Semester- I

Numerical Methods & Biostatistics (BSC)			
Course Code	22BBI11	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	3	Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives:

- Apply basics of Mathematics in statistics and numerical analysis.
- To enable the students to tackle live problems in various spheres of bioscience and bioengineering
- To learn and design various statistical problems

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

Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used.

	Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work

Module-2

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.

Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work

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 Co- efficient, 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, T-tests; F-tests. Algorithm and Implementation using numerical methods with case studies	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
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.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
Module-5	

STATISTICS IN MICROARRAY, GENOME MAPPING AND BIOINFORMATICS: Types of microarrays, objectives of the study, experimental designs for micro array studies, microarray analysis, interpretation, validation and microarray informatics. Genome mapping, discrete sequence matching	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks**

Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.

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 a 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

Suggested Learning Resources:

Books

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 Company, 1982
3. Numerical Methods, Wolfgang Boehm and Hartmut Prautzsch, CRC Press, 1993
4. Numerical Methods of Statistics, John F. Monahan, Cambridge University Press, 2011
5. Numerical Methods for Engineers `and Joe D. Hoffman CRC Press 2001
6. Statistical Methods in Bioinformatics: An Introduction Warren, J. Ewensregory Grant, Springer Science & Business Media, 2005.

Web links and Video Lectures (e-Resources):

1. https://archive.nptel.ac.in/courses/102/106/102106051/
2. https://archive.nptel.ac.in/courses/111/102/111102112/ https://archive.nptel.ac.in/courses/103/106/103106120/
3. https://www.youtube.com/watch?v=KhjM8YI3agk
4. https://nptel.ac.in/courses/102106065

Skill Development Activities Suggested

1. AV presentation by students (on specific topics).
2. Discussion of case studies based on research findings.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Apply the basics of Mathematics in analysing statistical data	L3, L4
CO2	Apply the basics of statistics in analysing experimental data	L3, L4
CO3	Apply the statistical tools in Genome analysis	L3, L4

Program Outcome of this course

Sl. No.	Description	POs
1	Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	PO 1
2	Problem analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	PO 2
3	Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations	PO 3
4	Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	PO 4
5	Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.	PO 5

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2								
CO2	3	3	3	2								
CO3	3	3	1	2	2							

Semester - I

Python Programming +Laboratory (IPCC)			
Course Code	**22BBI12**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 10-12 Lab slots	Total Marks	100
Credits	4	Exam Hours	3

Course objectives:

- To read and write simple Python programs.
- To develop Python programs with conditionals and loops.
- To define Python functions and call them.
- To use Python data structures–lists, tuples, dictionaries

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.

Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations.

	Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
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.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
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.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
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.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.

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.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.

PRACTICAL COMPONENT OF IPCC

Sl.NO	Experiments
1	**Installation and running of latest version of python from website, Introduction of console & Check data types**
2	Write a program to demonstrate different number data types and to perform different arithmetic operations on numbers in python.
3	Write a program to create, concatenate and print a string and accessing substring from a given string.
4	Write a python program to find largest of three numbers, to convert temperature to and from Celsius to Fahrenheit and to print prime numbers less than 20.

5	Create a function calculator to do basic mathematical operations
6	Write a python program to define a function to find Fibonacci Numbers
7	Construct a module and reuse the module in a program to create a personalized birthday song.
8	Write a program to enrol students to multiple games using list (maximum team size is 11)
9	Write a Python program to create a tuple with different data types and check whether an element exists within a tuple
10	Write a python program to create a dictionary and access an element from dictionary and to check if a key already exists in dictionary.
11	Write a python program to perform Linear search and Binary search
12	Write a python program to perform Selection sort, Insertion sort, Merge sort

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

CIE for the theory component of IPCC

Two Tests each of **20 Marks**

Two assignments each of **10 Marks/One Skill Development Activity of 20 marks**

Total Marks of two tests and two assignments/one Skill Development Activity added will be CIE for 60 marks, marks scored will be proportionally scaled down to **30 marks**.

CIE for the practical component of IPCC

On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The**15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end of the semester.

The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to 15 marks.

The laboratory test at the end /after completion of all the experiments shall be conducted for 50 marks and scaled down to 05 marks**.**

Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **20 marks**.

SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (duration 03 hours)

The question paper will be set for 100 marks and marks scored will be scaled down proportionately to 50 marks.

The question paper will have ten questions. Each question is set for 20 marks.

There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module.

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only.

Questions mentioned in the SEE paper shall include questions from the practical component).

The minimum marks to be secured in CIE to appear for SEE shall be the 15 (50% of maximum marks-30) in the theory component and 10 (50% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in

SEE, the questions from the laboratory component shall be included**.** The maximum of 04/05 questions to be set from the practical component of IPCC, the total marks of all questions should not be more than the 20 marks.

SEE will be conducted for 100 marks and students shall secure 40% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50. (Student has to secure an aggregate of 50% of maximum marks of the course(CIE+SEE)

Suggested Learning Resources:

Books

1. Think Python: How to Think Like a Computer Scientist Allen B. Downey. Shroff O'Reilly Publishers, 2nd, edition,2016.
2. An Introduction to Python –Revised and updated for Python 3.2 Guido van Rossum and Fred L. Drake Jr Network Theory Ltd., 2011.
3. Introduction to Computer Science using Python: A Computational Problem-Solving Focus Charles Dierbach Wiley India Edition, 2013.
4. Introduction to Programming in Python: An Inter-disciplinary Approach Robert Sedgewick, Kevin Wayne, Robert Dondero Pearson India Education Services Pvt. Ltd, 2016.
5. Fundamentals of Python: First Programs Kenneth A. Lambert CENGAGE Learning, 2012.

Web links and Video Lectures (e-Resources):

1. VTU EDUSAT / SWAYAM / NPTEL / MOOCS / Coursera / MIT-open learning resource
2. https://nptel.ac.in/courses/106106182
3. https://www.youtube.com/watch?v=_uQrJ0TkZlc
4. https://www.udemy.com/course/pythonforbeginners/
5. https://www.udemy.com/topic/python/
6. https://www.coursera.org/courses?query=python

7. https://www.freecodecamp.org/news/best-python-courses/
8. https://www.codecademy.com/catalog/language/python
9. https://www.edx.org/learn/python

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

1. Installation of the software and execution of programs.
2. Group Discussions and Presentations of Case studies

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Develop algorithmic solutions to simple computational problems	L3, L4
CO2	Read, write, debug, execute simple Python programs	L3, L4
CO3	Structure simple Python programs for solving problems.	L3, L4
CO4	Decompose a Python program into functions.	L3, L4

Program Outcome of this course

Sl. No.	Description	POs
1	**Problem analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2
2	**Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations	3
3	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	4
4	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.	5
5	**The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	6
6	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	9

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		2	3	3					3			2
CO2		3	3	2	3				3			
CO3			3	2	3	3			3			
CO4			3	2	3	3			3			

Semester- I

Essential Bioinformatics (PCC)			
Course Code	**22BBI13**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	50
Total Hours of Pedagogy	3	Total Marks	100
Credits	4	Exam Hours	3

Course Learning objectives:

- To inculcate the fundamentals of Bioinformatics.
- To comprehend the applications of Bioinformatics in biotechnology research.
- To impart knowledge of various software tools used in Bioinformatics studies.

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.

Teaching-Learning	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint

Process	presentations. Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
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.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
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.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
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.	

Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.

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.

Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

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
3. Current Protocols in Bioinformatics, Andreas D. Baxevanis, Wiley, 2003
4. Bioinformatics and Molecular Evolution, Paul G. Higgs, Teresa K. Attwood, Blackwell publishing, 2005.
5. Bioinformatics: Sequence and Genome Analysis David Mount, Cold Spring Harbor Laboratory Press, 2004

Web links and Video Lectures (e-Resources):

1. https://www.coursera.org/courses?query=bioinformatics
2. https://www.edx.org/learn/bioinformatics
3. https://bioinfotraining.bio.cam.ac.uk/
4. https://onlinecourses.nptel.ac.in/noc19_bt25/preview
5. https://pll.harvard.edu/course/introduction-proteomics?delta=0

Skill Development Activities Suggested

1. NGS and Microarray data Analysis
2. Proteomic data network analysis.
3. AV presentation by students (on specific topics).
4. Discussion of case studies based on research findings.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Detail the basic concepts in Bioinformatics.	L3, L4
CO2	Demonstrate the applications of Bioinformatics in biotechnology research.	L3, L4
CO3	Apply various software tools used in Bioinformatics for specific case studies.	L3, L4

Program Outcome of this course

Sl. No.	Description	POs
1	Problem analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2
2	Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations	3
3	Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	4
4	Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.	5

5	The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	6
6	Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	8

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		3	3	3	3							
CO2		2	3	3	3			3				
CO3					3	3		3				

Semester- I

Primer in Biotechnology (PCC)			
Course Code	**22BBI14**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	50
Total Hours of Pedagogy	3	Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives:

- To learn the basic principles of bioengineering relevant to biotechnology
- To learn to solve the live problems in various spheres of biotechnology
- To learn designing and execution of experiments using biological resources.

Module-1

INTRODUCTION TO BIOLOGY:

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.

Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data.

	Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
Module-2	
CELL STRUCTURES AND ITS FUNCTIONS: 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.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
Module-3	

SCOPE OF MICROBIOLOGY AND IMMUNOLOGY: 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.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
Module-4	
SCOPE OF AGRICULTURAL BIOTECHNOLOGY: Role of Microbes in agriculture, Bio-pesticides, 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. Discussion of case studies for addressing health and malnutrition, via Agriculture BT.	

Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.

Module-5

INDUSTRIALLY IMPORTANT MICROORGANISMS AND 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, Biosorption of toxic metals. Solid waste management. Biofuel production from agricultural wastes. Case studies and solutions for current issues of waste management.

Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

3. Three Unit Tests each of **20 Marks**
4. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. Bioprocess Engineering Principles, Pauline M. Doran, Elsevier Science & Technology Books , 2006
2. Elementary Principles of Chemical Processes, Richard M. Felder, Ronald W. Rousseau, Lisa G. Bullard, Wiley, 2018
3. Principles of Genetics, Gardner, Simmonns and Snustad, Wiley India Pvt. Ltd, 2005
4. Cell Biology, Genetics, Evolution and Ecology, P S Verma, V R Agarwal, New Publisher, Delhi, 2007
5. Plant biotechnology in Agriculture, K. Lindsey and M.G.K. Jones, Prentice Hall, 1989

Web links and Video Lectures (e-Resources):

1. https://archive.nptel.ac.in/courses/102/107/102107086/
2. https://archive.nptel.ac.in/courses/102/108/102108086/
3. https://onlinecourses.swayam2.ac.in/cec22_bt18/preview
4. https://archive.nptel.ac.in/courses/102/101/102101068/
5. https://www.youtube.com/watch?v=cfF-qDnbRa0.

Skill Development Activities Suggested

1. Class Presentations and discussions of research articles from publications.
2. Online tools for surprise quizzes.
3. Collection of case studies via Newspapers/Journal articles, on topics covered.

Group discussions on recent advancements and case studies.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Demonstrate strong basics in principles of biotechnology	L2, L3,
CO2	Tackle live societal problems in various spheres of biotechnology	L2, L3,
CO3	Apply microbial resources for the design and execution of experiments for environmental and societal use	L2, L3,

Program Outcome of this course

Sl. No.	Description	POs
1	Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	1
2	Problem analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2
3	Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations	3
4	Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of	4

	the information to provide valid conclusions.	
5	Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.	5
6	The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	6
7	Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.	7
8	Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change	12

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**3**	**3**	**3**								
CO2				**2**	**3**	**3**	**3**					**2**
CO3				**2**	**3**	**3**	**3**					**2**

Semester- I

Database Management Systems (PCC)			
Course Code	**22BBI15**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	3	Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives:

- To understand the types of data bases and their data formats.
- To study the importance of various Omics experiments, data generation techniques, data management strategies and their effective utilization.
- To comprehend the concepts of SQL and PL/SQL.

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.

Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations.

	Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
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,	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
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	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
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.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students on how tools are applied to solve biological problems.

	Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
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.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

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
3. An Introduction to Database Systems, Bipin C Desai, Galgotia publications, 1981
4. Principles of Database Systems, J. D. Ullman, F, Galgotia publications, 1982
5. Database Management Systems, Raghu Ramakrishnan, McGraw-Hill, 2002

Web links and Video Lectures (e-Resources):

1. https://www.udemy.com/topic/clinical-research/?
2. https://www.coursary.com/search?
3. https://www.coursera.org/learn/clinical-data-management
4. https://www.udemy.com/course/clinical-data-management-cdm-online-course/
5. VTU EDUSAT / SWAYAM / NPTEL / MOOCS / Coursera / MIT-open learning resource

Skill Development Activities Suggested

1. AV presentation by students (on topics as per choice of the teacher)
2. Online tools for surprise quizzes
3. Collection of case studies based on research findings
4. Model making and Poster presentations on specific case studies.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Decipher the differences in the types of data bases and their data formats.	L3, L4
CO2	Apply the knowledge of various Omics experiments, data generation techniques, data management concepts, dataminingstrategiesandtheireffective utilization. .	L3, L4
CO3	Comprehend the concepts of SQL and PL/SQL.	L3, L4

Program Outcome of this course

Sl. No.	Description	POs
1	Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	1
2	Problem analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2
3	Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations	3
4	Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.5	4

5	Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.	5
6	Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.	7

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	3	3	3							
CO2			3	3	3		3					
CO3	2	3	3	3	2							

Semester- I

Research Methodology and IPR (MCC)			
Course Code	**22RMI16**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	3	Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives:

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

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.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
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.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students on how tools are applied to solve biological problems.

	Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.

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.

Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.

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.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
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 on Biological 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.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

3. Three Unit Tests each of **20 Marks**
4. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. Research Methodology: Methods and Techniques, C.R. Kothari, Gaurav Garg, New Age International, 2018
2. Research Methodology a step- by-step guide for beginners(For the topic Reviewing the literature under module 2), RanjitKumar, SAGE, Publications, 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, The Institute of Company Secretaries of India, Statutory Body Under an Act of Parliament, 2013
4. Conducting Research Literature Reviews: From the Internet to Paper Fink A Sage Publications, 2009

Web links and Video Lectures (e-Resources):

1. https://archive.nptel.ac.in/courses/121/106/121106007/
2. https://onlinecourses.nptel.ac.in/noc22_ge08/preview
3. https://archive.nptel.ac.in/courses/110/105/110105091/
4. https://archive.nptel.ac.in/courses/102/106/102106051/
5. https://www.youtube.com/watch?v=aKohB8lPueg
6. https://archive.nptel.ac.in/courses/110/105/110105091/

Skill Development Activities Suggested

1. Class Presentations and discussions of research articles from publications.
2. Online tools for surprise quizzes.
3. Collection of case studies via Newspapers/Journal articles, on topics covered.
4. Group discussions on recent advancements and case studies.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Apply research methodology for defining a research problem	L3, L4
CO2	Relate research methodology for developing conceptual frameworks and writing a review.	L3, L4
CO3	Apply research designs, sampling designs, measurement and scaling techniques for data collection.	L3, L4
CO4	Analyse parametric tests of hypotheses, Chi-square test, art of interpretation and research reports.	L3, L4
CO5	Analyse intellectual property rights and its impact on the business.	L3, L4

Program Outcome of this course

Sl. No.	Description	POs
1	**Problem analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2
2	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations	3
3	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	4

4	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.	5
5	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	6
6	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	8
7	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	10
8	**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change	12

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		3	3	3	3							
CO2		3	3	3		3						
CO3		3	3	3	3							
CO4		3	3	3	3							
CO5								3		2		2

Semester I

Bioinformatics lab (PCCL)			
Course Code	**22BBIL17**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:2:0	SEE Marks	50
Credits	2	Exam Hours	3

Course objectives:

- To learn the usage of online resources, database sand tools related to biological data.
- To learn the underlying concepts of Bioinformatics and their diverse applications.
- To learn the utilities of various computational tools for specific biological problems.

Sl.NO	Experiments
1	Pair wise comparison of sequences–Analysis of parameters affecting alignment
2	Multiple alignments of sequences and pattern determination using PROSITE
3	Evolutionary studies/ Phylogenetic analysis–Analysis of parameters affecting trees
4	Identification of functional sites in Genes/ Genomes
5	Secondary structure and Tertiary structure prediction of proteins and nucleic acids (DNA/RNA)
6	Study of post translational modifications using relevant tools
7	Restriction mapping: Analysis of maps for suitable molecular biology experiment
8	Primer Design: Factors affecting primer design.
	Demonstration Experiments For CIE
9	Comparative Modelling of homologous sequences and validation of modelled structures

10	Determination of ligand-protein interactions using SPDBV/LIGPLOT
11	Docking studies– Analysis of substrate/ ligand binding using homologous structures
12	Derivation of pharmacophore patterns for selective ligands

Course outcomes (Course Skill Set):

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

- Comprehend the underlying concepts of Bioinformatics and their requirements.
- Detail the utilities of relevant online resources , data bases andsoftwaretools for case-specific problems.
- Applyvarious software tools for diverse case-studies and analyse the results for optimized solutions.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 40% of maximum marks in the semester-end examination(SEE). In total of CIE and SEE student has to secure 50% maximum marks of the course.

Continuous Internal Evaluation (CIE):

CIE marks for the practical course is **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled downed to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8th week of the semester and the second test shall be conducted after the 14th week of the semester.
- In each test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability.
- The average of 02 tests is scaled down to **20 marks** (40% of the maximum marks).

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University.

All laboratory experiments are to be included for practical examination.

(Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.

Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.

Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 10% Marks allotted to the procedure part to be made zero.

The duration of SEE is 03 hours

Suggested Learning Resources:

1. https://www.udemy.com/course/learn-bioinformatics-in-6-days/
2. https://omicstutorials.com/introduction-to-bioinformatics-sequencing-resource-video-tutorial/
3. https://cshl.libguides.com/c.php?g=746451&p=5434221
4. https://www.youtube.com/watch?v=OOmmXrkFFDg
5. https://www.youtube.com/watch?v=arpLDElBjsM
6. VTU EDUSAT / SWAYAM / NPTEL / MOOCS / Coursera / MIT-open learning resource

Semester- I

BOS recommended ONLINE courses (AUD/AEC)			
Course Code	**22AUD18/22AEC18**	CIE Marks	Evaluation procedures are as per the policy of the online course providers.
Teaching Hours/Week (L:P:SDA)	Classes are as per the policy of the online course providers.	SEE Marks	
Total Hours of Pedagogy		Total Marks	
Credits	pp	Exam Hours	

BOS RECOMMENDED ONLINE COURCES

1. Advanced Aquaculture Technology
2. Advanced Chemical Theory
3. Advanced Protein chemistry
4. Advanced Thermodynamics
5. An Introduction to Cardiovascular Fluid Mechanics
6. Animal Physiology
7. Applied Environmental Microbiology
8. Basic Principles and Calculations in Chemical Engineering
9. Bioenergetics of Life Processes
10. Bioenergy
11. Bioengineering : An Interface with Biology and Medicine
12. Biomedical nanotechnology
13. Biomicrofluidics
14. Bioreactors

15.	Cell Culture Technologies
16.	Cellular biophysics: a framework for quantitative biology
17.	Computational Fluid Dynamics
18.	Computational Systems Biology
19.	Computer Aided Applied Single Objective Optimization
20.	Computer Aided Drug Design
21.	Conservation Geography
22.	Current regulatory requirements for conducting clinical trials in India for investigational new
23.	Dairy And Food Process And Products Technology
24.	Data Science for Engineers
25.	Descriptive Statistics with R Software
26.	Design Thinking - A Primer
27.	Design, Technology and Innovation
28.	Diary and food process and products technology
29.	Drug Delivery: Principles and Engineering
30.	drug/new drug (Version 2.0)
31.	Effective Engineering Teaching In Practice
32.	Electrochemical Technology in Pollution Control
33.	Electronic Waste Management - Issues And Challenges
34.	Employment Communication A Lab based course
35.	Energy Resources, Economics and Environment

36.	Entrepreneurship Essentials
37.	Environmental Biotechnology
38.	Environmental Quality Monitoring & Analysis
39.	Environmental Remediation of Contaminated Sites
40.	Equipment Design : Mechanical Aspects
41.	Essentials of Biomolecules : Nucleic Acids and Peptides
42.	Ethics in Engineering Practice
43.	Experimental Biotechnology
44.	Forest Biometry
45.	Forests and their management
46.	Functional Genomics
47.	Fundamentals Of Food Process Engineering
48.	Fundamentals Of Micro And Nanofabrication
49.	Fundamentals of Protein Chemistry
50.	Fundamentals of Spectroscopy
51.	Fuzzy Logic and Neural Networks
52.	General Microbiology
53.	Genetic Engineering: Theory and Application
54.	Genome Editing and Engineering
55.	Geographic Information System
56.	Health Research Fundamentals

57.	Human Behaviour
58.	Human Molecular Genetics
59.	Immunology
60.	Industrial Biotechnology
61.	Innovation by Design
62.	Instrumentation
63.	Intellectual Property
64.	Interactomics : Basics & Applications
65.	Introduction to Biomedical Imaging Systems
66.	Introduction to Biostatistics
67.	Introduction to Brain & Behaviour
68.	Introduction to Cell Biology
69.	Introduction to Cognitive Psychology
70.	Introduction to Developmental Biology
71.	Introduction to Dynamical Models in Biology
72.	Introduction to Environmental Economics
73.	Introduction to mechanobiology
74.	Introduction To Process Modelling In The Membrane Separation Process
75.	Introduction to Professional Scientific Communication
76.	Introduction to Proteogenomic
77.	Introduction To Proteomics

78.	Introductory Mathematical Methods for Biologists
79.	Manage TB
80.	Material and Energy Balances
81.	Matlab Programming for Numerical Computation
82.	Medical Biomaterials
83.	Medicinal Chemistry
84.	Membrane Technology
85.	Multiphase Flows
86.	Non-Conventional Energy Resources
87.	Offshore Structures Under Special Environmental Loads Including Fire Resistance
88.	Optical Spectroscopy and Microscopy : Fundamentals of optical measurements and
89.	Optimization in Chemical Engineering
90.	Organic farming for sustainable Agricultural production
91.	Patent Drafting for Beginners
92.	Patent Law for Engineers and Scientists
93.	Physics of Biological Systems
94.	Physics through Computational Thinking
95.	Plant Cell Bioprocessing
96.	Plastic Waste Management
97.	Post-Harvest Operations and Processing of Fruits, Vegetables, Spices and Plantation Crop Products
98.	Principles and Applications of NMR Spectroscopy

99.	Principles Of Downstream Techniques In Bioprocess
100.	Process Control - Design, Analysis and Assessment
101.	Product Design and Innovation
102.	Programming, Data Structures And Algorithms Using Python
103.	Protein folding
104.	Qualitative Research Methods and Research Writing
105.	Quantitative Methods in Chemistry
106.	Regulatory requirements for medical devices including in vitro diagnostics in India (Version
107.	Roadmap for patent creation
108.	Soft Nano Technology
109.	Strategic Performance Management
110.	The Joy of Computing using Python
111.	Thermal Processing of Foods
112.	Thermodynamics for Biological Systems : Classical and Statistical Aspect
113.	Tissue Engineering
114.	Transport Phenomena in Biological Systems
115.	Advanced Chemical Thermodynamics and Kinetics
116.	Ultrafast laser spectroscopy
117.	Understanding Design
118.	Waste to Energy Conversion
	Classes and evaluation procedures are as per the policy of the online course providers.

Semester II

NGS Informatics and High Performance Computing (PCC)			
Course Code	22BBI21	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	3	Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives:

- To learn the application of Next Generation Sequencing
- To learn the application of the appropriate tools and techniques to perform high throughput data analysis
- To learn the application of High-performance Computing in the field of Bioinformatics

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.

Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students on how tools are applied to solve biological problems.

	Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-2	
ALIGNMENT 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.	
Teaching-Learning Process	. Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
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.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
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.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations.

	Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
Module-5	
TOOLS AND TECHNIQUES FOR HIGH THROUGH PUT DATA ANALYSIS IN HP- 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.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks**

Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.

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 a sub-question covering all the topics under a module.

Suggested Learning Resources:

Books

1. Review of "Next-generation DNA sequencing informatics Stuart M. Brown 2013.

2. Cold Spring Harbor Laboratory Press, Cold Spring Harbor:New York. 256.
3. Bioinformatics for High Throughput Sequencing Naiara Rodríguez- Ezpeleta, Michael Hackenberg, Ana M. Aransay, Springer, 2011
4. High-Throughput Next Generation Sequencing Methods and Applications Series, Young Min Kwon, Steven C. Ricke, Springer, 2011.
5. DNA Sequencing III: Dealing With Difficult Templates, Jan Kieleczawa Publisher, Jones & Bartlett, 2008

Web links and Video Lectures (e-Resources):

1. https://nptel.ac.in/courses/102104056
2. https://nptel.ac.in/courses/102101076
3. https://nptel.ac.in/courses/102106065
4. https://onlinecourses.nptel.ac.in/noc22_bt42/preview
5. https://archive.nptel.ac.in/courses/106/108/106108055/
6. https://slideplayer.com/slide/9839026/
7. https://archive.nptel.ac.in/courses/102/104/102104056/

Skill Development Activities Suggested

1. AV presentation by students (on topics as per choice of the teacher)
2. Online tools for surprise quizzes
3. Collection of case studies based on research findings
4. Model making and Poster presentations on specific case studies.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Comprehend the basics of Next Generation Sequencing	L2, L3
CO2	Analyse and apply the appropriate tools and techniques to perform high throughput data analysis	L3, L4
CO3	Apply High performance Computing in the field of biological problems	L3, L4

Program Outcome of this course

Sl. No.	Description	POs
1	Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	1
2	Problem analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2
3	Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations	3
4	Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	4
5	Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and	5

	IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.	
6	The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2									
CO2		3	3	3	2	2						
CO3		3	3	3	2	2						

Semester - II

Biomolecular Simulations + Lab (IPCC)			
Course Code	**22BBI22**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 10-12 Lab slots	Total Marks	100
Credits	4	Exam Hours	3

Course objectives:

- To comprehend the basics of modelling and simulations for specific problems in Biology.
- To learn the three steps (i) formulate and construct a mathematical model (ii) mathematically analyse and apply a model, and (iii) interpret and evaluate the results in the context of the experimental knowledge.

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.

Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations.

	Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
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	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
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	

Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
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.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
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	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.

PRACTICAL COMPONENT OF IPCC

Sl.NO	Experiments
1	Bio-molecular Modeling of 3D structuresa)Comparative/Homology Based modelling b) Fold prediction and modelling c)Ab initio modeling
2	Molecular Visualization Softwares: Pymol and Rasmol
3	Modelling Protein-Protein Interactions
4	Modelling mutations and Single Nucleotide Polymorphisms
5	Geometry Optimization Techniques

6	Energy Minimization Techniques
7	Molecular Dynamics and Simulations via Gromacs
8	Binding Site Identification and Evaluation
9	Structure based Drug Design - Docking of small molecules into active sites.
10	Ligand based Drug Design – QSAR
11	ADMET analysis via tools
12	3D modelling of Membranes/Tissues

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

CIE for the theory component of IPCC

Two Tests each of **20 Marks**

Two assignments each of **10 Marks/One Skill Development Activity of 20 marks**

Total Marks of two tests and two assignments/one Skill Development Activity added will be CIE for 60 marks, marks scored will be proportionally scaled down to **30 marks**.

CIE for the practical component of IPCC

On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the

same day. The**15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end of the semester.

The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to 15 marks.

The laboratory test at the end /after completion of all the experiments shall be conducted for 50 marks and scaled down to 05 marks**.**

Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **20 marks**.

SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (duration 03 hours)

The question paper will be set for 100 marks and marks scored will be scaled down proportionately to 50 marks.

The question paper will have ten questions. Each question is set for 20 marks.

There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module.

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only.

Questions mentioned in the SEE paper shall include questions from the practical component).

The minimum marks to be secured in CIE to appear for SEE shall be the 15 (50% of maximum marks-30) in the theory component and 10 (50% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included**.** The maximum of 04/05 questions to be set from the practical component of IPCC, the total marks of all questions should not be more than the 20 marks.

SEE will be conducted for 100 marks and students shall secure 40% of the maximum marks to qualify in the SEE. Marks secured will be

scaled down to 50. (Student has to secure an aggregate of 50% of maximum marks of the course(CIE+SEE)

Suggested Learning Resources:

Books

1. Biological Modeling and Simulation. Russell Schwartz. MIT Press: Cambridge, MA, 2008.
2. Computer Simulation in Biology: a BASIC introduction. Keen, R.E. and Spain, J.D Wiley-Liss. 1991.
3. Modeling Biological Systems: Principles and Applications. Haefner, James W. Springer, 2005.
4. Modeling and Computer Simulation, Dragan Cvetković, Immtech Open, 2019.
5. Modeling Life The Mathematics of Biological Systems, Alan Garfinkel, Jane Shevtsov, Yina Guo Alan Garfinkel, Jane Shevtsov, Yina Guo, 2017.

Web links and Video Lectures (e-Resources):

1. https://www.ebi.ac.uk/training/search-results?query=molecularmodelling&domain=ebiweb_training&page=1&facets=
2. https://www.learntoupgrade.com/s/store/courses/description/Molecular-Modelling
3. https://nptel.ac.in/courses/104101095
4. https://nanohub.org/resources/7570/share
5. https://ocw.mit.edu/courses/3-320-atomistic-computer-modeling-of-materials-sma-5107-spring2005/resources/lecture-13-molecular-dynamics-i/
6. https://www.coursera.org/lecture/dense-gases-liquids-solids/molecular-dynamics-h2Mtp
7. VTU EDUSAT / SWAYAM / NPTEL / MOOCS / Coursera / MIT-open learning resource

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

1. AV presentation by students (on topics as per choice of the teacher)
2. Online tools for surprise quizzes
3. Collection of case studies based on research findings

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Detail the basic aspects of modelling and simulations for specific problems in Biology.	L2, L3,
CO2	Apply the key steps of problem formulation, mathematical modeling, simulation for specific case studies.	L3, L4,
CO3	Deduce the inferences from these theoretical studies and compare them with experimental results.	L3, L4,

Program Outcome of this course

Sl. No.	Description	POs
1	Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	1
2	Problem analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2
3	Design/development of solutions: Design solutions for complex engineering problems and design system	3

	components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations	
4	Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	4
5	Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.	5
6	The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	6
7	Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.	7

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2			3	3	3			3			
CO2	2			3	3	3			3			
CO3		3	2	2					3			

Semester II

Chemoinformatics and Computational Medicinal Chemistry (PEC-1)			
Course Code	22BBI231	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	3	Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives:

- To understand the basic concepts, databases and tools of medicinal chemistry used in drug design.
- To understand the basic concepts of chemoinformatics, databases and tools used in drug design.
- To learn the application of knowledge of chemistry of medicinal compounds on Virtual Screening process

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.

Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations.

	Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
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 design and Focused libraries.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
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.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
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.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used.

	Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
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).	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks**

Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.

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 a sub-question covering all the topics under a module.

Suggested Learning Resources:

Books

1. Foye's Principles of Medicinal Chemistry by Lemke, Thomas L. Williams, David A. , Lippincott, Williams &Wilkins 7th edition

2012.

2. Burgers Medicinal Chemistry. Drug Discovery and Development, Edited by Donald J Abraham, Volumes 1 – 8,Wiley, 2021.
3. Introduction to principles of drug design by Smith and Williams, CRC Press, 2005.
4. Handbook of Chemoinformatics, volume 1, by John Gastiger, Thomas Engel, WILEYVCH pub 2003.
5. An Introduction to Chemoinformatics, by Andrew R. Leach & Valerie j. Gillet, Springer 3. Instant Notes in Medicinal Chemistry, by G. Patrick, BIOS Scientific pub. 2001.
6. Chemoinformatics: A Textbook by Johann Gasteiger and Thomas Engel, Wiley, 2003.
7. Chemoinformatics in Drug Discovery: 23 (Methods & Principles in Medicinal Chemistry) by Tudor I.Oprea, Raimund Mannhold, Hugo Kubinyi and Gerd Folkers, Wiley, 2005.

Web links and Video Lectures (e-Resources):

1. Web links and Video Lectures (e-Resources):
2. https://www.classcentral.com/course/swayam-medicinal-chemistry-12908
3. https://onlinecourses.nptel.ac.in/noc20_cy16/preview
4. https://www.edx.org/course/medicinal-chemistry-the-molecular-basis-of-drug-di
5. https://www.futurelearn.com/courses/discovering-science-medicinal-chemistry

Skill Development Activities Suggested

1. AV presentation by students (on topics as per choice of the teacher)
2. Online tools for surprise quizzes
3. Collection of case studies via newspaper on topics covered
4. Discussion on recent advancements and case studies.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Apply the basic concepts of medicinal chemistry, databases and tools towards drug design.	L3, L4
CO2	Apply the basic concepts of chemoinformatics, databases and tools involved in drug design.	L3, L4
CO3	Apply knowledge of chemistry of medicinal compounds on Virtual Screening process.	L3, L4

Program Outcome of this course

Sl. No.	Description	POs
1	**Problem analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2
2	**Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations	3
3	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	4
4	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.	5

5	**The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	6
6	**Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.	7
7	**Ethics: Apply** ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	8

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		3	3	3	3							
CO2		3	3	3	3							
CO3					3	2	2	2				2

Semester II

Insilico Protein Engineering & Design (PEC-1)			
Course Code	22BBI232	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	3	Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives:

- To learn the analysis of the basics of protein structures, functional units, architectures and topologies
- To learn the analysis of the methods of isolation, purification and characterization of proteins
- To learn the application of the principles towards selective modification of proteins strictures and functions
- To learn the analysis of the computational aspects of protein engineering and design, with specific case studies.

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.

Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations.

	Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
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.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
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.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
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.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students on how tools are applied to solve biological problems.

	Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
Module-5	
CASE STUDIES: Membrane proteins: engineering of Transmembrane segments, prediction, analysis of bacteriorhodopsin and Photosynthetic reaction centre. 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.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks**

Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.

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 a sub-question covering all the topics under a module.

Suggested Learning Resources:

Books

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
3. Bioinformatics Methods & Applications: Genomics, Proteomics & Drug Discovery, S, C, Rastogi, N Mendiratta & P Rastogi, PHI, 2013
4. Protein engineering: principles and practice, Jeffrey L. Cleland, Charles S. Craik Wiley-Liss, 1996
5. Introduction to Protein Science. Arthur M Lesk, Oxford university, 2016

Web links and Video Lectures (e-Resources):

1. https://onlinecourses.nptel.ac.in/noc22_bt28/preview
2. https://nptel.ac.in/courses/121106008
3. https://www.broadinstitute.org/talks/machine-learning-based-design-proteins-and-small-molecules-and-beyond-note-12pm-start
4. https://www.digimat.in/nptel/courses/video/102107086/L55.html

Skill Development Activities Suggested

1. AV presentation by students (on topics as per choice of the teacher)
2. Online tools for surprise quizzes
3. Collection of case studies via newspaper on topics covered
4. Discussion on recent advancements and case studies.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Analyse the basics of protein structures, functional units, architectures and topologies	L3, L4
CO2	Analyse the methods of isolation, purification and characterization of proteins	L3, L4
CO3	Apply the principles towards selective modification of proteins strictures and functions	L3, L4
CO4	Analyse the computational aspects of protein engineering and design, with specific case studies.	L3, L4

Program Outcome of this course

Sl. No.	Description	POs
1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	1
2	**Problem analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2
3	**Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations	3
4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	4

5	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.	5
6	**The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	6
7	**Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.	7
8	**Ethics: Apply** ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	8

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3										
CO2			3	3	3	2						
CO3	2	3	3									
CO4					3	3	3	3				

Semester II

Immunoinformatics (PEC-1)			
Course Code	22BBI233	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	3	Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives:

- To learn analysis of the computational aspects of immunology
- To learn the application of Tools and databases related to immunoinformatics studies
- To learn the application of computational tools for antibody engineering

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.

Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations.

	Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
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.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
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	

Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
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.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
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.

Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks**

Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.

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 a 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

Suggested Learning Resources:

Books

1. Immunological Bioinformatics, Ole Lund Darren Flower, MIT press, Springer, September 2005
2. Immunoinformatics: Predicting Immunogenicity in Silico, Darren R Flower Humana Press, 2007
3. Immunoinformatics- Bioinformatics Strategies for Better Understanding of Immune, Rammensee, Wiley, 2003
4. Computational, Immunology: Basics, Shyamasree Ghosh, CRC Press, 2020
5. Kuby Immunology, Thomas J. Kindt , Richard A. Goldsby, Barbara A borne, W. H. Freeman & Company 2006

Web links and Video Lectures (e-Resources):

1. https://nptel.ac.in/courses/102106068
2. https://archive.nptel.ac.in/courses/104/108/104108055/
3. https://nptel.ac.in/courses/102106065
4. https://archive.nptel.ac.in/courses/106/106/106106166/
5. https://www.youtube.com/watch?v=nZQ5IrMUT-8
6. https://www.youtube.com/watch?v=xtjm8ZqtJpA
7. https://www.youtube.com/watch?v=EKafePK910w

Skill Development Activities Suggested

1. Class Presentations and discussions of research articles from publications.
2. Online tools for surprise quizzes.
3. Collection of case studies via Newspapers/Journal articles, on topics covered.
4. Group discussions on recent advancements in animal biotechnology and case studies.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Analyse the computational aspects of immunology	L3, L4,
CO2	Apply Tools and databases related to immunoinformatics studies	L3, L4,
CO3	Apply computational tools for antibody engineering	L3, L4,

Program Outcome of this course

Sl. No.	Description	POs
1	Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	1
2	Problem analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2
3	Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.	5
4	Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	8
5	Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change	

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	P11	P12
CO1	**2**	**3**			**3**			**1**				**2**
CO2	**2**	**3**			**3**			**1**				**2**
CO3	**2**	**3**			**3**			**1**				**2**

Semester II

Health Informatics (PEC-1)			
Course Code	22BBI234	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	3	Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives:

- To analyze the interaction between biomedicine and information system.
- To learn the application of tools and techniques used in health informatics.
- To learn the application IT in health informatics

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.

Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data.

	Incorporate Inquiry based approach using demonstration, field study, experiments and project work

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.

Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work

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.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
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.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
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- centred symptom monitoring. Computer aided techniques in Medicine: Laparoscopic surgery navigation, Intro-operative imaging, multi-model imaging, Biosignal processing and algorithms.Biosignal databases.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks**

Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.

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 a 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

Suggested Learning Resources:

Books

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
3. Information Technology Essentials for behavioural Health Clinicians, Naakesh A. Dewan, John Luo, Nancy M. Lorenz, Springer, 2010.

Web links and Video Lectures (e-Resources):

1. https://onlinecourses.nptel.ac.in/noc20_bt10/preview
2. https://ahttps://nptel.ac.in/courses/106104135 rchive.nptel.ac.in/noc/courses/noc18/SEM1/noc18-ee08/
3. https://onlinecourses.nptel.ac.in/noc22_hs03/preview
4. https://www.coursera.org/lecture/health-informatics-professional/electronic-health-records-nItrS
5. https://onlinecourses.nptel.ac.in/noc22_hs40/preview

Skill Development Activities Suggested

1. NGS and Microarray data Analysis
2. Proteomic data network analysis.
3. AV presentation by students (on specific topics).
4. Discussion of case studies based on research findings.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	To analyze the interaction between biomedicine and information system.	L3, L4
CO2	To learn the application of tools and techniques used in health informatics.	L3, L4
CO3	To learn the application IT in health informatics	L3, L4

Program Outcome of this course

Sl. No.	Description	POs
1	Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.	5
2	The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	6
3	Environment and sustainability: Understand the impact of the professional engineering solutions in	7

	societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.	
4	Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	8
5	Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change	12

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1						3	3	3				2
CO2					3	3	3	3				2
CO3					3	3	3	3				2

Semester II

Genome Informatics & Proteome informatics (PEC-1)			
Course Code	22BBI235	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	3	Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives:

- To inculcate the fundamentals of Genome Informatics & Proteome informatics.
- To comprehend the applications of Genome Informatics & Proteome informatics in biotechnology research.
- To impart knowledge of various software tools used in Genome Informatics & Proteome informatics studies

Module-1

INTRODUCTION:

Polymorphisms-types of polymorphism, genomes sequences and data base subscriptions. Early sequencing efforts. Extraction of DNA, Methods of preparing genomic DNA for sequencing, DNA sequence analysis methods -Maxam &Gilbert Method, Sanger Di-deoxy method, Fluorescence method,shot-gun approach. NGS methods and their principles. BioinformaticstoolsandautomationinGenomeSequencing,analysisofrawgenomesequencedata, Transcriptome (RNA) sequencing, Exome sequencing, Genome Annotation, Using NGS to detect sequence variants, Utility of EST database in sequencing.

Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations.

	Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-2	
GENOMICS: General architecture of prokaryotic and eukaryotic genome. Regulation of transcription, transcription factors and the coordination of gene expression, Gene variation and Single Nucleotide Polymorphisms (SNPs), Bioinformatics in detection of Polymorphisms - dbSNP, Gene-disease association, diagnostic genes and drug targets, genotyping tools-DNA Chips. Genome projects of Model systems: Drosophila, Yeast, *C. elegans, E. coli*., Arabidopsis and rice; Human genome project and the genetic map. Interference RNA, RNA silencing, SiRNA. Genetic and physical maps: Breeding requirements for mapping. Molecular markers - RFLP, RAPD, AFLP, Micro-array in functional genomics. Bioinformatics tools in microarray data analysis. Tools for comparative genomics: BLAST2, Vista, MUMmer, COG, VOG. Mummer, COG, VOG.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-3	

PROTEOMICS:

Two-dimensional PAGE for proteome analysis, Detection of proteins on SDS gels, Protein cleavage, Edman protein micro sequencing, Automation in proteomics, Protein interaction assays - Two-hybrid methods, TAP/ GFP tags, Phage Display, Mass-spec based analysis of protein expression. MS-MS approaches, Peptide Mass finger printing and Post Translational Modifications Interactomics, Protein Arrays and "Protein Chip" - interactions and detection techniques. Phage antibodies as tools for proteomics. Proteome-wide interaction maps, Proteomics workflows; Proteomics and the study of diseases, Applications of proteome analysis to drug development and toxicology. Organellar proteomics. Protein Engineering.

Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work

Module-4

DATABASES& SEQUENCEANALYSIS:

Bioinformatics resources: NCBI,EBI, ExPASy, RCSB. Significance of databases towards informatics projects.Databases and classifications. GenBank, DDBJ, EMBL, PIR, Uniprot-KB,SWISS-PROT, TrEMBL. Genebank flat file. Protein Data Bank (PDB) flat file; FASTA Format, PIR Format; Structure file formats. the Modular Nature of proteins, Optional Alignment Methods, substitution matrices, Statistical significance of Alignments, BLAST and its different types,ProgressiveAlignmentMethods,MUSCLE,MotifsandPatterns,PROSITE, Hidden Markov Models (HMMs). Phylogenetic analysis:

Alignment, Tree Building, and Tree Evaluation, Tree - Building Methods-Distance based and character-based methods, Evaluating Trees and Data- Bootstrapping (parametric and nonparametric), Phylogenetic softwares (CLUSTAL-omega, PHYLIP etc)	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
Module-5	
INSILICO APPLICATIONS: Detecting Functional Sites in the Prokaryotic and Eukaryotic Genomes (promoters, transcription factor binding sites, translation initiation sites), Integrated Gene Parsing, finding RNA Genes, Web based tools (GENSCAN,GRAIL,GENEFINDER). Protein Identity based on composition, Physical propertiesBasedonsequence,secondarystructureandfoldingclasses,tertiary structure. protein fold prediction tools,Relatedweb-basedsoftware(JPRED,NNPREDICT,SOPMA,DSSP,STRIDE).Restriction mapping, Utilities, DNA strider, MacVector and OMIGA, Web based tools (MAP, REBASE); Primer design – need for tools, Primer design programs and software(PRIME3).3D Structure Modelling in drug discovery, molecular docking, quantitative structure activity relationship(QSAR), deriving the Pharmacophoric Pattern, Receptor Mapping, Estimating Biological Activities, Ligand-Receptor Interactions: Docking software (AUTODOCK,HEX), Energy Calculations (no derivation).	
Teaching-Learning	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint

Process	presentations. Collaborate with students how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks**

Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.

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 a 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

Suggested Learning Resources:

Books

1. Genomics and Proteomics Principles, Technologies, and Applications. By Devarajan Thangadurai and Jeyabalan Sangeetha. Apple Academic Press.2021.
2. Concepts and Techniques in Genomics and Proteomics, by N Saraswathy, P Ramalingam. Woodhead Publishing Series in Biomedicine, 2011.
3. Introduction to Proteomics by D.C Liebler; Humana Press, 2002.
4. Introduction to Genomics Arthur M Lesk, Oxford University Press, 2007
5. Discovering Genomics, Proteomics & Bioinformatics, by A M Campbell & L J Heyer, Pearson Education, 2007
6. Proteins and Proteomics by Richard J Simpson, IK International, 2003.
7. Genomics & Proteomics by Sabesan Ane Books, 2007.

Purifying Proteins for Proteomics by Richard J Simpson IK International, 2004.

Web links and Video Lectures (e-Resources):

1. https://www.coursera.org/courses?query=bioinformatics
2. https://www.edx.org/learn/bioinformatics
3. https://bioinfotraining.bio.cam.ac.uk/
4. https://onlinecourses.nptel.ac.in/noc19_bt25/preview
5. https://pll.harvard.edu/course/introduction-proteomics?delta=0
6. https://www.coursera.org/courses?query=genomics
7. https://www.classcentral.com/subject/genomics
8. https://online.stanford.edu/programs/genetics-and-genomics-program
9. VTU EDUSAT / SWAYAM / NPTEL / MOOCS / Coursera / MIT-open learning resource

Skill Development Activities Suggested

1. NGS and Microarray data Analysis
2. Proteomic data network analysis.
3. AV presentation by students (on specific topics).
4. Discussion of case studies based on research findings.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Detail the basic concepts in Genome Informatics & Proteome informatics	L3, L4
CO2	Demonstrate the applications of Genome s & Proteome informatics in biotechnology research.	L3, L4
CO3	Apply various software tools used in Genome & Proteome informatics for biological problems	L3, L4

Program Outcome of this course

Sl. No.	Description	POs
1	Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	4
2	Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.	5
3	The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	6
4	Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.	7

5	Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	8

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1				3	3	3						
CO2				3	3	3	3	3				
CO3				3	3	3	3	3				

Semester II

Object Oriented Programming Using JAVA (PEC-2)			
Course Code	22BBI241	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	3	Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives:

- To learn application of Java programming for various web-based tools to solve real world problems.
- To learn application of Object Oriented programming for various web based tools.
- To learn analysis of streams and efficient user interface design techniques to solve real world problems.

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.

Teaching-Learning	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint

Process	presentations. Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
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.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
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	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
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.	
Teaching-Learning	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint

Process	presentations. Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.

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.

Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

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to attain the COs and POs

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CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.

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 a sub-question covering all the topics under a module.

Suggested Learning Resources:

Books

1. Programming with JAVA, E.Balaguruswamy, TATA McGraw- Hill Company,2006
2. Object Oriented Programming using Java, Chirag Patel Books India Publications, 2007
3. Introduction to JAVA Programming, Y. Daniel Liang, Pearson Education, 6th Edition, 2007.
4. Introduction to Java Programming Comprehensive Version, Y. Daniel Liang, Pearson Prentice Hall, (7th Edition) 2010.
5. Java - The Complete Reference, Herbert Schildt, Tata McGraw Hill 7th Edition, 2007

Web links and Video Lectures (e-Resources):

1. https://archive.nptel.ac.in/courses/106/105/106105191/
2. https://www.youtube.com/watch?v=eQvUcO35wnU
3. https://onlinecourses.nptel.ac.in/noc22_cs47/preview
4. https://www.digimat.in/nptel/courses/video/106105191/L01.html
5. https://www.youtube.com/watch?v=pQG-ojR0K3Y
6. https://www.digimat.in/nptel/courses/video/106105225/L01.html
7. https://www.youtube.com/watch?v=0pzR2FGTEhk

Skill Development Activities Suggested

1. AV presentation by students (on specific topics).
2. Discussion of case studies based on research findings.
3. Model making and Poster presentations

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Apply Java programming for various web based tools to solve real world problems.	L3, L4
CO2	ApplyObject Oriented programming for various web based tools.	L3, L4
CO3	Analyze streams and efficient user interface design techniques to solve real world problems.	L3, L4

Program Outcome of this course

Sl. No.	Description	POs
1	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations	3
2	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.	5
3	**The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	6
4	**Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.	7

5	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.	8

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1			**3**		**3**	**3**	**3**	**3**				
CO2			**3**		**3**	**3**	**3**	**3**				
CO3			**3**		**3**	**3**	**3**	**3**				

Semester II

Data Warehousing and Data mining (PEC-2)			
Course Code	22BBI242	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	3	Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives:

- To learn classical models and algorithms in data warehouses and data mining
- To learn master data mining techniques in various social, scientific and environmental application.
- To learn the application of acquired knowledge for understanding data and select suitable methods for data analysis.

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.

Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students on how tools are applied to solve biological problems.

	Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work

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.

Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work

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.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-4	
DATA MINING ALGORITHMS: One-R, Naïve Bayes Classifier, Decision trees, Decision rules, Association Rules, Regression, K-Nearest Neighbour Classifiers.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
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.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks**

Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the

course.

Semester End Examination:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.

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 a 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

Suggested Learning Resources:

Books

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
3. The Data Warehouse, Toolkit, Ralph Kimball, Wiley, 1996
4. Principles of Data Mining, D. Hand, H. Mannila and P. Smyth, MIT Press, 2001
5. Data Mining: Introductory and Advanced Topic, M. H. Dunham, Prentice Hall, 2003

Web links and Video Lectures (e-Resources):

1. https://onlinecourses.swayam2.ac.in/cec19_cs01/preview
2. https://www.youtube.com/watch?v=_mSkA-wA2Wk
3. https://onlinecourses.nptel.ac.in/noc22_ee44/preview
4. https://archive.nptel.ac.in/noc/courses/noc22/SEM1/noc22-ag03/
5. https://onlinecourses.nptel.ac.in/noc22_cs29/preview
6. https://onlinecourses.nptel.ac.in/noc22_cs29/preview

Skill Development Activities Suggested

1. AV presentation by students (on specific topics).
2. Discussion of case studies based on research findings.
3. Model making and Poster presentations

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Analyse and implement classical models and algorithms in data warehouses and data mining.	L3, L4,
CO2	Apply Master data mining techniques in various social, scientific and environmental application.	L3, L4,
CO3	Apply acquired knowledge for understanding data and select suitable methods for data analysis.	L3, L4,

Program Outcome of this course

Sl. No.	Description	POs
1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	1
2	**Problem analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2
3	**Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations	3

4	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.	5
5	**The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	6
6	**Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.	7
7	**Ethics: Apply** ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	8

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3		3							
CO2					3	3	3	3				
CO3	3	3	3									

Semester II

Artificial Intelligence & Neural Networks (PEC-2)			
Course Code	22BBI243	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	3	Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives:

- To learn the application of basic principles of AI in solutions that require problem solving, inference, perception, knowledge representation, and learning.
- To learn the application of AI techniques in intelligent agents, expert systems, artificial neural networks and other machine learning models
- To learn the application of scientific method to models of machine learning.

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.

Teaching-Learning	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint

Process	presentations. Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
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.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
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.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
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 toBioinformatics.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations.

	Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
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.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks**

Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.

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 a sub-question covering all the topics under a module.

Suggested Learning Resources:

Books

1. Artificial Intelligence Methods and Tools for Systems Biology, Werner Dubitzky, Francisco Azuaje, Springer, 2005
2. Artificial Neural Networks, Yegnanarayana, PHI, 1998
3. Intelligent Bioinformatics:The Application of Artificial Intelligence Techniques to Bioinformatics, Edward Keedwell, Ajit Narayanan, John Sons Wiley, 2005
4. Computational Bioinformatics Intelligence, Arpad Kelemen, Ajith Abraham, Yuehui Chen, SpringerLink, Springer, 2008
5. Computational Intelligence in Biomedicine and Bioinformatics: Current Trends and Applications, Tomasz G. Smolinski, Mariofanna G. Milanova, Aboul Ella Hassanien, Springer, 2008

Web links and Video Lectures (e-Resources):

1. https://www.youtube.com/watch?v=xbYgKoG4x2g
2. https://www.youtube.com/watch?v=h9MqCkAopqw
3. https://www.youtube.com/watch?v=6ixqKw7uK6o
4. https://archive.nptel.ac.in/courses/102/106/102106065/
5. https://archive.nptel.ac.in/courses/102/101/102101068/

Skill Development Activities Suggested

1. AV presentation by students (on specific topics).
2. Discussion of case studies based on research findings.
3. Model making and Poster presentations

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Apply basic principles of AI in solutions that require problem solving, inference, perception, knowledge representation, and learning.	L3, L4,
CO2	Apply AI techniques in intelligent agents, expert systems, artificial neural networks and other machine learning models	L3, L4,
CO3	Apply scientific method to models of machine learning.	L3, L4,

Program Outcome of this course

Sl. No.	Description	POs
1	Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	1
2	Problem analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2
3	Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations	3
4	Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the	4

	information to provide valid conclusions.	
5	Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.	5

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	3	3	2							
CO2	3	3	3	3	2							
CO3	2	3	3	3	2							

Semester II

PERL Programming and Bioinformatics (PEC-2)			
Course Code	22BBI244	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	3	Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives:

- Learn to operate the Perl programming language to read and write perl scripts, and download and use perl bioinformatics libraries.
- Lear to Apply gained knowledge to write automatic scripts that query local and web-based biological databases
- Learn the applications of perl programming for various bioinformatics exercises

Module-1

INTRODUCTION

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.

Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations.

	Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
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.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
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.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
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.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
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 .	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work

Assessment Details (both CIE and SEE)

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to attain the COs and POs

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CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.

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 a sub-question covering all the topics under a module.

Suggested Learning Resources:

Books

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
3. Beginning Perl for Bioinformatics, James T Tisdall O'Reilly & Associates, 2001
4. Building Bioinformatics Solutions: With Perl, Conrad Bessant, Darren Oakley, Ian Shadforth, Oxford, 2010
5. Genomic Perl: From Bioinformatics Basics to Working Code, Rex A. Dwyer, Cambridge University Press, 2002

Web links and Video Lectures (e-Resources):

1. https://nptel.ac.in/courses/102106065
2. https://nptel.ac.in/courses/111104100
3. https://archive.nptel.ac.in/courses/102/106/102106065/
4. https://nptel.ac.in/courses/102101076
5. https://scitechgen.com/2020/03/04/math-and-programming-for-biotechnology-and-bioinformatics/comment-page-1/
6. https://archive.nptel.ac.in/courses/106/104/106104028/

Skill Development Activities Suggested

1. AV presentation by students (on specific topics).
2. Discussion of case studies based on research findings.
3. Model making and Poster presentations

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Operate the Perl programming language to read and write perl scripts, and download and use perl bioinformatics libraries.	L2, L3, L4,
CO2	Apply gained knowledge to write automatic scripts that query local and web-based biological databases	L2, L3, L4,
CO3	Apply perl programming for various bioinformatics exercises	L2, L3, L4,

Program Outcome of this course

Sl. No.	Description	POs
1	Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	1
2	Problem analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2
3	Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations	3
4	Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	4

5	Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.	5
6	The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	6
7	Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.	7

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**2**	**3**	**3**	**3**	**3**							
CO2				**3**	**3**	**2**	**2**					
CO3		**3**	**3**	**3**								

Semester II

Statistical Analysis System and Clinical Data Management (PEC-2)			
Course Code	22BBI245	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	3	Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives:

- Learn to analyze the relevance of statistical tools in Clinical Data Management
- Learn to apply SAS system to analyse biological big data.
- Learn to apply NGS data analysis tools at different steps of data analysis

Module-1

INTRODUCTION

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.

Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data.

	Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-2	
DATA MANIPULATION 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.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
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.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used.

	Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work
Module-4	
CLINICAL DATA MANAGEMENT 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.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students on how tools are applied to solve biological problems. Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work.
Module-5	
DATA MANAGEMENT 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.	
Teaching-Learning Process	Include traditional teaching learning process such as Chalk and Talk using writing boards. Construct graphical and pictorial representation of the subject in the form of Chart, hand-outs or PowerPoint presentations. Collaborate with students on how tools are applied to solve biological problems.

	Integrate real time case studies in various scientific tools used. Reflective approaches on analysing how and why the tools are used in self-reflected or published data. Incorporate Inquiry based approach using demonstration, field study, experiments and project work

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

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CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

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Each full question will have a 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

Suggested Learning Resources:

Books

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
3. Informatics for the Clinical Laboratory: A Practical Guide for the Pathologist (Health Informatics), Editor: Daniel Cowan, Health Informatics Series, 2002
4. Statistical Modelling and Machine Learning, Principlesfor Bioinformatics Techniques, Tools, and Applications (Algorithms for Intelligent Systems), Editors: K G, Srinivasa, G M, Siddesh, Manisekhar, S R, Springer, 2020
5. Systems Analysis Tools for Better Health Care Delivery Optimization and Its Applications, Panos M. Pardalos, Pando G. Georgiev, Springer, 2013

Web links and Video Lectures (e-Resources):

1. https://onlinecourses.nptel.ac.in/noc22_hs40/preview
2. https://archive.nptel.ac.in/courses/106/107/106107220/
3. https://nptel.ac.in/courses/109/107/109107190/
4. https://nptel.ac.in/courses/110105087
5. https://onlinecourses.nptel.ac.in/noc21_ge14/preview
6. https://onlinecourses.nptel.ac.in/noc22_bt20/preview
7. https://www.digimat.in/nptel/courses/video/102101082/L48.html

Skill Development Activities Suggested

1. AV presentation by students (on specific topics).
2. Discussion of case studies based on research findings.
3. Model making and Poster presentations

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Analyse the relevance of statistical tools in Clinical Data Management	L2, L3,
CO2	Apply SAS system to analyse biological big data.	L2, L3, L4,
CO3	Apply NGS data analysis tools at different steps of data analysis	L2, L3, L4,

Program Outcome of this course

Sl. No.	Description	POs
1	Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	1
2	Problem analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2

3	Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations	3
4	Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	4
5	Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.	5

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3							
CO2	3	3	3	3	3							
CO3	3	3	3	3	3							

Semester II

Computational Systems Biology lab (PCCL)			
Course Code	**22BBIL26**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:2:0	SEE Marks	50
Credits	2	Exam Hours	3

Course objectives:

- To learn the application of y the principles of bio-molecular modeling and simulations
- To learn the application of the basics of computational drug discovery process.

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

10	Ligand based Drug Design – QSAR
11	ADMET analysis via tools
12	3D modelling of Membranes/Tissues

Course outcomes (Course Skill Set):

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

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

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 40% of maximum marks in the semester-end examination(SEE). In total of CIE and SEE student has to secure 50% maximum marks of the course.

Continuous Internal Evaluation (CIE):

CIE marks for the practical course is **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled downed to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8th week of the semester and the second test shall be conducted after the 14th week of the semester.
- In each test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability.
- The average of 02 tests is scaled down to **20 marks** (40% of the maximum marks).

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University.

All laboratory experiments are to be included for practical examination.

(Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.

Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.

Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 10% Marks allotted to the procedure part to be made zero.

The duration of SEE is 03 hours

Suggested Learning Resources:

1. https://archive.nptel.ac.in/courses/102/106/102106068/
2. https://onlinecourses.nptel.ac.in/noc22_bt58/preview
3. https://onlinecourses.nptel.ac.in/noc20_bt14/preview
4. https://www.youtube.com/watch?v=4bdSHU4ZnXE

Semester- I

BOS recommended ONLINE courses (AUD/AEC)			
Course Code	**22AUD27**	CIE Marks	Evaluation procedures are as per the policy of the online course providers.
Teaching Hours/Week (L:P:SDA)	Classes are as per the policy of the online course providers.	SEE Marks	
Total Hours of Pedagogy		Total Marks	
Credits	pp	Exam Hours	

1. Advanced Aquaculture Technology
2. Advanced Chemical Theory
3. Advanced Protein chemistry
4. Advanced Thermodynamics
5. An Introduction to Cardiovascular Fluid Mechanics
6. Animal Physiology
7. Applied Environmental Microbiology
8. Basic Principles and Calculations in Chemical Engineering
9. Bioenergetics of Life Processes
10. Bioenergy
11. Bioengineering : An Interface with Biology and Medicine
12. Biomedical nanotechnology
13. Biomicrofluidics
14. Bioreactors
15. Cell Culture Technologies

16.	Cellular biophysics: a framework for quantitative biology
17.	Computational Fluid Dynamics
18.	Computational Systems Biology
19.	Computer Aided Applied Single Objective Optimization
20.	Computer Aided Drug Design
21.	Conservation Geography
22.	Current regulatory requirements for conducting clinical trials in India for investigational new
23.	Dairy And Food Process And Products Technology
24.	Data Science for Engineers
25.	Descriptive Statistics with R Software
26.	Design Thinking - A Primer
27.	Design, Technology and Innovation
28.	Diary and food process and products technology
29.	Drug Delivery: Principles and Engineering
30.	drug/new drug (Version 2.0)
31.	Effective Engineering Teaching In Practice
32.	Electrochemical Technology in Pollution Control
33.	Electronic Waste Management - Issues And Challenges
34.	Employment Communication A Lab based course
35.	Energy Resources, Economics and Environment
36.	Entrepreneurship Essentials

37.	Environmental Biotechnology
38.	Environmental Quality Monitoring & Analysis
39.	Environmental Remediation of Contaminated Sites
40.	Equipment Design : Mechanical Aspects
41.	Essentials of Biomolecules : Nucleic Acids and Peptides
42.	Ethics in Engineering Practice
43.	Experimental Biotechnology
44.	Forest Biometry
45.	Forests and their management
46.	Functional Genomics
47.	Fundamentals Of Food Process Engineering
48.	Fundamentals Of Micro And Nanofabrication
49.	Fundamentals of Protein Chemistry
50.	Fundamentals of Spectroscopy
51.	Fuzzy Logic and Neural Networks
52.	General Microbiology
53.	Genetic Engineering: Theory and Application
54.	Genome Editing and Engineering
55.	Geographic Information System
56.	Health Research Fundamentals
57.	Human Behaviour

58.	Human Molecular Genetics
59.	Immunology
60.	Industrial Biotechnology
61.	Innovation by Design
62.	Instrumentation
63.	Intellectual Property
64.	Interactomics : Basics & Applications
65.	Introduction to Biomedical Imaging Systems
66.	Introduction to Biostatistics
67.	Introduction to Brain & Behaviour
68.	Introduction to Cell Biology
69.	Introduction to Cognitive Psychology
70.	Introduction to Developmental Biology
71.	Introduction to Dynamical Models in Biology
72.	Introduction to Environmental Economics
73.	Introduction to mechanobiology
74.	Introduction To Process Modelling In The Membrane Separation Process
75.	Introduction to Professional Scientific Communication
76.	Introduction to Proteogenomic
77.	Introduction To Proteomics
78.	Introductory Mathematical Methods for Biologists

79.	Manage TB
80.	Material and Energy Balances
81.	Matlab Programming for Numerical Computation
82.	Medical Biomaterials
83.	Medicinal Chemistry
84.	Membrane Technology
85.	Multiphase Flows
86.	Non-Conventional Energy Resources
87.	Offshore Structures Under Special Environmental Loads Including Fire Resistance
88.	Optical Spectroscopy and Microscopy : Fundamentals of optical measurements and
89.	Optimization in Chemical Engineering
90.	Organic farming for sustainable Agricultural production
91.	Patent Drafting for Beginners
92.	Patent Law for Engineers and Scientists
93.	Physics of Biological Systems
94.	Physics through Computational Thinking
95.	Plant Cell Bioprocessing
96.	Plastic Waste Management
97.	Post-Harvest Operations and Processing of Fruits, Vegetables, Spices and Plantation Crop Products
98.	Principles and Applications of NMR Spectroscopy
99.	Principles Of Downstream Techniques In Bioprocess

100.	Process Control - Design, Analysis and Assessment
101.	Product Design and Innovation
102.	Programming, Data Structures And Algorithms Using Python
103.	Protein folding
104.	Qualitative Research Methods and Research Writing
105.	Quantitative Methods in Chemistry
106.	Regulatory requirements for medical devices including in vitro diagnostics in India (Version
107.	Roadmap for patent creation
108.	Soft Nano Technology
109.	Strategic Performance Management
110.	The Joy of Computing using Python
111.	Thermal Processing of Foods
112.	Thermodynamics for Biological Systems : Classical and Statistical Aspect
113.	Tissue Engineering
114.	Transport Phenomena in Biological Systems
115.	Advanced Chemical Thermodynamics and Kinetics
116.	Ultrafast laser spectroscopy
117.	Understanding Design
118.	Waste to Energy Conversion