COURSE TITLE	**ALGORITHMS IN BIOINFORMATICS**
COURSE CODE	**01CB0706**
COURSE CREDITS	**3**

Objective:

1 To introduce algorithms used in bioinformatics for efficient analysis, interpretation, and modelling of complex biological data and systems.

Course Outcomes: After completion of this course, student will be able to:

1 Apply basic bioinformatics tools to solve sequence and pattern search problems.

2 Apply programs for sequence analysis and functional prediction.

3 Compare different alignment/sequence analysis methods to find which works best.

4 Evaluate the strengths and weaknesses of bioinformatics methods, and suggest improved solutions.

Pre-requisite of course: Understanding of Basic Bioinformatics

Teaching and Examination Scheme

Theory Hours	Tutorial Hours	Practical Hours	ESE	IA	CSE	Viva	Term Work
2	0	2	50	30	20	25	25

Contents : Unit	Topics	Contact Hours
1	**Introduction** Overview of Algorithms, Stages of algorithm development, Describing the problem, Identifying a suitable technique, Design of an algorithm, Proof of Correctness of the algorithm, Sequence and String search algorithms: Mathematical Formulations for Similarity and Distance Scoring Systems, Algorithmic Implementations	7
2	**Algorithm Design Techniques** Brute Force and branch and bound algorithms, Exhaustive Search, Greedy Algorithms, Divide-and-Conquer Algorithms, Graph-based Algorithms	5
3	**Combinatorial Pattern Matching** Hash Tables, Repeat Finding, Exact Pattern Matching, Expectation and Maximization (EM) Algorithm, Genetic Algorithm	5
4	**Algorithmic Approaches** Median String Search algorithms and its refinements, Motif and Regulatory element Algorithms	5

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Contents : Unit	Topics	Contact Hours
5	**Gene Prediction & Computational Challenges** Contig Assembly and Super-Contigs Formation, Computational Challenges in Gene Prediction, Popular Algorithms and Their Implementations, Exon Chaining and Spliced Alignment Problems	6
Total Hours		**28**

Suggested List of Experiments:

Contents : Unit	Topics	Contact Hours
1	**Experiment 1** To formulate and describe a computational biology problem and design an appropriate algorithmic approach	2
2	**Experiment 2** To prove the correctness of a basic algorithm using logical reasoning.	2
3	**Experiment 3** To implement similarity and distance scoring algorithms such as Hamming and Edit distance.	2
4	**Experiment 4** To apply string matching algorithm for exact pattern search in biological sequences.	2
5	**Experiment 5** To apply algorithm for efficient string matching.	2
6	**Experiment 6** To perform sequence alignment using scoring matrices in the Needleman-Wunsch or Smith-Waterman algorithm.	2
7	**Experiment 7** To solve an optimization problem using a greedy algorithm in a sequence context.	2
8	**Experiment 8** To implement a divide-and-conquer algorithm for sequence alignment	2
9	**Experiment 9** To implement exact pattern matching using hashing.	2
10	**Experiment 10** To detect and analyse tandem repeats in genomic sequences.	2
11	**Experiment 11** To construct genome assembly from sequence reads using De novo assembly algorithm.	2
12	**Experiment 12** To develop a genetic algorithm for finding conserved motifs in sequences.	2
13	**Experiment 13** To implement exon chaining using dynamic programming for gene prediction.	2

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Suggested List of Experiments:

Contents : Unit	Topics	Contact Hours
14	**Experiment 14** To implement spliced alignment for RNA-seq data analysis.	2
Total Hours		**28**

Textbook :

1 Bioinformatics Algorithms: An Active Learning Approach, Phillip Compeau and Pavel Pevzner, Active learning publisher, 2018

References:

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

2 Combinatorial Pattern Matching Algorithms in Computational Biology Using Perl and R, Combinatorial Pattern Matching Algorithms in Computational Biology Using Perl and R, Gabriel Valiente, CRC Press, 2017

3 Methods for Computational Gene Prediction, Methods for Computational Gene Prediction, William H. Majoros, Cambridge Press, 2007

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

Suggested Theory Distribution:

The suggested theory distribution as per Bloom's taxonomy is as follows. This distribution serves as guidelines for teachers and students to achieve effective teaching-learning process

Distribution of Theory for course delivery and evaluation

Remember / Knowledge	Understand	Apply	Analyze	Evaluate	Higher order Thinking / Creative
0.00	0.00	35.00	35.00	30.00	0.00

Instructional Method:

1 The course delivery method will depend upon the requirement of content and need of students. The teacher in addition to conventional teaching method by black board, may also use any of tools such as demonstration, role play, Quiz, brainstorming, MOOCs etc.

2 The internal evaluation will be done on the basis of continuous evaluation of students in the laboratory and class-room.

3 Practical examination will be conducted at the end of semester for evaluation of performance of students in laboratory.

Supplementary Resources:

1 https://onlinecourses.nptel.ac.in/noc21_bt06/preview

2 https://nptel.ac.in/courses/102106065

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