Grammatik Intensivtrainer A 1", Goyal Publishers & Distributors Pvt. Ltd., New Delhi, 2012

**19G003 FRENCH LANGUAGE LEVEL 1**

**0 0 4 2**

**PARTS OF SPEECH :**

1. inviter et répondre à une invitation, Pronoms sujets
  2. L'article définis, l'article indéfinis
  3. Conjugation : présent, adjectifs possessifs
  4. interrogation, décrire les personnes
  5. La vie de quatre parisiens de professions différentes
- (12)

**ELEMENTS OF GRAMMAR :**

1. Exprimer l'ordre et l'obligation demander et commander
  2. l'adjectif possessifs, l'article partitif, l'article démonstratif, négation ne
  3. pas, l'article contracté
  4. verbe pronominaux
  5. prepositions
- (12)

**SENTENCE STRUCTURE :**

1. Raconter et reporter-donner son avis
  2. Futur simple, pronom complètement d'objet direct, passé composé
  3. plusieurs région de France, imparfait, pronom y/en, imparfait
- (12)

**TENSES AND NUMBERS :**

1. Demander l'autorisation-passé récent, futur proche
  2. La vie administrative et régionale, Pluriel des noms, moyens de transport
- (12)

**DISCOURSE :**

1. le discours rapporté, décrire un lieu, exprimer ses préférences
2. décrire la carrière, discuter d'un système éducation de France
3. parler de la technologie de l'information

(12)

**Total P: 60**

**TEXT BOOKS:**

1. Christine Andant étal "À propos (livre de l'élève", LANGER., NEW DELHI, 2012
2. Myrna Bell Rochester "Easy French Step By Step", MCGrawhill Companies., USA, 2008

**REFERENCES:**

1. Michael D. Oates "Entre Amis: An Interactive Approach", Houghton Mifflin., 2005 , 5th
2. Bette Hirsch, Chantal Thompson "Moments Literaries : An Anthology for intermediate French", ..
3. Simone Renaud, Dominique van Hooff "En bonne forme", ..

**19G004 BASIC JAPANESE**

**0 0 4 2**

**JAPANESE PEOPLE AND CULTURE :**

1. Basic greetings and responses
2. Basic script — Method of writing hiragana and katakana — Combination sounds and simple words
3. Selfintroductions: "Hajimemashite"-Demonstratives "Kore", "Sore", "Are"— Demonstrative "Kono", "Sono", "Ano"
4. Possessive noun particle "no" — Japanese apartments: Greeting your neighbor

(12)

**PATICLE "NI (AT)" FOR TIME :**

1. kara (from) ~ made(until) — Particle "to (and)"
2. Time periods: Days of the week, months, time of day -Verbs (Present / future and pasttense)
3. Telephone enquiry: Asking for a phone no. And business hours- Destination particle "e".

(12)

**LIKES AND DISLIKES :**

1. Potential verbs (wakarimasu and dekimasu) — "Kara ( ~ because)"
2. Adverbs — Asking some one out over the phone-Verbs denoting presence
3. Introduction to Adjectives (na and ii type) -Verb groups — I, II and III — Exercises to group verbs- Please do (te kudasai)
4. Present continuous tenses (te imasu) — Shall I? ( ~ mashou ka) — Describing a natural phenomenon (It is raining)

(12)

**DIFFERENT USAGES OF ADJECTIVES :**

1. Comparison — Likes and dislikes — Going to a trip- Need and desire (ga hoshii) — Wanting to . . . (Tabeti desu)- Going for a certain purpose (mi -ni ikimasu)
2. Choosing from a menu-Adjectives ("i" and "na" type) — Adjectives (Positive and negative useage)

(12)

**ROLE PLAYS IN JAPANESE :**

1. Framing simple questions & answers
2. Writing Short paragraphs & Dialogues
3. A demonstration on usage of chopsticks and Japanese tea party

(12)

**Total P: 60**

**TEXT BOOKS:**

1. Minna no Nihongo, Honsatsu Roma "ji ban (Main Textbook Romanized Version)", . International publisher — 3A Corporation., Tokyo, 2012

**REFERENCES:**

1. Eri Banno et.al "Genki I: An Integrated Course in Elementary Japanese I -Workbook", .. 1999
2. Tae Kim "A Guide to Japanese Grammar: A Japanese Approach to Learning Japanese Grammar", .. 2014
3. Minna No Nihongo "Translation & Grammatical Notes In English Ele

**ONE CREDIT COURSES**

**ENGLISH**

**19GF01 INTERPERSONAL AND ORGANIZATIONAL COMMUNICATION**

**1 0 0 1**

**INTRA ORGANIZATIONAL COMMUNICATION :** Communication Networks in an Organization; Intra- organizational communication (2)

**INTER ORGANIZATIONAL COMMUNICATION :** Flow Nomenclature; Workplace diversity and intercultural aspects of communication (2)

**COMMUNICATION FUNCTIONS IN ORGANIZATIONS** : Teamwork and team dynamics; Conflict resolution strategies and styles; Leading and influencing others-facilitation skills (3)

**WRITTEN COMMUNICATION** : Email Writing, Professional Reports, and Memos (4)

**INTERPERSONAL SKILLS** : Nature and Dimensions of Interpersonal Communication; Personality and Communication styles; Active listening and intentional responding; Working with emotional intelligence (4)

**Total L: 15**

**REFERENCES:**

1. Bagchi Subroto , "The Professional", Penguin Publications, UK, 2011.
2. PMBOK guide , "A Guide to the Project Management Body of Knowledge", Project Management Institute Inc, USA, 2013.

## **19GF02 HUMAN VALUES THROUGH LITERATURE**

**1 0 0 1**

**PROSE** : Kalam's vision of college education in Wings of fire - Emerson's advocacy of independence of Human will in Self-reliance - Harmony in Education-views of Bertrand Russel (4)

**POETRY** : Maintaining Human relations in Robert Frost's Mending Wall - Quest for identity and freedom in Kamala Das's An Introduction (2)

**DRAMA** : Statesmanship and friendship in Girish Karnad's Tughlaq (3)

**ONE-ACT PLAY** : The theme of love in Chekhov's The Bear (3)

**SHORT STORY** : Empathy in Somerset maugham's Mr. Know-all - Family bond in Anita Desai's Devoted son (3)

**Total L: 15**

**TEXT BOOKS:**

1. Faculty - Department of English , "Course materials", PSG College of Technology, Coimbatore, 2019.

**REFERENCES:**

1. Abrams M .H, Harpham , "A Glossary of Literary Terms", Cengage, Boston, 2015.
2. Scholes R, et.al. , "Elements of Literature", IV, Indian Rpt. OUP, New Delhi, 2013.

## **HUMANITIES**

### **19OFA1 EXPORT – IMPORT PRACTICES**

**1 0 0 1**

**INTRODUCTION** : Export – Import Business – Preliminaries for starting Export – Import Business Registration. (3)

**EXPORT PROCEDURES** : : Obtaining an Export License – Export Credit Insurance – Procedures and Documentation (4)

**FOREIGN EXCHANGE** : Finance for Exports – Pricing - Understanding Foreign Exchange Rates. (3)

**IMPORT PROCEDURES** : Import Policy – License - Procedure and Documentation. (3)

**EXPORT INCENTIVES** : Incentives - Institutional support (2)

**Total L: 15**

**REFERENCES:**

1. Ramagopal C , "Export Import Procedures - Documentation and Logistics", New Age International, 2014.
2. Cherian and Parab , "Export Marketing", Himalaya Publishing House, New Delhi, 2008.
3. Parul Gupta , "Export Import Management", MC-Graw Hill, 2017.
4. Justin Paul, Rajiv Aserkar , "Export Import Management", Oxford, 2013.

## 190FA2 INSURANCE - CONCEPTS AND PRACTICES

1 0 0 1

**INTRODUCTION TO INSURANCE AND RISK MANAGEMENT** : Origin, History, Nature and Scope of insurance – Meaning, types and significance of risk. (3)

**INSURANCE LAWS AND REGULATIONS** : Insurance Act, IRDA Act, Consumer Protection Act, Ombudsman Scheme. (2)

**INSURANCE UNDERWRITING AND RISK MANAGEMENT** : Meaning of underwriting and underwriter, guidelines and steps in the process of underwriting – characteristics, significance and principles of risk management. (4)

**FINANCIAL ASPECTS OF INSURANCE MANAGEMENT** : Role and functions of financial institutions, determination of premium for various insurance products. (3)

**SETTLEMENT OF INSURANCE CLAIMS** : Documents needed during various claims, Factors affecting insurance claims (3)

**Total L: 15**

### REFERENCES:

1. Scott Harrington, Gregory Niehaus , "Risk Management and Insurance", McGraw Hill Education, 2017.
2. George E Rejda , "Principles of Risk Management & Insurance", Pearson Education, 2017.
3. John Hull , "Risk Management & Financial Institution", John Wiley and Sons, 2018.
4. Arjun Mittal, D D Chaturvedi , "Insurance and Risk Management", Scholar Tech Press, 2017.

## 190FA3 PUBLIC FINANCE

1 0 0 1

**INTRODUCTION:** Nature and Scope of public finance – Principles of taxation. (2)

**PUBLIC REVENUE AND TAXATION:** Sources of Revenue – Tax and non-tax revenue – Classification of Taxes, GST. (4)

**PUBLIC EXPENDITURE:** Importance – Types – Causes of increase in public expenditure – Effects of public expenditure in India. (3)

**DEFICIT FINANCING AND BUDGET:** Sources of public debt – Debt redemption – Budget – Types – Preparation of Budget in India. (3)

**FEDERAL FINANCE:** Centre-State financial relations – Finance commissions. (3)

**TOTAL: 15**

### REFERENCE BOOKS:

1. Richard A Musgrave and Peggy B Musgrave, "Public Finance in Theory and Practice" – Tata McGraw Hill Education, New Delhi, 2004.
2. Bhatia H.L, "Public Finance" – Vikas Publishing House, 29th Edition, New Delhi, 2012.
3. David N Hyman, "Public Finance: A contemporary application of theory and policy", Cengage Publication, 11th Edition, Noida, 2014.
4. Santhosh Dalvi and Krishnan Venkatasubramanian, "An introduction to Goods and Service Tax: The biggest tax reform in India", CCH Publisher, New Delhi, 2015.

## 190FA4 SECURITY ANALYSIS AND PORTFOLIO MANAGEMENT

1 0 0 1

- INVESTMENT ENVIRONMENT** : Financial Markets - Classification - Financial Instruments – Security Trading. (2)
- TYPES OF SECURITIES** : Trading – Orders, Margin Trading – Clearing and Settlement Procedures. (5)
- SECURITY ANALYSIS I** : Industry Analysis –Estimation of Rates of Return. (2)
- SECURITY ANALYSIS II** : Company Analysis — Estimation of Rates of Return. (2)
- PORTFOLIO MANAGEMENT** : Measuring Risk and Returns and Treatment in Portfolio Management. (4)

**Total L: 15**

**REFERENCES:**

1. William F Sharpe, Gordon J. Alexander, Jeffery V Bailey , "Investments", Prentice Hall, 2012.
2. Prasanna Chandra , "Investment Analysis and Portfolio Management", TATA McGraw Hill Publishing, 2011.
3. Ranganathan , "Investment Analysis and Portfolio Management", Pearson, 2004.
4. Bhalla V K , "Investment Management", TATA McGraw Hill Publishing, 2011

**190FA5SOCIAL ENTREPRENEURSHIP**

**1 0 0 1**

**INTRODUCTION TO SOCIAL ENTREPRENEURSHIP:** Social Entrepreneur - Meaning, qualities and skills. Social Entrepreneurship – Characteristics, process and ecosystem – Case Studies. (3)

**SOURCES OF FUNDING FOR SOCIAL ENTREPRENEURSHIP:** The Social Entrepreneurship Frame work. Start-ups and funding - Internal and External. Schemes for social entrepreneurship. (4)

**STRATEGIES IN SOCIAL ENTREPRENEURSHIP:**Industry and Market Analysis, Business planning, concepts of value creation,new ideas and risk taking. (4)

**PROSPECTS AND PROBLEMSIN SOCIAL ENTREPRENEURSHIP:** Opportunities for Social entrepreneurs, an overview of legal structure, tax structure and other liabilities. (4)

**TOTAL: 15**

**REFERENCE BOOKS:**

- 1.S.S.Khanka, "Creativity and Innovation in Entrepreneurship", Sultan Chand & Sons, 2021.
- 2.C. Paramasivan, "Social Entrepreneurship", New Century Publications, 2016.
- 3.Robert A. Philips Margret Bonefiel Ritesh Sharma, "Social entrepreneurship, the next big business opportunity", Global Vision Publishing House, 2011.
- 4.Drucker, Peter, "Innovation and Entrepreneurship", Harper Business, 2006.