BIJU PATNAIK UNIVERSITY OF TECHNOLOGY, ORISSA

Biotechnology Engineering

3rd Semester

Theory **Contact Hours**

Code	Subject	L-T-P	Credit
BSCM1205	Mathematics - III	3- 1- 0	4
BSCP1206	Physics II	3- 0- 0	3
	OR		
BSCP1207	Physics of Semiconductor Devices		
BECS2212	C++ & Object Oriented Programming	3- 0- 0	3
HSSM3204	Engineering Economics& Costing	3- 0- 0	3
	OR		
HSSM3205	Organisational Behavior		
BEME2209	Fluid Mechanics & Machines	3- 0- 0	3
PCBT4201	Biochemistry	3- 0- 0	3
	Theory Credits	**19**	

Practical/ Sessional

HSSM7203	COMMUNICATION AND INTERPERSONAL SKILLS FOR CORPORATE READINESS	0- 0- 3	2
BECS7212	C++ & Object Oriented Programming Lab	0- 0- 3	2
PCBT7201	Biochemistry Lab	0- 0- 3	2
PCME7202	Mechanical Engg. Lab	0- 0- 3	2

TOTAL SEMESTER CREDITS 27

4th Semester

Theory **Contact Hours**

Code	Subject	L-T-P	Credit
PCBT4202	Cell Biology & Genetics	3- 1- 0	4
BSCC1208	Chemistry II	3- 0- 0	3
	OR		
BSMS1209	Material Sciences		
BECS2208	Database Management System	3- 0- 0	3
HSSM3205	Organisational Behavior	3- 0- 0	3
	OR		
HSSM3204	Engg. Economics & Costing		
PCBT4203	Micro Biology	3- 1- 0	4
PCBT4204	Molecular Biology	3- 1- 0	3
	Theory Credits		**20**

Practical/ Sessional

BECS7208	Database Management System Lab.	0- 0- 3	2
PCBT7204	Cell & Molecular Biology Lab	0- 0- 3	2
PCBT7203	Microbiology Lab	0- 0- 3	2

TOTAL SEMESTER CREDITS 26

BSCM1205 **Mathematics - III**

Module-I **(18 hours)**

Partial differential equation of first order, Linear partial differential equation, Non-linear partial differential equation, Homogenous and non-homogeneous partial differential equation with constant co-efficient, Cauchy type, Monge's method, Second order partial differential equation The vibrating string, the wave equation and its solution, the heat equation and its solution, Two dimensional wave equation and its solution, Laplace equation in polar, cylindrical and spherical coordinates, potential.

Module-II **(12 hours)**

Complex Analysis:
Analytic function, Cauchy-Riemann equations, Laplace equation, Conformal mapping, Complex integration: Line integral in the complex plane, Cauchy's integral theorem, Cauchy's integral formula, Derivatives of analytic functions

Module –III **(10 hours)**
Power Series, Taylor's series, Laurent's series, Singularities and zeros, Residue integration method, evaluation of real integrals.

Text books:

1. E. Kreyszig," Advanced Engineering Mathematics:, Eighth Edition, Wiley India Reading Chapters: 11,12(except 12.10),13,14,15
2. B.V. Ramana, " Higher Engineering Mathematics", McGraw Hill Education, 2008 Reading chapter: 18

Reference books:

1. E.B. Saff, A.D.Snider, " Fundamental of Complex Analysis", Third Edition, Pearson Education, New Delhi
2. P. V. O'Neil, "Advanced Engineering Mathematics", CENGAGE Learning, New Delhi

BSCP1206 **PHYSICS-II**

This one semester physics course is divided into three (Modules). Module-I deals with some aspects of nuclear accelerators, Module-II introduces certain features of condensed matter physics and Module-III deals with certain aspects of fibre optics and different types of lasers and crystal defects.

Module-I

This unit covers the basic principles and applications of different types of accelerators and their important applications.

Need for nuclear accelerators.

D.C. Accelerators: Cockcroft-Walton, Van de Graff, Tandem accelerators.

R.F. Accelerators: Linear accelerators, cyclotrons, electron accelerator, betatron.

Application of nuclear accelerators - Production of radio isotopes, Radiation processing of materials, medical applications.

This unit covers the basic principle, properties of nanoparticles.

Nanoparticles.

Properties, Classification & characterization of nanoparticles, fabrication of nanoparticles, Structure of carbon nanotubes, types of carbon nanotubes, Properties of (Electrical, thermal) carbon nanotubes, Quantum Dots.

Module-II

Study of crystal structure by diffractions methods, Bragg's condition for crystal diffraction, Laue's Condition, Miller indices, Reciprocal laltice, Geometrical Structure factor, Atomic form factor.

Energy bands in solids: Kronig-Penney model, allowed bands and forbidden gaps, elemental and compound semiconductors.

Superconductivity: Superconductors and their properties, Meisner's effect, Type-I and Type-II superconductors, thermodynamic properties of superconductors, London equation, Application of superconductors

Module-III

Defects in crystal:-Schottky and Frenkel defects, color centres, dislocation.

Laser: - Principle of lasing, Properties of laser, Ruby laser, He-Ne laser, semiconductor laser(construction and working). Application of laser.

LED: Principle, construction of operation and application, Introduction to fiber optics, basic characteristics of optical fibers, optical fibre communication system.

Books Recommended

Text books

(1) Concepts in Engineering Physics,Md.N.Khan
(2) Physics-II, B.B.Swain, P.K.Jena.

Reference Books

(3).Principles of Nanotechnology, Phani Kumar
(4) Physics-II, Randhir Singh, Shakti Mohanty,
(5) Physics-II, A.Serway,W.Jewett
(6) Solid state Physics, W.Ashcroft, N.David Mermin,
(7) Introduction to Solid State Physics, C.Kittel,
(8) Solid State Physics, Dan Wei

BSCP 1207 **Physics of Semiconductor Devices**

Module-I (10 Hours)

1. **Introduction to the quantum theory of solids**: Formation of energy bands, The k-space diagram (two and three dimensional representation), conductors, semiconductors and insulators.
2. **Electrons and Holes in semiconductors:** Silicon crystal structure, Donors and acceptors in the band model, electron effective mass, Density of states, Thermal equilibrium, Fermi-Dirac distribution function for electrons and holes, Fermi energy. Equilibrium distribution of electrons & holes: derivation of *n* and *p* from D(E) and f(E), Fermi level and carrier concentrations, The *np* product and the intrinsic carrier concentration. General theory of *n* and *p*, Carrier concentrations at extremely high and low temperatures: complete ionization, partial ionization and freeze-out. Energy-band diagram and Fermi-level, Variation of E_F with doping concentration and temperature.
3. **Motion and Recombination of Electrons and Holes:** Carrier drift: Electron and hole mobilities, Mechanism of carrier scattering, Drift current and conductivity.

Module II (11 Hours)

4. **Motion and Recombination of Electrons and Holes (continued):** Carrier diffusion: diffusion current, Total current density, relation between the energy diagram and potential, electric field. Einstein relationship between diffusion coefficient and mobility. Electron-hole recombination, Thermal generation.
5. **PN Junction:** Building blocks of the pn junction theory: Energy band diagram and depletion layer of a pn junction, Built-in potential; Depletion layer model: Field and potential in the depletion layer, depletion-layer width; Reverse-biased PN junction; Capacitance-voltage characteristics; Junction breakdown: peak electric field. Tunneling breakdown and avalanche breakdown; Carrier injection under forward bias-Quasi-equilibrium boundary condition; current continuity equation; Excess carriers in forward-biased pn junction; PN diode I-V characteristic, Charge storage.
6. **The Bipolar Transistor:** Introduction, Modes of operation, Minority Carrier distribution, Collector current, Base current, current gain, Base width Modulation by collector current, Breakdown mechanism, Equivalent Circuit Models - Ebers -Moll Model.

Module III (12 Hours)

7. **Metal-Semiconductor Junction:** Schottky Diodes: Built-in potential, Energy-band diagram, I-V characteristics, Comparison of the Schottky barrier diode and the pn-junction diode. Ohmic contacts: tunneling barrier, specific contact resistance**.**
8. **MOS Capacitor:** The MOS structure, Energy band diagrams, Flat-band condition and flat-band voltage, Surface accumulation, surface depletion, Threshold condition and threshold voltage, MOS C-V characteristics, Q_{inv} in MOSFET.
9. **MOS Transistor:** Introduction to the MOSFET, Complementary MOS (CMOS) technology, V-I Characteristics, Surface mobilities and high-mobility FETs, JFET, MOSFET V_t, Body effect and steep retrograde doping, pinch-off voltage,

Text Books:

1. Modern Semiconductor Devices for Integrated Circuits, Chenming Calvin Hu, Pearson Education/Prentice Hall, 2009.
2. Semiconductor Physics and Devices, 3rd Edition, Donald A. Neamen, Tata McGraw Hill Publishing Company Limited, New Delhi.

Reference Books:

1. Fundamentals of Semiconductor Devices, M.K. Achuthan and K.N. Bhatt, Tata McGraw Hill Publishing Company Limited, New Delhi.
2. Solid State Electronics Devices, 6th Edition, Ben. G. Stretman and Sanjay Banarjee, Pearson Educ, New Delhi.
3. Physics of Semiconductor Devices, 3rd Edition, S.M. Sze and Kwok K. Ng, Wiley India Pvt. Limited, New Delhi.
4. Physics of Semiconductor Devices, 2nd Edition, Dillip K. Roy, University Press (India) Pvt. Ltd., Hyderabad.
5. Solid State Electronics Devices, D.K. Bhattacharya and Rajnish Sharma, Oxford University Press, New Delhi.

BECS2212 C++ & Object Oriented Programming

Module I **(08 hrs)**

Introduction to object oriented programming, user defined types, structures, unions, polymorphism, encapsulation. Getting started with C++ syntax, data-type, variables, strings, functions, default values in functions, recursion, namespaces, operators, flow control, arrays and pointers.

Module II **(16 hrs)**

Abstraction mechanism: Classes, private, public, constructors, destructors, member data, member functions, inline function, friend functions, static members, and references.
Inheritance: Class hierarchy, derived classes, single inheritance, multiple, multilevel, hybrid inheritance, role of virtual base class, constructor and destructor execution, base initialization using derived class constructors.
Polymorphism: Binding, Static binding, Dynamic binding, Static polymorphism: Function Overloading, Ambiguity in function overloading, Dynamic polymorphism: Base class pointer, object slicing, late binding, method overriding with virtual functions, pure virtual functions, abstract classes.
Operator Overloading: This pointer, applications of this pointer, Operator function, member and non member operator function, operator overloading, I/O operators.
Exception handling: Try, throw, and catch, exceptions and derived classes, function exception declaration.

Module III **(08 hrs)**

Dynamic memory management, new and delete operators, object copying, copy constructor, assignment operator, virtual destructor.
Template: template classes, template functions.
Namespaces: user defined namespaces, namespaces provided by library.

Text Books:

1. Object Oriented Programming with C++ - E. Balagurusamy, McGraw-Hill Education (India)
2. ANSI and Turbo C++ - Ashoke N. Kamthane, Pearson Education

Reference Books:

1. Big C++ - Wiley India
2. C++: The Complete Reference- Schildt, McGraw-Hill Education (India)
3. "C++ and Object Oriented Programming" – Jana, PHI Learning.
4. "Object Oriented Programming with C++ "- Rajiv Sahay, Oxford
5. Mastering C++ - Venugopal, McGraw-Hill Education (India)
6. "Object Oriented Programming with C++", David Parsons, Cengage Learning.

HSSM3204 Engineering Economics & Costing

Module-I: **(12 hours)**

Engineering Economics – Nature and scope, General concepts on micro & macro economics. The Theory of demand, Demand function, Law of demand and its exceptions, Elasticity of demand, Law of supply and elasticity of supply. Determination of equilibrium price under perfect competition (Simple numerical problems to be solved). Theory of production, Law of variable proportion, Law of returns to scale.

Module-II: **(12 hours)**

Time value of money – Simple and compound interest, Cash flow diagram, Principle of economic equivalence. Evaluation of engineering projects – Present worth method, Future worth method, Annual worth method, internal rate of return method, Cost-benefit analysis in public projects. Depreciation policy, Depreciation of capital assets, Causes of depreciation, Straight line method and declining balance method.

Module-III: **(12 hours)**

Cost concepts, Elements of costs, Preparation of cost sheet, Segregation of costs into fixed and variable costs. Break-even analysis-Linear approach. (Simple numerical problems to be solved)

Banking: Meaning and functions of commercial banks; functions of Reserve Bank of India. Overview of Indian Financial system.

Text Books:

1. Riggs, Bedworth and Randhwa, "Engineering Economics", McGraw Hill Education India.
2. D.M. Mithani, Principles of Economics.

Reference Books :

1. Sasmita Mishra, "Engineering Economics & Costing ", PHI
2. Sullivan and Wicks, " Engineering Economy", Pearson
3. R.Paneer Seelvan, " Engineering Economics", PHI
4. Gupta, " Managerial Economics", TMH
5. Lal and Srivastav, " Cost Accounting", TMH

HSSM 3205 **Organizational Behaviour**

Module I :

The study of Organizational Behaviour : Defination and Meaning, Why Study OB
Learning – Nature of Learning, How Learning occurs, Learning and OB.
Foundations of Individual Behaviour : Personality – Meaning and Defination, Determinants of Personality, Personality Traits, Personality and OB.
Perception – Meaning and Definition, Perceptual Process, Importance of Perception in OB. Motivation – Nature and Importance, Herzberg's Two Factor Theory, Maslow's Need Hierarchy Theory, Alderfer's ERG Theory, Evaluations.

Module II :

Organizational Behaviour Process : Communication – Importance, Types, Gateways and Barriers to Communication, Communication as a tool for improving Interpersonal Effectiveness, Groups in Organizations – Nature, Types, Why do people join groups, Group Cohesiveness and Group Decision-making Managerial Implications, Effective Team Building. Leadership-Leadership & Management, Theories of Leadership-Trait theory, Leader Behaviour theory, Contingency Theory, Leadership and Followership, How to be an effective Leader, Confict-Nature of Conflict and Conflict Resolution. An Introduction to Transactional Analysis (TA).

Module-III :

Organization : Organizational Culture – Meaning and Definition, Culture and Organizational Effectiveness. Introduction to Human Resource Management-Selection, Orientation, Training and Development, Performance Appraisal, Incentives Organizational Change – Importance of Change, Planned Change and OB techniques. International Organisational Behaviour – Trends in International Business, Cultural Differences and Similarities, Individual and Interpersonal Behaviour in Global Perspective.

Text Books :

1. Keith Davis, Organisational Behaviour, McGraw-Hill.
2. K.Aswathappa, Organisational Behaviour, Himalaya Publishing House.

Reference Books :

1. Stephen P. Robbins, Organisational Behaviour, Prentice Hall of India
2. Pradip N. Khandelwal, Organizational Behaviour, McGraw-Hill, New Delhi.
3. Uma Sekaran, "Organizational Behaviour", TATA McGraw-Hill, New Delhi.
4. Steven L McShane, Mary Ann Von Glinow, Radha R Sharma" Organizational Behaviour" , TATA McGraw- Hill.
5. D.K. Bhattachayya, "Organizational Behaviour", Oxford University Press
6. K.B.L.Srivastava & A.K.Samantaray, "Organizational Behaviour" India Tech
7. Kavita Singh, "Organizational Behaviour", Pearson

BEME2209 **Fluid Mechanics & Machines**

Module I **(12 Lectures)**

Introduction : Scope of fluid mechanics and its development as a science

Physical property of Fluid: Density, specific gravity, specific weight, specific volume, surface tension and capillarity, viscosity, compressibility and bulk modulus, Fluid classification.

Fluid static Pressure, Pascal's Law, Pressure variation for incompressible fluid, atmospheric pressure, absolute pressure, gauge pressure and vacuum pressure, manometer.

Hydrostatic process on submerged surface, force on a horizontal submerged plane surface, force on a vertical submerged plane surface.

Buoyancy and flotation, Archimedes' principle, stability of immersed and floating bodies, determination of metacentric height.

Fluid kinematics : Introduction, description of fluid flow, classification of fluid flow. Acceleration of fluid particles, flow rate and continuity equation, differential equation of continuity,

Module II **(10 Lectures)**

Fluid dynamics : Introduction, Euler's equation along a streamline, energy equation, Bernoulli's equation,

Hydraulic Measurements: Water level measurements, velocity measurements, discharge measurements, venturimeter, orifice meter, current meter, pitot tube, orifice, notch and weir.

Module III **(14 Lectures)**

Hydraulic turbines and pumps: Impulse and reaction turbines, construction and working principle of tangential, radial and axial type turbines. Power of turbines, efficiency of turbines. Construction and working principles of centrifugal type pumps. Power and efficiency of the pump. Positive displacement pump.

Hydraulic systems: hydraulic accumulator, hydraulic intensifier, hydraulic ram, hydraulic lift, hydraulic crane, hydraulic press, hydraulic torque converter.

Text Books

1. Fluid Mechanics and hydraulic machines, Modi & Seth
2. Hydraulics fluid machines and fluid machines by S. Ramamrutham

Reference Books:

1. Fluid Mechanics by A.K. Mohanty, PHI
2. Introduction to Fluid Mechanics by Fox and McDonald, Willey Publications
3. Fluid Mechanics by Kundu, Elsevier
4. An Introduction to Fluid Dynamics by G.K.Batchelor, Cambridge University Press
5. Engineering Fluid Mechanics by Garde et. al., Scitech
6. Fluid Mechanics by J.F.Douglas, J.M.Gasiorek, J.A.Swaffield and L.B.Jack, Pearson Education.

PCBT4201 **Biochemistry**

Module-I **(16 Hr.)**

Introduction to Biomolecules:
Structure and Function of Carbohydrates: Monosaccharide, Oligosaccharides, Polysaccharides (Starch, Glycogen, Cellulose), Optical Isomerism;
Structure and Function of Lipids: Saturated and Unsaturated Fatty Acids, Triacylglycerols, Phosphoglycerides, Sphingolipids, Waxes and Sterol;
Structure and Function of Proteins: 20 Amino acids, Peptide bond, Hierarchy of protein architecture, Ramachandran Plot, 3-D structure;
Structure and Function of Nucleic Acids: DNA, RNA, Double Helix Model of DNA, Denaturation and Renaturation DNA;
Structure and function of Hormones, Minerals and Vitamins; Bio-complexes: Nucleoproteins, Glyco-proteins, Lipoproteins and Vitamin complexes.

Module-II **(12Hr.)**

Principle of Bioenergetics: Bioenergetics and Thermodynamics; Phosphoryl group transfer and energy currency-ATP; Biological Oxidation and reduction reactions
Metabolism-I: Introduction to metabolic processes;
Metabolism of Carbohydrates: Glycolysis, TCA Cycle, ETS and Oxidative Phosphorylation, HMP pathway, Gluconeogenesis , Glycogen metabolism;
Metabolism of Lipids: Anabolism (Saturated and Unsaturated), Catabolism (α- Oxidation, β-Oxidation) and Energetics of lipid metabolism;
Metabolism Of Nucleic Acids: Catabolism and anabolism of purine and pyrimidine nucleotides.

Module-III **(12Hr.)**

Metabolism-II: Metabolism of proteins: Properties of Amino acids, Biosynthesis of amino acids (Valine, Serine, Histidine and Glutamic Acid); Protein Catabolism (Genetic code and Protein synthesis); Protein Turnover, Protein Targetting.
Enzymes: Properties of Enzyme, Classification of Enzymes, Mechanism of enzyme action, Kinetics of of enzyme action, Activation energy, Enzyme Inhibition, Coenzyme, Apozyme and Holozyme

Text Book

1. Principle of Bio-Chemistry – Lehinger, Nelson and Cox
2. Biochemistry of Biochemistry by L. Stryer
3. Fundamentals of Biochemistry – Voet & Voet
4. Biochemistry by Zubay.
5. Biochemistry, C.B.Powar & G.R.Chatwal, Himalaya Publishing House.
6. Biochemistry, Rastogi, Tata McGraw Hill.

HSSM7203 Communication & Interpersonal skills for Corporate Readiness Lab.

Lab **30 hours**

This course will focus on communication in professional (work-related) situations of the kind that BPUT graduates may expect to encounter on entering the professional domain.

Some typical forms of work-related communication, oral or written, are listed below. Practice activities for all four skills can be designed around these or similar situations.

1. Gaining entry into an organization
   i. Preparing job-applications and CVs
   ii. Facing an interview
   iii. Participating in group discussion (as part of the recruitment process)

2 In-house communication

a. Superior/ Senior ➔ subordinate / junior (individual ➔ individual / group)
   i. Welcoming new entrants to the organization, introducing the workplace culture etc.
   ii. Briefing subordinates / juniors : explaining duties and responsibilities etc.
   ii. Motivating subordinates / juniors ('pep talk')
   iii. Instructing/ directing subordinates/ juniors
   iv. Expressing / recording appreciation, praising / rewarding a subordinate or junior
   v Reprimanding / correcting / disciplining a subordinate/junior (for a lapse) ; asking for an explanation etc.

b. Subordinate / Junior ➔ Superior / Senior
   i. Responding to the above
   ii. Reporting problems / difficulties / deficiencies

Offering suggestions

BECS7212 C++ & Object Oriented Programming Lab

1. Programs on concept of classes and objects.(1 class)
2. Programs using inheritance.(1 class)
3. Programs using static polymorphism.(1 class)
4. Programs on dynamic polymorphism.(1 class)
5. Programs on operator overloading.(1 class)
6. Programs on dynamic memory management using new, delete operators.(1 class)
7. Programs on copy constructor and usage of assignment operator.(1 class)
8. Programs on exception handling .(1 class)
9. Programs on generic programming using template function & template class.(1 class)
10. Programs on file handling.(1 class)

PCBT7201 **Biochemistry Lab**

1. Spectrophotometric/Colorimetric estimation of Protein using Lowry's Method
2. Spectrophotometric estimation of DNA using DPA method
3. Spectrophotometric estimation of RNA using Orcinol Method
4. Estimation of iodine Number and Saponification value of fatty acids
5. Separation of Amino acids by Paper Chromatography
6. Separation of Sugars by Thin Layer Chromatography
7. Separation of Proteins by SDS-PAGE
8. Assay of Enzyme activity: Protease from bacteria
9. Assay of Enzyme activity: Amylase from Plant tissue & Saliva
10. Determination of Km and Vmax of an enzyme catalyzed reaction.

Books:
Introduction to Practical Biochemistry, Plummer, Tata McGraw Hill

PCME7202 **Mechanical Engg. Lab**

Group A

1. Determination of equilibrium of coplanar forces.
2. Determination of Moment of Inertia of Flywheel
3. Determination of tensile strength of materials by Universal Testing Machine.

Group B

4. Determination of Metacentric Height and application to stability of floating bodies.
5. Verification of Bernoulli's Theorem and its application to Venturimeter.
6. Determination of Cv and Cd of Orifices.

Group C

7. Calibration of Bourdon Tube Pressure gauge and measurement of pressure using manometers.
8. Study of Cut-Sections of 2 stroke and 4 stroke Diesel Engine.
9. Study of Cut-Sections of 2 stroke and 4 stroke Petrol Engine.

4th Semester

PCBT4202 Cell Biology and Genetics

Module-I **(12 Hr.)**

Organization of Cell (Prokaryotic and Eukaryotic), Cell Wall & Cell Membrane, Cell Organelles (Plastid, Golgibodies, Mitochondria, Ribosome), Nucleus, Cytoskeleton, Cell Cycle, Cell Divisions- Mitosis and Meiosis, Molecular Organization of Chromosome (Nucleosome concept), Cell-cell signaling(G-protein and Receptor mediated).

Module-II **(16Hr.)**

Principles of Inheritance: Chromosome theory of Heredity, Mendelism, Non-Mendelian Gene Interactions (Epistasis, Lethality, Pleiotropy), Allelic Complementation, Linkage and Crossing over, Chromosome mapping, Coincidence and Interference, Cytoplasmic Inheritance, Sex Determination, Mutation and Chromosomal Aberration, Transposable genetic elements, Principles breeding in plants and animals, Heterosis and Hybrid vigour, Inbreeding depressions, Genetic diseases in Human (Colour blindness, Haemophillia).

Module-III **(12Hr.)**

Quantitative Inheritance: Polygenes and Multiple alleles, Introduction to QTLs and its inheritance, Detection of QTLs

Population Genetics: Hardy-Weinberg's law, Genetic Equilibrium, Changes in gene frequency, Genetic Drift, Effect of evolutionary forces on genetic equilibrium of apopulation.

Developmental genetic with reference to Arabidopsis and Drosophilla.

Text Books

1. Theory & Problems in Molecular & Cell Biology, Stansfield, Tata McGraw Hill
2. The Cell Molecular approach, Geoffrey M. Cooper, ASM press Washington D.C. Sinauer Associates, Inc.
3. Principles of Genetics, Robert Tamarin, Tata McGraw Hill
4. Molecular Biology of Cell – Alberts, Garland Science, Taylor & Francis Group.
6. Concept of Genetics by Klug.
7. Genetics, David R Hyde, Tata McGraw Hill.

BSCC1208 **Chemistry - II**

Module I

1.Water Technology: Hardness of Water : Types of hardness, Units of hardness and their interrelation, Determination of hardness(EDTA method only). Disadvantage of hard water . Water softening technology (internal and external (limesoda,zeolite,and ion exchange methods) Desalination(electrodialysis, reverse osomosis, Sterilization of water by bleaching power, chlorine, ozone, chloramine. Determination of B.O.D and C.O.D of water sample.

2.Corrosion: Theories of corrosion , Types of corrosion , Factors affecting corrosion, Corrosion Control: (Proper design and fabrication procedure, Cathodic protection, Passivation).

MODULE-II

1. **Fuels**: Classification of fuels, calorific value, (Determination by Dulong's formula),G.C.V&N.C.V

Liquid fuel: Classification of petroleum, Refining of petroleum , Cracking, Knocking and anti knocking,cetane and octane numbers . Unleaded petrol, synthetic petrol, power alcohol

Gaseous Fuel : Producer gas, Water gas, LPG , CNG, Kerosene gas

Combustion Calculation.

2.Battery technology

Introduction, Batteries and cells, Basic components of battery, its Classification characteristics,Chemical batteries(dry, Lead acid & gel batteries) Alkaline batteries(zinc-air,aluminium-air,Nickel metal hydride battery) Reserve batteries(magnesium-copper,Gordan-magnesium battery) Nickel cadmium battery

Module III

1.POLYMER . Polymer: Types, polymerization process and mechanisms

Conducting polymers(poly aniline, poly acetylene),polymer composite(carbon fiber)

Preparation. Properties and uses of following polymer(polyethylene,PMMA,PTFE

Bakelite,polyurethanes,polycarbonate)

2 Nano materials

Nano material; Carbon nano tube,(synthesis, properties and application.) Application of nano material in medicine, fuel cell, catalysis (only general idea)

Text Books:

1.Engineering chemistry by Putti R.vIjayasararhy ,PHI Ltd

2. Engineering chemistry by P.C jain and M. jain

Reference Books:

1. Engineering chemistry by N Krishnamurthy ,p vallinaygam, Dmadhavan, PHI Ltd
2. Engineering chemistry by mary,jane.shultz ,Cengage learning publication
3. Engineering chemistry by R.Gopalan,D.venkaapaya,and SNagarajan, Vikas publishing house.

BSMS 1209 **Material Science**

MODULE – I

1. Classification of Engineering Materials. Engineering properties of materials. Selection of Materials.
2. Electron theory of solids : Free electron theory of metals. Electrical conductivity; Thermal conductivity, Quantum theory of free electrons. Band theory of solids, Conductivity of metals
3. Conductors, Insulators, Semiconductors, Intrinsic and extrinsic semiconductors, Band theory of semi conductors Hall effect.
4. Super Conductors – Zero resistivity, Critical magnetic field and critical current density. Type I and II super conductors. Applications of Supercoductors.

MODULE – II

5. Dielectric Materials : Microscopic Displacement of atoms and molecules in an external dc electric field, Polarization and dielectric constant, Dielectric _nitially_lity. Temperature dependence, Dielectric Breakdown.
   Ferro electric material Piezoelectrics, Pyroelectrics, Dielectric Materials as electrical isulators.
6. Magentic Properties of Materials : Dia, Para and Ferro magenetic materials. Theory of magnetism, Ferro magnetic materials or Ferrites, Comparison of magnetic behaviour and magnetic parameters of Dia, Para and Ferro magnetic materials.
7. Optical Properties of Materials : Scattering, Refraction, Theory of Refraction and absorption, Atomic Theory of optical properties. Lasers, Optical fibres – Principle, structure, application of optical fibre.

MODULE – III

8. Plastics – Types : Thermosetting and thermoplastics. Transfer moulding, injection moulding, extension moulding, Blow moulding, Welding of plastics; Rubber types, application.
9. Ceramics : Types, Structure, Mechanical properties, applications
10. Composite Materials : Agglomerated Materials : Cermets, Reinforced Materials : Reinforced Concrete. Glass fibre reinforced plastics, Carbon fiber reinforced plastics. Whiskers, fiber reinforced plastics, Laminated plastic sheets. Tufnol, Properties of composites. Metal matrix composites, manufacturing procedure for fibre reinforced composites.
11. Environmental Degradation:Oxidation-Direct atmospheric attack,Aqueous corrosion-Electro chemical attack,Glavanic two –metal corrosion,corrosion by Gaseous reduction, Effect of mechanical stress on corrosion,method of corrosion prevention

Text book:

1. Vijaya M. S., Rangarajan G, Materials Science, TMH
2.Introduction to Materials science for engineers by James.F.shackelford,Madanapalli.k.Muralidhara ,Pearson(sixth edition)

Reference Book:

1. Rajendra V., Marikani A., Materials Science, TMH
2. Van Vlack L. H., Elements of Material Science and Engineering, Addison Wesley
3. Raghavan , Material Science
4. Callister W.D., Materials Science and Engineering, John Wiley & Sons.
5. Smith, Materials Science & Engineering.Mc. Graw Hill.
6. Processes and Material of manufacture : Lindberg, PHI.

BECS2208 Database Management System

Module I : **(10 hours)**

Database System Architecture - Data Abstraction, Data Independence, Data Definitions and Data Manipulation Languages. Data models - Entity Relationship(ER), Mapping ER Model to Relational Model, Network .Relational and Object Oriented Data Models, Integrity Constraints and Data Manipulation Operations.

Module II : **(12 hours)**

Relation Query Languages, Relational Algebra and Relational Calculus, SQL.

Relational Database Design: Domain and Data dependency, Armstrong's Axioms, Normal Forms, Dependency Preservation, Lossless design.

Query Processing Strategy.

Module III: **(10 hours)**

Transaction processing: Recovery and Concurrency Control. Locking and Timestamp based Schedulers.

Database Recovery System: Types of Data Base failure & Types of Database Recovery, Recovery techniques

Text Books:

1. Database System Concepts by Sudarshan, Korth (McGraw-Hill Education)
2. Fundamentals of Database System By Elmasari & Navathe- Pearson Education

References Books:

(1) An introduction to Database System – Bipin Desai, Galgotia Publications
(2) Database System: concept, Design & Application by S.K.Singh (Pearson Education)
(3) Database management system by leon &leon (Vikas publishing House).
(4) Fundamentals of Database Management System – Gillenson, Wiley India
(5) Database Modeling and Design: Logical Design by Toby J. Teorey, Sam S. Lightstone, and Tom Nadeau, "", 4th Edition, 2005, Elsevier India Publications, New Delhi

PCBT4203 **Micro Biology**

Module-I (10 Hr.)

Introduction to Microbial Kingdom- Bacteria, Viruses, Fungi and Yeast; Classical and Modern approaches of microbial taxonomy; Classification of bacteria, fungi and Viruses; Methods of Microbiology- Culture media, Sterilization, Establishment of pure culture, Staining of bacteria (Gram's, Acid Fast, Capsule), Micrometry and Microscopy(Bright Field, Fluorescence, Phase Contrast and Electron).

Module-II (16Hr.)

Microbial growth and metabolism: Pattern of bacterial growth, Growth kinetics, Monod's Equation, Synchronous Growth and its Kinetics, Continuous culture and its growth kinetics, Growth inhibitory substances. Metabolism of carbohydrate in bacteria, Enerdoudorf,s pathway and glyoxalate pathway, Energy transduction mechanism in bacteria, Cyanobacteria and nitrogen fixation, Anaerobic respiration.

Microbial genetics: Organization of bacterial and viral genome, Plasmids and Episomes, Genetic recombination in bacteria (Transformation, Conjugation and Transduction), Genetic analysis in bacteria, DNA repair mechanisms in bacteria, Transposons, Mutation in Microorganisms.

Module-III (14Hr.)

Food Microbiology: Microbiology of foods, Types of microbes associated with food spoilage, Food preservation methods, Food poisioning, Microbiology of Milk and dairy products.

Medical Microbiology: disease causing bacteria, virus and fungi; Antimicrobial agents, Antibiotics, Disinfectants and Vaccines

Environmental Microbiology: Microbiology of water, Microbiology of Air, Baceriological analysis of water & water treatment, Microbiology of extreme environments (Halobacteria, Methanogens, Thermofiles), Microbiology of sewage.

Text Books :

1. Text book of Microbiology by Stanier.
2. Microbiology, R.S. Mehrotra, Tata McGraw Hill
3. Microbiology by Pelczar
4. Brock Biology of micro-organisms
5. Microbiology by Presscort.
6. Microbial Genetics- Freifelder
7. Mol. Genetic of bacteria by R. Snyder
8. Microbiology by Atlas
9. Microbiology by Devis

PCBT4204 **Molecular Biology**

Module-I (16 Hr.)

Genome Organization Prokayotes and Eukaryotes, Nuclear genome and Organellar genome, DNA as the genetic material, Central dogma of molecular biology, Genome complexity, C- value Paradox, Cot curve analysis, Repetitive DNA, satellite DNA; Gene structure in prokaryotes and Eukaryotes, Cistron, Recon, Muton; Variants of gene- Split genes, pseudogenes, Overlapping genes and selfish DNA.

DNA Replication: Models of DNA replication, Enzymology of DNA replication, Process of DNA replication (Initiation, Elongation, Termination), DNA replication at the telomere, Replication of Mitochondrial and Chloroplast genome, DNA-protein interaction, DNA repair.

Module-II (10Hr.)

Transcription: Components of transcription machinery in prokaryotes and eukaryotes, Transcription factors, Transcription process (Initiation, Elongation, Termination), Transcription factors, m-RNA processing, Pre and Post transcriptional processing, Capping and poly (A) tailing, m-RNA stability, m-RNA editing, Gene Silencing

Module-III (14Hr.)

Translation: Genetic code- the principle of translation, Translation machinery (t-RNA, Aminoacyl synthetase, Ribosome), Translation process, Post translational modification of protein.

Regulation of Gene Expression: Constitutive and Induced gene expression, Regulation of gene expression in prokaryotes and eukaryotes, Operon model (Lac-operon and Trp- operon), DNA methylation.

Molecular evolution (DNA based phylogenetic trees and its applications), Introduction to recombinant DNA technology.

Books :

1. Text Book of Molecular Biology By Padmanabhan and Shastri.
2. MOLBIO – Avinash & K. Upadhyaya, Himalaya Publishing House.
2. Mol. Biology. by Turner.
3. Mol. “Biology of Gene” – Watson
4. Principles of Mol. Biology - OS Prim Rose
5. Recombinant DNA Technology – Watson
6. Mol. Cell Biology. - Baltimore

BECS7208 **Database Management System Lab**

1. Use of SQL syntax: insertion, deletion, join, updation using SQL. (1 class)
2. Programs on join statements and SQL queries including where clause. (1 class)
3. Programs on procedures and functions. (1 class)
4. Programs on database triggers. (1 class)
5. Programs on packages. (1 class)
6. Programs on data recovery using check point technique. (1 class)
7. Concurrency control problem using lock operations. (1 class)
8. Programs on ODBC using either VB or VC++. (1 class)
9. Programs on JDBC. (1 class)
10. Programs on embedded SQL using C / C++ as host language. (1 class)

PCBT7204 **Cell and Molecular Biology Lab.**

1. Chromosome preparation from onion root tip (Mitosis) & grasshopper testis (Meiosis).
2. Isolation, purification of DNA from plant sample and its yield estimation.
3. Isolation, purification of DNA from blood sample and its quantification using UV spectrophotometer.
4. Isolation, purification of DNA from bacterial sample and its quality assessment using UV spectrophotometry.
5. Isolation of plasmid DNA and estimation its size using agarose gel electrophoresis.
6. Effect of gel concentration on solidification and migration of DNA sample
7. Restriction digestion of supplied DNA sample and estimate the molecular weight of the fragments resulted.
8. Elution of the DNA from the supplied gel and assess the integrity of the fragments.
9. Isolation and purification of RNA from plant/bacterial sample and its quantification using UV spectrophotometer..
10. Isolation and purification of protein from the supplied sample and its quantification using UV spectrophotometer.

PCBT7203 **Micro Biology Lab**

1. Micrometry: calibration of stage and ocular micrometer and measurement of microbial sample.
2. Staining of microbial sample (Gram’s Staining, Capsule staining, Fungal staining)
3. Media preparation and sterilization (Slant, Stab and Broth culture)
4. Isolation of micro organisms from natural habitats (Air, Water, Soil & Milk)
5. Establishment of pure culture by streak plate and serial dilution method.
6. Study the bacterial growth curve using spectrophotometer and viability assessment.
7. Antibiotic assay and estimation of Zone of inhibition.
8. Chemical assay and MIC determination of antibiotics.
9. Biochemical assay of microorganisms (Starch Hydrolysis, Casein Hydrolysis and IMVIC test).
10. Microscopy: Study of Compound, Phase contrast and Fluorescence Microscopes.

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BIJU PATNAIK UNIVERSITY OF TECHNOLOGY, ORISSA

BIOTECHNOLOGY

5th Semester				6th Semester			
Theory	**Subject**	**Credit Hrs**	**Credit**	**Theory**	**Subject**	**Credit Hrs**	**Credit**
HSSM3304	Biostatistics	3-0-0	3	HSSM3303	Environmental Engg. and Safety	3-0-0	3
PCBT4301	Immunology and immunotechnology	3-0-0	3	PCBT4304	Bioinformatics	3-0-0	3
PCBT4302	Genetic Engineering and r-DNA Technology	3-0-0	3	PCBT4307	Industrial Microbiology and Enzyme technology	4-0-0	4
PCBT4303	Upstream Process Engineering	3-0-0	3	PCBT4305	Plant Biotechnology	3-0-0	3
PCBT5304	Biochemical reaction Engineering	4-0-0	4	PCBT4306	Downstream process Engineering	3-0-0	3
	Free Elective- (Any one)	3-0-0	3		Professional Elective- Any one	3-0-0	3
PECH5304	Process Instrumentation,			PEBT5303	Biomaterials		
PCBM4302	Signal & System,			PEBT5302	Molecular modeling and drug designing		
PECS5304	Theory of Computation,			PEBT5301	Nano Biotechnology		
PEIT5302	Data mining and Data ware housing.						
	Total		19		Total		19
Practical / Sessionals				Practical / Sessionals			
PCBT7303	Upstream process engg. Lab.	0-0-3	2	PCBT7306	Downstream process Engineering & Enzyme tech. lab	0-0-3	2
PCBT7302	r-DNA technology lab	0-0-3	2	PCBT7305	Plant Biotechnology & Industrial Microbiology lab	0-0-3	2
PCBT7301	Immunotechnology lab	0-0-3	2	PCBT7304	Bioinformatics lab	0-0-3	2
	Total		6		Total		6
			25				25

**Industrial / Institutional visit should be made (at least one visit per semester)

List of Free Electives to be floated by Biotechnology Stream.

1. Genetic Engineering and r-DNA Technology
2. Bioinformatics
3. Biomaterials
4. Nano Biotechnology
5. Molecular modeling and drug designing
6. IPR in biotechnology, Biosafety & Bioethics

Distribution of Credits for B.Tech Syllabus in BIOTECHNOLOGY

Semester / Subjects	1st	2nd	3rd	4th	5th	6th	7th	8th	Total	Recommended as per Dayaratnam Committee.
Basic Science including Math.	7	7	7	3	-	-	-	-	24	25-30
Humanities, Social & Mangt. Study	4	4	7	3	3	3	3	-	27	25-30
Engg. Sc., TA & Comp. Engg.	17	17	8	5	-	-	-	-	47	30-35
Professional Core	-	-	5	15	16	13	6	6	59	45-55
Professional Electives	-	-	-	-	4	10	6	3	23	25-30
Free Electives	-	-	-	-	3	-	3	3	9	20-25
Project	-	-	-	-	3	-	2	8	10	10-15
Seminar, Vivavoce. & Training							2	3	5	5-10
Total	28	28	27	26	25	25	22	23	204	

HSSM3304 **BIOSTATISTICS** (3-0-0)

Module-I:

Introduction and definition of Biostatistics; Concept of variables in biological systems. Collection, Classification, tabulation graphical and diagrammatic representation of numerical data; Measures of central tendency: Mean, Median and Mode and their relationship; Measures of dispersion: Range, Quartile deviation, Mean deviation, Standard deviation, Concept of standard error, Coefficient of variation, Skew ness and Kurtosis.

Module-II:

Probability: Random experiment, events, sample space, mutually exclusive events, independent and dependent events; Various definitions of probability, addition and multiplication theorems of probability, Random variables (discrete and continuous), Probability density functions and its properties; Probability distributions: normal, Binomial, Poisson and their application.

Module-III:

Concept of populations and sample. Simple random sampling without replacement. Definition of simple random sample; Designing of Experiments-Random block design and Split plot design; Correlation and Regression, linear and quadratic regression; Analysis of variance: One- way and two-way classifications with single observation per cell. Duncan's multiple range test; Tests of significance: Chi-square, student's t, z and f-distributions, their properties and uses.

Text Books:

1. Biostatistics: Rao KS, Himalaya Publishing House
2. Introduction to Biostatistics & Research Methods: Sundar Rao PSS & Richard J, PHI learning Pvt. Ltd.
3. Biostatistics: Arora and Mohan, Himalaya Publishing House

Reference:

1.

PCBT4301**IMMUNOLOGY & IMMUNOTECHNOLOGY**(3-0-0)

Module-I:

The origin of Immunology, types of immunity, humoral and cell mediated immunity, Primary and secondary lymphoid organ, antigen, cells of immune system, immunoglobulin and antibodies, Major Histocompatibility Complex (MHC)

Module-II:

Antigen processing and presentation, synthesis of antibody and secretion, Molecular basis of Immunology, Molecular basis of antibody diversity, polyclonal and monoclonal antibody, complement system, antigen-antibody reaction.

Module-III

Immune response and tolerance: Regulation of immune response, immune tolerance, hyper sensitivity, autoimmunity; graft versus host reaction, Immuno- deficiency and immuno-proliferate diseases. Dysfunctions of immune system and their modulation, Approaches for correcting immune dysfunction, Vaccinology, Monoclonal antibody technology.

Text Books:

1. Immunology: Lydyard, P.M., Whelan, A., Fanger, M.W., 1st Ed., Viva Books.
2. Essential Immunology: Roitt, I.M., 9th Ed.(1997) Blackwell Scientific, Oxford, UK.
3. Immunology: Kuby, J. 3rd Ed. (1997) Freeman W. H., oxford.
4. Immunotechnology by A Khan, Pearson Publication

Reference:

1. Microbiology and Immunology by B K Patnaik, T.C. Kar, H.N. Thatoi, India-Tech publication. New Delhi

PCBT4302 **GENETIC ENGINEERING & R-DNA TECHNOLOGY**

(3-0-0)

Module-I:

Basic principle of DNA isolation and purification; Restriction endonuclease, Ligase and other modifying enzymes; DNA& RNA Markers, Linker, Adapter and MCS; Gene cloning vectors- Plasmid, bacteriophage, cosmid, BAC, YAC; Expression vectors: basic concept, bacteria and yeast based expression vector; Gene library- genomic and c-DNA, contig library; Polymerase Chain reaction, Blotting techniques: Southern, Northern, Western, Dot and Slot; Nucleic acid hybridization;

Module-II:

Basic concept of gene cloning; Cloning of interacting gene: two hybrid and three hybrid assay; Cloning of differentially expressed gene; DNA micro arrays and Chips- principle and manufacturing process; DNA finger printing and DNA foot printing; DNA Sequencing; Site directed mutagenesis; Expression of heterologous gene; In vitro transcription and translation; Gene knock out strategies; RNA interference: Antisense RNA, si RNA and mi RNA; Ribozyme Technology.

Module-III:

Molecular markers- Types (RFLP, RAPD, AFLP, SCAR, SSR, SNP, EST), Principle and methodology; Application of molecular markers: in diagnostics, gene tagging, gene mapping, Physical mapping, Map based cloning of gene and cloning of QTLs.

Genome projects: Human, Rice; Gene therapy and its applications; DNA vaccines and rDNA products; Genetic engineering regulations and safety guidelines.

Text Books:

1. H S Chawla, Plant Biotechnology, Oxford University Press
2. T A Brown, Gene cloning and DNA Analysis, Black well publishing
3. Primerose et al., Principle of gene manipulation and genomics, Black well publishing.

Reference

1. Sambrooks et al., Molecular cloning (Vol.I,II,II), CSH Press.
2. Spurr N & Young TD, ICRF Hand book of genome analysis, Blackwell

PCBT4303 **UPSTREAM PROCESS ENGINEERING** (3-0-0)

Module-I: Fluid Transfer concepts and applications
Basic Equations of Fluid Flow: Newtonian and non-Newtonian fluids, Turbulence and its nature, Reynolds number and transition from laminar to turbulent flow, flow in boundary layers, continuity equation, Bernoulli equation, pump work in Bernoulli equation. Flow of Incompressible Fluids: Fluid flow in pipes, friction factor, laminar flow in pipes, Hagen-Poiseuille equation, effect of roughness, friction factor charts, Reynolds numbers and friction factor relationship. Transportation and Metering of Fluids: pipe fittings and valves, positive displacement pumps, centrifugal pumps, blower and compressor, flow measuring devices such as venturimeter, orifice meter, pitot tube and rotameter. Drag force and terminal settling velocity, principles of filtration, centrifuges.

Module -II: Heat Transfer concepts and applications
Heat transfer by conduction in solids: Fourier's Law, thermal conductivity, Steady state conduction, compound resistance in series, heat flow through a cylinder, one dimensional unsteady state heat conduction, heat transfer from extended surface. Heat transfer by convection: Thermal boundary layer, Heat transfer by forced convection, heat transfer by natural convection, heat transfer from condensing vapors, filmwise and dropwise condensation. Heat Transfer equipments like evaporators and heat exchangers and autoclaves of different types.

Module -III: Mass Transfer concepts and applications
Diffusion concepts, Fick's law of diffusion. Phase diagram, temperature concentration diagram, enthalpy concentration diagram, Ideal solution, Roult's Law, relative volatility, azeotropes. Differential distillation, flash vaporization, vacuum and steam distillation. Ternary liquid equilibria, triangular graphical representation, concept of theoretical or ideal stages and multistage continuous operation. Leaching, solid-liquid equilibrium, equipments used in solid-liquid extraction. Single and multiple contact. Overall stage efficiency. Description of adsorption and absorption processes and their applications, types of adsorption, nature of adsorbents adsorption equillibria. Properties and handling of particulate solids, size reduction, screening and particle size distribution.

Text Books

1. McCabe, Smith and Harriot, Unit Operations of Chemical Engineering
2. Foust et al, Principles of Unit Operations.
3. Treybal, R.E. Mass Transfer Operations
4. Badger and Banchero. Introduction to Chemical Engineering.
5. Hollman, Heat transfer, 8^{th} Ed.
6. Foust, Wenzel, Clump, Maus and Andersen, Principles of Unit Operations.
7. Geankoplis, Transport processes and unit operations

PCBT5304 **BIO-CHEMICAL REACTION ENGINEERING**

(4-0-0)

Module I: Material, energy balance and concepts of reaction engineering

Material Balance & Energy Balances: Mathematical requisites – use of log-log and semi-log graph paper, triangular diagram, graphical differentiation and graphical integration, material balance without chemical reaction, material balance with chemical reaction, energy balance; enthalpy changes, heat of reaction and its temperature dependence, heats of solution and mixing, adiabatic flame temperature, use of psychometric charts. Kinetics of homogeneous reactions: classification of reactions, reaction rate, speed of reaction, rate equation, concentration-dependent term of rate equation, rate constant, order and molecularity, representation of elementary and nonelementary reactions, kinetic models for nonelementary reactions, temperature-dependent term of a rate equation, activation energy and temperature dependency.

Module II: Reaction engineering of batch and continuous reactors

Kinetic analysis of batch reactor data: Integral and differential methods for analyzing kinetic data, interpretation of constant volume batch reactor, data for zero, first, second and third order reactions, half life period, irreversible reaction in parallel and series, auto catalytic reaction. Kinetic interpretation of batch reactor data for single reactions: interpretation of variable volume batch reaction data for zero, first and second order reactions, Ideal batch reactor, steady state CSTR and plug flow reactors and their use for kinetic interpretation. Design for single reaction: size comparison of single reactors, plug flow reaction in series and/or parallel, equal and different size of mixed reactor in series, finding the best system for given conversion, recycle reactor, Design of multiple reactions in batch, CSTR and PFR.

Module III: Heterogeneous reactions and Biochemical reactions

Reaction catalyzed by solids: introduction to heterogeneous reactions, rate equation for surface kinetics, pore diffusion resistance combined with surface kinetics, porous catalyst particles, performance equations for reactors containing porous catalyst particles, experimental methods for finding rates, advantages and disadvantages of packed bed and fluidized bed catalytic reactors. Biochemical reaction systems: Cell and enzyme fermentation, Monod's model of growth kinetics. Kinetics of Enzyme catalyzed reactions for free and immobilized enzymes. – derivation of Michaelis-Menten equation, Briggs-haldane relationship, the determination and significance of kinetic constants, Lineweaver-burk and Eadie-Hofstee plot, principles of enzyme inhibition – Competitive, noncompetitive and uncompetitiveMichaelish-Menten kinetics, inhibition by foreign substances, kinetics of competitive and noncompetitive inhibitions, microbial fermentation, batch fermentor and mixed flow fermentor, kinetic expressions of fermentation.

Text Books

1. Chemical process Principles (Part I & II), Houge, Watson & Ragatz, Asian Student Edition, Asia Publishing House.
2. Basic Principles and Calculations in Chemical Engineering, Himmelbalu, Prentice Hall (I) 6th Ed.
3. Coulson & Richardson's Chemical Engineering- Volume 3 (Chemical and Biochemical Reactors and process controls) ed. Ricchardson. J.F., Peacock. D.G.,First Indian ed. Asian Books Pvt.Ltd. 1998.
4. Levenspiel, O., Chemical Reaction Engineering,Wiley Eastern Ltd.
5. Smith & Vanness, Thermodynamics for Chemical Engineers, MGH.
6. Bailey & Oils, Biochemical Engg. Fundamentals, MGH
7. Foggler, Elements of Chemical Reaction Engineering

PECH5304 **PROCESS INSTRUMENTATION** (3-0-0)

Module - I

Basic concepts and qualities of measurement, Level measurement: Methods of liquid level measurement, Direct methods, Hook-type level indicator, sight glass, Float-type level indicator, Displacer level detectors, Indirect methods, Hydrostatic pressure type, Pressure gauge method, Air bellows, Air purge system, Liquid purge system, Electrical methods.

Module – II

Flow Measurement: Methods of flow measurement, Inferential flow measurement, Quantity flowmeters, Mass flowmeters, Calibration of flowmeters, Selection of flowmeters.

Pressure measurement: Pressure, Methods of pressure measurement, Manometers, Elastic pressure transducers, Measurement of vacuum, Force-balance pressure gauges, Electrical pressure transducers, Pressure switches, Calibration of pressure measuring instruments, Maintenance and repair of pressure measuring instruments, Troubleshooting.

Module – III

Temperature measurement: Temperature, Temperature scales, Methods of temperature measurement, Expansion temperature, Filled-system thermometers, Electrical temperature instruments. Pyrometers: Radiation and optical,
Methods of composition analysis: Spectroscopic analysis, Absorption spectroscopy, Emission spectroscopy, Mass spectroscopy

Text books and References :

1. D. P. Eckman, Industrial Instrumentation, Wiley Eastern Ltd.
2. C. S. Rangan, G. R. Sarma and V. S. V. Mani, Instrumentation, Devices and Systems, TMH.
3. J. P. Bentley, Principles of Measurement Systems, Longman
4. S.K.Singh, Industrial instrumentation and control, Tata Mc Graw-Hill.

PCBM4302 **SIGNALS & SYSTEMS** (3-0-0)

Module – I **(10 hours)**

Discrete-Time Signals and Systems:

Discrete-Time Signals: Some Elementary Discrete-Time signals, Classification of Discrete-Time Signals, Simple Manipulation; Discrete-Time Systems : Input-Output Description, Block Diagram Representation, Classification, Interconnection; Analysis of Discrete-Time LTI Systems: Techniques, Response of LTI Systems, Properties of Convolution, Causal LTI Systems, Stability of LTI Systems; Discrete-Time Systems Described by Difference Equations; Implementation of Discrete-Time Systems; Correlation of Discrete-Time Signals: Crosscorrelation and Autocorrelation Sequences, Properties.

Selected portions from Chapter 2 (2.1, 2.2, 2.3.1, 2.3.3, 2.3.4, 2.3.5, 2.3.6, 2.4, 2.5, 2.6.1, 2.6.2) of Textbook – I

Properties of Continuous-Time Systems:

Block Diagram and System Terminology, System Properties: Homogeneity, Time Invariance, Additivity, Linearity and Superposition, Stability, Causality.

Selected portions from Chapter 4 (4.2, 4.4) of Textbook – II

Module – II **(12 hours)**

The Continuous-Time Fourier Series:

Basic Concepts and Development of the Fourier Series, Calculation of the Fourier Series, Properties of the Fourier Series.

Selected portions from Chapter 8 (8.3, 8.4, 8.7) of Textbook – II

The Continuous-Time Fourier Transform:

Basic Concepts and Development of the Fourier Transform, Properties of the Continuous-Time Fourier Transform.

Selected portions from Chapter 10 (10.3, 10.6) of Textbook – II

Module- III **(13 hours)**

The Z-Transform and Its Application to the Analysis of LTI Systems:

The Z-Transform: The Direct Z-Transform, The Inverse Z-Transform; Properties of the Z-Transform; Rational Z-Transforms: Poles and Zeros, Pole Location and Time-Domain Behavior for Causal Signals, The System Function of a Linear Time-Invariant System; Inversion of the Z-Transforms: The Inversion of the Z-Transform by Power Series Expansion, The Inversion of the Z-Transform by Partial-Fraction Expansion; The One-sided Z-Transform: Definition and Properties, Solution of Difference Equations.

Selected portions from Chapter 3 (3.1, 3.2, 3.3, 3.4.2, 3.4.3, 3.6.1, 3.6.2) of Textbook– I : The Discrete Fourier Transform: Its Properties and Applications:

Frequency Domain Sampling: The Discrete Fourier Transform; Properties of the DFT: Periodicity, Linearity, and Symmetry Properties, Multiplication of Two DFTs and Circular Convolution, Additional DFT Properties.

Selected portion from Chapter – 7 (7.1.2, 7.2.1, 7.2.2, 7.2.3) of Textbook – 1.

Text Books:

1. *Digital Signal Processing – Principles, Algorithms and Applications by J. G. Proakis and D. G. Manolakis, 4th Edition, Pearson.*
2. *Fundamentals of Signals and Systems - M. J. Roberts, TMH*

Reference Book:

1. Signals and Systems - P. R. Rao, TMH.
2. Signals and Systems – A Nagoor Kani, TMH
3. Signals and Systems by Chi-Tsong Chen, Oxford
4. Principles of Signal Processing and Linear Systems, by B.P. Lathi, Oxford.
5. Principles of Linear Systems and Signals, by B.p. Lathi, Oxford

PECS5304 **THEORY OF COMPUTATION** (3-0-0)

Module – I **10 Hrs**

Alphabet, languages and grammars. Production rules and derivation of languages. Chomsky hierarchy of languages. Regular grammars, regular expressions and finite automata (deterministic and nondeterministic). Closure and decision properties of regular sets. Pumping lemma of regular sets. Minimization of finite automata. Left and right linear grammars.

Module – II **12 Hrs**

Context free grammars and pushdown automata. Chomsky and Griebach normal forms. Parse trees, Cook, Younger, Kasami, and Early's parsing algorithms. Ambiguity and properties of context free languages. Pumping lemma, Ogden's lemma, Parikh's theorem. Deterministic pushdown automata, closure properties of deterministic context free languages.

Module – III **14 Hrs**

Turing machines and variation of Turing machine model, Turing computability , Type 0 languages. Linear bounded automata and context sensitive languages. Primitive recursive functions. Cantor and Godel numbering. Ackermann's function, mu-recursive functions, recursiveness of Ackermann and Turing computable functions. Church Turing hypothesis. Recursive and recursively enumerable sets.. Universal Turing machine and undecidable problems. Undecidability of Post correspondence problem. Valid and invalid computations of Turing machines and some undecidable properties of context free language problems. Time complexity class P, class NP, NP completeness.

Text Books:

1. Introduction to the theory of computation: Michael Sipser, Cengage Learning
2. Introduction to Automata Theory, Languages and Computation: J.E. Hopcroft and J.D Ullman, Pearson
Education, 3rd Edition.
3. Introduction to Computer Theory: Daniel I.A. Cohen, Willey India, 2nd Edition.

Reference Books:

1. Introduction to Languages and the Theory of Computation: Martin, TMH, 3rd Ed.
2. Introduction to Formal Languages, Automata Theory and Computation: K. Kirthivasan, Rama R, Pearson Education.
3. Theory of computer Science (Automata Language & computations) K.L. Mishra N. Chandrashekhar, PHI.
4. Elements of Theory of Computation: Lewis, PHI

PEIT5302 **DATA MINING & DATA WAREHOUSING** (3-0-0)

Module - I **12 Hours**

Overview: Data warehousing, The compelling need for data warehousing, the Building blocks of data warehouse, data warehouses and data marts, overview of the components, metadata in the data warehouse, trends In data warehousing, emergence of standards, OLAP, web enabled data warehouse, Introduction to the data warehouse project, understanding data warehousing Architecture, Data warehousing implementation, from data warehousing to data mining.

Module - II **14 Hours**

Introduction to Data mining, Data mining Functionalities, Data preprocessing (data summarization, data cleaning, data integration and transformation, data reduction, data discretization),

Mining frequent patterns, associations, correlations (market basket analysis, the apriori algorithm, mining various kinds of association rules, from association mining to correlation analysis)

Classification: classification by decision tree induction, Rule based classification, classification by neural networks, classification by genetic algorithm

Module - III **10 Hours**

Cluster Analysis: types of data in cluster analysis, A categorization of major clustering methods(partitioning methods, hierarchical methods),clustering high dimensional data, outlier analysis

Advanced techniques: web mining, spatial mining, temporal mining, Data mining applications in (financial data Analysis, retail industry, telecommunication industry, Biological data analysis, intrusion detection, in other scientific applications)

Text Books:

1. Data warehousing Fundamentals: Paulraj Ponniah, Willey India.
2. Data Mining: Concepts and techniques: J.Han and M.Camber, Elsevier.

Reference books:

1. Data Mining –a Tutorial based primer by R.J.Roiger, M.W.Geatz, Pearson Education.
2. Data Mining & Data Warehousing Using OLAP: Berson, TMH.

PCBT7303 **UPSTREAM PROCESS ENGINEERING LAB**

(0-0-2)

1. Experiments on Reynold's Apparatus-Determination of flow regime and construction of friction factor against NRe.
2. Experiments on flow measuring devices - in closed conduit using (a) Venturimeter, (b) Orifice meter (c) Rotameter.
3. Study and verification of conservation of energy of a flowing liquid in a Bernoulli's apparatus.
4. Determination of Pressure drop for flow through packed bed & verification of Ergun Equation, Kozeny-Karman equation, Blake-Plummer Equation.
5. To Determine the Overall heat transfer coefficient of a concentric pipe heat exchanger based on the inside diameter of the tube.
6. To calculate the heat loss in a lagged pipe made of various insulating materials.
7. Determination of volumetric mass transfer coefficient (Kla) of gas-liquid system.
8. Determination of mixing time in stirred tank reactor.
9. To determine the coefficient of absorption/adsorption in packed bed columns.
10. To separate the solute from one phase to another (aqueous to solvent) phase by liquid-liquid extraction.

PCBT7302 **r-DNA Technology Lab** (0-0-2)

1. Restriction digestion and Construction of restriction map
2. Amplification of DNA sample by PCR
3. DNA profiling by RAPD
4. Southern blotting
5. Western blotting
6. Isolation of m-RNA
7. Northern blotting
8. Gene cloning
9. Expression of cloned gene.
10. c-DNA synthesis by RT PCR

PCBT7301 **Immunotechnology lab**(0-0-2)

1. Preparation of blood film and identification of different leucocytes
2. Ouchterlony double diffusion technology
3. Radial immunodiffusion technology
4. Rocket immuno-electrophoresis
5. Immunoelectrophoresis
6. Dot ELISA and Sandwich ELISA
7. Immunoblotting
8. Purification of immunoglobulin from blood serum by column chromatography
9. Determination of blood group by agglutination
10. Localization of specific antigen by immunocytochemistry

6th Semester

HSSM3303 ENVIRONMENTAL ENGINEERING & SAFETY

(3-0-0)

Module – I:

Ecological Concepts: Biotic components, Ecosystem Process: Energy, Food Chain, Water cycle, Oxygen cycle, Nitrogen cycle etc., Environmental gradients, Tolerance levels of environment factor, EU, US and Indian Environmental Law. Chemistry in Environmental Engineering: Atmospheric chemistry, Soil chemistry. Noise pollution- Noise standards, measurement and control. Water Treatment: water quality standards and parameters, Ground water. Water treatment processes, Pre-treatment of water, Conventional process, Advanced water treatment process.

Module – II:

Waste Water Treatment: DO and BOD of Waste water treatment process, pretreatment, primary and secondary treatment of waste water, Activated sludge treatment: Anaerobic digestion, Reactor configurations and methane production.
Air Pollution : Air pollution and pollutants, criteria pollutants, Acid deposition, Global climate change – greenhouse gases, non-criteria pollutants, air pollution meteorology, Atmospheric dispersion. Industrial Air Emission Control. Flue gas desulphurization, NOx removal, Fugitive emissions.
Solid waste, Hazardous waste management, Solid Waste Management, Source classification and composition of MSW: Separation, storage and transportation, Reuse and recycling, Waste Minimization Techniques. Hazardous Waste Management, Hazardous waste and their generation, Transportation and treatment: Incinerators, Inorganic waste treatment. E.I.A., Environmental auditing,

Module – III:

Occupational Safety and Health Acts, Safety procedures, Type of Accidents, Chemical and Heat Burns, Prevention of Accidents involving Hazardous substances, Human error and Hazard Analysis. Hazard Control Measures in integratednsteel industry, Petroleum Refinery, L.P.G. Bottling, Pharmaceutical industry. Fire Prevention – Detection, Extinguishing Fire, Electrical Safety, Product Safety. Safety Management- Safety Handling and Storage of Hazardous Materials, Corrosive Substances, Gas Cylinders, Hydro Carbons and Wastes. Personal Protective Equipments.

Text Book

1. Environmental Engineering, Irwin/ McGraw Hill International Edition, 1997, G. Kiely,
2. Environmental Engineering by Prof B.K. Mohapatra, Seven Seas Publication, Cuttack
3. Industrial Safety Management, L. M. Deshmukh, Tata McGraw Hill Publication.

Reference

1. Environmental Engineering by Arcadio P. Sincero & Gergoria A. Sincero PHI Publication
2. Principles of Environmental Engineering and Science, M. L. Davis and S. J. Masen, McGraw 3. Hill International Edition, 2004
4. Environmental Science, Curringham & Saigo, TMH,
5. Man and Environment by Dash & Mishra
6. An Introduction to Environmental Engineering and Science by Gilbert M. Masters & Wendell P. Ela - PHI Publication.
7. Industrial Safety Management and Technology, Colling. D A – Prentice Hall, New Delhi.

PCBT4304 **BIOINFORMATICS** (3-0-0)

Module-I:

Searching Biological Data From databases: Finding the information stored and its retrieval methods at NCBI, EMBL and DDBJ, Protein Data Bank(PDB), NDB, CCSD, PIR, Swiss Prot, EMBL, Pfam, EST, SNP, Metabolic pathways databases, EMP, KEGG, MetaCyc, structural databases: SCOP, CATH ,Retrieving microbial and viral genome information.

Module-II:

Sequence alignment and analysis: Fast Alignment methods: Genome Comparison and Database Searching, Local and global alignment and application in determining gene and protein families, statistics of local alignment, Multiple sequence alignment and dynamic programming, Sequence profile and HMM, Basic algorithms for prediction of ORF, promoters, splice sites, UTRs Sequence variation and molecular evolution :significance of Ka/Ks.

Module-III:

Molecular modelling and drug design: Computational tools and Techniques: Homology modelling, Molecular mechanics and force fields, molecular dynamics simulation, Docking methods, Drug design Process, drug like Property of a molecule, target identification, Drug design process for a known and unknown target. Basic idea about Molecular descriptors and QSAR analysis.

Text Books:

1. Mount DW, Bioinformatics: Sequence and Genome Analysis, Spring Harbor Press
2. Arthur Lesk, Introduction to Bioinformatics, Oxford University Press.
3. Baxevanis AS and Ouellette BF, Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, Wiley International Science.
4. Bryan Bergeron, Bioinformatics computing, Prentice Hall Inc
5. Bernhard houbold ,Thomas Wiehe,Introduction to computational biology : an evolutionary approach Blkhauser verlag press

Reference:

1. Tao Jiang, Ying Xu, Michael Q. Zhang, Current Topics in Computational Molecular Biology, MIT press.
2. Thomas lengauer,Bioinformatics from genome to drug .WILLEY-VCH press.

PCBT4307 **INDUSTRIAL MICROBIOLOGY & ENZYME TECHNOLOGY** (3-1-0)

Module-I:
Microbial Processes and fermentation technology: Introduction to fermentation technology, Microbial growth and product formation kinetics in batch, continuous and feed batch fermentation, Large scale production: submerged, solid and semi-solid fermentation, Microbiological processes for production of organic acids; solvents; antibiotics, enzymes, polysaccharides; lipids; pigments and aroma.

Module-II:
Commercial media and strain development: Media selection and development for industrial production, Isolation, selection, characterization of microorganisms, stock culture, development inocula, strain improvement: induced mutation, over producing decontrolled mutants, genetically engineered strain and fermentation.

Module-III:
Stability of enzyme: Enzyme stabilization by selection and genetic engineering, protein engineering. Application of enzymes in industry, analytical purpose and medical therapy. Application of Biocatalyst, Group transfer redox, Elimination, isomarization and rearrengement, C-C bond cleavage, Reaction environment rebuilding, chemical modification, intramolecular cross linking and immobilization.

Text Books
1. Principle of Fermentation Technology , P.F. Stanbury, A. Whitaker and S.J. Hall, Elsevier
2. Industrial Microbilogy, Prescot and Dunn,
3. Biochemical Engineering and Biotechnology Handbook, Atkinson, B and Marituna, F., The Nature Press, Macmillan Publ. Ltd.
4. Biochemical Engineering Fundamentals, Bailey & Olis. MGH.

PCBT4305 **PLANT BIOTECHNOLOGY** (3-0-0)

Module-I: Plant Tissue Culture concepts and Methods
Concept of totipotency and plasticity of plant cell; Tissue culure media- preparation, composition and plant growth regulators; Initiation and establishment of culture: Explant preparation, Callus culture, Single cell culture, Suspension culture, Microspore culture, Embryo rescue; Micropropagation: Organogenesis, Somatic embryogenesis, Artificial seed; Protoplast technology: Isolation and culture of protoplast, Somatic hybridization, Screening and selection of somatic hybrid.

Module-II: Biotechnology of secondary metabolites
Secondary metabolites of plant origin and its type; Production of secondary metabolites through tissue culture, Factors affecting the production and its optimization, Bioreactor based production of secondary metabolites and its kinetic studies, isolation and purification of secondary metabolites, Biotransformation with case studies.

Module-III: Plant genetic Engineering and its applications
Concept of genetic transformation: Vector based (Agrobacterium, Virus) and Direct transformation (Gene gun, Electroporation, Microinjection, etc.); Application of genetic transformation: promoter tagging, activation tagging, herbicide resistance, insect resistance, disease resistance, molecular farming, terminator seed technology; Products of genetic transformation: Case studies for golden rice, Bt cotton and Flavr Savr tomato.

Text Books:
1. H S Chawla, Plant Biotechnology, Oxford University Press.
2. K G Ramawat, Plant Biotechnology, S. Chand & Co.
3. A Kumar and SK Sopory, Recent advances in Plant Biotechnology, I.K. International.
4. A Slater et al., Plant Biotechnology, Oxford Univ. Press.

PCBT4306 **DOWNSTREAM PROCESS ENGINEERING** (3-0-0)

Module -I:
Introduction; An overview of bioseparation. Separation of cells and other insolubles from fermented broth. Filtration and microfiltration, centrifugation (batch, continuous, basket). Cell disruption: Physical methods (osmotic shock, grinding with abrasives, solid shear, liquid shear), Chemical methods (alkali, detergents), Enzymatic methods

Module -II:
Ultra-filtration: Semipermeable membranes, membrane geometry and ultrafiltration module configuration. Chromatography: Adsorption chromatography, Ion- exchange, gel-filtration, affinity, high pressure / performance liquid chromatography (HPLC), hydrophobic chromatography. Reverse phase (RP) and thin layer chromatography (TLC).

Module-III:
Separation of soluble bio-products: Liquid-liquid extraction, aqueous two-phase extraction, precipitation, adsorption. Other bioseparation techniques like Dialysis, electro-dialysis, Liquid Electrophoresis.roducts polishing : Crystallization and drying.

Text Books:
1. M.R. Ladisch, Bioseparations Engineering, Wiley Interscience 2001
2. Kennedy and Cabral, Recovery processes for biological materials.
3. Heinemann, Product Recovery in Bioprocess Technology, Butterworth Publication.
4. Roger G. Harrison, Paul W. Todd, Scott R. Rudge, and Demetri Petrides, Bioseparations Science and Engineering, Oxford University Press, USA (October 31, 2002)

PEBT5303 **BIOMATERIALS** (3-0-0)

Module-I:
Introduction to biomaterials, Structure and properties (mechanical, thermal, optical, electrical and surface) of biomaterials, Synthetic polymer, Biopolymer

Module-II
Novel Biomaterials and uses in engineering and tissue engineering: Hydrogels, self-assembling peptides. Implants materials: metallic implant materials, stainless steels, Co-based alloys, Ti-based alloys; ceramic implant materials, aluminum oxides, hydroxyapatite glass ceramics carbons. Polymeric implant, Polymers for drug delivery: types of polymer, pharmaceutical polymers, physicochemical properties of polymers and relationship with structure, properties, kinetics, mechanisms and applications.

Module- III:
Biocompatibility and blood compatibility, Biomaterials: its foreign body response in a body. Biological interface, interaction with biomaterials and adhesion, Biological response to implants, 2D and 3D matrices (scaffolds) of biomaterials for tissue engineering, Soft tissue and hard tissue replacement, cardiovascular implants, Biomaterials for ophthalmology, orthopaedic and dental implants, Biologically functional biomaterials, Testing and clearance of biomaterials, Evaluation of biomaterials.

Text Books
1. Buddy D. Ratner Allan S. Hoffman Frederick J. Schoen Jack E. Lemons. Biomaterials Science, Second Edition: Wiley Science 2004.
2. Bhatt SV, Biomaterial, Narosa publishing house
3. Park J and R. S. Lakes R S, Biomaterials: An Introduction, Springer 2009

PEBT5302 **Molecular Modeling and Drug Designing** (3-0-0)

Module-I:
Introduction to Molecular Modelling and its applications Biomolecular modeling problems: protein folding, protein misfolding, nucleic acid/ protein interactions, and RNA folding.
Basic concepts of quantum mechanics, ab initio, semi-empirical and density functional theory calculations, Molecular size versus accuracy. Approximate molecular orbital theories. Molecular mechanisms, energy calculations, Bond stretch, Angle bending, torsional terms, Electrostatic interaction- Van der waals interactions. Miscellaneous interactions.

Module-II:
Introductionto molecular dynamics and simulations; Molecular Dynamics using simple models; Dynamics with continuous potentials, Constant temperature and constant dynamics; Conformation searching and systematic search; Monte-carlo simulation of biomolecules and bio-polymers.
Comparative modeling of protein: by homology- the alignment, construction of frame work, selecting variable regions, side chain placement and refinement, validation of protein models –Ramchandran plot, threading and ab initio modeling.

Module-III:
Analog based drug designing : Introduction to QSAR. lead module, linear and nonlinear modeled equations, biological activities, physicochemical parameter and molecular descriptors, molecular modelling in drug discovery.
Structure based drug designing: 3D pharmacophores, molecular docking, De novo Ligand design, Free energies and solvation, electrostatic and non-electrostatic contribution to free energies. 3D data base searching and virtual screening, Sources of data, molecular similarity and disimilarity searching, combinatorial libraries – generation and utility.

Text Book:
1. A R Leach, Principles and applications of modeling, Prentice Hall.
2. Hans Pieter, Heltje & Gerd Folkens, Molecular Modelling, VCH.
References:
1. Jonathan Good man, Chemical Applications of Molecular Modelling, Cambridge Press

PEBT5301 **NANOBIOTECHNOLOGY** (3-0-0)

Module-I
Introduction to Nanosciences and Nanotechnologies. Exploration of biology and biological systems, biology at the nano-interface. Cell nano structure interaction.

Module-II
Structural and functional principles of nanobiotechnology. Protein and DNA based nanostructures. Microbial synthesis of nanoparticles, magnetosomes, bacteriorhodopsin. Micro- and nano -fabrication; Micromachining: MEMS NEMS; BioMEMS; Scanning probe techniques (SPM). Molecular nanotechnology. Carbon nanotubes, nanoparticles and nanowires. Polymeric nanocontainers for drug delivery.

Module-III
Microfabricated devices to study directed cell migration, drug and gene delivery, Nano-particles and imaging applications, Nanoanalysis and nanobiosensors; Lab-on-a-chip devices and their potential in nanobiotechnology.

Text Book:
1. Niemeyer C M and Mirkin C A, Nanobiotechnology: Concepts, Applications and Perspectives, Wiley VCH, 2004
2. Chattopadhyaya KK and Banerjee AN, Nanoscience and Nanotechnology, PHI learning Pvt. Ltd.

PCBT7306 **DOWNSTREAM PROCESS ENGG. & ENZYME TECH LAB** (0-0-3)

Downstream Processing:
1. Harvesting cells using filtration or centrifugation techniques, identification of extracellular products (enzyme / poly saccharide / some other traceable element) from fermentation broth or shake-flask culture broth.
2. Cell disruption by homogenizers, osmotic shock, sonication and French press.
3. Protein fractionation using precipitation/solvent extraction techniques.
4. Protein fractionation using chromatography (gel filtration and ion-exchange)
5. Separation of proteins and DNA using affinity chromatography

Enzyme technology laboratory:
1. Enzyme assay techniques (e.g Alkalne phosphatase / Amylase / Invertase / dehydrogenases) using whole cells and/ or purified enzyme; Kinetic studies and determination of K_m and V_{max}
2. Effect of inhibitors on enzyme kinetics
3. Immobilization of cells and enzymes using different matrices (PVA, alginate, etc.)
4. Application of immobilized cells and enzymes in batch and continuous stirred tank reactors.
5. Biotransformation reaction using whole cell and/or enzyme(s).

PCBT7305 PLANT BIOTECHNOLOGY AND INDUSTRIAL MICROBIOLOGY LAB (0-0-3)

Plant Biotechnology

1. Media preparation, sterilization, explant preparation and establishment of meristem culture
2. Study of organogenesis and multiple shoot generation
3. Somatic embryogenesis in carrot and encapsulation somatic embryo or PLBs
4. Anther culture of Datura
5. Establishment of suspension culture
6. Agrobacterium mediated transformation (Co-cultivation & GUS expression)-

Industrial Microbiology

1. Preparation of starter culture of yeast in grape juice
2. Submerged fermentation in single-culture, co-culture condition
3. Production and optimization microbial metabolites (Ethanol or Citric acid) and study of fermentation kinetics
4. Analysis of alcohol or citric acid by spectrophotometric method and gravimetric method.
5. Fermenter operation and study of product formation by batch culture.

PCBT7304 BIOINFORMATICS LAB (0-0-3)

1. Retrieving Human genome data, OMIM, SNP databases to understand genetic and metabolic disorders. (At least 2 each)
2. Mining genomic data to identify genomic features: codon usage, repeats, Homologous sequences etc.
3. Making Phylogenetic tree of given sequences by using ClustalW and PHYLIP.
4. Gene and promoter prediction for Prokaryotes and eukaryotes (comparative analysis by using different tools: at least 3)
5. Learning about molecule visualisation software like Rasmol, Pymol etc.
6. Primary Structural databases: pdb, ndb, ccsd and Derived databases of structures: DSSP, FSSP, CATH & SCOP.
7. Prediction of secondary structures of proteins: at least 3 methods
8. Prediction of Tertiary structure of proteins and Validation of model protein structure: Energy minimization, Procheck, verify 3D, Prosa II, ERRAT etc.
9. Molecule drawing. Conversion of 2D structure to 3D structure.
10. Molecular docking and analysis of receptor with ligand

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BIJU PATNAIK UNIVERSITY OF TECHNOLOGY , ORISSA

BIOTECHNOLOGY

7th Semester				8th Semester			
Theory	**Subject**	**Credit Hrs**	**Credit**	**Theory**	**Subject**	**Credit Hrs**	**Credit**
PCBT4401	Medical & Pharmaceutical Biotechnology	3-0-0	**3**	HSSM3403	Marketing Management	3-0-0	**3**
				PCBT4403	Food biotechnology	3-0-0	**3**
PCBT4402	Bioreactor Design & analysis	3-0-0	**3**				
	Professional Elective	3-0-0	**3**	PCBT4404	IPR in biotechnology,Biosafety & Bioethics	3-0-0	**3**
PEBT5401	Protein Engineering.						
	Professional Elective (Any One)	3-0-0	**3**				
PEBT5402	Animal & stem cell technology				**Free Electives-III**	3-0-0	**3**
PEBT5403	Genomics & proteomics			PECS5410	Algorithms in Bioinformatics		
				PECE5404	Process Simulation & Modeling		
	Professional Elective (Any One)	3-0-0	**3**				
PEBT5404	Environmental Biotechnology						
PEBT5405	Biosensor and Diagnostics						
	Free Electives-II (Any One)	3-0-0	**3**				
PECS5401	Artificial Intelligence						
PEEC5416	Biomedical Instrumentation						
					Total		**12**
	Total		**18**				
Practical							
PCBT7401	Minor Project	0-0-2	**2**	PCBT7403	Major Project	0-0-6	**6**
PCBT7402	Industrial Internship Seminar	0-0-2	**2**	PCBT7404	Entrepreneurship project	0-0-2	**2**
				PCBT7405	Comprehensive Viva	0-0-3	**3**
	Total		**4**		Total		**11**
			22				**23**

MEDICAL AND PHARMACEUTICAL BIOTECHNOLOGY (3-0-0)

Module-I Drug Development in Pharmaceutical Process

Production of pharmaceuticals by genetically engineered cells (hormones, interferon), Microbial transformation for production of important pharmaceuticals (steroids and semi-synthetic antibiotics), Techniques for development of new generation antibiotics, Protein engineering, drug design, drug targeting

Module-II Disease Diagnosis and Therapy

ELISA and hybridoma technology, Use of enzymes in clinical diagnosis, Use of biosensors for rapid clinical analysis, Diagnostic kit development for microanalysis, Genetic diseases and DNA based diagnoses, DNA vaccine, Gene Therapy, Toxicogenomics

Module III Proteomics in Drug Development

Role of Proteomics in Drug Development, Diagnosis of disease by Proteomics, Separation and identification techniques for protein analysis, Development of antibody based protein array for diagnosis

Text Books

1. Balasubramanian, Bryce, Dharmalingam, Green and Jayaraman(ed), Concepts in Biotechnology, University Press, 1996
2. Epenetos A.A.(ed), Monoclonal antibodies: applications in clinical oncology, Chapman and Hall Medical, London
3. Text book of industrial pharmacy by S R Hiremath, Orient Black Swan publication

BIOREACTOR DESIGN AND ANALYSIS (3-0-0)

Module- I: Principles and concepts

Recapitulation of the principles of Kinetics for chemical and Bio-chemical Reactions. Fundamentals of homogeneous reactions for batch / semi-batch, plug low reactor (PFR), continuous stirred rank reactors (CSTR), fluidized bed reactor bubble column, air lift fermenter etc, stirred tank/mixed reactors., adiabatic and programmed reactors. Unconventional bioreactors: Hollow fiber reactor, membrance reactor, perfusion reactor for animal and plant cell culture.

Module- II: Bioreactor Analysis

Analysis of ideal bioreactors: Fed-Batch reactors, Enzyme catalyzed reactions in CSTRs, CSTR reactors with Recycle and Wall growth, Ideal Plug- Flow Tubular reactor. Analysis of Non-ideal Reactor Analysis: Concept of ideal and non-ideal reactor; residence time distribution; models of non-ideal reactors – plug flow reactor for microbial processes; Mass transfer in biochemical processes; Multiphase bioreactors – packed bed with immobilized enzymes or microbial cells; three – phase fuidized bed trickling bed reactor; Design and analysis of the above reactor systems; Gas liquid reactors, Reactor stability.

Module- III: Bioreactor Design

Design considerations: oxygen transfer, heat transfer, rheology, mixing. Scale up and scale down concepts. Bioprocess control and computer coupled bioreactors; Growth and product formation by recombinant cells. Mechanical fittings in a bioreactor: vessel, agitation system materials, welds, finish, valves, piping and valves for biotechnology, special requirements of utilities and cleaning of production plants. Instrumentation and control of bioprocesses: Physical and chemical sensors, online sensors for cell properties, off-line analytical methods; Biosensors. Bioreactor design calculation.

Text Books

1. Levenspiel, O., Chemical Reaction Engineering, Wiley Eastern Ltd.
2. Bailey & Olis, Biochemical Engg. Fudamentals, MGH.,1990
3. Atkinson, B.,Biological Reactors, pion Ltd., London,1974.
4. Coulson, Richardson, Sinnott, An introduction to chemical engineering design, Pergamon Press. Lydersen, D'Elia, Nelson, Bioprocess engineering: Systems and equipment.

PROTEIN ENGINEERING (3-0-0)

Module- I

Overview of protein structure and its hierarchical architecture; Protein engineering – definition, applications; Features or characteristics of proteins that can be engineered- affinity and specificity; Spectroscopic properties; Stability to changes in parameters as pH, temperature and amino acid sequence, aggregation propensities, etc.; Forces stabilizing proteins – Van der waals, electrostatic, hydrogen bonding and weakly polar interactions, hydrophobic effects; Entropy – enthalpy compensation.

Module-II

Methods of measuring the stability of a protein; Spectroscopic methods to study physicochemical properties of proteins: UV, CD, Fluorescence, ORD; Hydrodynamic properties–viscosity, hydrogen-deuterium exchange; Brief introduction to NMR spectroscopy, Mass spectroscopy and X-ray crystallography and their application in protein engineering.

Module-III

Experimental methods of protein engineering: Rational designing, Directed evolution like site directed mutagenesis, Module shuffling, Guided protein recombination, etc.; Computational approaches to protein engineering: sequence and 3D structure analysis, Data mining, Ramachandran map, Mechanism of stabilization of proteins from psychrophiles and thermophiles vis-à-vis those from mesophiles; Protein and enzyme engineering case studies for its stability, specifity and affinity- Protease, Lipase and Lysozyme.

Text Books /References:

1. Edited by T E Creighton, Protein structure: A practical approach, 2nd Edition, Oxford press.
2. Edited by T E Creighton, Protein function. A practical approach, 2nd Edition, Oxford university press.
3. Edited by T E Creighton, Protein function. A practical approach. Oxford university press. .
4. Cleland and Craik, Protein Engineering, Principles and Practice, Vol 7, Springer Netherlands.
5. Mueller and Arndt., Protein engineering protocols, 1st Edition, Humana Press.
6 L. Alberghina, Protein Engineering for industrial biotechnology, Harwood Academic Publisher.

ANIMAL AND STEM CELL TECHNOLOGY (3-0-0)

Module-I:

History of animal cell culture and development, Equipments and materials for animal cell, culture technology, Brief discussion on the chemical, physical and metabolic functions of different constituents of culture medium, Development of primary culture. Development of cell line by enzymatic disaggregation, Culture media and growth conditions. Cell type and characterization, origin of animal cell line, maintenance and characterization of different cell lines, Marker gene characterization.

Module-II:

Cell growth characteristics and kinetics, Micro-carrier attached growth, Cell culture in continuous, perfusion and hollow fibre reactor, Mass transfer in mammalian cell culture. Measurement of viability and cytotoxicity; Biology and characterization of the cultured cells, measuring parameters of growth;

Module III:

Cell transformation, Application of animal cell culture, stem cell cultures, embryonic stem cells and their applications. Hybridoma technology, Organ culture technology, Transfection of animal cells, Future tissue engineering, animal cloning

Text Books:

1. R. Ian Freshney, Culture of Animal Cells, 3rd Edition, Wiley-Liss publication
2. Martin Clynes, (Eds) Animal Cell culture Techniques Springer Publication
3. Balasubramanian, Bryce, Dharmalingam, Green and Jayaraman (Eds.),Concepts in Biotechnology, University Press, 1996.
4. Hood L.E., Weissman I., Wood W.B. & Wilson J.H. Immunology,Benjamin Cummings, 1989.
5. Biotol Series – Butterworth and Heineman, Oxford, 1992
6. A Text Book of Biotechnology R C Dubey, S Chand publication

GENOMICS AND PROTEOMICS (3-0-0)

Module-I:

Genome organization in prokaryotes and eukaryotes; Concept of minimal cell genome; Genome sequencing strategies, principles and methodology; Recognition of coding and non-coding sequences and gene annotation; Tools for genome analysis-Linkage analysis including pedigree, Genetic mapping using molecular markers (RFLP, RAPD, SSR, STS), Physical mapping of the genome. Genome analysis using 16S rRNA typing/ sequencing, ESTs and SNPs; Concept of TILLING, DNA Chip technology.

Module-II:

Genome sequencing projects- Microbes, plants and animals; Accessing and retrieving genome project information from web; Reverse genetics, Structural genomics, Functional genomics and Comparative genomics; High throughput screening in genome for drug discovery-identification of gene targets, Pharmaco-genomics and drug development.

Module-III:

Introduction to proteome, Protein analysis (includes measurement of concentration, amino-acid composition, N-terminal sequencing); 2-D electrophoresis of proteins; Microscale solution, isoelectrofocusing; Peptide fingerprinting; LC/MS-MS for identification of proteins and modified proteins; MALDI-TOF; SAGE and Differential display proteomics, Protein-protein interactions, Yeast two hybrid and three hybrid system; Protein micro array; structural proteomics; Proteomics and Drug delivery.

Texts / References Book:

1. Voet D, Voet JG & Pratt CW, Fundamentals of Biochemistry, 2nd Edition. Wiley
2. Brown TA, Genomes, 3rd Edition. Garland Science
3. Campbell AM & Heyer LJ, Discovering Genomics, Proteomics and Bioinformatics, 2nd Edition. Benjamin Cummings
4. Primrose S & Twyman R, Principles of Gene Manipulation and Genomics, Blackwell,
5. Glick BR & Pasternak JJ, Molecular Biotechnology, 3rd Edition, ASM Press
6. Pennington SR & Dunn MJ, Proteomics, Viva publications

ENVIRONMENTAL BIOTECHNOLOGY (3-0-0)

Module-I:
Introduction to environmental biotechnology, definitions and facts. Overview of microbial transformations. Environmental monitoring: bioreporter, biomarker and biosensor technology.
Module-II:
Metagenomics, environmental genomics. Bioprospecting, Biomicroelectronics and Nano-biotechnology. Metabolic pathways for biodegradation of hydrocarbon compounds and other organic pollutants. Microbial interaction with metals and radionuclides, mechanisms. Nitrate and phosphate removal. Biotechnology of sewage treatment. Principles of bioremediation of organic and inorganic contaminants. and. In situ and ex situ remediation strategies. Phytoremediation.
Module-III:
Clean technologies: biofertilizers, biopesticides, microbial polymer production and bio plastic technology. Biotechnology of fossil fuels: desulfurization of coal, oil shales, microbial enhanced oil recovery (MEOR). Biofuels: biogas, biohydrogen, bioethahnol production. Biotechnology of mineral processing. Ethical issues in environmental biotechnology.

Text Books
1. Rittmann B and McCarty P, Environmental Biotechnology: Principles and Applications Mc Graw Hill 2001
2. Environmental biotechnology, Alan Scragg, Oxford University Press, 2005

BIOSENSOR AND DIAGNOSTICS (3-0-0)

Module-I
Introduction to biosensors- principles and applications; Components of Biosensor- Biological, Biochemical, Electrochemical, Electronic; Immobilization as key to biosensor construction, Bioaffinity principle and biosensor.
Module-II
Biosensor diversification, Principle, construction and applications of Redox mediated (Amperometric & Potentiometric) biosensor, Field Effect transitor systems (FETs) based biosensor, Thermistor based biosensor, Piezoelectric biosensors, Conductimetric biosensor, Calorimetric biosensor & Optoelectric biosensors; Whole cell biosensor, Immunosensors & In-vivo Biosensors.
Module-III
Applications of Biosensors: Clinical Chemistry & diagnostics, Medicine and health care, Veterinary, Agriculture and food production, Food preservation & contamination, Environment and pollution monitoring.

Text Books:
1. Turner APF et al., Biosensors fundamentals & Applications, Oxford University Press
2. Blum LJ & Coulet PR, Biosensor Principles & Applications, Marcel & Decker Inc.
3. Ramsay G, Commercial Biosensor, John Willey & Son
4. Walker JM & Rapley R, Molecular Biology and Biotechnology, Panima publishers.

ARTIFICIAL INTELLIGENCE

Module 1

What is Artificial Intelligence? AI Technique, Level of the Model,Problem Spaces, and Search: Defining the Problem as a State Space Search, Production Systems, Problem Characteristics, Production System Characteristics, Issues in the Design of Search Programs.Heuristic Search Techniques: Generate-and-Test, Hill Climbing, Best-first Search, Problem Reduction, Constraint Satisfaction, Means-ends Analysis,**Knowledge Representation:** Representations and Mappings, Approaches to Knowledge Representation, **Using Predicate Logic**: Representing Simple Facts in Logic, Representing Instance and ISA Relationships, Computable Functions and Predicates, Resolution, Natural Deduction.**Using Rules**: Procedural Versus Declarative Knowledge, Logic Programming, Forward Versus Backward Reasoning, Matching, Control Knowledge.**Symbolic Reasoning Under Uncertainty**: Introduction to Nonmonotonic Reasoning, Logics for Nonmonotonic Reasoning, Implementation Issues, Augmenting a Problem-solver, Depth-first Search, Breadth-first Search.**Weak and Strong Slot-and-Filler Structures**: Semantic Nets, Frames, Conceptual DependencyScripts, CYC.

Module 2

Game Playing: The Minimax Search Procedure, Adding Alpha-beta Cutoffs, Iterative Deepening. **Planning**: The Blocks World, Components of a Planning System, Goal Stack Planning, Nonlinear Planning Using Constraint Posting, Hierarchical PlanningOther Planning Techniques.**Understanding**: What is Understanding, What Makes Understanding Hard?, Understanding as Constraint Satisfaction.**Natural Language Processing**: Introduction, Syntactic Processing, Semantic Analysis, Discourse and Pragmatic Processing, Statistical Natural Language Processing, Spell Checking.

Module 3

Learning: Rote Learning, Learning by Taking Advice, Learning in Problem-solving, Learning from Examples: Induction, Explanation-based Learning, Discovery, Analogy, Formal Learning Theory, Neural Net Learning and Genetic Learning. **Expert Systems**: Representing and Using Domain Knowledge, Expert System Shells, Explanation, Knowledge Acquisition.

Text Book:

1. Elaine Rich, Kevin Knight, & Shivashankar B Nair, Artificial Intelligence, McGraw Hill, 3rd ed.,2009

References:

1. Introduction to Artificial Intelligence & Expert Systems, Dan W Patterson, PHI.,2010
2. S Kaushik, Artificial Intelligence, Cengage Learning, 1st ed.2011

BIOMEDICAL INSTRUMENTATION

Module – I **(10 Hours)**

Fundamentals of Biomedical Instrumentation: Sources of Biomedical Signals, Basic Medical Instrumentation System, Intelligent Medical Instrumentation Systems, PC Based Medical Instrumentation Systems, General Constraints & Regulations of Medical Devices

Biomedical Signals & Electrodes: Origin of Bioelectric Signals-Repolarization, Depolarization, Resting Potential Recording Electrodes – Ag-AgCl Electrodes, Electrodes for ECG, EEG, EMG, Microelectrodes, Skin Contact Impedance, Motion Artifacts

Module – II **(13 Hours)**

Physiological Transducers: Introduction to Physiological Transducers, Classification of Transducers, Pressure Transducers, Transducers for Body Temperature Measurement, Biosensors, Smart Sensors

Biomedical Recording Systems: Basic Recording Systems, General Considerations for Signal Conditioners, Biomedical Signal Analysis Techniques, Signal Processing Techniques, Writing Systems: Direct Writing Recorders, Inkjet Recorder, Potentiometric Recorders, Digital Recorders

Biomedical Recorders: Electrocardiograph (ECG), Phonocardiograph, Electroencephalograph (EEG), Electromayograph (EMG)

Module – III **(14 Hours)**

Patient Monitoring Systems: System Concepts, Measurement of Heart Rate, Blood Pressure Measurement, Measurement of Respiration Rate

Blood Flow meters: Electromagnetic Blood Flow meter, Ultrasonic Blood Flow meter, NMR Blood Flow meter, Laser-Doppler Blood Flow meter

Patient Safety: Electric Shock Hazards, Leakage Currents, Safety Codes for Biomedical Equipment

Text Books:

1. Hand Book of Biomedical Instrumentation-2nd Edition by R.S.Khandpur, Tata McGraw Hill 2003 (Chapters 1-6,11,18)
2. Biomedical Instrumentation and Measurements-2nd Edition by Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, PHI learning Pvt Ltd 2nd Edition

Reference Books:

1. Introduction to Biomedical Equipment Technology-4th Edition by Joseph J. Carr, John M. Brown, Pearson Education 2007

8th Semester

MARKETING MANAGEMENT (3-0-0)

Objective of the Course: The course aims at introducing the basic concepts of marketing to the undergraduate students in engineering. The learning shall help the students in better designing, manufacturing and selling product/ service packages keeping competitive market, customers and cost in view.

Module -I (10 hours)

Marketing Management: Concept, Process, Functions and relevance in the current context.
Marketing Environment: Elements of micro and macro environment
Competition Analysis: Factors contributing to competition, porter's five forces model, Identifying and analyzing competitors.
Marketing Planning : Exploring Opportunity, Product –market selection, Marketing Planning Process.
Market Research and Information Systems: Research Process, The Internet and World Wide Web based Information collection and processing, Database, Data Warehouses and Data Mining, Global Market Research.
Consumer Behavior: Factors influencing consumer behavior, consumer decision process. Organizational buying behavior.

Module- II (10 hours)

Market Segmentation, Targeting and Positioning: Definition, Bases of segmenting consumer and Industrial markets. Target Market strategies: Market Positioning.
Market Demand Forecasting: Key Terms, Forecasting Tools: Short term tools: Moving average and Exponential smoothing methods, Long-term forecasting Tools: Time series analysis, Econometrics methods, Qualitative tools : Buying Intention Survey, Sales Force Opinion and Delphi Techniques.
Product Planning : Product Life Cycle, New Product Development Process, Branding Strategy, Positioning a Brand, Brand Equity, Packaging and Labeling, Product-mix and Product Line, Planned Obsolescence.

Module - III (10 hours)

Pricing Decision: Objectives and Factors influencing pricing, Pricing method and strategies.
Integrated Marketing Communication(IMC)- Concept of IMC, the marketing communication process, Promotion Mix, elements of promotion mix, Direct marketing.
Channels of Distributions: Types of intermediaries, functions of distribution channels, channel levels, Designing Distribution Channels, Physical Distribution, Supply Chain Management (Basic only).
Trends in Marketing: Green Marketing, Customer Relationship Management, E-marketing, Rural Marketing and Service Marketing (concepts only)
Books:

Text Book:

1. Etzel , Walker ,Stanton and Pandit, Marketing, 14/e, Tata McGraw Hill.
2. Saxena, "Marketing Management" Tata McGraw Hill, 4/e.

Reference

1. Grewal, Levy, 'Marketing' Tata McGraw Hill, special Indian edition.
2. Karunakaran "Marketing Management", Himalaya Publishing House, 2010/e.
3. Kotler, Keller,Koshy and Jha, "Marketing Management", 13/e, Pearson Education.

FOOD BIOTECHNOLOGY (3-0-0)

Module I: Food quality and Production technology

Analysis of food, major ingredients present in different product, Food additives colour, flavour, vitamins, Single cell protein, mushroom, Fermentative production of food, Pickling and alcoholic beverages, Genetically manipulated crop based food, oriental foods, probotics/ prebiotics in food products.

Module II: Technology for improved process

Enzyme in bakery, fermented cereal products, Enzymes in fat/oil industries, Protease in cheese making, enzymes in beverage production, Utilization of food waste for production of value added products, enzymes in sugar syrup, genetically modified food

Module III Food spoilage and control

Spoilage of food, Microbiology of water, meat, milk, vegetables, Microbial safety of food products, Chemical safety of food products, heavy metal, fungal toxins, pesticide and herbicide contamination, Food preservatives and additives, Post-harvest technology for food preservation. Technology – canning, dehydration, ultrafiltration, sterilization, irradiation etc.

Text Books

1. Jay, Modern Food Microbilogy, CBS Publishers, 1987
2. Frazier, Food Microbiology
3. G.Reed, Prescott and Dunn's Microbiology, CBS publishers, 1987
4. Desrosier, Teachnology of food preservation, CBS publishers
5. R.P. Singh and D.R. Headman, Introduction to food engineering, Aca. Press

IPR IN BIOTECHNOLOGY, BIOSAFETY & BIOETHICS (3-0-0)

Module-I:
Concept of property, rights, duties and their correlation; Intellectual property rights and its types-Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of new GMOs; Process patent vs product patent; International framework for the protection of IP; IP as a factor in R&D; IPs of relevance to Biotechnology and few Case Studies; Introduction to History of GATT, WTO, WIPO and TRIPS.

Module-II:
Basic requirement of a patentable invention- novelty, inventive step, Prior art and Stae of art; Patent databases; Searching International Databases; Analysis and report formation; Indian Patent Act 1970 and Recent Amendments; Filing of a patent application; Precautions before patenting-disclosure/non-disclosure; WIPO Treaties; Budapest Treaty; PCT and Implications; Role of a Country Patent Office; Procedure for filing a patent, International patenting-requirement, Patent infringement- meaning, scope, litigation, remedies; Case studies and examples-Rice, Neem etc.

Module-III:
Introduction to Biosafety regulations; Primary Containment for Biohazards and Biosafety Levels; Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals; Biosafety guidelines - Government of India. Definition of GMOs & LMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Overview of National Regulations and relevant International Agreements including Cartagena Protocol.
Concept of Bioethics, Public concerns on Human genome research and transgenics- Genetic testing and screening, Ethics in clinical trials and GCP, ELSI & Human genome projects; Ethics in human cloning-a case study.

Text Book
1. Stanley SA, Bioethics, Wisdom educational services
2. Sateesh MK, Bioethics and Biosafety, IK International Pvt. Ltd.

ALGORITHMS IN BIOINFORMATICS

Module 1

Introduction, Algorithms and Complexity: Biological Algorithms versus Computer Algorithms, Biological Algorithms versus Computer Algorithms, Biological Algorithms versus Computer Algorithms, Notations, Algorithm Design Techniques, Tractable versus Intractable Problems.

Molecular Biology Primer: Genes, Molecules, Structure of DNA, Proteins, Analysis. **Exhaustive Search**: Restriction Mapping, Impractical Restriction Mapping Algorithms, A Practical Restriction Mapping Algorithm, Regulatory Motifs in DNA Sequences, Pro les, The Motif Finding Problem, Search Trees, Finding Motifs, Finding a Median String.

Module 2

Greedy Algorithms: Genome Rearrangements, Sorting by Reversals, Approximation Algorithms, Breakpoints: A Different Face of Greed, A Greedy Approach to Motif Finding. **Dynamic Programming Algorithms**: The Power of DNA Sequence Comparison, The Change Problem Revisited, The Manhattan Tourist Problem, Edit Distance and Alignments, Longest Common Subsequences, Global Sequence Alignment, Scoring Alignments, Local Sequence Alignment, Alignment with Gap Penalties, Multiple Alignment, Gene Prediction, Statistical Approaches to Gene Prediction, Similarity-Based Approaches to Gene Prediction, Spliced Alignment. **Divide-and-Conquer Algorithms**: Divide-and-Conquer Approach to Sorting, Space-Ef cient Sequence Alignment, Block Alignment and the Four-Russians Speedup, Constructing Alignments in Subquadratic Time.

Graph Algorithms: Graphs and Genetics, DNA Sequencing, Shortest Superstring Problem, DNA Arrays as an Alternative Sequencing Technique, Sequencing by Hybridization, SBH as a Hamiltonian Path Problem, SBH as an Eulerian Path Problem, Fragment Assembly in DNA Sequencing, Protein Sequencing and Identi cation, The Peptide Sequencing Problem, Spectrum Graphs, Protein Identi cation via Database Search, Spectral Convolution, Spectral Alignment.

Module 3

Combinatorial Pattern Matching: Repeat Finding, Hash Tables, Exact Pattern Matching, Keyword Trees, Suf x Trees, Heuristic Similarity Search Algorithms, Approximate Pattern Matching, BLAST: Comparing a Sequence against a Database. **Clustering and Trees**: Gene Expression Analysis, Hierarchical Clustering , k-Means Clustering , Clustering and Corrupted Cliques, Evolutionary Trees, Distance-Based Tree Reconstruction, Reconstructing Trees from Additive Matrices, Evolutionary Trees and Hierarchical Clustering, Character-Based Tree Reconstruction, Small Parsimony Problem, Large Parsimony Problem.

Hidden Markov Models: CG-Islands and the “Fair Bet Casino”, The Fair Bet Casino and Hidden Markov Models, Decoding Algorithm, HMM Parameter Estimation, Pro le HMM Alignment. **Randomized Algorithms**: The Sorting Problem Revisited, Gibbs Sampling, Random Projections.

Text Book:

1. Neil C. Jones and Pavel A. Pevzner, An Introduction to Bioinformatics Algorithms, MIT Press, 2004.

References:

1. Wing-Kin Sung, "Algorithms in Bioinformatics: A Practical Introduction", CRC Press (Taylor & Francis Group), 2009.

2. Ion Mandoiu, Alexander Zelikovsky, Bioinformatics Algorithms: Techniques and Applications
Wiley, 2008.

PROCESS SIMULATION AND MODELLING (3-0-0)

Module I

Modeling: Fundamentals of mathematical models and formulation – Continuity equation, Equation of motion, Transport equations, Energy equation, Equations of state, Equilibrium, Chemical kinetics and their applications; Lumped and distributed parameter models – Fluid systems, C.S.T.R. (single, series, isothermal, constant hold up, variable hold up, gas phase pressurized and non-isothermal), Single component vaporizer, Multi-component flash drum, Batch reactor, Reactor with mass transfer, Ideal binary distillation column, Batch distillation, Heat exchanger, etc;

Module II

Optimization: Single variable optimization (analytical, dichotomous search, fibonacci, golden section, regula falsi), Multivariable optimization (analytical, geometric programming, linear programming), Convergence methods (Newton's methods, direct substitution, Wegstein's method).

Module III

Simulation:; Techniques of digital simulation – Information flow, from process to information flow diagram, From information flow diagram to numerical form, Recycles, Calculation of a recycle set, etc.

Essential Reading:

1. W. L. Luyben, *Process Modelling, Simulation and Control for Chemical Engineers,* McGraw Hill, 1990.

Suggested Readings:

1. B. V. Babu, *Process Plant Simulation*, Oxford University Press, 2004.
2. S. S. Rao, *Engineering Optimization: Theory and practice*, New Age Publishers, 1999.
3. A. Hussain and K. Gangaiah, *Optimisation Techniques for Chemical Engineers*, Macmillan, 2001.
4. B. W. Bequette, *Process Control: Modeling, Design and Simulation.* Prentice-Hall India, 2006.

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