VISVESVARAYA TECHNOLOGICAL UNIVERSITY
BELAGAVI

Scheme of Teaching and Examinations and Syllabus

M.Tech BIOINFORMATICS (BBI)

(Effective from Academic year 2020 - 21)

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examinations – 2020 - 21
M.Tech BIOINFORMATICS(BBI)
Choice Based Credit System (CBCS) and Outcome Based Education(OBE)

I SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Field work/ Assignment	Duration in hours	CIE Marks	SEE Marks	Total Marks	
1	PCC	20BBI11	Numerical methods and Biostatistics	04	--	03	40	60	100	4
2	PCC	20BBI12	Concepts in Biotechnology	04	--	03	40	60	100	4
3	PCC	20BBI13	Essential Bioinformatics	04	--	03	40	60	100	4
4	PCC	20BBI14	Database Management Systems	04	--	03	40	60	100	4
5	PCC	20BBI15	Python Programming	04	--	03	40	60	100	4
6	PCC	20BBIL16	Python Programming Laboratory	-	04	03	40	60	100	2
7	PCC	20RMI17	Research Methodology and IPR	02	--	03	40	60	100	2
			TOTAL	**22**	**04**	**21**	**280**	**420**	**700**	**24**

Note: PCC: Professional core.

Internship: All the students have to undergo mandatory internship of 6 weeks during the vacation of I and II semesters and /or II and III semesters. A University examination shall be conducted during III semester and the prescribed credit shall be counted for the same semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared as fail in internship course and have to complete the same during the subsequent University examination after satisfying the internship requirements.

Note: (i) Four credit courses are designed for 50 hours Teaching – Learning process.
(ii) Three credit courses are designed for 40 hours Teaching – Learning process.

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M.Tech BIOINFORMATICS(BBI)
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II SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Field work/ Assignment/ Project	Duration in hours	CIE Marks	SEE Marks	Total Marks	
1	PCC	20BBI21	NGS Informatics and High Performance Computing	04	--	03	40	60	100	4
2	PCC	20BBI22	Computational Systems Biology	04	--	03	40	60	100	4
3	PCC	20BBI23	Biomolecular Simulations	04	--	03	40	60	100	4
4	PEC	20BBI24X	Professional elective 1	04	--	03	40	60	100	4
5	PEC	20BBI25X	Professional elective 2	04	--	03	40	60	100	4
6	PCC	20BBIL26	Biomolecular Simulations Laboratory	--	04	03	40	60	100	2
7	PCC	20BBI27	Technical Seminar	--	02	--	100	--	100	2
TOTAL				**20**	**06**	**20**	**340**	**360**	**700**	**24**

Note: PCC: Professional core, PEC: Professional Elective.

Professional Elective 1		**Professional Elective 2**	
Course Code under 20XXX24X	**Course title**	**Course Code under 20XXX25X**	**Course title**
20BBI241	Chemoinformatics And Computational Medicinal Chemistry	20BBI251	Object Oriented Programming Using JAVA
20BBI242	Insilico Protein Engineering & Design	20BBI252	Data Warehousing And Data mining
20BBI243	Immunoinformatics	20BBI253	Artificial Intelligence & Neural Networks
20BBI244	Health Informatics	20BBI254	PERL Programming And Bioinformatics

Note:

1. Technical Seminar: CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide, if any, and a senior faculty of the department. Participation in the seminar by all postgraduate students of the same and other semesters of the programme shall be mandatory.

The CIE marks awarded for Technical Seminar, shall be based on the evaluation of Seminar Report, Presentation skill and Question and Answer session in the ratio 50:25:25.

2. Internship: All the students shall have to undergo mandatory internship of 6 weeks during the vacation of I and II semesters and /or II and III semesters. A University examination shall be conducted during III semester and the prescribed credit shall be counted in the same semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared as fail in internship course and have to complete the same during the subsequent University examination after satisfying the internship requirements.

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III SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Field work/ Assignment	Duration in hours	CIE Marks	SEE Marks	Total Marks	
1	PCC	20BBI31	Data Security And Regulatory Affairs	04	--	03	40	60	100	4
2	PEC	20BBI32X	Professional elective 3	03	--	03	40	60	100	3
3	PEC	20BBI33X	Professional elective 4	03	--	03	40	60	100	3
4	Project	20BBI34	Project Work phase -1	--	02	--	100	--	100	2
5	PCC	20BBI35	Mini-Project	--	02	--	100	--	100	2
6	Internship	20BBII36	Internship	(Completed during the intervening vacation of I and II semesters and /or II and III semesters.)		03	40	60	100	6
TOTAL				**10**	**04**	**12**	**360**	**240**	**600**	**20**

Note: PCC: Professional core, PEC: Professional Elective.

Professional elective 3		Professional elective 4	
Course Code under 20XXX32X	**Course title**	**Course Code under 20XXX33X**	**Course title**
20BBI321	Genomics& Proteomics	20BBI331	Statistical Analysis System And Clinical Data Management
20BBI322	Biomedical Informatics And Translational Research	20BBI332	Algorithms In Computational biology
20BBI323	Computational Neuroscience	20BBI333	Advanced Bioinformatics& LINUX Operating System
20BBI324	Metabolomics and Metabolic Engineering	20BBI334	Bio Business & Entrepreneurship Development

Note:

1. Project Phase-1: Students in consultation with the guide/co-guide if any, shall pursue literature survey and complete the preliminary requirements of selected Project work. Each student shall prepare relevant introductory project document, and present a seminar.

CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide if any, and a senior faculty of the department. The CIE marks awarded for project work phase -1, shall be based on the evaluation of Project Report, Project Presentation skill and Question and Answer session in the ratio 50:25:25.

SEE (University examination) shall be as per the University norms.

2. Internship: Those, who have not pursued /completed the internship shall be declared as fail in internship course and have to complete the same during subsequent University examinations after satisfying the internship requirements. Internship SEE (University examination) shall be as per the University norms.

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IV SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Field work/ Assignment	Duration in hours	CIE Marks	SEE Marks Viva voce	Total Marks	
1	Project	20XXX41	Project work phase -2	--	04	03	40	60	100	20
			TOTAL	--	**04**	**03**	**40**	**60**	**100**	**20**

Note:

1. Project Phase-2:

CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide, if any, and a Senior faculty of the department. The CIE marks awarded for project work phase -2, shall be based on the evaluation of Project Report subjected to plagiarism check, Project Presentation skill and Question and Answer session in the ratio 50:25:25.

SEE shall be at the end of IV semester. Project work evaluation and Viva-Voce examination (SEE), after satisfying the plagiarism check, shall be as per the University norms.

M.TECH BIOINFORMATICS
Choice Based Credit System (CBCS) and Outcome Based Education(OBE)
SEMESTER -I

Numerical Methods and Biostatistics

Course Code	**20BBI11**	CIE Marks	40
Teaching Hours/Week (L:T:P)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Introduction to statistics and study design: Introduction to statistics, data, variables, types of data, tabular, graphical and pictorial representation of data. Significance of statistics to biological problems, experimental studies; randomized controlled studies, historically controlled studies, cross over, factorial design, cluster design, randomized; complete, block, stratified design, biases, analysis and interpretation.

Module-2

Design: Descriptive statistics and Observational study design: Types of variables, measure of spread, logarithmic transformations, multivariate data. Basics of study design, cohort studies, case-control studies, outcomes, odd ratio and relative risks. Principles of statistical inference: Parameter estimation, hypothesis testing. Statistical inference on categorical variables; categorical data, binomial distribution, normal distribution, sample size estimation

Module-3

Comparison of means: Test statistics; t-test, F distribution, independent and dependent sample comparison, Wilcoxon Signed Rank Test, Wilcoxon-Mann-Whitney Test, ANOVA. Correlation and simple linear regression: Introduction, Karl Pearson correlation coefficient Spearman Rank correlation coefficient, simple linear regression, regression model fit, inferences from the regression model, ANOVA tables for regression. Multiple linear regression and linear models: Introduction, Multiple linear regression model, ANOVA table for multiple linear regression model, assessing model fit, polynomials and interactions. One-way and Two-way ANOVA tables, F-test. Algorithm and implementation using numerical methods with case studies.

Module-4

Design and analysis of experiments: Random block design, multiple sources of variation, correlated data and random effects regression, model fitting. Completely randomized design, stratified design. Biological study designs. Optimization strategies with case studies

Module-5

Statistics in microarray, genome mapping and bioinformatics: Types of microarray, objectives of the study, experimental designs for micro array studies, microarray analysis, interpretation, validation and microarray informatics. Genome mapping, discrete sequence matching, programs for mapping sequences with case studies.

Course outcomes:

At the end of the course the student will be able to:

- Demonstrate strong basics in statistics and numerical analysis
- Apply the mathematical principles to solve problems in spheres of bioscience and bioengineering
- Study and design various statistical problems

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook/ Textbooks

Sl No	Title of the book	Name of the Author/s	Publisher Name	Edition and year
1	Biostatistics	Alvin E. Lewis	McGraw-Hill Professional Publishing	**2013**
2	Statistics and Numerical Methods in BASIC for Biologists	D. Lee and T.D. Lee	Van Nostrand Reinhold	**1982**
Reference Books				
1	Numerical Methods	Wolfgang Boehm and Hartmut Prautzsch	CRC Press	**1993**
2	Numerical Methods of Statistics	John F. Monahan	Cambridge University Press	**2011**
3	Numerical Methods for Engineers and Scientists	Joe D. Hoffman	CRC Press	**2001**
4	Statistical Methods in Bioinformatics: An Introduction	Warren J. Ewens Gregory Grant	Springer Science & Business Media	**2005**

CONCEPTS IN BIOTECHNOLOGY			
Course Code	**20BBI12**	CIE Marks	40
Teaching Hours/Week (L:T:P)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Introduction: Macromolecules; Carbon chemistry; Proteins: Structure, folding, catalysis; Nucleic acids: DNA & RNA; storage and transfer of genetic information; Lipids: membranes, structure & function; Carbohydrate chemistry, energy storage, building blocks.

Module-2

Cell Biology: Eukaryotic and Prokaryotic cells, plant and animal cells, structure of nucleus, mitochondria, ribosomes, Golgi bodies, lysosomes, endoplasmic reticulum, chloroplast, vacuoles; Cell cycle and cell division: Different phases of cell cycle, cell division: Mitosis and meiosis. Mendelian law of inheritance: Monohybrid and dihybrid inheritance, law of segregation and independent assortment; Gene Interaction; Multiple alleles, supplementary and complementary genes, epistasis. Identification of genetic material: classical experiments; chromosome structure and organization, chemical composition of chromatin, structural organization of nucleosomes, heterochromatin, Polytene and lamp-brush chromosomes, human chromosomes, chromosomal disorders.

Module-3

Microbiology: Scope and History of microbiology, Introduction to the structure and functions of microorganism: Bacteria, Viruses, Fungi and Protozoan's. Microscopy and microbial techniques: Study of microscopes; sterilization techniques: Heat, steam, Radiation, Filtration and chemical methods; Pure culture techniques: Serial Dilution, Streak, Spread, Pour Plate. Immune System, Innate and adaptive immunity, antigens and antibodies; types of immune response, hypersensitivity. Humoral immunity: B-lymphocytes, Immunoglobulin classes, Major Histocompatibility Complex (MHC). Cell mediated immunity. Thymus derived lymphocytes (T-cells), Antigen presenting cells (APC); Immunity to infection, Cytokines.

Module-4

Agri BT: Role of Micorbes in agriculture, Biopesticides, Bio fertilizers (Nitrogen fixing microbes), GM crops. Plant metabolic engineering and industrial products: Molecular farming for the production of industrial enzymes, biodegradable plastics, antibodies, edible vaccines. Metabolic engineering of plants for the production of fatty acids, industrial oils, flavonoids etc. Basic aspects of Food & Nutrition.

Module-5

Industrial BT: Industrially important Microorganisms, Preservation techniques, Different media for fermentation, basic structure of fermenter and different types. Types of fermentation processes (surface, submerged, and solid state) and their products (ethanol, citric acid, lactic acid, enzymes, antibiotics) Biological treatment of waste water, primary, secondary and tertiary treatments. Bio indicators, Bioremediation of xenobiotic compounds, Bioleaching of minerals from ores, Bio-sorption of toxic metals. Solid waste management. Biofuel production from agricultural wastes.

Course outcomes:

At the end of the course the student will be able to:

- Demonstrate strong fundamentals in principles of Biotechnology.
- Apply the theoretical principles for specific case studies and societal issues.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook/ Textbooks

Sl No	Title of the book	Name of the Author/s	Publisher Name	Edition and year
1	Cell Biology, Genetics, Evolution and Ecology	P S Verma, V R Agarwal,	New Publisher, Delhi	2007
2	Industrial Microbiology	Prescott and Dunn, Industrial Microbiology	Macmillan	1982
Reference Books				
1	Cell and Molecular Biology	De Robertis EDP and De Robertis Jr. EMF,	Wippincott, Williams and Willkins	2001.
2	Plant biotechnology.	K. Lindsey and M.G.K. Jones	Agriculture, Prentice hall, New Jersey	1989

3	Biodegradation and Detoxification of Environmental Pollutants,	Munnecke DM, Johnson LM and others	CRC Press	1982

ESSENTIAL BIOINFORMATICS			
Course Code	**20BBI13**	CIE Marks	40
Teaching Hours/Week (L:T:P)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Biological Databases: Introduction to Bioinformatics, Goals, Scope, Applications in biological science and medicine and Limitations, a) Sequence Databases b) Structure Databases c) Special Databases and applications: Genome, Microarray, Metabolic pathway, motif, multiple sequence alignment and domain databases. Mapping databases – genome wide maps. Chromosome specific human maps. Applications of these databases. Database Similarity Searching: Unique Requirements of Database Searching. Heuristic Database searching, Basic Local Alignment Search Tool (BLAST), FASTA, Comparison of FASTA and BLAST, Database Searching with the Smith–Waterman Method.

Module-2

Sequence Alignment: Evolutionary basis, Homology vs Similarity, Similarity vs Identity. Types of Sequence alignment - Pairwise and Multiple sequence alignment, Alignment algorithms, Scoring matrices, Statistical significance of sequence alignment. Multiple Sequence Alignment: Scoring function, Exhaustive algorithms, Heuristic algorithms, Practical issues. Profiles and Hidden Markov Models: Position-Specific scoring matrices, Profiles, Markov Model and Hidden Markov Model.

Module-3

Motifs and Domains: Motif and Domain databases, Identification of Motifs and Domains in Multiple Sequence Alignment using Regular expressions, Motif and Domain Databases statistical models, Protein Family databases, Motif Discovery in unaligned sequences. Sequence logos. Gene and Promoter Prediction: Promoter and Regulatory elements in Prokaryotes and Eukaryotes. Promoter and Regulatory element prediction – algorithms. Gene prediction. Gene prediction in Prokaryotes and Eukaryotes. Categories of Gene Prediction Programs. Prediction algorithms. Discussions with case studies.

Module-4

Predictive Methods: Predictive methods using Nucleic acid sequence – DNA framework, Masking of repetitive DNA, predicting RNA secondary structure, Finding RNA genes, Detection of functional sites and Codon bias in the DNA. Predictive methods using protein sequence – Protein identity and Physical properties. Structure prediction - Prediction of secondary structure of protein, Antigenic sites, Active sites, Folding classes, specialized structures and Tertiary structures. Discussions with case studies. Concepts involved in Insilco Primer Designing and developing Restriction Maps.

Module-5

Molecular Phylogenetics: Phylogenetics Basics. Molecular Evolution and Molecular Phylogenetics - Terminology, Gene Phylogeny v/s Species Phylogeny, Forms of Tree Representation. Phylogenetic Tree Construction Methods and Programs - Distance-Based Methods, Character-Based Methods. Phylogenetic Tree evaluation methods. Phylogenetic analysis software and algorithms. Bootstrap methods.

Course outcomes:
At the end of the course the student will be able to:

- Understand the importance of different biological databases, tools and algorithms, and their applications.
- Apply the diverse tools to solve specific bioinformatics problems.

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook/ Textbooks

Sl No	Title of the book	Name of the Author/s	Publisher Name	Edition and year
1	Essential Bioinformatics	Jin Xiong,	Cambridge University Press	2006.
2	Bioinformatics Basics: Applications in Biological Science and Medicine	Lukas K. Buehler Hooman H. Rashidi	Tylor & Francis (CRC)	2005
Reference Books				
1	Current Protocols in Bioinformatics	Andreas D. Baxevanis,	Wiley	2003
2	Bioinformatics and Molecular Evolution	Paul G. Higgs, Teresa K. Attwood,	Blackwell publishing	2005.
3	Bioinformatics: Sequence and Genome Analysis	David Mount	Cold Spring Harbor Laboratory Press	2004

DATABASE MANAGEMENT SYSTEMS			
Course Code	**20BBI14**	CIE Marks	40
Teaching Hours/Week (L:T:P)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Overview of Database Management System: Introduction, file-based system, Drawbacks of file-Based System , Data and information, Database, Database management System, Objectives of DBMS, Evaluation of Database management System, Classification of Database Management System, DBMS Approach, advantages of DBMS, Anis/spark Data Model, data models, Components and Interfaces of Database Management System. Database Architecture, Situations where DBMS is not Necessary, DBMS Vendors and Their Products.

Module-2

Entity-Relationship Model: Introduction, the building blocks of an entity relationship diagram, classification of entity sets, attribute classification, relationship degree, relationship classification, reducing ER diagram to tables, enhanced entity-relationship model (EER model), generalization and specialization, **IS A** relationship and attribute inheritance, multiple inheritance, constraints on specialization and generalization, aggregation and composition, entity clusters, connection types,

advantages of ER modelling.

Module-3

Relational Model: Introduction, CODD Rules, relational data model, concept of key, relational integrity, relational algebra, relational algebra operations, advantages of relational algebra, limitations of relational algebra, relational calculus, tuple relational calculus, domain relational Calculus (DRC). QBE

Module-4

Structured Query Language: Introduction, History of SQL Standard, Commands in SQL, Data Types in SQL, Data Definition Language, Selection Operation, Projection Operation, Aggregate functions, Data Manipulation Language, Table Modification Commands, Table Truncation, Imposition of Constraints, Join Operation, Set Operation, View, Sub Query, and Embedded SQL.

Module-5

PL/SQL: Introduction, Shortcoming in SQL, Structure of PL/SQL, PL/SQL Language Elements, Data Types, Operators Precedence, Control Structure, Steps to Create a PL/SQL, Program, Iterative Control, Cursors, Steps to create a Cursors, Procedure, Function, Packages, Exceptions Handling, Database Triggers, Types of Triggers.

Course outcomes:

At the end of the course the student will be able to:

- Understand the concepts of database structures , systems and formats
- Understand the design and models of data in database.
- Understand the concepts of SQL and PL/SQL.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook/ Textbooks

Sl No	Title of the book	Name of the Author/s	Publisher Name	Edition and year
1	Database System Concepts	Abraham Silberschatz, Henry Korth, and S. Sudarshan,	McGraw Hill,	2010
2	Fundamentals of Database Systems"	R. Elmasri and S.B Navathe,	Pearson	2017
Reference Books				
1	An Introduction to Database Systems	Bipin C Desai	Galgotia publications	1981
2	Principles of Database Systems	J. D. Ullman, F	Galgotia publications	1982
3	Database Management Systems"	Raghu Ramakrishnan	McGraw-Hill	2002

PYTHON PROGRAMMING			
Course Code	**20BBI15**	CIE Marks	40
Teaching Hours/Week (L:T:P)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Algorithmic Problem Solving

Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion). Illustrative problems: find minimum in a list, insert a card in a list of sorted cards, guess an integer number in a range, Towers of Hanoi.

Module-2

Data, Expressions, Statements

Python interpreter and interactive mode; values and types: int, float, boolean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; modules and functions, function definition and use, flow of execution, parameters and arguments; Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two points.

Module-3

Control Flow, Functions

Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, local and global scope, function composition, recursion; Strings: string slices, immutability, string functions and methods, string module; Lists as arrays. Illustrative programs: square root, gcd, exponentiation, sum an array of numbers, linear search, binary search.

Module-4

Lists, Tuples, Dictionaries

Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing – list comprehension; Illustrative programs: selection sort, insertion sort, merge sort, histogram.

Module-5

Files, Modules, Packages

Files and exception: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages; Illustrative programs: word count, copy file.

Course outcomes:

At the end of the course the student will be able to:

- Understand Python syntax and semantics and be fluent in the use of Python flow control and functions.
- Structure Python programs for specific problems.
- Develop algorithmic solutions to simple computational problems

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook/ Textbooks

Sl No	Title of the book	Name of the Author/s	Publisher Name	Edition and year

1	Python for Bioinformatics	Sebastian Bassi,	Chapman & Hall/ CRC,	2009.
2	"Programming Python",	Mark Lutz,	O'Reilly Media,	4th Edition 2 011,
Reference Books				
1	Python Programming using problem solving approach	Reema Thareja	Oxford university press,	2017
2	Fundamentals of Python: First Programs	Kenneth A. Lambert	CENGAGE Learning	2011
3	Introduction to Programming in Python: An Inter-disciplinary Approach	Robert Sedgewick, Kevin Wayne, Robert Dondero	Pearson India Education Services Pvt. Ltd	2016

PYTHON PROGRAMMING LAB			
Course Code	**20BBIL16**	CIE Marks	40
Teaching/Hours/Week (L:T:P)	0:0:4	SEE Marks	60
Credits	02	Exam Hours	03

Sl.NO	**Experiments**
1	Compute the GCD of two numbers.
2	Find the square root of a number (Newton's method)
3	Exponentiation (power of a number)
4	Find the maximum of a list of numbers
5	Linear search and Binary search
6	Selection sort, Insertion sort
7	Merge sort
8	First n prime numbers
9	Multiply matrices
10	Find the most repeating words in a text

Course outcomes:

At the end of the course the student will be able to:

- Understand Python syntax and semantics and be fluent in the use of Python flow control and functions.
- Structure Python programs for specific problems.
- Develop algorithmic solutions to simple computational problems

RESEARCH METHODOLOGY AND IPR			
Course Code	20RMI17	CIE Marks	40
Teaching Hours/Week (L:T:P)	2:0:0	SEE Marks	60
Credits	02	Exam Hours	03

Module-1

Research Methodology: Introduction, Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Importance of Knowing How Research is Done, Research Process, Criteria of Good Research, and Problems Encountered by Researchers in India.

Defining the Research Problem: Research Problem, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem, An Illustration.

Module-2

Reviewing the literature: Place of the literature review in research, Bringing clarity and focus to your research problem, Improving research methodology, Broadening knowledge base in research area, Enabling contextual findings, How to review the literature, searching the existing literature, reviewing the selected literature, Developing a theoretical framework, Developing a conceptual framework, Writing about the literature reviewed.

Research Design: Meaning of Research Design, Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs, Basic Principles of Experimental Designs, Important Experimental Designs.

Module-3

Design of Sampling: Introduction, Sample Design, Sampling and Non-sampling Errors, Sample Survey versus Census Survey, Types of Sampling Designs.

Measurement and Scaling: Qualitative and Quantitative Data, Classifications of Measurement Scales, Goodness of Measurement Scales, Sources of Error in Measurement Tools, Scaling, Scale Classification Bases, Scaling Technics, Multidimensional Scaling, Deciding the Scale.

Data Collection: Experimental and Surveys, Collection of Primary Data, Collection of Secondary Data, Selection of Appropriate Method for Data Collection, Case Study Method

Module-4

Testing of Hypotheses: Hypothesis, Basic Concepts Concerning Testing of Hypotheses, Testing of Hypothesis, Test Statistics and Critical Region, Critical Value and Decision Rule, Procedure for Hypothesis Testing, Hypothesis Testing for Mean, Proportion, Variance, for Difference of Two Mean, for Difference of Two Proportions, for Difference of Two Variances, P-Value approach, Power of Test, Limitations of the Tests of Hypothesis.

Chi-square Test: Test of Difference of more than Two Proportions, Test of Independence of Attributes, Test of Goodness of Fit, Cautions in Using Chi Square Tests.

Module-5

Interpretation and Report Writing: Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports.

Intellectual Property: The Concept, Intellectual Property System in India, Development of TRIPS Complied Regime in India, Patents Act, 1970, Trade Mark Act, 1999,The Designs Act, 2000, The Geographical Indications of Goods (Registration and Protection) Act1999, Copyright Act,1957,The Protection of Plant Varieties and Farmers' Rights Act, 2001,The Semi-Conductor Integrated Circuits Layout Design Act, 2000, Trade Secrets, Utility Models, IPR and Biodiversity, The Convention onBiological Diversity (CBD) 1992, Competing Rationales for Protection of IPRs, Leading International Instruments Concerning IPR, World Intellectual Property Organisation (WIPO),WIPO and WTO, Paris Convention for the Protection of Industrial Property, National

Treatment, Right of Priority, Common Rules, Patents, Marks, Industrial Designs, Trade Names, Indications of Source, Unfair Competition,

Patent Cooperation Treaty (PCT), Advantages of PCT Filing, Berne Convention for the Protection of Literary and Artistic Works, Basic Principles, Duration of Protection, Trade Related Aspects of Intellectual Property Rights(TRIPS) Agreement, Covered under TRIPS Agreement, Features of the Agreement, Protection of Intellectual Property under TRIPS, Copyright and Related Rights, Trademarks, Geographical indications, Industrial Designs, Patents, Patentable Subject Matter, Rights Conferred, Exceptions, Term of protection, Conditions on Patent Applicants, Process Patents, Other Use without Authorization of the Right Holder, Layout-Designs of Integrated Circuits, Protection of Undisclosed Information, Enforcement of Intellectual Property Rights, UNSECO.

Course outcomes:

At the end of the course the student will be able to:

- Discuss research methodology and the technique of defining a research problem
- Explain the functions of the literature review in research, carrying out a literature search, developing theoretical and conceptual frameworks and writing a review.
- Explain various research designs, sampling designs, measurement and scaling techniques and also different methods of data collections.
- Explain several parametric tests of hypotheses, Chi-square test, art of interpretation and writing research reports
- Discuss various forms of the intellectual property, its relevance and business impact in the changing global business environment and leading International Instruments concerning IPR.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbooks

Sl No	Title of the book	Name of the Author/s	Publisher Name	Edition and year
1	Research Methodology: Methods and Techniques	C.R. Kothari, GauravGarg	New Age International	4th Edition, 2018
2	Research Methodology a step-by-step guide for beginners. (For the topic Reviewing the literature under module 2)	Ranjit Kumar	SAGE Publications	3rd Edition, 2011
3	Study Material (For the topic Intellectual Property under module 5)	Professional Programme Intellectual Property Rights, Law and Practice, The Institute of Company Secretaries of India, Statutory Body Under an Act of Parliament, September 2013.		
Reference Books				
1	Research Methods: the concise knowledge base	W.M Trochim	Atomic Dog Publishing	2005
2	Conducting Research Literature Reviews: From the Internet to Paper	Fink A	Sage Publications	2009

*** END ***

M.TECH BIOINFORMATICS(BBI)
Choice Based Credit System (CBCS) and Outcome Based Education(OBE)
SEMESTER -II

NGS INFORMATICS AND HIGH PERFORMANCE COMPUTING

Course Code	**20BBI21**	CIE Marks	40
Teaching Hours/Week (L:T:P)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Introduction to Sequencing technology: Sequencing platforms, Chemistry of difference sequencing platforms, Advantages and disadvantages of the platforms, Need of Hybrid platforms. Base calling algorithms, Base quality, phred values, Reads quality checks, Interpretations from quality checks. Adapter and primer contamination. Processing reads using clipping of reads-Advantages and disadvantages of processing of reads. BWA and Bowite Alignment programs, burrows wheeler algorithm. Reference indexing and Alignment.

Module-2

Building from source, the bowtie aligner, the –n alignment mode, the -v alignment mode, Reporting Modes, Paired-end Alignment, Color space Alignment, Color space reads, Building a color space index, Decoding color space alignments, Paired-end color space alignment, Performance Tuning, SAM and BAM format. Artifacts in alignment programs. **Assembly-** Denovo assembler, Debunj graph theory, error removing, bubbles and sorts, contigs and scaffolds, Calculation N50 and its importance in assessing assembly, Quality checks for assembly, MIRA, Columbus, Velvet.

Module-3

Overview of NGS Application: Human Exome sequencing, Transcriptome sequencing, chip Sequencing, smallRNA sequencing, Methylome sequencing, RAD Sequencing and RRL sequencing. **Big Data analytics-**Introduction of Cloud computing, Hadoop architecture. MIKE2.0, Multiple layer architecture, Distributed Parallel architecture, NGS data analysis using Hadoop.

Module-4

HPC overview and programming prerequisite- Applications of High performance Computing in the field of Bioinformatics. Introduction to Linux operating system, Basic commands used in HPC cluster, Major components and its functions in HPC Cluster- head node, login node, interactive node, compute node, I/O node, HPC Data Storage, Serial and parallel batch jobs and scripting to run processes in parallel. Molecular dynamics and use of VMD Software's and tools used to access HPC cluster with examples.

Module-5

Tools and Techniques for high through put data analysis in HPC- Conversion of SRA files and FASTQC analysis using HPC – Command and tools required, result interpretation. Comparison of the results from different tools. Trimming of Adapter contamination from the Sequence reads using HPC – commands and tools required, interpretation of results, Comparison of output from different tools. Alignment of the Raw Sequence reads by various alignment algorithms using HPC cluster followed by analysis of the obtained output. Variant scanning in the Aligned reads using VARSCAN – examples of practical application of the process and the tool - case studies. Using Velvet to generate maps and indexes for transcriptome data. Performing BLAST using HPC cluster – interpretation of the results.

Course outcomes:

At the end of the course the student will be able to:

- Understand the basics of Next Generation Sequencing.
- Analyze and apply the appropriate tools and techniques to perform high throughput data analysis.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook/ Textbooks

Sl No	Title of the book	Name of the Author/s	Publisher Name	Edition and year
1	Review of "Next-generation DNA sequencing informatics	Stuart M. Brown 2013.	" Cold Spring Harbor Laboratory Press, Cold Spring Harbor:	New York. 256.
2	Bioinformatics for High Throughput Sequencing	Naiara Rodríguez-Ezpeleta, Michael Hackenberg, Ana M. Aransay	Springer	2011
Reference Books				
1	High-Throughput Next Generation Sequencing Methods and Applications Series	Young Min Kwon, Steven C. Ricke	Springer	2011.
2	DNA Sequencing III: Dealing With Difficult Templates	Jan Kieleczawa	publisher, Jones & Bartlett	2008

M.TECH BIOINFORMATICS(BBI)
Choice Based Credit System (CBCS) and Outcome Based Education(OBE)
SEMESTER -II

COMPUTATIONAL SYSTEMS BIOLOGY

Course Code	**20BBI22**	CIE Marks	40
Teaching/Hours/Week (L:T:P)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Introduction to Systems Biology: Scope, Applications. Concepts, implementation and application. Databases for Systems Biology, Mass Spectrometry and systems Biology. Bioinformatics databases supporting systems biology approaches.

Module-2

Network Models and Applications: Natural Language Processing and Ontology enhanced Biomedical data mining, text mining. Integrated Imaging Informatics - ntegrin, centroid, cell culture. Standard platforms and applications – metabolic control analysis, glycolysis, metabolic network, Michaelis-Menten kinetics, and flux balance analysis. Signal Transduction - phosphorylation, Jak-Stat pathway, MAP kinase.

Module-3

Biological Processes: Mitochondria, cyclin, Cdc2. Modeling of Gene Expression - lactose, lac operon, tRNA. Analysis of Gene Expression Data – support vector machines, cDNA microarray. Evolution and Self-organization - hypercycle, quasispecies model, self-replication. Reconstruction of metabolic network from Genome Information.

Module-4

Integrated Regulatory and Metabolic Models: Phosphorylation, Gene expression, and Metabolites. Estimation Modeling and Simulation – Circadian rhythms, Petri net, mRNA.Deterministic - Circadian rhythms, mRNA, Circadian oscillations. Multi scale representations of Cells and Emerging Phenotypes - Gene Regulatory Networks, attractor, and Boolean functions. Mathematical models and Optimization methods for De Novo Protein design. Global Gene expression assays. Mapping Genotype - Phenotype relationship in cellular networks.

Module-5

Multiscale representations of cells and Emerging phenotypes: Multistability and Multicellurarity. Spatio-Temporal systems biology, Interactomics, Cytomics – from cell state to predictive medicine. Modeling Tools: SBML, MathMLCellML, Petri Nets and Bioinformatics with case studies.

Course outcomes:
At the end of the course the student will be able to:

- Understand the basics of systems biology
- Learn about modeling and simulation of various biological processes using bioinformatics tools.
- Gain knowledge about the importance of modeling and simulation of biological processes

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook/ Textbooks

Sl No	Title of the book	Name of the Author/s	Publisher Name	Edition and year

1	Computational Systems Biology	Andres Kriete, Roland Eils	Academic Press	2006
2	Transactions on Computational Systems Biology	Corrado Priami,	Springer – Publisher.	2012
Reference Books				
1	Systems Biology	Michael G. Katze	Springer	2013.
2	Systems Biology	IsidoreRigoutsos, G. Stephanopoulos,	Oxford University Press US,	2006.
3	Systems Biology: Principles, Methods, and Concepts.	Konopka A.K.	CRC Press	Tailor & Francis.2007.

BIOMOLECULAR SIMULATIONS			
Course Code	**20BBI23**	CIE Marks	40
Teaching Hours/Week (L:T:P)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Molecular Mechanics: Introduction, The Morse Potential, The Harmonic Oscillator Model for Molecules, Comparison of Morse and Harmonic Potential, Two atoms connected by a bond, Poly atomic Molecules, Energy due to Stretch, Bend, Stretch-Bend, Torsional strain, van der Waals and Dipole-Diploe interactions. Types of Potentials: Lennard-Jones, Truncated Lennard-jones, Exponential-6, Ionic and Polar potentials. Types of Force Fields: AMBER, CHARMM, Merck Molecular Force Field, Consistent Force Field, MM2, MM3 and MM4 force fields.

Module-2

Potential Energy Surface: Convergence Criteria, Characterizing Stationary Points, Search for Transition States. Optimization:- multivariable Optimization Algorithms, level Sets, Level Curves, Gradients, Optimization Criteria, Unidirectional Search, Finding Minimum Point, Gradient based Methods-Steepest Descent and Conjugate Gradient Methods

Module-3

Molecular Dynamics Simulation: Introduction, Radial distribution functions, Pair Correlation function, Newtonian dynamics, Integrators- Leapfrog and Verlet algorithm, Potential truncation and shifted-force potentials, Implicit and explicit Solvation models, Periodic boundary conditions, Temperature and pressure control in molecular dynamics simulations

Module-4

Molecular modeling in Drug design: Conformational analysis, lead identification, optimization and validation. Methods and Tools in Computer-aided molecular Design, Analog Based drug design:-Pharmacophores and QSAR. Structure based drug design:- Docking, De Novo Drug Design, Virtual screening.

Module-5

Structure Activity Relationship: Introduction to QSAR, QSPR, Various Descriptors used in QSARs, Regression Analysis, Significance and Validity of QSAR Regression Equations, Partial Least Squares (PLS) Analysis, Multi Linear Regression Analysis. Application of Genetic Algorithms, Neural Networks and Principle Components Analysis in QSAR analysis.

Course outcomes:

At the end of the course the student will be able to:

- Understand the basic principles of biomolecular simulations
- Appreciate and apply the various algorithms used for diverse applications.
- Understand the utilities of various tools and their multitude of applications.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook/ Textbooks

Sl No	Title of the book	Name of the Author/s	Publisher Name	Edition and year
1	Computational Chemistry and Molecular Modelling-Principles and Applications	Ramachandran, Deepa and Namboodri,	Springer_Verlag.	2008
2	Mathematical Approaches to Biomolecular Structure and Dynamics	Jill P. Mesirov, Klaus Schulten, De Witt L. Sumners	Springer	1996.
Reference Books				
1	Molecular Modeling for Beginners.	Alan Hinchliffe	John Wiley & Sons Ltd.	(2nd Edition), 2008
2	Foundations of Molecular Modeling and Simulation.	Peter T. Cummings, Phillip R.Westmorland, Brice Carnahan,	American Institute of Chemical Engineers	2001
3	New Algorithms for Macromolecular Simulation	Timothy J. Barth, Michael Griebel, David E.Keyes, Risto M. Nieminen, Dirk Roose, Tamar Schlick,	Springer	2011

CHEMOINFORMATICS AND COMPUTATIONAL MEDICINAL CHEMISTRY			
Course Code	**20BBI241**	CIE Marks	40
TeachingHours/Week (L:T:P)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Introduction to Chemoinformatics: Fundamental concepts - molecular descriptors and chemical spaces, chemical spaces and molecular similarity, modification and simplification of chemical spaces. Compound classification and selection – cluster analysis, partitioning, support vectors machines. Predicting reactivity of biologically important molecules, combining screening and structure - 'SAR by NMR', computer storage of chemical information, data formats, OLE, XML, web design and delivery. Representing intermolecular forces: *ab initio* potentials, statistical potentials, force fields, molecular mechanics.

Module-2

Chemoinformatics Databases: Compound availability databases, SAR databases, chemical reaction databases,patent databases and other compound and drug discover databases. Database search methods: Chemical indexing, Proximity searching, 2D and 3D Structure and Substructure searching. Similarity Searching: Structural queries and Graphs, Pharmacophores, Fingerprints. Topological analysis. Machine learning methods for similarity search –

Generic and Neural networks. Library design – Diverse libraries, Diversity estimation, Multi-objective designand Focused libraries.

Module-3

Computational Models: Introduction, Historical Overview, Deriving a QSAR Equation. Simple and Multiple Linear Regression. Designing a QSAR "Experiment". Principal Components Regression, Partial Least Squares. Molecular Field Analysis and Partial Least Squares. Quantitative Structure-Activity Relationship Analysis: Model building, Model evaluation, 3DQSAR, 4DQSAR. Methods of QSAR analysis - Monte Carlo methods, Simulated annealing, Molecular dynamics and Probabilistic methods. Virtual screening and Compound filtering.

Module-4

Virtual Screening: Introduction. "Drug-Likeness" and Compound filters. Structure-based virtual screening and Prediction of ADMET Properties. Discussions with case studies. Combinatorial Chemistry and Library Design: Introduction. Diverse and Focused libraries. Library enumeration. Combinatorial library design strategies. Discussions with case studies.

Module-5

Drug Discovery: Interaction of 'receptors' with agonists and antagonists. Receptor structure prediction methods. Enzyme kinetics and Interaction of enzymes with inhibitors (competitive, non-competitive). Drug discovery pipeline. Optimization of lead compound, SAR (structure-activity relationships), Physicochemical and ADME properties of drugs and Prodrugs. QSAR (Quantitative structure activity relationships), Combinatorial synthesis. Case studies (e.g. G-coupled protein receptor agonists and antagonists, antibacterial agents etc).

Course outcomes:

At the end of the course the student will be able to:

- Learn about various chemoinformatics databases and their importance in drug discovery process.
- Gain knowledge about chemistry of medicinal compounds and Virtual Screening process.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook/ Textbooks

Sl No	Title of the book	Name of the Author/s	Publisher Name	Edition and year
1	Chemoinformatics: Theory, Practice, & Products	Barry A. Bunin, Jürgen Bajorath, Brian Siesel, Guillermo Morales,	Springer	2005
2	An Introduction to Chemoinformatics	Andrew R. Leach, Valerie J. Gillet,	Springer	2007
Reference Books				
1	Chemoinformatics	Johann Gasteiger	Wiley-VCH	2003
2	An introduction to medicinal chemistry	G. L. Patrick	Oxford University Press, New York.	5th edition
3	Computational Drug Design: A Guide for Computational and Medicinal Chemists,	Young D. C.,	John Wiley & Sons,	2009.

INSILICO PROTEIN ENGINEERING & DESIGN			
Course Code	**20BBI242**	CIE Marks	40
TeachingHours/Week (L:T:P)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Introduction to Proteins: Amino acids (three and single letter codes) and their molecular properties (size, solubility, charge, pKa), Chemical reactivity in relation to posttranslational modification (involving amino, carboxyl, hydroxyl, thiol, imidazole groups) and peptide synthesis. Primary structure: peptide mapping, peptide sequencing - automated Edman method and Mass Spectrometry. High-throughput protein sequencing. Methods of protein isolation, purification and quantification, and functional analysis.

Module-2

Higher order structures: Alpha, beta and loop structures and methods to determine Super-secondary structure: Alpha-turn-alpha, beta-turn beta (hairpin), beta-sheets, alpha-beta-alpha, topology diagrams, TIM barrel structures, nucleotide binding folds. Tertiary structure: Domains, denaturation and renaturation, protein folding pathways, overview of methods to determine 3D structures, Interaction with electromagnetic radiation (radio, micro, infrared, visible, ultraviolet, X-ray) and elucidation of protein structure. Quaternary associations: Modular nature, formation of complexes.

Module-3

Protein Structures: PDB, structure based classification, databases, visualization tools, structure alignment, domain architecture databases, protein-ligand interactions. Covalent, Ionic, Hydrogen, Coordinate, hydrophobic and Vander walls interactions in protein structure. Bioinformatics Approaches: Secondary structure prediction and determination of motifs, profiles, patterns, fingerprints, super secondary structures, prediction of substrate binding sites, tertiary structure, quaternary structure, methods to determine tertiary and quaternary structure, posttranslational modifications.

Module-4

Protein databases: Analysis, computational methods to alter primary structure of proteins, examples of engineered proteins, protein design, principles and examples. Advantages and purpose, overview of methods, underlying principles with specific examples: thermal stability T4-lysozyme, *de novo* protein design. Case studies of DNA-binding proteins, transcription factors, Helix-turn-Helix motif, Zn fingers, helix-turn helix motifs in homeodomain, Leucine zippers,

Module-5

Case Studies: Membrane proteins: engineering of Transmembrane segments, prediction, analysis of bacteriorhodopsin and Photosynthetic reaction center. Engineering antibodies. Case studies on Abzymes and Enzymes: Serine proteases, understanding catalytic design by engineering trypsin, chymotrypsin and elastase, substrate assisted catalysis other commercial applications. Peptide design, computational design of peptide therapeutics, peptide drugs, design of synthetic peptides.

Course outcomes:

At the end of the course the student will be able to:

- Understand the basics of protein structures, functional units, architectures and topologies
- Understand the methods of isolation, purification and characterization of proteins
- Apply the principles towards selective modification of proteins strictures and functions
- Understand the Computational aspects of protein engineering and design, with specific case studies.

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook/ Textbooks

Sl No	Title of the book	Name of the Author/s	Publisher Name	Edition and year
1	Protein Engineering	Moody P.C.E and A.J Wilkinson	IRL Press, Oxford University Press	1991
2	Introduction of protein structure	Branden C and Tooze R	Garland	1998
Reference Books				
1	Bioinformatics Methods & Applications: Genomics, Proteomics & Drug Discovery	S, C Rastogi, N Mendiratta& P Rastogi	PHI	2013
2	Protein engineering: principles and practice,	Jeffrey L. Cleland, Charles S. Craik	Wiley-Liss,	1996
3	Introduction to Protein Science.	Arthur M Lesk,	Oxford university	2016

IMMUNOINFORMATICS			
Course Code	**20BBI243**	CIE Marks	40
Teaching Hours/Week (L:T:P)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Immunoglobulins: Structure and function-- Monoclonal antibodies. B Cell generation and differentiation: BCR--Antibody diversity: Genetic basis—T- dependent activation of B cells-B-lymphocyte signal transduction. Cytokines. Complement system. Antigen- antibody interaction: antibody affinity and activity- Isolation of lymphoid cells from blood and lymphoid organs--precipitation reaction, agglutination reaction --Radioimmunoassay, ELISA, Western Blot, Immuno-precipitation, Immun-fluoresence, flow cytometry. Cell cultures and Experimental animal models. Analysis of gene expressions.

Module-2

SEQUENCE ANALYSIS: Alignments- DNA alignments- Molecular evolution and phylogeny-viral evolution and escape- prediction of functions. Methods applied in Immunological Bioinformatics- starting from sequence weighing methods to cluster analysis- Gibbs Sampling-HMM- Neural network- microarray and its applications.

Module-3

MHC- I PREDICTION: Prediction of Cytotoxic T Cell (MHC Class I) Epitopes- Antigen Processing in the MHC Class I Pathway. MHC-II PREDICTION: Prediction of Helper T Cell (MHC Class II) Epitopes- Processing of MHC Class II Epitopes

Module-4

B CELL EPITOPE PREDICTION AND WEB SOURCES: Recognition of Antigen by B Cells-vaccine design - Web-Based Tools for Vaccine Design. The IMGT® Immunoinformatics page. Databases associated with Immunoglobulins (or Antibodies) (IG), T cell receptors (TR), Major

histocompatibility (MH), Antigens, Allergens, Peptides binding to MH etc.

Module-5

Hybridoma technology for mass production. Chimeric antibodies, antibody engineering via computational tools, large scale manufacture of antibodies. Vaccine development and Immunoinformatics: Recombinant vaccines, combined vaccines, polyvalent vaccines. Immunoinformatics, databases in immunology, DNA, Plant and protein based recombinant antigens as vaccines.

Course outcomes:

At the end of the course the student will be able to:

- Understand the computational aspects of immunology
- Tools and databases related to immunoinformatics studies

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook/ Textbooks

Sl No	Title of the book	Name of the Author/s	Publisher Name	Edition and year
1	"Immunological Bioinformatics"	Ole Lund Darren Flower,	MIT press, Springer	September 2005, 2006.
2	"Immunoinformatics: Predicting Immunogenicity in Silico"	Darren R Flower	Humana Press	2007
Reference Books				
1	"Immunoinformatics-Bioinformatics Strategies for Better Understanding of Immune	Rammensee	Wiley	2003
2	Computational Immunology: Basics	Shyamasree Ghosh	CRC Press	2020
3	Kuby Immunology	Thomas J. Kindt , Richard A. Goldsby, Barbara A borne	W. H. Freeman & Company	2006

HEALTH INFORMATICS			
Course Code	**20BBI244**	CIE Marks	40
TeachingHours/Week (L:T:P)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Introduction: An interaction between health care and information systems. Acquisition, storage, retrieval, and use of information in health and biomedicine. Tools and techniques. Information systems in Medicine, Dentistry, Nursing, surgery and diagnosis. Future prospects.

Module-2

Building blocks: Standards, types of standards. Modeling –principles of modeling for healthcare. Architecture of Health care system – models, subsystems, packages and components. Modeling framework for health care. Generic health care information model. Unified modeling language. Modeling methodologies in healthcare systems. Databases, types, and applications. Database Architecture; ANSI/SPARC three tier architecture. Data warehousing; architecture.

Module-3

Tools and techniques: Introduction, conditions for telemedicine development, applications, access techniques intelecare and Internet technologies in medical systems: Requirement of Medical systems in the internet environment, internet medical architectures, and internet based telemedical services, next generation point of care information systems, internet access technologies in Telecare Wireless communication technologies. Electronic Health records (HER): Challenges in clinical care, characteristics of good EHR, Generic HER representation, EHR Standards and Scope of the HER.

Module-4

Decision support systems and Telematic networks: Decision support systems, knowledge based and Expert based. Probabilistic and Logical decision systems. Transport layer in telematics networks, health digital data standards, E-health networks services.

Module-5

Applications of IT: Methodology of hearing screening, computer aided adjustment of hearing aids, diagnosis, tinnitus treatment. Application of IT to diagnose chronic conditions patient-centered symptom monitoring. Computer aided techniques in Medicine: Laproscopic surgery navigation, Intro-operative imaging, multi-model imaging, Biosignal processing and algorithms. Biosignal databases.

Course outcomes:

At the end of the course the student will be able to:

- Understand the concepts and building blocks of health informatics.
- Understand the tools and techniques used in health informatics.
- Understand the applications of IT in health informatics

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook/ Textbooks

Sl No	Title of the book	Name of the Author/s	Publisher Name	Edition and year
1	Health Informatics: Transforming Healthcare with Technology	Moya Conrick	Thomson :Social Science Press	2006.
2	ABC of Health Informatics,	Frank Sullivan, Jeremy Wyatt.	Blackwell Publishing	2009
Reference Books				
1	Information Technology Essentials for behavioral Health Clinicians,	Naakesh A. Dewan, John Luo, Nancy M. Lorenz	Springer	2010.

2	Information Technology Solutions for Healthcare	**Zielinski**, Krzysztof, **Duplaga**, Mariusz, **Ingram**, David	Springer	2006
3	Health Informatics: An Interprofessional Approach	Ramona Nelson Nancy Staggers	Elsevier	2017

OBJECT ORIENTED PROGRAMMING USING JAVA			
Course Code	**20BBI251**	CIE Marks	40
TeachingHours/Week (L:T:P)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

FUNDAMENTALS OF OBJECT – ORIENTED PROGRAMMING: Introduction, Object Oriented paradigm, Basic Concepts of OOP, Benefits of OOP, Applications of OOP, Java features: OVERVIEW OF JAVA LANGUAGE: Introduction, Simple Java program structure, Java tokens, Java Statements, Implementing a Java Program, Java Virtual Machine, Command line arguments.

CONSTANTS, VARIABLES & DATA TYPES: Introduction, Constants, Variables, Data Types, Declaration of Variables, Giving Value to Variables, Scope of variables, Symbolic Constants, Type casting, Getting Value of Variables, Standard Default values; OPERATORS & EXPRESSIONS.

Module-2

DECISION MAKING & BRANCHING: Introduction, Decision making with if statement, Simple if statement, if. Else statement, Nesting of if else statements, the else if ladder, the switch statement, the conditional operator. LOOPING: Introduction, The While statement, the do-while statement, the for statement, Jumps in loops.

OBJECTS & METHODS: Introduction, Defining a class, Adding variables, Adding methods, Creating objects, Accessing class members, Constructors, Method overloading, Static members, Nesting of methods.

Module-3

INHERITANCE: Extending a class, Overloading methods, Final variables and methods, Final classes, Abstract methods and classes;

ARRAYS, STRINGS AND VECTORS: Arrays, One-dimensional arrays, Creating an array, Two – dimensional arrays, Strings, Vectors, Wrapper classes;

INTERFACES: MULTIPLE INHERITANCE: Introduction, Defining interfaces, Extending interfaces, Implementing interfaces, Assessing interface variables.

Module-4

MULTITHREADED PROGRAMMING: Introduction, Creating Threads, Extending the Threads, Stopping and Blocking a Thread, Lifecycle of a Thread, Using Thread Methods, Thread Exceptions, Thread Priority, Synchronization, Implementing the 'Runnable' Interface.

MANAGING ERRORS AND EXCEPTIONS: Types of errors: Compile-time errors, Run-time errors, Exceptions, Exception handling, Multiple Catch Statements, Using finally statement.

Module-5

APPLET PROGRAMMING: local and remote applets, Applets and Applications, Building Applet code, Applet Life cycle: Initialization state, Running state, Idle or stopped state, Dead state, Display state.

PACKAGES: Introduction, Java API Packages, Using System Packages, Naming conventions, Creating Packages, Accessing a Package, using a Package.

MANAGING INPUT/OUTPUT FILES IN JAVA: Introduction, Concept of Streams, Stream classes, Byte Stream Classes, Input Stream Classes, Output Stream Classes, Character Stream classes: Reader stream classes, Writer Stream classes, Using Streams, Reading and writing files.

Course outcomes:

At the end of the course the student will be able to:

- Understand the basics of Java programming for various web based tools and specific applications.
- Understand the basics of Object Oriented programming for various web based tools and applications.

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook/ Textbooks

Sl No	Title of the book	Name of the Author/s	Publisher Name	Edition and year
1	Programming with JAVA	E.Balaguruswamy	TATA McGraw-Hill Company	2006
2	Object Oriented Programming using Java	Chirag Patel	Books India Publications	2007
Reference Books				
1	Introduction to JAVA Programming	by Y. Daniel Liang	Pearson Education	6th Edition, 2007.
2	Introduction to Java Programming Comprehensive Version	Y. Daniel Liang	Pearson Prentice Hall	(7th Edition) 2010.
3	Java - The Complete Reference	Herbert Schildt,	Tata McGraw Hill	7th Edition,2007

DATA WAREHOUSING AND DATA MINING

Course Code	**20BBI252**	CIE Marks	40
Teaching Hours/Week (L:T:P)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Introduction to Data Warehousing: Heterogeneous information, Integration problem. Warehouse architecture. Data warehousing, Warehouse vs DBMS. Aggregations: SQL and Aggregations, Aggregation functions and Grouping. Data Warehouse Models and OLAP Operations: Decision support; Data Marts, OLAP vs OLTP. Multi- Dimensional data model. Dimensional Modelling. ROLAP vs MOLAP; Star and snowflake schemas; the MOLAP cube; roll-up, slicing, and pivoting.

Module-2

Issues in Data Warehouse Design: Design issues - Monitoring, Wrappers, Integration, Data cleaning, Data loading, Materialised views, Warehouse maintenance, OLAP servers and Metadata. Building Data Warehouses: Conceptual data modeling, Entity-Relationship (ER) modeling and Dimension modeling. Data warehouse design using ER approach. Aspects of building data warehouses.

Module-3

Introducing Data Mining: KDD Process, Problems and Techniques, Data Mining Applications, Prospects for the Technology. CRISP-DM Methodology: Approach, Objectives, Documents, Structure, Binding to Contexts, Phases, Task, and Outputs. Data Mining Inputs and Outputs: Concepts, Instances, Attributes. Kinds of Learning, Kinds of Attributes and Preparing Inputs. Knowledge representations – Decision tables and Decision trees, Classification rules, Association rules, Regression trees & Model trees and Instance-Level representations.

Module-4

Data Mining Algorithms: One-R, Naïve Bayes Classifier, Decision trees, Decision rules, Association Rules, Regression, K-Nearest Neighbour Classifiers.

Module-5

Evaluating Data Mining Results: Issues in Evaluation; Training and Testing Principles; Error Measures, Holdout, Cross Validation. Comparing Algorithms; Taking costs into account and Trade-Offs in the Confusion Matrix.

Course outcomes:

At the end of the course the student will be able to:

- Learn about data warehouse design and concepts of data warehousing.
- Understand about data mining algorithms and evaluation of data mining results.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook/ Textbooks

Sl No	Title of the book	Name of the Author/s	Publisher Name	Edition and year
1	Fundamentals of Data Warehouses	M. Jarke, M. Lenzerini, Y. Vassiliou ,	Springer-Verlag	P. Vassiliadis (ed.), 1999
2	Data Mining: Concepts and Techniques	J. Han and M. Kamber, Morgan Kaufman		2000
Reference Books				
1	The Data Warehouse Toolkit	Ralph Kimball,	Wiley	1996
2	Principles of Data Mining	D. Hand, H. Mannila and P. Smyth	MIT Press	2001
3	Data Mining: Introductory and Advanced Topic	M. H. Dunham,	Prentice Hall	2003

ARTIFICIAL INTELLIGENCE & NEURAL NETWORKS

Course Code	**20BBI253**	CIE Marks	40
Teaching Hours/Week (L:T:P)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Introduction to Artificial Intelligence: Introduction to Artificial Intelligence, Problems, Approaches and tools for Artificial Intelligence. Introduction to search, Search algorithms, Heuristic search methods, Optimal search strategies. Use of graphs in Bioinformatics. Grammers, Languages and Automata. Current Techniques of Artificial Intelligence: Probabilistic approaches: Introduction to probability, Bayes' theorem, Bayesian networks and Markov networks.

Module-2

Classification methods: Nearest Neighbour method, Nearest Neighbour approach for secondary structure protein folding prediction, Clustering and Advanced clustering techniques. Identification Trees - Gain criterion, Over fitting and Pruning. Nearest Neighbour and Clustering Approaches for Bioinformatics.

Module-3

Applications: Genetic programming, Neural Networks for the study of Gene-Gene interactions. Artificial neural networks for reducing the dimensionality of expression data. Cancer classification with Microarray data using Support Vector Mechanics. Prototype based recognition of splice sites. Analysis of Large-Scale mRNA expression data sets by genetic algorithms.

Module-4

Artificial Immune Systems in Bioinformatics. Evolutionary algorithms for the protein folding problem. Considering Stem-Loops as sequence signals for finding Ribosomal RNA genes. Assisting cancer diagnosis. Neural Networks: Methods and Applications. Application of Neural Networks to Bioinformatics. Genetic algorithms and Genetic programming: Single-Objective Genetic algorithm, Multi-Objective Genetic algorithm. Applications of Genetic algorithms to Bioinformatics.

Module-5

Genetic programming – Method, Applications, Guidelines and Bioinformatics applications. Boolean Networks, Bayesian Networks and Fuzzy Neural Networks with case studies. Applications of Neural Networks: Introduction, Modeling gene regulatory networks. QSAR and structure prediction with case studies.

Course outcomes:

At the end of the course the student will be able to:

- Understand the concepts of artificial intelligence and their applications in bioinformatics.
- Understand the approaches of neural networks applications of neural networks in biological studies.
- Understand the principals of Genetic programming and Neural Networks

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook/ Textbooks

Sl No	Title of the book	Name of the Author/s	Publisher Name	Edition and year
1	Artificial Intelligence Methods and Tools for Systems Biology	Werner Dubitzky, Francisco Azuaje,	Springer	2005
2	Artificial Neural Networks	Yegnanarayana	PHI	1998

Reference Books

1	Intelligent Bioinformatics: The Application of Artificial Intelligence Techniques to Bioinformatics	Edward Keedwell, Ajit Narayanan	John Wiley and Sons	2005
2	Computational Intelligence in Bioinformatics	Arpad Kelemen, Ajith Abraham, Yuehui Chen, SpringerLink	Springer	2008
3	(3) Computational Intelligence in Biomedicine and Bioinformatics: Current Trends and Applications	Tomasz G. Smolinski, Mariofanna G. Milanova, Aboul Ella Hassanien	Springer	2008

PERL PROGRAMMING AND BIOINFORMATICS			
Course Code	**20BBI254**	CIE Marks	40
TeachingHours/Week (L:T:P)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Introduction to Perl, Downloading and installation from Website, Writing and Running a Perl Program, Editing, Advantages Data Types: Scalar data and scalar variables: Number, String, Conversion between Numbers and Strings, Variable Interpolation, Arithmetic and Decimal Precision, Arrays: Initialization, Manipulation of Array elements; Associative Array (Hashes): Initialization, Manipulation of Elements of Array.

Module-2

Arithmetic and Logical Operators: Arithmetic Operators, Assignment Operators, Increment and Decrement Operators, String Concatenation and Repetition, Operators precedence and Associativity, Conditional Operators, Logical Operators, Operators for manipulating arrays, Operators for Manipulating hashes.

Conditionals and Loops: Conditional Statement; if, if…else, if and if-else, unless statement, Loops: while, for, until, do..while, do..until and foreach loop, last next, redo, continue and case switch statement. Input and Output: Creating a file, Reading Data from a file, Writing data to a file, Closing a file, Managing Files and Directories.

Module-3

Regular Expressions and Pattern Matching: Regular Expression, Pattern Matching, Meta Character, Simple Pattern, Matching Group of Characters, Matching multiple instances of Characters, Pattern Building, Pattern and Variable, Pattern and Loops, Using Pattern for Search and Replace, Matching Pattern over multiple Lines etc.

Module-4

Built-in Functions, Defining and calling subroutines, Returning Values from Subroutines, Using Local Variables in Subroutines, Passing Values into Subroutine, Perl References, Perl module and their uses.

Module-5

Applications of Perl in Bioinformatics: Concatenating DNA Fragments, Transcription: DNA to RNA, Reading Protein Files, Finding Motifs, Simulating DNA, Generating Random DNA, Analysing DNA, Translating DNA to Proteins, Reading DNA from Files in FASTA format, Separating Sequence and Annotation, Parsing Annotation, Parsing PDB files, Parsing BLAST output, Bio-perl .

Course outcomes:

At the end of the course the student will be able to:

- learn the basics of Perl syntax, functions and algorithms used in coding
- Understand the applications of perl programming for various bioinformatics exercises.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook/ Textbooks

Sl No	Title of the book	Name of the Author/s	Publisher Name	Edition and year
1	Perl Programming for Biologists	D. Curtis Jamison	Wiley-IEEE	2003
2	Mastering Perl for Bioinformatics	James T Tisdall	O'Reilly Media, Inc, USA	2007
Reference Books				
1	Beginning Perl for Bioinformatics	James T Tisdall	O'Reilly & Associates	2001

2	Building Bioinformatics Solutions: With Perl	Conrad Bessant, Darren Oakley, Ian Shadforth	Oxford	2010
3	Genomic Perl: From Bioinformatics Basics to Working Code	Rex A. Dwyer	Cambridge University Press	2002

BIOMOLECULAR SIMULATIONS LABORATORY			
Course Code	**20BBIL26**	CIE Marks	40
Teaching Hours/Week (L:T:P)	0:0:4	SEE Marks	60
Credits	02	Exam Hours	03

Sl.NO	**Experiments**
1	Bio-molecular Modeling of 3D structures a) Comparative/Homology Based modeling b) Fold prediction and modeling c) *Ab initio* modeling
2	Molecular Visualization Softwares: Pymol and Rasmol
3	a) Modelling Protein-Protein Interactions b) Modelling mutations and Single Nucleotide Polymorphisms
4	Geometry Optimization Techniques
5	Energy Minimization Techniques
6	Molecular Dynamics and Simulations via Gromacs
7	Binding Site Identification and Evaluation
8	a) Structure based Drug Design - Docking of small molecules into active sites. b) Ligand based Drug Design – QSAR
9	ADMET analysis via tools
10	3D modelling of Membranes/Tissues

Course outcomes:

At the end of the course the student will be able to:

- Understand the principles of bio-molecular modeling and simulations
- Understand the basics of computational drug discovery process.

TECHHNICAL SEMINAR			
Course Code	**20BBI27**	CIE Marks	100
Number of contact Hours/week (L:T:P)	0:0:2	SEE Marks	--
Credits	02	Exam Hours	--

Course objectives:

The objective of the seminar is to inculcate self-learning, face audience confidently, enhance communication skill, involve in group discussion and present and exchange ideas.

Each student, under the guidance of a Faculty, is required to

- Choose, preferably through peer reviewed journals, a recent topic of his/her interest relevant to the Course of Specialization.
- Carryout literature survey, organize the Course topics in a systematic order.
- Prepare the report with own sentences.
- Type the matter to acquaint with the use of Micro-soft equation and drawing tools or any such facilities.
- Present the seminar topic orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit two copies of the typed report with a list of references.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

The CIE marks for the seminar shall be awarded (based on the relevance of the topic, presentation skill, participation in the question and answer session and quality of report) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three

Marks distribution for CIE of the course 20BBI27 seminar:

Seminar Report: 30 marks

Presentation skill:50 marks

Question and Answer:20 marks

*** END ***

M.TECH BIOINFORMATICS(BBI)
Choice Based Credit System (CBCS) and Outcome Based Education(OBE)
SEMESTER -III

DATA SECURITY AND REGULATORY AFFAIRS

Course Code	**20BBI31**	CIE Marks	40
TeachingHours/Week (L:T:P)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Data security fundamentals: types of attacks, firewall, packet filtering, classification of data security threats, protection mechanism (authentication, access control and access rules), Encryption/Decryptions techniques, An overview of Computer viruses: How do they get transmitted? What are the dangers? General Precautions to be taken, Current & future technologies (Grid Computing, VPN, wireless, mobile computing, biometrics etc.

Module-2

Computer Networking; Network and Data security, Fundamentals of networking: OSI Reference Model, TCP/IP, topologies and protocols, designing networks, Networking gadgets (Router, Switch, etc); Data Communication (ISDN, VPN, DSL, cable modem, cellular modem, etc); Communication Links (Wire pairs, Coaxial cables, Fiber optics, Microwave, Satellite, etc). Network security fundamentals: types of attacks, firewall, packet filtering, classification of data security threats, protection mechanism (authentication, access control, access rules). Encryption/Decryptions techniques - An overview of Computer malware, Current & future technologies (Grid Computing, mobile computing, biometrics etc.)

Module-3

Social context of computing and biology, Privacy and civil liberties, Economic issues in bioinformatics, monopolies and their economic implications, effect of skilled labor supply and demand on the quality of bioinformatics products, pricing strategies in the bioinformatics domain, differences in access to bioinformatics resources and the possible effects thereof. Health, psychological and legal issues in GMOs. Biosafety and Bio-security issues.

Module-4

Introduction to Intellectual Property, Copyright & Related Rights; Trademarks; Geographical Indications, Patent Searching, Patent Information, Major Treaties, Issues in Biotechnology & Bioinformatics. Patent filing procedures and formats, Discussions of relevant case studies. Plagiarism and its concerns. Tools for checking plagiarism.

Module-5

Regulations with regard to utilization of Open Source and Web-based resources for Bioinformatics exercises. Web based servers and software for genome analysis, Biological network analysis. Access to protein sequence and functional information, Tools and resources for drug discovery, ChEMBL- drug-gene interactions, drug-protein interactions, microarray expression profiles, Neural network analysis. Citations and acknowledgements for utilization of open source tools.

Course outcomes:

At the end of the course the student will be able to:

- Understand the importance of data security, protection mechanisms, threats and implications.
- Understand the importance of regulatory affairs and IPR

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook/ Textbooks

Sl No	Title of the book	Name of the Author/s	Publisher Name	Edition and year
1	Computer Ethics: Cautionary Tales and Ethical Dilemmas in Computing	Tom Forester	Perry Morrison	2014
2	Security in Computing.	Willis H. Ware, Charles P. Pfleeger, Shari Lawrence	Pearson	2007
Reference Books				
1	Database Security and Auditing Protecting Data Integrity and Accessibility	Hassan A. Afyouni	Thomson publishers	2013
2	Genetic Patent Law & Strategy	Kankanala C.,	Manupatra Information Solution Pvt	1st Edition,2007
3	Malware Data Science: Attack Detection and Attribution	Joshua Saxe and Hillary Sanders	No Starch Press IN	2018

GENOMICS & PROTEOMICS			
Course Code	**20BBI321**	CIE Marks	40
TeachingHours/Week (L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Module-1

Whole genome analysis, Genome sequencing technology. Comparative genomics – Paralogs and orthologs, Phylogeny, Human genetic disorders, Candidate gene identification, Concepts of Pharmacogenomics.

Module-2

Target selection, customized microarray design, image processing and quantification, normalization and filtering, statistical analysis of microarray data, tools used for data analysis, public microarray data sources.

Module-3

Basics of Protein structure, Introduction to basic Proteomics technology, 2D Gel-electrophoresis and MS data analysis. Protein Arrays. Bio-informatics in Proteomics, Basics of Proteome Analysis, Concepts in Enzyme Catalysis.

Module-4

Introduction to the concepts cloning and mapping, Construction of Physical maps, Basics of radiation hybrid maps, Sequencing: Related discoveries and technology development, Implications of the Human Genome Project, Basic Human Inheritance Patterns, Basics of Single Nucleotide Polymorphism detection and its implication, Practical Application of medical Genetics Technology.

Module-5

Annotating genomes: Gene prediction in Prokaryotes and Eukaryotes, ORF prediction Functional annotation: sequence based and structure based annotation. Comparative Genomics – Purpose and Methods of Comparison. Applications of comparative Genomics, Case studies on target prediction using Comparative genomics.

Course outcomes:

At the end of the course the student will be able to:

- Understand the utilities and applications of various experiments to study genomes
- Understand the aspects of proteome & their roles in biological functions.
- Understand the utilities and applications of various experiments to study proteomes

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook/ Textbooks

Sl No	Title of the book	Name of the Author/s	Publisher Name	Edition and year
1	Genomics and Proteomics	Sándor Suhai	Springer	2000
2	Discovering genomics, proteomics and bioinformatics	A. Malcolm Campbell, Laurie J. Heyer,	Pearson/Benjamin Cummings	2006.
Reference Books				
1	Data Mining for Genomics and Proteomics: Analysis of Gene and Protein Expression Data	Darius M. Dziuda	John Wiley & Sons	2010
2	Bioinformatics, Genomics, and Proteomics: Getting the Big Picture	Ann Finney Batiza	Infobase Publishing	2006
3	Bioinformatics ,Genomics, and Proteomics	Ann Batiza, Ann Finney Batiza	Chelsea House Publishers	2005

BIOMEDICAL INFORMATICS AND TRANSLATIONAL RESEARCH			
Course Code	**20BBI322**	CIE Marks	40
TeachingHours/Week (L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Module-1

Overview of Medical Informatics - Healthcare functions and information technology, Key Players in Health Information technology (HIT), Organizations involved with HIT, Barriers to HIT Adoption. Public Health Informatics - Information systems in public health - National Health Information Infrastructure (NHII). Internet based consumer health information - telehealth and telemedicine.

Module-2

Biomedical data - Their acquisition, storage and use, Electronic health records (EHR), Information Retrieval from Digital Libraries, Imaging Systems in Radiology and Picture archiving. Genomics and Proteomics data - Human Genome project, HapMap and 1000 genomes projects, Genetic profiling of individuals and large populations, Creation and use of Bioinformatics databases - gene, metabolic pathways of diseases.

Module-3

Managing Information Security and Privacy in Health Care Data. General approaches to assuring appropriate use of data, data tracking and identifying data. Methods and Evaluation in biomedical decision making: Sampling, appropriate use of controls, data collection, testing of statistical significance, sensitivity and specificity, ROC plots. Standards in Biomedical informatics; Ethics, legal and regulatory matters in health informatics.

Module-4

Clinical Decision-Support Systems - The Nature of clinical decision making, types of decisions, The role of computers in decision support, Historical perspectives- Leeds abdominal pain system, MYCIN, HELP; Illustrative examples of clinical decision-support systems-Internist-1, DXplain system. Patient monitoring system and information management in intensive care unit.

Module-5

Translational Research - Concepts and Principles. Therapeutic discovery in an academic setting, Technology Transfer and Commercialization process of a product. Bringing drugs from bench to bedside for cancer therapy - Molecular basis of cancer, strategies for developing therapeutic treatments, how imatinib and dasatinib were developed. Principles of Clinical Trials: Genetics/-Omics in Clinical Investigation, Principles of biomarker development and utility, pharmacogenomics including utilization of key knowledge from the human genome projects for personalized medicine. Regulatory and ethical issues involved in translational clinical research.

Course outcomes:

At the end of the course the student will be able to:

- Understand the importance of biomedical data, handling and its storage
- Understand the relevance of healthcare data, information security, clinical decision support system and translational research

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook/ Textbooks

Sl No	Title of the book	Name of the Author/s	Publisher Name	Edition and year
1	Biomedical Informatics: computer applications in Health care and Biomedicine	Shortliffe EH, Ciminio JJ	New York Springer-Verlag,	3rd ed 2000
2	Translational Research in Genetics and Genomics,	Ed. Moyra Smith	Oxford University press	2008
Reference Books				
1	Evaluation methods in medical Informatics	Friedman CP. Wyatt JC	New York Springer Verlag,	1996,
2	Biomedical Informatics in Translational Research	Ed. Hai Hu, Richard J. Mural and Michael N. Liebman	Artech House	2008

3	Biomedical informatics	Edward H. Shortliffe, James J.	Springer	2013

COMPUTATIONAL NEUROSCIENCE			
Course Code	**20BBI323**	CIE Marks	40
Teaching/Hours/Week (L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Module-1

Definition- Domains in Computational Neuroscience- Brain metaphors-computer and brain- basic neuroscience- Basic synaptic mechanisms and the generation of action potentials- Nernst Potential, Hodgkin-Huxley equations, the propagation of action potentials.

Module-2

Spiking neurons- concept neurons- the neural code- spike trains- cable theory- Spike time variability- post synaptic potential(PSP)- firing threshold and action potential- Neurons in a Network- Population Dynamics- rate code- Information in spike trains- Population coding and decoding- single neuron models, Hodgkin- Huxley Model, spiking neuron models- integrate and firing model- noise in spiking neuron models- compartmental modeling.

Module-3

From artificial neural network to realistic neural networks-Perception, function representation, and look-up tables- The sigma node as perception- Multi-layer mapping networks- Learning, generalization and biological interpretations- Self- organizing network architectures and genetic algorithms- Mapping networks with context units- Probabilistic mapping networks- Associators and synaptic plasticity, Associative memory and Hebbian learning, Hebbian plasticity- features of associators and Hebbian learning.

Module-4

Associative memory networks- Short-term memory and reverberating network activity, Long-term memory and auto-associators- Point attractor networks- The Grossberg-Hopfield model- sparse attractor neural networks- Chaotic networks- biologically more realistic variations of attractor networks- Continuous attractor and competitive networks.

Module-5

Motor learning and control- supervised learning-the delta rule and back propagation- generalized delta rules- plasticity and coding- Reward learning- System level organization and coupled networks- System level anatomy of the brain- Modular mapping networks- Coupled attractor networks- working memory- Attentive vision- an interconnecting workspace hypothesis. CASE STUDY Introduction to the MATLAB programming environment- A MATLAB guide to computational neuroscience- Spiking neurons and numerical integration in MATLAB.

Course outcomes:

At the end of the course the student will be able to:

- Understand the basics of neuroscience
- Understand the relevance of computational tools and their applications in neurobiology
- Apply MATLAB programming to specific case studies.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module

Textbook/ Textbooks

Sl No	Title of the book	Name of the Author/s	Publisher Name	Edition and year
1	"Fundamentals of Computational Neuroscience	Thomas Trappenberg,	Oxford University Press	January 2010 (Edition 2) & June 2002 (Edition1)
2	Principles of Computational Modelling in Neuroscience	David Sterratt, Bruce Graham	Cambridge University Press	2014
Reference Books				
1	Neural Control Engineering: The Emerging Intersection between Control Theory and Neuroscience"	Steven J. Schiff	The MIT Press	2012.
2	"From Computer to Brain - Foundations of Computational Neuroscience	Lytton, William W	Springer publications	2002
3	Spiking Neuron Models. Single Neurons, Populations, Plasticity"	Gerstner and Kistler,	Cambridge University Press,	2002.

METABOLOMICS AND METABOILIC ENGINEERING			
Course Code	**20BBI324**	CIE Marks	40
Teaching Hours/Week (L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Module-1

METABOLOMICS

Role of metabolomics in systems biology –application of metabolomics- Analytical methods in metabolomics – Data standards– Databases for Chemical, Spectral and Biological Data – Reconstruction of dynamic metabolic network model- examples- study of metabolome of a simple organism like E.Coli.

Module-2

BIOINFORMATICS IN METABOLOMICS

Online databases and pipelines for metabolomics – GC-MS based metabolomics – Computational methods to compute and integrate metabolic data-software for metabolomics- metabolomics and medical sciences

Module-3

METABOLIC ENGINEERING

Importance of metabolic engineering-comprehensive models for cellular reactions-material balances & data consistency- metabolic pathway synthesis.

Module-4

METABOLIC FLUX ANALYSIS AND ITS APPLICATION

Theory-determination of flux by isotope labeling-Metabolic control analysis- (control coefficients and summation theorems, FCC determination)-Grouping of reactions (gFCC, identification of independent pathways).

Module-5

METABOLIC NETWORKS

Kinetic model of metabolic networks-Systems metabolic engineering of E.coli- bottom up and top down approaches of network analysis.

Course outcomes:

At the end of the course the student will be able to:

- Understand the aspects of metabolic pathways
- Utilize the knowledge of cellular metabolic pathways and regulation to enhance the yield.
- Understand the concepts of metabolomics and computational methods to integrate metabolic data

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook/ Textbooks

Sl No	Title of the book	Name of the Author/s	Publisher Name	Edition and year
1	Metabolic engineering –Principles and Methodologies	Gregory N. Stephanopoulos, Aristos A. Aristidou and Jens	Academic press, USA	1998
2	Pathway analysis and optimization in Metabolic processes,	Nestor V. Torres and Eberhard O. Voit	Cambridge University Press,	2002
Reference Books				
1	An introduction and metabolic and cellular Engineering.	Cortassa s., Aon, M.A., Lglesias, A.A., and L Lyod D	World scientific publications Pvt ltd	Singapore. 2002.
2	Pathway Analysis and Optimization in Metabolic Engineering	Néstor V. Torres and Eberhard O. Voit	Cambridge Press	2011
3	The Metabolic Pathway Engineering Handbook: Tools and Applications	Christina Smolke	Tylor and Francis CRC	2017

M.TECH BIOINFORMATICS(BBI)
Choice Based Credit System (CBCS) and Outcome Based Education(OBE)
SEMESTER -III

STATISTICAL ANALYSIS SYSTEM AND CLINICAL DATA MANAGEMENT

Course Code	**20BBI331**	CIE Marks	40
Teaching/Hours/Week (L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Module-1

SAS Introduction, SAS syntax, SAS Dataset; Reading SAS Dataset, (Different data types, Base/SAS, SAS/STAT, SAS/GRAPH, SAS/ACCESS, SAS Procedures, SAS Macros, Brief Introduction to SQL, SAS/SQL, SAS Enterprise Guide)Reading Excel Worksheet, Reading delimited Raw Data File. SAS in CDM, Components of SAS.

Module-2

Manipulating Data; Combining SAS Data Set; Do Loop & Array Processing; SAS Function Statistics for clinical trials: Types of data in clinical trials, Computer System Validation: CFR, CTM system, Systems Software Validation Issues: auto encoder, User Acceptance Test, SDLC; Oracle Clinical, workflow, Intelligent Character Recognition.

Module-3

NGS data analysis: Downloading the genome sequence, Quality Check & Filtering, Read assembly, Gene prediction, Gene annotation, Advance annotation and analysis, Diseases variant identification, Haplogroup identification, Binding site identification, pathway analysis.

Module-4

Introduction of Clinical Data Management; Data And Databases; Data Entry; Transcribing Data CRF Data Tracking; Cleaning Data; Discrepancies Managements; Data Management Plan. Case Study using SAS: TLG (Tables listings and Graphs) of clinical trials in SAS, Tables in clinical trials, Screening failures, Subject disposition.

Module-5

CRF Review And source Documents; Electronic Data Capture; Design Consideration; Study Setup; Managing Laboratory Data; Collection Of Adverse Events Data; Medical coding; Creating Reports; Data Acquisition And Database Closure; Data Transfers; Audit trial; QA In CDM.Clinical Research Site Management: Preparation of protocol, Audits and Inspection of Trial sites, Budgeting of Clinical trials.

Course outcomes:

At the end of the course the student will be able to:

- Understand the relevance of statistical tools in Clinical Data Management
- Understand the applications of SAS in CDMs
- Understand the statistical rigor in NGS data analysis.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook/ Textbooks

Sl No	Title of the book	Name of the Author/s	Publisher Name	Edition and year
1	Clinical Prediction Models: A Practical Approach to Development, Validation, and Updating (Statistics for Biology and Health)	Ewout W. Steyerberg	Springer	2008
2	Practical Guide to Clinical Data Management	Susanne Prokscha	Interpharma/CRC	2011
Reference Books				
1	Informatics for the Clinical Laboratory: A Practical Guide for the Pathologist (Health Informatics)	Editor: Daniel Cowan	Health Informatics Series	2002

2	Statistical Modelling and Machine Learning Principles for Bioinformatics Techniques, Tools, and Applications (Algorithms for Intelligent Systems)	**Editors:** K G**, Srinivasa,** G M**, Siddesh,** Manisekhar**, S R**	Springer	2020
3	Systems Analysis Tools for Better Health Care Delivery Optimization and Its Applications	Panos M. Pardalos, Pando G. Georgiev,	Springer	2013

ALGORITHMS IN COMPUTATIONAL BIOLOGY			
Course Code	**20BBI332**	CIE Marks	40
TeachingHours/Week (L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Module-1

DNA Computing: DNA Structure, and Processing , Computational operations and Step involve in DNA computing, Bio-soft Computing Based on DNA Length, Beginnings of Molecular Computing-Adelman Experiment. **RNA secondary structure prediction**: Base pair maximisation and the Nussinov folding algorithm, Energy minimisation and the Zuker folding algorithm, Design of covariance models, Application of RNA fold.

Module-2

Combinatorial Pattern Matching- Hash Tables, Repeat Finding, Exact Pattern Matching; **Genetic Algorithm**:- Basic Concepts, Reproduction, Cross over, Mutation, Fitness Value, Optimization using GAs; Applications of GA in bioinformatics.

Module-3

Hidden Markov Model: Markov processes and Markov Models, Hidden Markov Models. Forward and Backward Algorithms, Most probable state path: Viterbi algorithm, Parameter Estimation for HMMs:-Baum-Welch Algorithm, EM Algorithm, Applications of profile HMMs for multiple alignment of proteins and for finding genes in the DNA.

Module-4

Support Vector Machines: Introduction, hyperplane separation (maximum and soft margin hyperplanes), linear classifier, Kernel functions, Large Margin Classification, Optimization problem with SVM, Applications of SVM in bioinformatics. **Bayesian network**: Bayes Theorem, Inference and learning of Bayesian network, BN and Other Probabilistic Models.

Module-5

Artificial Neural Network: Historic evolution –Perceptron, characteristics of neural networks terminology, models of neuron McCulloch –Pitts model, Perceptron, Adaline model, Basic learning laws, Topology of neural network architecture, single layer ANN, multilayer perceptron, back propagation learning, input -hidden and output layer computation, back propagation algorithm, Applications of ANN.

Course outcomes:

At the end of the course the student will be able to:

- Understand the basic aspects of DNA computing, Pattern matching, HMMS, SVMs and ANNs
- Understand the applications of DNA computing, Pattern matching, HMMS, SVMs and ANNs in bioinformatics analysis and solutions.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook/ Textbooks

Sl No	Title of the book	Name of the Author/s	Publisher Name	Edition and year
1	Algorithms on Strings, Trees, and Sequences: Computer Science and Computational Biology	Dan Gusfield	Cambridge	1997
2	Algorithms in Bioinformatics: A Practical Introduction	Wing-Kin Sung	Chapman & Hall/CRC Computational Biology Series	2009
Reference Books				
1	An introduction to bioinformatics algorithms	Neil C. Jones, PavelPevzner	MIT Press	2004
2	Bioinformatics: the machine learning approach	Pierre Baldi, SørenBrunak	MIT Press	2001
3	Biological sequence analysis: Probabilistic models of proteins and nucleic acids	R Durbin, Sean Eddy, Anders Krogh, G Mitchison	Cambridge	1998

ADVANCED BIOINFORMATICS & LINUX OPERATING SYSTEM			
Course Code	**20BBI333**	CIE Marks	40
TeachingHours/Week (L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Module-1

Sequence Repeats: Tandem and Interspersed repeats, repeat finding, Motifs, consensus, position weight matrices, Algorithms for derivation of and searching sequence patterns: MEME, PHI-BLAST, SCanProsite and PRATT, Algorithms for generation of sequence profiles: Profile Analysis method of Gribskov, HMMer, PSI-BLAST

Module-2

Introduction to Markov chains and HMM using Markov chains for discrimination of biological sequences. Forward and backward algorithms. Parameters estimation for HMMs. HMMs for pairwise and multiple sequence alignments. Profile HMMs.

Module-3

Introduction to various Machine Learning techniques and their applications in Bioinformatics. Genetic algorithms, Support Vector Machine, Neural Networks and their applications in Bioinformatics.

Module-4

History and features of UNIX and GNU/Linux. Linux ,file and directory commands, file permissions. Basic commands, I/O redirection and piping, simple filters, vi as text editor. archives and file compressions.

Module-5

Multiple commands as a shell script simple shell script creation and execution. Variables: System variables and User defined variables, read values to variables, Mathematic and String handling. Decisions and loopings: if, for and while loops, case statement.

Course outcomes:

At the end of the course the student will be able to:

- Understand the basics of Linux operating system
- Understand the relevance of Machine Learning techniques and their applications in Bioinformatics.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook/ Textbooks

Sl No	Title of the book	Name of the Author/s	Publisher Name	Edition and year
1	Linux with Operating System concepts	Richard Fox	CRC publishers	2014
2	Bioinformatics: Concepts, Skills & Applications	R.S. Rastog	CBS 2nd Edition	2019
Reference Books				
1	Beginning Linux Programming	Neil Mathew & Richard Stones	Wiley Dreamtech India	2008
2	Essential Bioinformatics	Jin Xiong	Cambridge University Press	2007
3	Computational Biology: A Practical Introduction to Bio Data Processing and Analysis with Linux, MySQL, and R	Röbbe Wünschiers	Spriger	2015

BIO BUSINESS & ENTREPREUNERSHIP DEVELOPMENT			
Course Code	**20BBI334**	CIE Marks	40
Teaching Hours/Week (L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Module-1

BIO ENTERPREUNERSHIP:

Introduction to bio-business, from the Indian context, SWOT analysis of bio-business. Concept of Entrepreneurship - Evolution of Entrepreneurship, Development of Entrepreneurship; Stages in entrepreneurial process; Role of entrepreneurs in Economic Development; Entrepreneurship in India; Entrepreneurship - its barriers. Small scale industries: Definition; Characteristics; Need and rationale; Objectives; Scope; Market Feasibility Study; Technical Feasibility Study; Financial Feasibility Study & Social Feasibility Study. Global bio business and industry future trends

Module-2

BUSINESS OPPORTUNITY IN AGRI BIOTECHNOLOGY:

Business opportunity, Essential requirement, marketing, strategies, schemes, challenges and scope-with case study on Plant cell and tissue culture technique, polyhouse culture. Herbal bulk drug production, Nutraceuticals, value added herbal products. Bioethanol production using Agri waste, Algal source. Integration of system biology for agricultural applications. Biosensor development in

Agri management.

Module-3

BUSINESS OPPORTUNITY IN INDUSTRIAL BIOTECHNOLOGY:

Business opportunity, Essential requirement, marketing strategies, schemes, challenges and scope-with case study- Pollution monitoring and Bioremediation for Industrial pollutants, Pesticides, Herbicides etc. Integrated compost production- microbe enriched compost. Biopesticide/insecticide production. Fermented products-probiotic and prebiotics. Stem cell production, stem cell bank, contract research. Production of monoclonal/polyclonal antibodies, Single cell protein and secondary metabolite production. Contact research in microbial genomics.

Module-4

PROJECT MANAGEMENT, INTELLECTUAL PROPERTY, TECHNOLOGY MANAGEMENT AND STARTUP SCHEMES:

Building Biotech business challenges in Indian context-biotech partners (BICEPS, BIRAC, DBT, Incubation centres. etc.), operational biotech parks in India. Indian Company act for Bio business-schemes and subsidies. Meaning of Project; Project Identification; Project Selection; Project Report; Need and Significance of Report; Contents; Formulation; Guidelines by Planning Commission for Project report; Network Analysis; Errors of Project Report; Project Appraisal. Identification of business opportunities: Market Feasibility Study; Technical Feasibility Study; Financial Feasibility Study & Social Feasibility Study. Patent expiry and Entrepreneurship opportunity, Principles of Technology leasing, licensing and transfer, Start-up schemes in Indian government, Business incubation support schemes, Successful start-ups-case study

Module-5

REGULATORY AFFAIRS, BIOETHICS & BIO-SAFETY:

Regulatory affairs in Bio business-regulatory bodies and their regulations (ex.FDA, EU, DSIR, AYUSH, FSSAI etc.,) Public education of the process of biotechnology involved in generating new forms of life for informed decision-making. Ethical concerns of biotechnology research and innovation Interference with nature, fear of unknown, unequal distribution of risks. Rational vs. subjective perceptions of risks and benefits, relationship between risk, hazard, exposure and safeguards. Biosafety concerns at the level of individuals, institutions, society, region, country and the world. The Cartagena protocol on biosafety. Biosafety management.

Course outcomes:

At the end of the course the student will be able to:

- Demonstrate strong basics in principles and applications of Project Management, IPR, regulatory affairs and bio-safety
- Demonstrate good understanding of Bio-business opportunities

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook/ Textbooks

Sl No	Title of the book	Name of the Author/s	Publisher Name	Edition and year
1	Management Fundamentals – Concepts, Application, Skill Development	Robers N. Lusier	SAGE publication	2012

2	Entrepreneurship Development	S.S.Khanka –	S.Chand& Co	2007
Reference Books				
1	Bioethics & Biosafety	R Rallapalli & Geetha Bali	APH Publication	2007
2	Principles of Management	P. C.Tripathi, P.N. Reddy	Tata McGraw Hill	2018
3	Biotechnology Entrepreneurship: Leading, Managing and Commercializing Innovative Technologies	Craig Shimasaki	AP	2020

PROJECT WORK PHASE – 1			
Course Code	**20BBI34**	CIE Marks	100
Number of contact Hours/Week (L:T:P)	0:0:2	SEE Marks	--
Credits	02	Exam Hours	--

Course objectives:

- Support independent learning.
- Guide to select and utilize adequate information from varied resources maintaining ethics.
- Guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- Develop interactive, communication, organisation, time management, and presentation skills.
- Impart flexibility and adaptability.
- Inspire independent and team working.
- Expand intellectual capacity, credibility, judgement, intuition.
- Adhere to punctuality, setting and meeting deadlines.
- Instil responsibilities to oneself and others.
- Train students to present the topic of project work in a seminar without any fear, face

Project Phase-1 Students in consultation with the guide/s shall carry out literature survey/ visit industries to finalize the topic of the Project. Subsequently, the students shall collect the material required for the selected project, prepare synopsis and narrate the methodology to carry out the project work.

Seminar: Each student, under the guidance of a Faculty, is required to

- Present the seminar on the selected project orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit two copies of the typed report with a list of references.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

Revised Bloom's Taxonomy Level	L_3 – Applying, L_4 – Analysing, L_5 – Evaluating, L_6 – Creating.

Course outcomes:

At the end of the course the student will be able to:

- Demonstrate a sound technical knowledge of their selected project topic.
- Undertake problem identification, formulation and solution.
- Design engineering solutions to complex problems utilising a systems approach.
- Communicate with engineers and the community at large in written an oral forms.
- Demonstrate the knowledge, skills and attitudes of a professional engineer.

Continuous Internal Evaluation

CIE marks for the project report (50 marks), seminar (30 marks) and question and answer (20 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session by the student) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculty from the department with the senior most acting as the Chairperson.

M.TECH BIOINFORMATICS(BBI)
Choice Based Credit System (CBCS) and Outcome Based Education(OBE)
SEMESTER -III

MINI PROJECT

Course Code	**20BBI35**	CIE Marks	40
Number of contact Hours/Week (L:T:P)	(0:0:2)	SEE Marks	60
Credits	02	Exam Hours/Batch	03

Course objectives:

- To support independent learning and innovative attitude.
- To guide to select and utilize adequate information from varied resources upholding ethics.
- To guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- To develop interactive, communication, organisation, time management, and presentation skills.
- To impart flexibility and adaptability.
- To inspire independent and team working.
- To expand intellectual capacity, credibility, judgement, intuition.
- To adhere to punctuality, setting and meeting deadlines.
- To instil responsibilities to oneself and others.
- To train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present

Mini-Project: Each student of the project batch shall involve in carrying out the project work jointly in constant consultation with internal guide, co-guide, and external guide and prepare the project report as per the norms avoiding plagiarism.

Course outcomes:

At the end of the course the student will be able to:

- Present the mini-project and be able to defend it.
- Make links across different areas of knowledge and to generate, develop and evaluate ideas and information so as to apply these skills to the project task.
- Habituated to critical thinking and use problem solving skills.
- Communicate effectively and to present ideas clearly and coherently in both the written and oral forms.
- Work in a team to achieve common goal.
- Learn on their own, reflect on their learning and take appropriate actions to improve it.

CIE procedure for Mini - Project:

The CIE marks awarded for Mini - Project, shall be based on the evaluation of Mini - Project Report, Project Presentation skill and Question and Answer session in the ratio 50:25:25.The marks awarded for Mini - Project report shall be the same for all the batch mates.

Semester End Examination

SEE marks for the mini-project shall be awarded based on the evaluation of Mini-Project Report, Presentation skill and Question and Answer session in the ratio 50:25:25 by the examiners appointed

INTERNSHIP / PROFESSIONAL PRACTICE			
Course Code	**20BBII36**	CIE Marks	40
Number of contact Hours/Week	0:0:2	SEE Marks	60
Credits	06	Exam Hours	03

Course objectives:

Internship/Professional practice provide students the opportunity of hands-on experience that include personal training, time and stress management, interactive skills, presentations, budgeting, marketing, liability and risk management, paperwork, equipment ordering, maintenance, responding to emergencies etc. The objective are further,

- To put theory into practice.
- To expand thinking and broaden the knowledge and skills acquired through course work in the field.
- To relate to, interact with, and learn from current professionals in the field.
- To gain a greater understanding of the duties and responsibilities of a professional.
- To understand and adhere to professional standards in the field.
- To gain insight to professional communication including meetings, memos, reading, writing, public speaking, research, client interaction, input of ideas, and confidentiality.
- To identify personal strengths and weaknesses.

Internship/Professional practice: Students under the guidance of internal guide/s and external guide shall take part in all the activities regularly to acquire as much knowledge as possible without causing any inconvenience at the place of internship.

Seminar: Each student, is required to

- Present the seminar on the internship orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit the report duly certified by the external guide.
- The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

Course outcomes:

At the end of the course the student will be able to:

- Gain practical experience within industry in which the internship is done.
- Acquire knowledge of the industry in which the internship is done.
- Apply knowledge and skills learned to classroom work.
- Develop a greater understanding about career options while more clearly defining personal career goals.
- Experience the activities and functions of professionals.
- Develop and refine oral and written communication skills.
- Identify areas for future knowledge and skill development.
- Expand intellectual capacity, credibility, judgment, intuition.

Continuous Internal Evaluation

CIE marks for the Internship/Professional practice report (20 marks), seminar (10 marks) and question and answer session (10 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session by the student) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculty from the department with the senior most acting as the Chairperson.

Semester End Examination
SEE marks for the internship report (30 marks), seminar (20 marks) and question and answer session (10 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session) by the examiners appointed by the University.

M.TECH BIOINFORMATICS(BBI)
Choice Based Credit System (CBCS) and Outcome Based Education(OBE)
SEMESTER -IV

PROJECT WORK PHASE -2

Course Code	**20BBI41**	CIE Marks	40
Number of contact Hours/Week(L:T:P)	0:0:4	SEE Marks	60
Credits	20	Exam Hours	03

Course objectives:

- To support independent learning.
- To guide to select and utilize adequate information from varied resources maintaining ethics.
- To guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- To develop interactive, communication, organisation, time management, and presentation skills.
- To impart flexibility and adaptability.
- To inspire independent and team working.
- To expand intellectual capacity, credibility, judgement, intuition.
- To adhere to punctuality, setting and meeting deadlines.
- To instil responsibilities to oneself and others.
- To train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present

Project Work Phase - II: Each student of the project batch shall involve in carrying out the project work jointly in constant consultation with internal guide, co-guide, and external guide and prepare the project report as per the norms avoiding plagiarism.

Course outcomes:
At the end of the course the student will be able to:

- Present the project and be able to defend it.
- Make links across different areas of knowledge and to generate, develop and evaluate ideas and information so as to apply these skills to the project task.
- Habituated to critical thinking and use problem solving skills
- Communicate effectively and to present ideas clearly and coherently in both the written and oral forms.
- Work in a team to achieve common goal.
- Learn on their own, reflect on their learning and take appropriate actions to improve it.

Continuous Internal Evaluation:

Project Report: 20 marks. The basis for awarding the marks shall be the involvement of the student in the project and in the preparation of project report. To be awarded by the internal guide in consultation with external guide if any.

Project Presentation: 10 marks.

The Project Presentation marks of the Project Work Phase -II shall be awarded by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculty from the department with the senior most acting as the Chairperson.

Question and Answer: 10 marks.

The student shall be evaluated based on the ability in the Question and Answer session for 10 marks.

Semester End Examination

SEE marks for the project report (30 marks), seminar (20 marks) and question and answer session (10 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session) by the examiners appointed by the University.