Scheme of Instruction and Syllabi
of
Choice Based Credit System (CBCS) of

BE / B.TECH V AND VI SEMESTERS
OF
FOUR YEAR DEGREE COURSE
IN

BIO-TECHNOLOGY

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY™
(An Autonomous Institution)
Affiliated to OU; All U.G. and 5 P.G. Programmes (Civil, CSE, ECE, Mech. & EEE)
Accredited by NBA; Accredited by NAAC - 'A' Grade (UGC); ISO Certified 9001:2015
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CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (A)

Choice Based Credit System (with effect from 2018-19)

B.Tech (Bio-Technology)

S.No	Course Code	Title of the Course	Scheme of Instruction		Scheme of Examination			Credits
			Hours per week		Duration of SEE in Hours	Maximum Marks		
			L/T	P/D		CIE	SEE	
THEORY								
1	16MT C08	Biostatistics	3	-	3	30	70	3
2	16BT C19	Fluid Mechanics and Heat Transfer	3	-	3	30	70	3
3	16BT C20	Protein Engineering and Enzyme Technology	4	-	4	30	70	4
4	16BT C21	Genetic Engineering and rDNA Technology	3	-	3	30	70	3
5	16BT E22 16BT E23 16MT E02	**Elective-I** 1.Environmental Biotechnology 2. Food Biotechnology 3. Computational Numerical Methods	3	-	3	30	70	3
6	18CS E02 16BT E24 16BT E25	**Elective-II** 1. Python for Bioinformatics 2. Virology 3. Metabolic Engineering	3	-	3	30	70	3
PRACTICALS								
7	16BT C26	Fluid Mechanics and Heat Transfer Lab	-	3	3	25	50	2
8	16BT C27	Enzyme Technology Lab	-	3	3	25	50	2
9	16BT C28	Genetic Engineering Lab		3	3	25	50	2
TOTAL			**19**	**9**	**28**	**255**	**570**	**25**

BIOSTATISTICS

Instruction	3L Periods per week
Duration of End Examination	3 Hours
Semester End Examination	70 Marks
Sessionals	30 Marks
Credits	3

Course Objectives:

1. Explain and apply principles of design, data collection and represent the data graphically.
2. Understand properties of the normal curve.
3. Infer properties of a population from a sample.
4. Compute simple probabilities of events.

Course Outcomes: At the end of the course the students are able to

1. Demonstrate the ability to apply fundamental concepts in exploratory data analysis.
2. Understand the concept of the sampling distribution of a statistic, and in particular describe the behavior of the sample mean.
3. Understand the foundations for classical inference involving. confidence intervals and hypothesis testing.
4. Apply inferential methods relating to the means of Normal distributions.
5. Demonstrate an appreciation of one-way analysis of variance (ANOVA).

UNIT – I DESCRIPTIVE STATISTICS

Types of data – Methods of collection of data-Graphical representation of data-Histogram-frequency polygon-Pie chart. Frequency distribution-Measures of central tendencies - Measures of dispersion (mean deviation and standard deviation) coefficient of variation and its significance Measures of dispersion-Skewness-Kurtosis-Boweyl's coefficient-Karl Pearson's coefficient of skewness- correlation-Lines of regression- applications of Biotechnology.

UNIT - II PROBABILITY

Classical approach- Axiomatic approach of probability. Basic theorems - addition and product theorem, conditional probability-Baye's theorem- applications to Biotechnology.

UNIT – III PROBABILITY DISTRIBUTIONS

Random variable- types of Random variable-probability mass function-probability density functions-Expectation, variance, co variance and their properties.

Probability function-Moment generating function (M.G.F), Cumulant generating function (C.G.F) and Characteristic function (CF). Discrete Distributions-Binomial distribution, Poison distribution-their expectation, M.G.F, C.G.F and

CF Continuous distributions: Normal Distribution- mean, variance, M.G.F and C.G.F. Properties of Normal distribution.

UNIT- IV INFERENCIAL STATISTICS I

Estimation-Hypothesis-Testing of Hypothesis-Types of Errors. Testing the single sample mean (αknown), Testing of single sample mean (σunknown).Testing the single sample proportion- single sample variance.

Testing the differences between two means, two proportions and two variances.

UNIT-V INFERENCIAL STATISTICS II

Testing of many proportions-χ^2 – test independent of attributes-r x c-tables. Analysis of variance-CRD.

Text Books:

1. Introduction to Bio-Statistics and Research Methods, by P.S.S Sunder Rao and J.Richard; fifth edition, PHI Learning Pvt. Ltd.2012.
2. Fundamentals of Applied Statistics by S.C.Gupta and Dr.V.K.Kapoor, Tenth edition, Publishers: Sultan Chand & Sons.

Suggested Reading:

1. Methods in Bio-Statistics by Mahajan, Japee Brothers Publishers, 2002
2. Text Book of Bio-Statistics; by A.K.Sharma Discovery Publishing House, 2005-Edition.
3. Fundamentals of Mathematical Statistics A Modern Approach, by S.C.Gupta and Dr.V.K.Kapoor, 10th edition, Publishers: Sultan Chand & Sons.

16BT C19

FLUID MECHANICS AND HEAT TRANSFER

Instruction	3L Periods per week
Duration of End Examination	3 Hours
Semester End Examination	70 Marks
Sessionals	30 Marks
Credits	3

Course Objectives:

1. This course aims at providing knowledge on basic concepts in flow of fluids, flow field, flow past immersed bodies.
2. The course is designed to give an understanding on measurement of viscosity, flow measuring devices.
3. The course also deals with basic concepts in heat transfer, evaporation and condensation.

Course Outcomes: At the end of the course the students should

1. Be able to measure viscosity of different fluids.
2. Explain the functions of different flow measuring and monitoring devices.
3. Enable to calculate friction in flew process.
4. Enable to calculate pressure drop in flow process.
5. Calculate the heat transfer area, overall heat transfer co-efficient required for various processes.
6. Explain the operation of various, evaporators, condensers, heat exchange equipment.

UNIT-I BASIC CONCEPTS IN FLOW OF FLUIDS

Introduction, Nature of fluid, Rheology of fluids -Newton's law of viscosity. Concept of Newtonian and non-Newtonian fluids-Different types of non-Newtonian fluids with examples in bioprocessing. Measurement of viscosity using extrusion rheometer, plate and cone viscometer, coaxial cylinder viscometer etc.

UNIT-II FLOW FIELD

Friction losses in laminar flow through a circular tube (Hagen-Poiseuille equation), Friction losses in turbulent flow (Fanning equation), Pumping of fluids flow through pipes, average velocity, flow regimes, boundary layer concept. Laminar and turbulent flow -characterization by Reynold's number, pressure drop due to skin friction and form friction, friction factor chart, Hagen - Poiseuille equation.

UNIT-III FLOW PAST IMMERSED BODIES

Definition of drag and drag coefficient. Friction in flow through beds of solids, Brief introduction to flow of compressible fluids. Flow measuring and monitoring

systems- valves, bends, elbows, prevention of leaks, mechanical seals, stuffing box. Flow measuring devices-manometers, orifice-meter, venturimeter and rotameter. Brief description of Pumps and Blowers.

UNIT-IV BASIC CONCEPTS IN HEAT TRANSFER

Introduction and Mechanisms of heat transfer; Conduction heat transfer (through slab, cylinder & Sphere); Conduction through solids in series, Forced convection heat transfer inside pipes, Introduction to radiation heat transfer, Chilling and freezing of food and Biological materials. Heat transfer correlations, and calculations, basic heat exchange equipment.

UNIT-V BASIC CONCEPTS IN EVAPORATION AND CONDENSATION

Introduction, Types of evaporation equipment and operation methods; Overall heat transfer coefficients in evaporators; simple material balances. Calculation methods for single effect evaporators, Evaporation of biological materials. Types of condensation, numerical problems and condensation equipment.

Text books:

1. W L McCabe and JC Smith, "Unit operations in Chemical Engineering", 6th edition., McGraw Hill Intl. Ed, 2005.
2. Christie J. Geankoplis, "Transport Processes and Unit Operations", 3rd edition, Prentice Hall India Pvt. Ltd.

Suggested Reading:

1. Kothandaraman CP and Rudramoorthy. R, "Basic Fluid Mechanics", New Age International Publishers, New Delhi, 1998.
2. Sachdeva RC, "Fundamentals of Engineering Heat and Mass Transfer", New Age International Publishers, New Delhi, 1996.

16BT C20

PROTEIN ENGINEEERING AND ENZYME TECHNOLOGY

Instruction	4L Periods per week
Duration of End Examination	3 Hours
Semester End Examination	70 Marks
Sessionals	30 Marks
Credits	4

Course Objectives:

1. The course aims at providing knowledge about structure and functions of proteins.
2. To understand the synthesis of proteins and analytical techniques for protein.
3. To learn the commercial applications of enzymes in diverse fields namely medicine, food industry, diagnostic industries.
4. To learn the role of enzyme kinetics and its action.
5. To understand the methods of enzyme immobilization and its mass transfer kinetics.

Course Outcomes: At the end of the course students will be able to

1. Explain structure properties and functions of proteins.
2. Outline protein isolation and analytical techniques.
3. Identify engineered proteins and its applications.
4. Discuss the applications of enzymes in different fields.
5. Explain the kinetics of enzyme action.
6. Compare various enzyme immobilization techniques and its mass transfer effects.

UNIT- I PROTEIN STRUCTURE AND FUNCTIONS

Peptide bond- Structure, functions; Proteins-classification and Biological functions; Physico-chemical properties, forces stabilizing protein structure - primary structure, secondary structure (á-helical, â-pleated sheets), super secondary structures, Ramachandran Plot, tertiary and quaternary structure; Myoglobin, Lysozyme, Ribonuclease A, Hemoglobin; Fibrous protein (Collagen).

UNIT- II PROTEIN SYNTHESIS AND PROTEIN DESIGN

Methods of protein isolation, purification and quantification; Chemical synthesis of peptides – Solid phase and liquid phase synthesis; Methods of detection (peptide mass fingerprinting, MALDI-TOF); Protein engineering strategies (Rational protein design & Directed evolution) and applications.

UNIT- III PRODUCTION AND APPLICATIONS OF ENZYMES

Enzyme nomenclature and classification of enzymes; Production and purification of crude enzyme extracts from plant, animal and microbial sources; Development of enzymatic assays; Applications of commercial enzymes; Proteases; Amylases; Lipases; Cellulases; Pectinases; Isomerases in food, pharmaceutical and other industries; Enzymes for analytical and diagnostic purposes; Design of enzyme electrodes and their application as biosensors in industry, health care and environment.

UNIT- IV MECHANISMS AND KINETICS OF ENZYME ACTION

Mechanisms of enzyme action; Concept of active site and energetics of enzyme substrate complex formation; Specificity of enzyme action; Kinetics of single substrate reactions; Turn over number; Derivation of Michaelis -Menten equation; Multi substrate reaction mechanisms ; Types of Enzyme Inhibition; Allosteric enzymes.

UNIT - V ENZYME IMMOBILIZATION & MASS TRANSFER EFFECTS IN IMMOBILISED ENZYME SYSTEMS

Physical and chemical techniques for enzyme immobilization - adsorption, matrix entrapment, encapsulation, cross-linking, covalent binding; Advantages and disadvantages of different immobilization techniques; Overview of applications of immobilized enzyme systems; Analysis of Film and pore Diffusion Effects on kinetics of Immobilized Enzyme Reactions; Formulation of dimensionless groups and calculation of Effectiveness Factors.

Text Books:

1. Trevor Palmer, Philip Bonner, "Enzymes", 2nd edition, Woodhead Publishing, 2007.
2. J.L. Jain, "Fundamentals of Biochemistry", revised edition, Chand (S.) & Co Ltd, India, 2016.

Suggested books:

1. Voet and Voet J.G, "Biochemistry", 4nd edition, John C.Wiley and Sons, 2010.
2. **Andreas S.** Bommarius and Bettina R. Riebel, "Biocatalysis - Fundamentals and Applications", Wiley-VCH, 2004.

16BT C21

GENETIC ENGINEERING AND rDNA TECHNOLOGY

Instruction	3L Periods per week
Duration of End Examination	3 Hours
Semester End Examination	70 Marks
Sessionals	30 Marks
Credits	3

Course Objectives

1. To provide theoretical concepts, basic principles and tools used in rDNA technology.
2. To learn essential features and various vectors used in gene cloning and rDNA technology.
3. To describe the principle, methodology and applications of PCR and molecular markers.
4. To outline the range of cloning strategies that are employed to clone a DNA sequence.
5. To describe how rDNA is used to produce proteins.
6. To illustrate the impact of rDNA technology on biotechnology applications.

Course Outcomes: At the end of the course students will be able to

1. Explain the basic principles and tools used in rDNA research starting from isolation of nucleic acid, enzymes etc.
2. Compare various types of cloning vectors and expression vectors and their use in rDNA technology.
3. Discuss about PCR, and its applications and molecular markers.
4. Predict various cloning strategies used in rDNA technology.
5. Identify high level expression of protein in different host systems
6. Apply gene cloning and rDNA technology in various fields.

UNIT-I: ISOLATION AND PURIFICATION OF DNA AND ENZYMES USED IN CLONING

Isolation and purification of DNA; Host controlled restriction and modifications; Enzymes used in cloning - **Restriction endonuclease, Polymerases, Ligase, Phosphatase, Kinase, Nuclease;** Restriction mapping; Blotting techniques – Southern, Northern and Western Blotting.

UNIT- II: CLONING VEHICLES

Essential features of cloning vectors; Cloning vectors - Plasmid vectors - pBR 322, pUC 18/19; Phage vectors – ëZAP, ëEMBL4; M13 derived vectors – M13mp18; Phagemid- Blue script vectors; Cosmid- pJB8; Artificial chromosomes - BAC, YAC; Expression vectors - pET vectors.

UNIT- III: POLYMERASE CHAIN REACTION AND MOLECULAR MARKERS

PCR – Principle, Designing of primers, PCR Methodology, RT-PCR, Multiplex PCR, PCR for site directed mutagenesis, Applications of PCR; Molecular marker – RFLP, RAPD, AFLP.

UNIT- IV: **CLONING STRATEGIES**

Construction of genomic and cDNA libraries; Basic concept of blunt end and cohesive end ligation, homopolymer tailing, use of linkers, adaptors. Introduction of cloned genes into hosts- Transformation, Transfection, packaging phage DNA *In vitro*; Detection of clones with desired gene; Methods of gene sequencing: - Maxam and Gilbert method, Sanger's dideoxy chain termination method, Pyrosequencing, automation of DNA sequencing.

UNIT- V: EXPRESSION OF RECOMBINANT PROTEINS AND APPLICATIONS OF rDNA TECHNOLOGY

High level expression of proteins in different host systems in *E. coli,* yeast, Insect and mammalian cells; Applications of Gene cloning and rDNA Technology - Recombinant Insulin, Recombinant Factor VIII, Golden rice. Introduction to Gene therapy (*Ex vivo* & *In vivo*), case study of ADA as an example. Safety guidelines for rDNA research.

Text books:

1. Brown TA, "Gene Cloning and DNA Analysis: An Introduction", 7th edition., Wiley Blackwell , A John Wiley & Son Ltd publications, UK, 2015.
2. Primrose SB and Twyman RM, "Principles of Gene manipulation and Genomics", 7th edition, John Wiley & Sons, 2013.

Suggested Reading:

1. Glick BR, Pasternak JJ and Patten CL, "Molecular Biotechnology: Principles and applications of Recombinant DNA", 4th edition, ASM Press, 2010.
2. Desmond S T Nicholl, "An Introduction to Genetic Engineering", 3rd edition, Cambridge End Press, 2008.
3. Richard J. Reece, "Analysis of Genes and Genomes", Wiley, 2004.

16BT E22

ENVIRNOMENTAL BIOTECHNOLOGY
(Elective –I)

Instruction	3L Periods per week
Duration of End Examination	3 Hours
Semester End Examination	70 Marks
Sessionals	30 Marks
Credits	3

Course Objectives

1. To provide theoretical concepts and a comprehensive knowledge on bioremediation methods.
2. To provide knowledge on metal leaching and non conventional fuels.
3. To impart theoretical basics on various methods used in treatment of waste water.
4. To provide knowledge on degradation of Xenobiotic compounds.
5. To update the students with the available information on biotechnological applications in hazardous waste management.

Course Outcomes: At the end of the course students will be able to

1. Discuss bioremediation in detail.
2. Use of Microorganisms for metal leaching and biofuels.
3. Out line the different methods for waste water treatment.
4. Explain the importance of Xenobiotics in nature.
5. Analyze hazardous waste disposal.
6. Demonstrate the role of biotechnology in dealing with environmental problems.

UNIT – I: BIOREMEDIATION

Introduction; Constraints and priorities of Bioremediation, Biostimulation of naturally occurring microbial activities Bio-augmentation; *In situ, Ex situ*, Intrinsic and Extrinsic Bioremediation; Solid phase bioremediation- Land farming, composting , Biopile. Phyto-remediation techniques, Liquid phase bioremediation.

UNIT – II: METAL BIOTECHNOLOGY AND BIOFUELS

Introduction to metal biotechnology; Microbial transformation; Biosorption, Metal leaching; Metal Extraction and future prospects. Microorganisms and their role in energy requirements of mankind. Role of carbon credits in Industries. Production of non-conventional fuels: Methane (Biogas), Hydrogen, Alcohols and Algal Hydrocarbons.

UNIT – III: BIOLOGICAL WASTE WATER TREATMENT

Biological processes for domestic and industrial waste water treatment. Aerobic systems – Activated sludge process, trickling filters, Biological filters, Rotating biological contractors (RBC), Fluidized bed reactor (FBR), Expanded bed reactor, Inverse fluidized bed bio-film reactor (IFBBR). Anaerobic biological treatment-Contact digesters, Packed column reactors, UASB.

UNIT- IV: DEGRADATION OF XENOBIOTIC COMPOUNDS

Introduction- Xenobiotic compounds; Recalcitrants; Biodegradation of Xenobiotics present in Environment. Degradative plasmids; Oil Pollution and Bioremediation of Contaminated soils. Biological Detoxification-Cyanide detoxification, Detoxification of Toxic Organics and Phenols.

UNIT- V: HAZARDOUS WASTE MANAGEMENT

Hazardous Waste, Biotechnological applications to hazardous waste management. Global Environmental problems and Biotechnological approaches for management. Nuclear waste generation and treatment.

Text books:

1. Alan Scragg "Environmental Biotechnology", 2nd edition , Oxford End Press, 2005.
2. Foster CF, John Ware DA, "Environmental Biotechnology", Ellis Horwood Ltd. 1987.

Suggested readings

1. Stanier RY Ingram JL., Wheelis ML & Painter RR "General Microbiology" Mcmillan Publications, 1989
2. Environmental Biotechnology By Priv.-Doz. Dr.Hans-Joachim Jördening, Prof. Dr. Josef Winter, Wiley-VCH Verlag GmbH & Co. KGaA. 2005.
3. John. T. Cookson "Bioremediation Engineering: Design And Application" by, Jr. Mc Graw Hill, Inc. 1995.

16BT E23

FOOD BIOTECHNOLOGY

(Elective-I)

Instruction	3L Periods per week
Duration of End Examination	3 Hours
Semester End Examination	70 Marks
Sessionals	30 Marks
Credits	3

Course Objectives:

1. Student is made to understand the importance of food biotechnology and its nutritive value.
2. Students are taught the types of food available in the nature and its consumption value.
3. Students made to understand the food spoilage.
4. Students are enlightened about the importance of food processing.
5. Students are made aware of chemical and physical methods of food processing.
6. Student is made to understand the methods of food preservation and its control in food spoilage.

Course Outcomes: At the end of the course the students are able to

1. Apply the fundamentals of food biotechnology to their real life situation.
2. Differentiate types of food and explain their consumption value.
3. Describe the types of pathogens and their effect on food.
4. Describe the physical and chemical methods of food processing.
5. Be in a position to preserve the food material to avoid food spoilage.
6. By understanding the principles of biotechnology able to work in a suitable food industry.

UNIT-I SCOPE AND IMPORTANCE OF FOOD BIOTECHNOLOGY

Introduction to Scope and importance of food biotechnology, Nutritive value of the food ; consumption and structure of foods and the importance of industrial processing of foods, various technologies and methods in food preservation, processing and packaging, food grade polymers.

UNIT- II FOOD PRODUCTS

Introduction to Probiotics, Nutraceuticals and GM foods ; Development of Industrial Food products: High Fructose Corn syrup, Single Cell Protein and Fermented foods, Bakery Products, Beverages, Milk Products and Mushroom Development; Food labeling.

UNIT- III FOOD SPOILAGE AND FOOD MICROBIOLOGY

Food spoilage, Bacterial agents of food borne illness; Clostridium, Salmonella, Vibrio and Shigella, non bacterial agents; Protozoa, Algae, Fungi and Viruses.

UNIT- IV FOOD PROCESSING

Bio-processing : Enzymes and chemicals used in food processing for flavor development; Processing of meat, fisheries, vegetables, dairy products; Thermal processing of foods; Microwave heating; Thermal inactivation of microorganisms; Freezing and thawing methods of food processing.

UNIT- V FOOD PRESERVATION

Food preservation using Irradiation: Characteristics of Radiations of Interest in food preservation, Principles underlying the destruction of microorganisms by irradiation, Processing of foods for Irradiation, Legal status of food irradiation, Effect of Irradiation of Food constituents and Storage Stability; Food Preservation with low and High Temperatures and Preservation of foods by Drying, equipment for Drying.

Text Books:

1. Roger Angold, Gordon Beech & Taggart, "Food Biotechnology" 1st edition, Cambridge End Press, 1989.
2. Frazier, William, C.Westhoff, Dennisc, "Food Microbiology" 2nd Edition TATA Mcgraw Hill Publishers, 1989.

Suggested Reading:

1. Ashok Pandey, "Biotechnology:Food Fermentation" Asia Tech Publishers Inc,New Delhi,1999.
2. J.M.Jay, M.J.Loessner and D.A.Golden, "Modern food microbiology", 7th edition,Springer,2006.
3. Romeo T. Toledo, "Fundamentals of Food Process Engineering", 3rd edition, Springer, February, 2007.

COMPUTATIONAL NUMERICAL METHODS
(Elective-I)

Instruction:	3L Periods per week
Duration of End Examination	3 Hours
Semester End Examination	70 Marks
Sessional:	30 Marks
Credits:	3

Course Objectives:

1. Learn interpolation and extrapolation techniques to fit the numerical tabulated data.
2. Solve numerical integration to get approximate solution of given date using Simpson's 1/3 rd, 3/8th Weddle's rules.
3. Solve numerical differentiation to get approximate solution of ODE using Taylor, Picard's , Euler's, modified Euler's , Runge kutta methods.
4. Solve algebraic and transcendental equations.
5. Solve simultaneous equations when the number of unknown increases by iterative methods and ill condition and well condition equations.

Course Outcomes: At the end of the course the students are able to

1. Learn interpolation and extrapolation techniques to fit the numerical tabulated date.
2. Solve numerical integration of given date using Simpson's 1/3 rd, 3/8th Weddle's rules.
3. Solve numerical differentiation to get approximate solution of ODE using Taylor, Picard's , Euler's, modified Euler's , Runga kutta methods.
4. Solve algebraic and transcendental equations.
5. Derive the solutions when system of equations has more than two unknowns and learn to reduce the instability of equations.

UNIT I: INTERPOLATION: Finite difference operators, Newton's forward and backward interpolation formulas, Newton's divided difference interpolation for unequal intervals,Lagrange's interpolation, inverse interpolation.

UNIT II: NUMERICAL DIFFERENTIATION & INTEGRATION: Numerical differentiation using Newton's forward & backward interpolation formulas, and Newton's divided difference interpolation formula. Numerical integration: Simpson's 1/3 rd, 3/8th rules. Weddle's rule.

UNIT III: NEMERICAL SOLUTIONS FOR DIFFENTIAL EQUATIONS: Solution of differential equation: Taylor's method, Picard's method, Euler's method, modified Euler's method, Runga kutta fourth order method.

UNIT-IV: Solutions of Algebraic and Transcendental Equations: Method of Bisection, Regulae Falsi Method (method of false position); Newton Raphson Method.

UNIT-V: Solutions of Simultaneous Equations: Gauss elimination method, Jacobi iteration Method, Gauss Serial Method of Iteration.

Text Books:

1. Numerical Methods by S. S. Shastry.
2. Numerical Analysis for Scientists and Engineers- by Mittal.
3. Numerical and statistical Methods in Computer by V.K.Singh.

Suggested Reading:

1. B.S.Grewal: Higher Engineering Mathematics, Hanna Publications.2 .Miller and Freund, Probability and Statistics for Engineers, PEARSON, 2005.
2. Erwyn Kreyszig: Advanced Engineering Mathematics.

18CS E02

Python for Bioinformatics

(Elective-II)

Instruction	3L Periods per week
Duration of End Examination	3 Hours
Semester End Examination	70 Marks
Sessionals	30 Marks
Credits	3

Course Objectives

1. Introduce Python with reference to bioinformatics.
2. Study Object-Oriented programming in Python.
3. Explain Biological sequence analysis using Python.
4. Describe advanced analysis techniques.
5. Describe expression and gene analysis using Python.

Course Outcomes: At the end of the course students shall be able to:

1. Understand the basics of Python Programming.
2. Develop applications using Python to solve problems.
3. Identify and use Python modules related to Biology.
4. Analyze biological sequences using Python.
5. Understand advanced analysis techniques.
6. Analyze gene expressions using Python.

Unit-I

Introduction to Python: Basics of Python, Python IDEs,,running Python programs, types and operations, Functions, modules, classes, Exceptions.

Unit-II

Object-Oriented Programming, Modules: Object Oriented Programming, Threads, process, synchronization, databases and persistence, NumPy, SciPy, Image manipulation, Akando and Dancer modules

Unit-III

Biological Sequence Analysis: Biopython: Parsing DNA data files, Sequence Analysis, Dynamic Programming, Hidden Markov Model, Genetic Algorithms, Multiple Sequence Alignment, gapped alignment.

Unit-IV

Advanced Analysis Techniques: Trees, Text Mining, Clustering, Self-Organizing Map, Principal Component Analysis, Numerical Sequence Alignment.

Unit-V

Expression Analysis: Gene expression array analysis, Spot finding and Measurement, Spreadsheet Arrays and Data Displays, Applications with expression Alignment.

Text Books:

1. Jason Kinser, "**Python for Bioinformatics**", Jones & Bartlett Publishers, 2nd Edition, 2013.
2. ReemaThareja "**Python Programming**", Oxford Press, 2017.

Suggested Reading:

1. Mark Lutz, "**Learning Python**", 3rd edition, O'Reilly, 2007.
2. Alex Martelli, David Ascher, "**Python cookbook**", O'Reilly, 2002.
3. http://www.biopython.org

16BT E24

VIROLOGY

(Elective–II)

Instruction	3L Periods per week
Duration of End Examination	3 Hours
Semester End Examination	70 Marks
Sessionals	30 Marks
Credits	3

Course objectives:

1. Students are made to understand the morphology and genetics of viruses.
2. Students recognize the procedures for cultivation of plant & animal viruses.
3. Students are enlightened about the characterization of viruses.
4. Students are taught the ultra structure of bacteriophages.
5. Students are taught the replication of plant & animal viruses.
6. The concept of viral vaccines preparation is introduced to the students.

Course outcomes: At the end of the course the students are able to

1. Students understand the basic structure of viruses.
2. Students compare the techniques for cultivation of plant & animal viruses.
3. Students explain the pros & cons of characterization techniques of viruses.
4. Students illustrate the structure of different phages.
5. Student recognizes the differences between replication of plant & animal viruses.
6. Be able to understand the procedures in preparation of vaccines.

UNIT- I INTRODUCTION TO VIROLOGY

Brief outline of discovery of Viruses; Properties of Viruses; Morphology of Viruses- Structure, Capsid Architecture, Envelopes and peplomers; Chemistry of Viruses- Viral Proteins, Genome- Structure and Types; Study of sub viral agents- Brief account on Diseases caused by Viroids- PSTV, Cadang cadang; Prions- Scrape, Cruetzfeldy jakob. Satellite viruses.

UNIT- II CULTIVATION OF VIRUSES I

General methods of cultivation of viruses- in embryonated eggs, cultivation of animal and plant viruses; cultivation of bacteriophages, Isolation and purification of viruses- plant viruses, animal viruses; Criteria of purity, Maintenance and

preservation of infectivity; Characterization of viruses- Electron microscopy, X-ray crystallography, sedimentation analysis;

UNIT- III CHARACTERIZATION OF VIRUSES II

Enumeration viruses- By electron microscopy, plaque assay, acid end point method, Haemagglutinin assay; Detection of viruses-By serological characterization, detection of viral antigen, detection of viral nucleic acid; chemical determination Ultra structure and life cycles of Bacteriophages- Ml3, T4 & lambda.

UNIT- IV PLANT VIRUSES

Taxonomy; Symptoms of diseases caused by plant viruses (Morphological, Physiological and Histological); Ultra structure and life cycles of TMV; transmission of plant viruses- Mechanical and biological (vector and non-vector); Basic control measures of plant diseases- vector and chemical control, biopesticides with examples.

UNIT- V ANIMAL VIRUSES

Taxonomy; Detailed structure and brief account on life cycles of RNA viruses- Polio, Influenza, Rota virus and HIV; Ultra structure and brief account on life cycles of DNA viruses- Vaccina, SV40 and Hepatitis Virus; Viral vaccines-types and preparation of conventional vaccines

Text Books

1. Dimmock NJ and Primrose SB, "Introduction to Modern Virology", 4th edition, Blackwell Scientific Publications, 1994.
2. Matthews REF "Fundamentals of Plant Virology". Academic Press, San Diego, 1992.

Suggested books

1. Carter J and Saunders V "Virology: Principles and Applications" John Wiley and Sons ltd, 2007.
2. Morag C, Timbury M, Chrchill Livingstone, "Medical Virology", London, 1994.

16BT E25

Metabolic Engineering

(Elective–II)

Instruction	3L Periods per week
Duration of End Examination	3 Hours
Semester End Examination	70 Marks
Sessionals	30 Marks
Credits	3

Course Objectives:

1. To identify the different metabolic regulations.
2. To outline various pathways of Biosynthesis of secondary metabolic and their applications.
3. To identify factors and criteria for bioconversions and their applications.
4. To learn the concept of metabolic flux and its application.
5. To compute metabolic pathways and algorithms.
6. To identify various applications of metabolic engineering in pharma chemical bioprocess, agriculture etc.

Course Outcomes: At the end of the course the students are able to

1. Revise the regulations & requirements of metabolic engineering.
2. Analyze and design various pathways of biosynthesis of secondary metabolies & their applications in various fields.
3. Assess the criteria & factors necessary for bio concessions- and out line their applications.
4. Discuss the analysis & applications of metabolic.
5. Design algorithms metabolic pathway modeling synthesis using bioinformatics tools.
6. Assess and compute various applications of metabolic engineering different fields.

UNIT- I INTRODUCTION

Identification of metabolic regulation: a key point in Metabolic Engineering. Basic concepts of Metabolic Engineering- Overview of cellular metabolism, Different models for cellular reaction, induction, Jacob monad model & its regulation, Different regulation by Isoenzymes,feed back regulation. Amino acid synthesis, pathways with regulation at enzyme & cell level.

UNIT- II BIOSYNTHESIS OF SECONDARY METABOLITES

Regulation of secondary metabolic path ways, precursor effect, prophase, Idiophase –relationships. Catabolite regulation bypassing control of secondary metabolism, producers of secondary metabolites and their applications.

UNIT- III BIOCONVERSIONS

Factors affecting bioconversions, Specificity, Yields, Co metabolism, Product inhibition, mixed or sequential bioconversions, Conversion of insoluble substances. Applications of Bioconversions. Strain selection, Genetic improvement of strains, Gene dosage, metabolic pathway manipulations to improve fermentation. The modification of existing or the introduction of entirely new metabolic pathways.

UNIT- IV METABOLIC FLUX

Metabolic flux distribution analysis, Experiments determination method of flux distribution, Metabolic flux analysis and its applications.

UNIT- V METABOLOMICS & APPLICATIONS OF METABOLIC ENGINEERING

Metabolic pathway modeling, Analysis of metabolic control and the structure metabolic networks, Metabolic pathway synthesis algorithms. Application in pharmaceuticals, chemical bioprocess, food biotechnology, agriculture environmental bioremediation and biomass conversion.

Text Books:

1. Ste Phanopoulas.G.N "Metabolic Engineering Principles & Methodologies" , Academic Press-Elsevier,1998.
2. Wand.D.I.C Cooney C.L., Demain A.L., Dunnil.P.Humphrey A.E.Lilly M.D. " Fermentation and Enzyme Technology, John Wiley and sons, 1980.
3. Metabolic engineering Sangy Yuplee and E.T.Pa poutsakis Marcel Dekker Inc.

Suggested Reading:

1. Zubay G., Biochemistry, Macmillan Publishers, 1989.
2. Stanbury P.F., and Whitaker A., Principles of Fermentation Technology Pergamon Press, 1984.

16BT E26

FLUID MECHANICS AND HEAT TRANSFER LAB

Instruction	3P Periods per week
Duration of End Examination	3 Hours
Semester End Examination	50 Marks
Sessionals	25 Marks
Credits	2

Course Objectives:

1. This lab course is designed to understand the mechanics of fluid flow, analysis of various processes viz., Flow measuring devices Venturimeter, Mouth piece, and Triangular notch.), heat exchangers.

Course Outcomes: At the end of the course the students are able to

1. Course outcomes are based on a continuous evaluation basis, like viva voce, calculations etc., and a final exam.
2. Demonstrate various experimentation methods with skill and precision.
3. Determine Thermal conductivity of homogeneous wall.
4. Determine calculate heat transfer coefficient in unsteady state heat transfer.
5. Determine overall heat transfer coefficient in unsteady state heat transfer.
6. Determine friction losses in pipe fittings.

LIST OF EXPERIMENTS

1. Determination of discharge coefficient for orifice meter and venturi meter and their variation with Reynolds number.
2. Determination of weir meter constant K for v-notch and rectangular notch.
3. Calibration of rotameter and study of variation of flow rate with tube to float diameter.
4. Determination of viscosity of Glycerol - water solutions at different temperatures.
5. Determination of friction factor for flow of water through annulus using Farmings and Davos equations.
6. Determination of friction factor for flow through straight pipes of different diameters and study of variation of friction factor with Reynolds number.

7. Determination of friction losses in pipe fittings.
8. Determination of Thermal conductivity of homogeneous wall insulating powder under steady state conditions.
9. Determination of interface temperatures in composite wall under steady state conditions.
10. Determination of heat transfer coefficient in Natural convection.
11. Determination of overall heat transfer coefficient in unsteady state heat transfer.
12. Determination of inside heat transfer coefficient in coil heat exchangers.
13. Determination of overall heat transfer coefficient and effectiveness in a Double pipe heat exchange.
14. Determination of heat transfer area in a 1-2- shell and tube heat exchanges.
15. Determination of heat transfer coefficient on a single tube by film wise and drop wise condensation.

16BT C27

ENZYME TECHNOLOGY LAB

Instruction	3P Periods per week
Duration of End Examination	3 Hours
Semester End Examination	50 Marks
Sessionals	25 Marks
Credits	2

Course Objectives:

1. The course aims at providing knowledge about the preparation of buffers and chemicals.
2. Outline for isolation and purification of enzymes.
3. Compare the optimum ranges of physical parameters for enzyme activity.
4. Compute the Michelis-Menten kinetics.
5. The students understand the methods of immobilization of enzymes and their kinetics.

Course Outcomes: At the end of the course students will be able to

1. Preparation of buffers.
2. Demonstrate the isolation of enzymes.
3. Predict the optimum ranges of parameters on enzyme activity.
4. Analyze the effect of various physical parameters and Michelis-Menten kinetics (K_s, V_{max}) activity of enzyme.
5. Choose the suitable methods for immobilization of enzymes.

LIST OF EXPERIMENTS

1. Preparation of buffers.
2. Isolation and extraction of enzymes (Microbial, plant and animal source).
3. Effect of pH on enzyme activity.
4. Effect of temperature on enzyme activity.
5. Effect of substrate concentration on enzyme activity.
6. Effect of time interval on enzyme activity.
7. Development of Enzyme Assay.
8. Evaluation of Michelis Menten kinetic parameters.
9. Kinetic studies of enzyme inhibition.
10. Determination of growth curve of a supplied microorganism and to determine substrate degradation profile.
11. Studies on immobilization of enzyme/cell by gel entrapment method.
12. Comparative study of activities of free and immobilized enzyme systems.

16BT C28

GENETIC ENGINEERING LAB

Instruction	3P Periods per week
Duration of End Examination	3 Hours
Semester End Examination	50 Marks
Sessionals	25 Marks
Credits	3

Course objectives:

1. To provide an opportunity to experimentally verify the concepts of genetic engineering and rDNA technology already studied.
2. To provide hands on training to students to practically prove the theoretical concepts studied with respect to isolation, quantification, amplification, sequencing of DNA genome /fragments and analysis of recombinant protein from transformed bacterial cultures.

Course outcomes: At the end of the course the students are able to

1. Demonstrate isolation of nucleic acids.
2. Characterize the DNA by restriction digestion and restriction mapping.
3. Design polymerase chain reaction.
4. Plan different steps involved in cloning strategies.
5. Analyze and compute DNA Sequencing.
6. Analyze the recombinant protein by using SDS PAGE.

LIST OF EXPERIMENTS

1. Isolation of bacterial genomic DNA.
2. Isolation of plasmid DNA.
3. Visualization of Genomic and Plasmid DNA on Agarose gels.
4. Restriction digestion.
5. Restriction mapping of DNA fragments.
6. Gel elution.
7. DNA ligation.
8. Preparation of competent cells.
9. Genetic transformation and screening for recombinant bacterial cells.
10. Blotting techniques- southern blotting.
11. Amplification of DNA fragments by Polymerase Chain Reaction (PCR).
12. DNA sequencing- Sanger's Method.
13. Analysis of Recombinant Proteins using SDS-PAGE.

Suggested Reading:. Green MR and Sambrook J, "Molecular Cloning-A laboratory manual", Vol I, II and III, Cold spring Harbor Laboratory Press, 2012

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (A)

Choice Based Credit System (with effect from 2018-19)

B.Tech (Bio-Technology)

SEMESTER – VI

S.No	Course Code	Title of the Course	Scheme of Instruction		Scheme of Examination			Credits
			Hours per week		Duration of SEE in Hours	Maximum Marks		
			L/T	P/D		CIE	SEE	
THEORY								
1	16BT C29	Fermentation Technology	4	-	4	30	70	4
2	16BT C30	Mass Transfer Operations	4	-	4	30	70	4
3	16BT C31	Bioinformatics	4	-	4	30	70	4
4	18CS E02 16BT E32 16BT E33	**Elective – III** 1. JAVA Programming and Bio-Java 2. Medical Biotechnology 3. Phyto Chemicals and Herbal Products	3	-	3	30	70	3
5	16BT E34 16BT E35 16BT E36	**Elective – IV** 1.Developmental Biology 2.Pharamceutical Biotechnology 3.Bioprocess Economics & Plant Design	3	-	3	30	70	3
PRACTICALS								
7	16BT C37	Bioprocess Lab	-	3	3	25	50	2
8	16BT C38	Mass Transfer Operations Lab	-	3	3	25	50	2
9	16BT C39	Bioinformatics Lab	-	3	3	25	50	2
10	16BT C40	Mini Project	-	1	1	50	-	1
TOTAL			**18**	**10**	**28**	**225**	**500**	**25**

L: Lecture T: Tutorial D: Drawing P: Practical
CIE - Continuous Internal Evaluation SEE - Semester End Examination

16BT C29

FERMENTATION TECHNOLOGY

Instruction	4L Periods per week
Duration of End Examination	3 Hours
Semester End Examination	70 Marks
Sessionals	30 Marks
Credits	4

Course Objectives:

1. The course aims at providing knowledge to students on scope and chronological development of fermentation technology.
2. To understand the types of fermentation process and design of fermentation.
3. To learn about the ancillaries of fermentor and its applications.
4. To gain in-depth knowledge about the working principles and operation of fermentors.

Course Outcomes: At the end of the course students will be able to

1. Interpret the Fermentation process.
2. Explain the types of fermentation media design and development of inocula.
3. Hypothesize the control of fermentation by various physical and chemical process parameters.
4. Summarize the scale up of fermentors and working principles.
5. To know the Differentiation between various fermentation systems.
6. Evaluate rheological properties of fermented broths.

UNIT-I INTRODUCTION TO FERMENTATION PROCESSES

The range of fermentation processes; Industrial applications; Future trends in fermentations; General requirements of fermentation processes, Basic design and construction of fermentor and ancillaries, Main parameters to be monitored and controlled in fermentation processes.

UNIT- II MEDIA DESIGN AND DEVELOPMENT OF INOCULA

Typical media, Media formulation, energy resources, carbon and nitrogen components. Solid-substrate, Submerged fermentation and its applications. Development of Inocula – For yeast and Mycelial Process, The aseptic inoculation of plant fermenters.

UNIT- III AERATION AND AGITATION IN FERMENTATIONS

Oxygen transfer from gas bubble to cells; Oxygen transfer in fermentations; Oxygen transfer in large vessels: Bubble aeration and Mechanical agitation; Correlations for mass transfer coefficients; Gas Hold up; Measurement of $K_L a$- Oxygen-Balance method, Dynamic Method, Sulphite Oxidation

UNIT- IV SCALE UP AND RHEOLOGY IN FERMENTATIONS

Scale up of fermentation processes; Principles, theoretical considerations and techniques used; Scale down methods; The Rheology of fermentation broths; Rheological models; Measurement of rheological parameters; Rheological Control of fermentations; Mixing concepts, power requirement for mixing and improvement of mixing in fermentations.

UNIT - V FERMENTORS

Batch, Fed-batch and Continuous Fermentation systems; Dual and multiple fermentations; Comparison between batch and continuous fermentations; Steady state, unsteady state continuous fermentation theories; Examples of continuous fermentation; Practical problems with continuous operations. Behavior of microbes in different reactors (air lift, fluidized, batch, and continuous fed batch condition).

Text books:

1. Stanbury PF, Whitaker A and Hall S J, "Principles of Fermentation Technology" 2nd edition, Elsevier, 2013,
2. Pauline M. Doran, "Bioprocess Engineering Principles", Academic press, 1995

Suggested Reading:

1. Brian McNeil and Linda Harvey, " Practical Fermentation Technology" Wiley, 2008.
2. Crueger W and Crueger A, "Biotechnology: A Text Book of Industrial Microbiology", 2nd Edition, Panima Publishing Corporation, New Delhi, 2000.

16BT C30

MASS TRANSFER OPERATIONS

Instruction	4L Periods per week
Duration of End Examination	4 Hours
Semester End Examination	70 Marks
Sessionals	30 Marks
Credits	4

Course Objectives:

1. To provide the students with knowledge about various unit operations such as absorption, distillation, extraction, leaching.
2. To give insight about various membrane separation processes such as adsorption, Ion-exchange, dialysis and the application of these unit operations in commercial aspects of biotechnology.

Course Outcomes: At the end of the course the students are able to

1. Molecular diffusion in solids, liquids and gases
2. Determine the number of trays needed for the separation
3. Carry out material balances accurately.
4. Explain the principles of the various separation processes involved in the downstream processing of products, especially those of biological origin
5. Explain the principles and application of membrane separation processes.
6. Understand the types of adsorbents.

UNIT- I PRINCIPLES OF MASS TRANSFER

Introduction to Mass transfer and Diffusion, Molecular diffusion in Gases, Molecular diffusion in Liquids, Molecular diffusion in Biological solutions and gels, Molecular diffusion in Solids, Inter phase mass transfer and Mass transfer coefficients.

Gas - Liquid operations: Equilibrium relations between phases, Mass transfer between phases, Choice of solvent for absorption, Single stage and multi stage co current and counter current operations, Estimation of Mass transfer coefficient, Calculation of HTU, NTU concepts, equipments mechanically agitated vessels, packed columns and plate columns.

UNIT- II PRINCIPLES OF VLE FOR BINARY SYSTEM

Phase rule and Raoult's law, Boiling point diagrams and x-y plots, Relative volatility, Flash distillation, Differential distillation, Simple steam distillation. Distillation with reflux and McCabe - Thiele method. Special Cases for rectification using McCabe - Thiele; Stripping column distillation, Enriching Column distillation, Rectification with direct steam injection, Rectification with single side stream.

UNIT- III LIQUID - LIQUID EXTRACTION AND LEACHING

Introduction to Extraction process: Equilibrium relations in extraction, Analytical and graphical solutions for single and multi stage operations co-current and counter current operations without reflux. Equipments for liquid-liquid extraction: mixer-settlers for extraction, Plate and Agitated Tower Contactors for Extraction, Packed and spray Extraction towers.

Introduction to leaching process: Equilibrium diagrams for leaching, analytical and graphical solutions for single and multi stage counter current operations.

UNIT - IV BASIC CONCEPTS IN DRYING OF PROCESS MATERIALS

Methods of drying, Equipment for drying; Free moisture content of materials; Concept of bound and unbound moisture content of biological materials; Rate of drying curves; Calculation methods for constant-rate & falling rate drying methods; Freeze drying of biological materials.

UNIT- V ADSORPTION AND MEMBRANE SEPARATION PROCESS

Theory of adsorption, Industrial adsorbents, Adsorption equilibria, Frendlich equation-single and multiple operations- processing variables and adsorption cycles Introduction and Types of Membrane separation process: Principles of ion exchange. Dialysis, Gas permeation membrane processes, types of membranes and permeability's for separation of gases, Introduction to types of flow in gas permeation.

Text Books:

1. C J Geankopolis, "Transport Processes in chemical Operations", 4th edition, Prentice Hall India.
2. Robert ETreybal, "Mass Transfer operations", 3rd edition. McGraw-Hill.
3. Warren L, McCabe, Julian C. Smith, Peter Harriot, "Unit operations of Chemical Engineering", 5th Edition, McGraw- Hill.

Suggested Reading:

1. Jaime Benitez, "Principles and Modern Applications of Mass Transfer Operations", 2nd edition, 2009
2. J M Coulson and J F Richardson, "Chemical Engineering", Vol-II, 3rd edition, Pergamom Press.

16BT C31

BIOINFORMATICS

Instruction	4L Periods per week
Duration of End Examination	3 Hours
Semester End Examination	70 Marks
Sessionals	30 Marks
Credits	4

Course Objectives

1. To provide elementary knowledge in bioinformatics and biological information available to biologist on the web and learn how to use these resources on their own.
2. To learn fundamentals of biological databases and sequence alignment.
3. To understand evolutionary relationship among organisms.
4. To learn methods for determining the order of the nucleotide and to predict gene.
5. To aid in understanding structural bioinformatics and biochemical databases.

Course Outcomes: At the end of the course the students are able to

1. Explain the basics of bioinformatics and its scope.
2. Identify how biological databases are used for the retrieval of information.
3. Demonstrate the methods of sequence alignment and its use.
4. Create an evolutionary tree, evaluate and different software tools used for phylogenetic analysis.
5. Discuss about genome sequencing and genome sequencing projects.
6. Predict gene and protein structure and explain about biochemical databases.

UNIT-I INTRODUCTION TO BIOINFORMATICS AND BIOLOGICAL DATABASES

Need of Computers in Biotechnology Research, Elementary commands and protocols, ftp, telnet, http; Bioinformatics- Introduction, Scope of Bioinformatics, Applications; Introduction to biological databases, types of biological database, file formats for biological sequence (NCBI, EMBL, SWISSPROT, FASTA); Information retrieval from biological Databases.

UNIT- II SEQUENCE ALIGNMENTS

Sequence Alignment-Local, Global alignment; Methods of pairwise sequence alignment; Multiple Sequence alignment methods; Comparison of pair wise and

multiple alignment; Sequence database search- FASTA, BLAST, various versions of BLAST and FASTA; Amino acid substitution matrices- PAM and BLOSUM.

UNIT- III PHYLOGENETIC ANALYSIS

Understanding Evolutionary process; Origin of Molecular Phylogenetics; Relationship of phylogenetic Analysis to sequence alignment; Concept of evolutionary trees; Methods of Phylogenetic analysis, Tree Evaluation, Problems in Phylogenetic Analysis, Automated Tools for Phylogenetic Analysis.

UNIT-IV GENOME MAPPING AND GENE PREDICTION

DNA sequencing- Map assembly, Genome Mapping; Genome sequencing, cDNA sequencing, Genome sequence assembly, Comparative Sequence Analysis; Gene Annotation; Human Genome Project (HGP); Basis of Gene Prediction, Gene predictions in Microbial genomes and eukaryotes, Gene Prediction Methods, Other Gene Prediction Tools.

UNIT -V STRUCTURAL BIOINFORMATICS AND BIOCHEMICAL DATA BASES

Protein structure basics, protein structure classification, visualization and comparison, protein secondary structure prediction and protein tertiary structure prediction; Introduction to Biochemical databases- KEGG, BRENDA. Molecular Modeling Databases (MMDB).

Text books:

1. David Mount, "Bioinformatics Sequence and Genome Analysis", 2nd edition, CBS Publishers and Distributors Pvt. Ltd., 2005
2. Rastogi SC, Mendiratta N and Rastogi P, "Bioinformatics: Methods and Applications Genomics, Proteomics and Drug discovery", 3rd edition, PHI Learning Private Limited, New Delhi, 2010.

Suggested Reading:

1. Baxebanis AD and Francis Ouellette BF, "Bioinformatics a practical guide the analysis of genes and proteins", 2nd edition, John Wiley and Sons, Inc., Publication, 2001.
2. Vittal R Srinivas, "Bioinformatics: A modern approach. PHI Learning Private Limited", New Delhi, 2009.
3. Ji Xiong, "Essential Bioinfomatics", Cambridge End Press, 2006.

18CS E02

JAVA Programming and Bio-Java

(Elective-III)

Instruction	4L Periods per week
Duration of End Examination	3 Hours
Semester End Examination	70 Marks
Sessionals	30 Marks
Credits	4

Course Objectives: The main objective of this course is:

1. To introduce the concepts of Object-Oriented programming.
2. Prepare the students to develop solutions using OOPs concepts.
3. Identify Java class libraries and Bio-Java class libraries.
4. Understand and develop GUI based solutions.
5. Develop Biotechnology related solutions using Java and Java class libraries.

Course Outcomes: At the end of the course students will be able to

1. Understand fundamental concepts in object-oriented programming.
2. Design and develop computer based solutions to solve real world problems.
3. Handle file I/O and exceptions.
4. Create Windows, Containers, GUI components in Java.
5. Create GUI-based applications.
6. Develop programs related to Biotechnology problems.

UNIT-I

Java Essentials: Features of Java, OOPs concepts in Java, Elements of java program, Variables, and Literals, Data Types, variables and arrays, Operators, arrays
Control structures: if, if-else, nested if, if-else-if, switch, while, do-while, for, break and continue statements.

UNIT-II

Classes and Objects: Introduction to classes and methods, typecasting, access specifiers and modifiers, modifiers, passing arguments, Constructors.
Inheritance: Basics of inheritance, types of inheritance, polymorphism.

UNIT-III

Interfaces and Packages: Basics of interfaces, Packages, **Exception handling**: Types of exceptions and Errors, exception handling, Multithreading concepts.
Files and I/O Streams: File Class, Streams, Byte Streams.

UNIT-IV

AWT and Applets: Applets, GUI, Window class hierarchy, Dialog Boxes,, Layout managers, Swing Component Classes, Event-Handling, AWT Graphics classes and Swing Controls.

UNIT-V

StrBioLib: Molecular Biology Classes, Interfaces to Bioinformatics tools and Databases,General purpose tools, applications.

Writing simple Java programs for Biotechnology related problems.

Text Books:

1. Sagayaraj, Denis, KArthik and Gajalaxmi, "Java Programming", for Core and Adanced Learners", University Press, Pvt. Ltd, 2018.
2. Johan-Marc Chandonia, **StrBioLib**: a Java Library for Development of Custom Computations Structural Biology Applications", BIO-INFO ALPPLICATIONS NOTE, Vol. 23, No. 15,2007, PP2018-2020 (https://academic.oup.com/bioinformatics/article-abstract/23/15/2018/203542)

Suggested Reading:

1. https://www.tutorialspoint.com/java/index.htm
2. Herbert Schildt, " The complete reference Java 2", TMH
3. Internet World 60 minute Java by Ed Tittel

16BT E32

MEDICAL BIOTECHNOLOGY

(Elective-III)

Instruction	3L Periods per week
Duration of End Examination	3 Hours
Semester End Examination	70 Marks
Sessionals	30 Marks
Credits	3

Course Objectives

1. To understand the scope and importance of tools used in medical biotechnology.
2. The course aims at providing knowledge about the working principles and types of advanced materials used in medical field.
3. To gain the in-depth knowledge about the clinical applications of stems cells &banking
4. To understand the differences between the normal cells and cancer cells and various diagnostic methods used in cancer detection.
5. To learn current molecular therapies and controversial issues..
6. To understand the bioethical issues.

Course Outcomes: At the end of the course the students are able to

1. Use the tools for the diagnosis of diseases.
2. Be in a position to design the prototype of medical instruments.
3. Explain the potentiality of stem cells and purpose of banking.
4. Explain about the uses of molecular therapies and how which led to controversy in society.
5. Explain about the advances in vaccines in production.
6. Analyze the socio ethical issues in medicine.

UNIT - I : INTRODUCTION TO MEDICAL BIOTECHNOLOGY

Introduction, scope and importance of medical biotechnology; The genetic basis of the disease; chromosomal disorders; single gene disorders-modes of inheritance, Thalassemia, sickle cell anaemia, cystic fibrosis, Tay sachs disease, Fragile –X-syndrome; polygenetic disorders; Alzheimers disease,Type-1diabetis and mitochondrial disorders (neurological disorders).

UNIT- II MEDICAL ONCOLOGY

Cancer types (case study: breast cancer and stomach cancer); Normal cells vs. cancer cells; cancer genetics; oncogenes and their proteins; tumor suppressor genes

and their functions, diagnosis of cancer, Treatment of cancer; Radiation therapy, chemotherapy.

UNIT- III STEM CELL TREATEMENT

Cellular therapy, stem cells- definition, types, properties and uses of stem cells; sources of embryonic and adult stem cells; concept of tissue engineering; scaffolds and fabrication; clinical applications of stem cells; stem cell banking and ethical issues.

UNIT - IV MEDICAL INSTRUMENTATION AND DIAGNOSTICS

Concepts in Biomedical Engineering; principle, properties and applications of different types of biomedical devices; pacemakers, drug coated stents, dental implants, knee replacement implants, Molecular diagnosis by immunological approaches to detect protein biomarkers of the disease (types of ELISA), DNA approaches (Taq MAN approach, RT-PCR, epigenetic markers, detection of SNP by mass spectrometry; Applications of biosensors in medicine.

UNIT - V MOLECULAR THERAPEUTICS AND BIOETHICAL ISSUES

Types of molecular therapies; protein therapy by recombinant MAB, Enzymes (DNase-1, Alpha -1 antitrypsin), Lactic acid bacteria by Leptin, antisense therapy, immunotherapy by immunotoxins and recombinant vaccines.Bioethical issues in IVF, surrogacy and cloning technologies.

Text Books:

1. Judith Pongracz, Mary Keen, "Medical Biotechnology", illustrated edition, Elseiver health sciences, 2009.
2. Bernard R Glick, Cheryl L.Patton, Terry L.Delovitch, "Medical biotechnology", 1st edition, ASM press,2013.
3. Cato T.Laurencin, MD.Ph.D, Lakshmi S-Nair, M.Phil.,Ph.D "Nano Technology and Regenerative Engineering The Scaffold", Second Edition, CRC Press, Taylor & Francis Group, 2014.

Suggested Reading:

1. R.J.B.King, Robins, "Cancer biology", 3rd edition, Prentice Hall, 2006.
2. Subdery, "Human Molecular Genetics", 2nd edition, Prentice Hall, Pearson education.

16BT E33

PHYTO CHEMICALS AND HERBAL PRODUCTS

(Elective-III)

Instruction	3L Periods per week
Duration of End Examination	3 Hours
Semester End Examination	70 Marks
Sessionals	30 Marks
Credits	3

Course objectives:

1. To impart knowledge on medicinal plants and extraction of crude drugs.
2. To provide a comprehensive knowledge on analysis, types and detection of phytochemicals and adulterants.
3. To impart knowledge on the applications of various phytochemicals and herbal products.

Course outcomes: At the end of the course the students are able to

1. The undergraduates will know the sources of various crude drugs and their medicinal values.
2. The students will understand the procedures involved in the detection, extraction and analysis of crude drugs and adulterants.
3. The undergraduates will be able to implement their theoretical concepts and knowledge of extraction and their applications in herbal preparation for implementing the same practically.
4. Understand the preparation of adulterants.
5. Apply the different types of phyto chemicals in the real world.
6. Recognize the applications of herbal products.

UNIT I: CRUDE DRUGS, MEDICINAL AND AROMATIC PLANTS

Crude Drugs - Scope and Importance, Classification (Taxonomical, Morphological Chemical, Pharmacological); Collection and processing of Crude Drugs. Utilization of Medicinal and Aromatic Plants in India. Genetics as applied to Medicinal herbs. Biogenesis of Phytopharmaceuticals.

UNIT II: ANALYSIS OF PHYTOCHEMICALS

Methods of Drug evaluation (Morphological, Microscopic, Physical and Chemical). Preliminary screening, Assay of Drugs - Biological evaluation / assays, Microbiological methods, Chemical Methods of Analysis and Detection of Adulterants: Chemical estimations. Drug adulteration - Types of adulterants.

UNIT III : TYPES OF PHYTOCHEMICALS

Carbohydrates and its derived products- Structures, types and extraction methods : Glycosides - Digitalis, Aloe, Dioscorea ; Volatile Oils - Clove, Mentha; Alkaloids - Taxus, Papaver, Cinchona; Flavonoids-and Resins. Tannins (Hydrolysable and Condensed types).

UNIT IV: APPLICATIONS OF PHYTOCHEMICALS

Application of phytochemicals in industry and healthcare; Biocides, Bio-fungicides, Biopesticides (Bacterial, fungal, viral with examples).

UNIT V: HERBAL PRODUCTS

History, Scope, and Current aspects of herbs and herbal medicines; Classification of active components of therapeutic plant and herbal products; Preparation of standardized extracts of Garcinea, Forskolin, Garlic, Turmeric and Capsicum, issues of licencing of herbal drugs.

Text books:

1. Kokate CK, Purohit AP and Gokhale SB, "Pharmacognosy", 4th edition, Nirali Prakashan, 1996.
2. Trease and Evans WC Evans, " Pharmacognosy" , 14th edition, Harcourt Brace & Company. 1989.
3. Hornok L, "Cultivation & Processing of Medicinal Plants" Chichister, U. K: J. Wiley & Sons.1992.

Suggested Reading:

1. Natural Products in medicine: A Biosynthetic approach Wiley. 1997
2. Chaudhri RD, "Herbal Drugs industry, A practical approach to Industrial Pharmacognosy" Eastern publishers, 2nd reprint, New Delhi. 1999.

16BT E34

DEVELOPMENTAL BIOLOGY

(Elective-IV)

Instruction	3L Periods per week
Duration of End Examination	3 Hours
Semester End Examination	70 Marks
Sessionals	30 Marks
Credits	3

Course Objectives:

1. Students are made to understand the basic concepts of developmental biology.
2. Students are taught the structure of gametes, and how they are generated.
3. Students are taught the influence of genes on body axis formation in Drosophila and Mammals.
4. Students are enlightened about the later embryonic developments i.e Organogenesis.
5. Students are made aware of sex determination in Drosophila and Mammals.
6. The concept of Ramifications of developmental biology is introduced to the students.

Course Outcomes: At the end of the course the students are able to

1. Students understand the basic concepts of Developmental Biology.
2. Students understand the Anatomy of gametes and Biochemistry in its recognition.
3. Analyze the role of genes in the body axis formation of Drosophila and Mammals.
4. Understand the importance and differentiation of germinal layers in to different organs.
5. Compare the role of genes in the sex determination of Drosophila and Mammals.
6. Explain the genetic anomalies leads to diseases.

UNIT-I: INTRODUCTION TO DEVELOPMENTAL BIOLOGY

The Anatomical approach to developmental biology: Mathematical modeling for development: The frog life cycle: Evidence for Genomic equivalence (Potency of cells), Specification (Autonomous, Conditional and Morphogenic Gradients: Commitment, Induction (Paracrine Factors) and Competence.

UNIT-II : EARLY EMBRYONIC DEVELOPMENT (Gametogenesis and Fertilization)

Structure of Gametes, Spermatogenesis and oogenesis in Mammals, Recognition of egg and sperm: Mammalian Fertilization (Fusion of Gametes and prevention of Polyspermy), External Fertilization in Sea urchin.

UNIT-III: LATER EMBRYONIC DEVELOPMENT (Morphogenesis)

Cleavage and gastrulation in Drosophila and Mammals: Early Drosophila developments: Genes that pattern the

Drosophila body axis: The generation of dorsal, ventral polarity: The origin of anterior, Posterior polarity: Segmentation genes (Gap Genes, pair rule genes and segment polarity genes), The homeotic selector genes: The anterior and posterior axis formation in Mammals.

UNIT-IV: ORGANOGENESIS AND SEX DETERMINATION

The emergence of Ectoderm-The Central nervous system and epidermis development: the function of mesoderm –osteogenesis and myogenesis: Lateral plate mesoderm and endoderm – the development of heart, blood cells, digestive and respiratory systems, Sex determination in Drosophila and Mammals: regeneration of liver in Mammals.

UNIT-V : RAMIFICATIONS OF DEVELOPMENTAL BIOLOGY

Medical Implications of Developmental biology, genetic errors of human development, infertility, *in vitro* fertilization (IVF) and teratogenesis (disruptors of teratogenesis): Developmental biology and future of medicine.

Text Books:

1. Manju Yadav, "Molecular Developmental Biology" Discovery Publishing, September, 2008.
2. Scott F Gilbert, Michael JF Barresi. "Developmental Biology", 10th edition, Sinauer Associates, Inc, 2013.

Suggested Reading:

1. Snustad P, Simmons and Jenkins, "Principles of Genetics", 2nd Edition, John Wiley Publications, 1999.
2. P.C.Jain , "Elements of Developmental Biology" International Publications, 2013.

16BT E35

PHARMACEUTICAL BIOTECHNOLOGY

(Elective-IV)

Instruction	3L Periods per week
Duration of End Examination	3 Hours
Semester End Examination	70 Marks
Sessionals	30 Marks
Credits	3

Course Objectives:

Students are made to analyze the following concepts during there course of time:

1. Origin, Scope and importance of pharmaceutical biotechnology.
2. ADME of Drugs. Pharmacokinetics and Pharmacodynamics of drugs.
3. Materials and Formulations of pharmaceuticals.
4. Collection, processing and storage of whole human blood.
5. Ideal requirements of Polyvinyl Pyrollidine and Dextran 40.
6. Steroidal and Nonsteroidal drugs, Antacids, Alkaloids and Biological extracts.

Course Outcomes: At the end of the course the students are able to

1. Identify different microorganisms for the production of secondary metabolites used as drugs.
2. Explain drug delivery systems like oral, parenteral, transdermal etc.
3. Outline the manufacture, Labeling, preservation and release of drugs in to the market.
4. Discuss fractionation of human RBC, dried human plasma, HPPF, from whole human blood.
5. Plan the procedures for the production of blood transfusion products to avoid infectious diseases.
6. Select the therapeutic activity and dosage of drugs to treat the diseases.

UNIT- I: FUNDAMENTALS OF BIOPHARMACEUTICALS

Pharmaceutical Biotechnology: An introduction, Origin, definition, Scope and Importance. Human protein replacements, Therapeutic agents for human diseases: Tissue Plasminogen activator, Interferon, Recombinant vaccines. Methods of Biotechnology and their applications of Gene transfer.

UNIT- II: DRUG METABOLISM AND PHARMACOKINETICS

ADME properties- Physiochemical properties of Drug Absorption, Distribution, metabolism (Biotransformation), bioavailability and Excretion. Pharmacokinetics and Pharmacodynamics. Basic considerations: Drug receptors, Drug interactions, Surgical supplies, Oral, Parenteral, Transdermal, Ophthalmic, Intravaginal and Intrauterine Drug Delivery systems.

UNIT- III: THE DRUG MANUFACTURING PRACTICES

Good manufacturing practices and facilities for drug production. Types of Tablets and capsules. Materials and Formulations for Manufacture of Tablets, Capsules. Excepients and its ideal properties, Parenteral solutions, Oral liquids, Emulsions, Ointments, Suppositories, Aerosols.

UNIT-IV: BLOOD AND PLASMA SUBSTITUTES

Collection, processing and storage of whole human blood, concentrated human RBC, dried human plasma, Human plasma protein fraction, Dried human serum, Human fibrinogen, Human thrombin, Human normal Immunoglobulin, Plasma substitutes- Ideal requirements, PVP, Dextran 40, control of Blood products, Transfusion products.

UNIT-V: PHARMACEUTICAL PRODUCTS

Fundamentals of Therapeutic categories such as Analgesics, Antipyretic, Anti-inflammatory drugs, Anesthetics, Antacids, Alkaloids, Glycosides, Anti-neoclassic drugs, Biologicals (Immunizing agents and allergenic extracts), Chemotherapy of Tuberculosis and Urinary tract infections.

Text books:

1. Purohit SS, Kakrani HN and Saluja AK., "Pharmaceutical Biotechnology", Student Edition Jodhpur, 2003.
2. Brahmankar, D.M., Sunil, B.Jaiswals - Biopharmaceutics & Pharmacokinetics a Treatise , 2nd edition, M.K.Jain Publication, Delhi, 2009.
3. Cooper and Guns, "Pharmaceutics", CBS publishers, 1989.

Suggested Reading:

1. David B Troy and Paul Beringer, "Remington's: The Science and practice of Pharmacy", Vol 1 and 2, Lippincott Williams & Wilkins Publications, 2006.
2. Tripathi, K.D. "Essentials of Medical pharmacology", Jaypee Brothers Medical Publishers 6th Edition , John Wiley, New Delhi, 2000.
3. Milo Gibaldi - Biopharmaceutics and Clinical Pharmocokinetics, First edition, Pharma Book Syndicate, 2006.

16BT E36

BIOPROCESS ECONOMICS & PLANT DESIGN

(Elective-IV)

Instruction	3L Periods per week
Duration of End Examination	3 Hours
Semester End Examination	70 Marks
Sessionals	30 Marks
Credits	3

Course Objectives:

1. To provide the students with knowledge about basic concepts in Interest, capital investment tax and depreciation;
2. Measures of economic performance.
3. This course aims at providing an insight into capital, overhead and manufacturing costs estimation
4. The course is designed to give an understanding of process design development and general design considerations.
5. This course aims at providing knowledge on design of batch and continuous sterilizers**,** Design calculations for immobilized enzyme kinetics.
6. To give insight about various types of valves, pumps, steam traps, spargers and impellers used in biotech industries.

Course Outcomes: At the end of the course the students are able to

1. Carry out interest calculations and prepare balance sheets for business transactions.
2. Determine the economic analysis of bioprocesses.
3. Carry out cost estimations for different industrial productions.
4. Develop process design, flow diagrams.
5. Carry out material and energy balances accurately
6. Design filters for air sterilization, batch and continuous sterilizers, valves etc.

UNIT-I: ECONOMIC EVALUATION

Capital cost of a project; Interest calculations, nominal and effective interest rates; basic concepts in tax and depreciation; Measures of economic performance, rate of return, payout time; Cash flow diagrams; Cost accounting-balance sheet and profit loss account; Break even and minimum cost analysis.

UNIT- II : BIOPROCESS ECONOMICS

Bio-Products regulations; Economic analysis of bioprocess; Capital, overhead and manufacturing costs estimation; Case studies of antibiotics (Penicillin and Streptomycin), recombinant products, single cell protein, anaerobic processes and other fine chemicals.

UNIT- III : INTRODUCTION TO PLANT DESIGN

Process design development: design procedures, design information and flow diagrams, material and energy balances, comparison of different process and design specifications; Optimization; General design considerations: Health and safety hazards, Environment protection, plant location and plant layout, plant operation and control.

UNIT- IV : BASIC DESIGN PROBLEMS

Design examples on continuous fermentation, aeration, and agitation; Design calculation of filter for air sterilization; Design of batch and continuous sterilizers; Design calculations for immobilized enzyme kinetics; Practical considerations in designing of Bioreactor/Fermentor construction.

UNIT- V :

Introduction to different types of valves, pumps, steam traps, spargers and impellers used in fermentation industries; Design exercise on trickle flow fermentor; Problems associated with design equations.

Text Books:

1. Plant Design and Economics for Chemical Engineers, 5/e Max S. Peters, Ronald E. West, (2003) McGraw-Hill Higher.
2. Biochemical Engineering -Humphrey, A. E.; Millis, JSTOR 1966.
3. Biochemical Engineering, by Harvey W. Blanch, Douglas S. Clark CRC; 1st edition (1997).

Suggested Reading:

1. Biochemical Engineering and Biotechnology Handbook by Bernard Atkinson, Ferda MavitunaGrove's Dictionaries; 2 edition (1992).
2. Bioprocess Engineering:Basic Concepts. Michael L. Shuler / Fikret Kargi, Reihe:Prentice ,(2001) Hall.

16BT C37

BIOPROCESS LAB

Instruction	3P Periods per week
Duration of End Examination	3 Hours
Semester End Examination	50 Marks
Sessionals	25 Marks
Credits	2

Course Objectives

1. The course aims at providing knowledge about the methods of sterilization of cells and Thermal death kinetics of spores.
2. The course aims at demonstrating the design of the bioreactor.
3. The students understand the types of reactors and its instrumentation.
4. To analyze and compare fermentation kinetics.
5. To demonstrate the immobilized enzyme stability.

Course Outcomes: At the end of the course the students are able to

1. Out line the sterilization techniques.
2. Discuss about bioreactor instrumentation and control.
3. Compare the parameters to find optimum value where the microbial activity is higher.
4. To predict the $K_L a$ value.
5. Analyze the stability of immobilized enzyme.
6. Evaluate the flow characteristics of fluids.

LIST OF EXPERIMENTS

1. Sterilization techniques (chemical, physical and filter methods) and thermal death kinetics.
2. Media optimization (placket- Burman design)
3. Bioreactor instrumentation and its control.
4. Microbial production of fine chemicals (Eg: citric acid and alcohol).
5. Study of growth substrate utilization.
6. Product formation kinetics in shake flask cultures.
7. Batch fermentation kinetics.
8. Fed batch fermentation kinetics.

9. Measurement of $K_L a$ by sodium sulphite (Na_2SO_3) oxidation method.
10. Studies on immobilized enzyme/cells in packed bed reactor.
11. Estimation of rheological parameters in fermentation broths.

Suggested Reading:

1. Gunasekharan P, Laboratory manual in Microbiology, 2009
   Chellapandi P, Laboratory manual in Industrial Biotechnology, Pointer publishers, 2007

16BT C38

MASS TRANSFER OPERATIONS LAB

Instruction	3P Periods per week
Duration of End Examination	3 Hours
Semester End Examination	50 Marks
Sessionals	25 Marks
Credits	2

Course Objectives:

1. This lab course is designed to understand and study the behavior of different reactors. Eg: Batch, CSTR, PFR, analysis of various processes viz., Diffusion, Distillation VLE.

Course Outcomes: At the end of the course the students are able to

1. Determine the diffusion coefficient of liquids in air.
2. Verify the Rayleigh equation.
3. Calculate the theoretical and actual steam consumption.
4. Construct T-x-y diagram using VLE.
5. Determine equilibrium constant using Batch, CSTR and PFR reactors.
6. Calculate activation energy.

LIST OF EXPERIMENTS

1. Diffusion of CCL_4 organic vapor in air estimation.
2. Determine Liquid - liquid diffusivity.
3. Estimate Surface evaporation.
4. Wetted wall column.
5. To verify Rayleigh equation using Simple distillation.
6. Calculate the theoretical and actual steam consumption by Steam distillation.
7. To determine Packed bed distillation.
8. To determine Liquid - liquid equilibrium
9. To determine Liquid - liquid extraction.
10. To construct T-x-y diagram using Vapor liquid equilibrium
11. To determine equilibrium constant using Batch reactor.
12. To determine equilibrium constant using Continuous stirred tank reactor

13. To determine equilibrium constant using Saponification in a tubular reactor.
14. Mixed flow reactors in series.
15. To calculate the activation energy by Temperature dependency.

16BT C39

BIOINFORMATICS LAB

Instruction	3P Periods per week
Duration of End Examination	3 Hours
Semester End Examination	50 Marks
Sessionals	25 Marks
Credits	2

Course Objectives:

1. To provide practical instructions to the students on using the specific databases and learn how to use these resources on their own and analysis the output.

Course Outcomes:

1. Retrieve the information from biological databases.
2. Utilize BLAST, FASTA and some online tools.
3. Use and compare the online sequence alignment tools.
4. Construction evolutionary tree by phylogenetic analysis.
5. Predict gene and protein structure.
6. Design primers and construct restriction map.

LIST OF EXPERIMENTS

1. Searching Bibliographic databases for relevant information.
2. Sequence retrieval from DNA and Protein databases.
3. BLAST services.
4. FASTA services.
5. Pair wise comparison of sequences (Local and global alignment).
6. Multiple Sequence Alignment.
7. Evolutionary studies/Phylogenetic Analysis.
8. Protein Databank retrieval and visualization.
9. Structure Exploration of Proteins.
10. Restriction Mapping.
11. Identification of Genes in Genomes.
12. NCBI ORF Finder.
13. Primer Design.

Suggested Reading:

1. Baxebanis AD and Francis Ouellette BF, "Bioinformatics a practical guide the analysis of genes and proteins", 2nd edition, John Wiley and Sons, Inc., Publication, 2001.

16BT C40

MINI PROJECT

Instruction	1 P Periods per week
Duration of End Examination	1 Hours
CIE	50 Marks
Credits	1

Dealing with a real time problem should be the focus of under graduate project.

All projects will be monitored at least four times in the II-semester through individual presentations (Project batch wise).

Every student should maintain a project dairy, wherein he/she needs to record the progress of his/her work and get it signed at least once in a week by the guide(s). If working outside and college campus, both the external and internal guides should sign the same.

Sessional marks should be based on the marks, awarded by a project monitoring committee of faculty members as well as the marks given by the guide.

Common norms are established for final documentation of the project report, the students are directed to download from the website regarding the guidelines for preparing the project report and the project report format.

The project report shall be evaluated for 50 Marks by the External Examiner.

If the project work found inadequate in the end examination, the candidate should repeat the project work with a new problem or improve the quality of work and report it again.

Break up for 50 Marks in the end examination:

1. Power point presentation	20 Marks
2. Thesis/Report preparation	30 Marks