A. Course General Information:

Course Code:	**CSE43**
Course Title:	**Bioinformatics**
Credit Hours (Theory):	3
Contact Hours (Theory):	3
Category:	Program Elective
Type:	Theory, Lecture + Lab
Prerequisites:	CSE221: Algorithms
Co-requisites:	None

B. Course Catalog Description (Content):

Introduction to molecular biology and genetics: cell structure, central dogma, regulation of gene expression, Mendel's laws; Sequencing based assays: RNA-seq, ChIP-seq; Genome assembly; Sequence alignment and multiple sequence alignment: Needleman-Wunsch algorithm, Smith-Waterman algorithm; Phylogenetics: neighbor joining, statistical phylogenetics; Biological Databases: gene ontology, protein and nucleotide databases, data retrieval; Genome annotation: gene finding, regulatory motifs; Gene expression analysis: clustering, classification; Association Mapping; Single Cell RNA-Seq: challenges and applications; Structure, alignment and function prediction of RNA and Proteins; Protein Translational Modifications; Protein-protein interactions (PPI): introduction, experimental detection, prediction, dynamic PPI, PPI network; Drug design: docking and binding; Epigenetics; Gene Editing; Topics in population genetics: mutation, fixation, selection, drift, migration; Systems biology: pathways, networks.

C. Course Objective:

1. Understand the fundamentals of molecular biology, genetics, and gene regulation.
2. Learn core sequencing technologies (e.g., RNA-seq, ChIP-seq) and genome assembly methods.
3. Apply sequence alignment and phylogenetic techniques to analyze biological data.
4. Use biological databases for gene, protein, and functional annotation.
5. Analyze gene expression data through clustering, classification, and association mapping.
6. Explore protein structure, function prediction, interactions, and drug design principles.
7. Examine advanced topics including single-cell RNA-seq, epigenetics, gene editing, and systems biology.

D. Course Outcomes:

#	Course Outcome	PO	Bloom's Taxonomy Level	Delivery methods and activities	Assessment tools
CO1	Apply fundamental biological concepts and computational methods to analyze DNA, RNA, and protein sequences.	**b**			
CO2	Utilize bioinformatics tools and databases (e.g., BLAST, GenBank, UniProt) for sequence alignment, annotation, and functional prediction.	**e**			
CO3	Interpret results from genome assembly, phylogenetic analysis, and structural bioinformatics to solve biological problems.	**d**			
CO4	Design and implement basic pipelines for high-throughput biological data analysis using scripting languages and statistical approaches.	**c**			

E. Text and Reference Books:

1. [B1] Bioinformatics Algorithms: An Active Learning Approach Vol I&II Book by Pavel A. Pevzner and Phillip Compeau
2. [B2] Genome-Scale Algorithm Design Bioinformatics in the Era of High-Throughput Sequencing, Second Edition, Makinen et al.
3. Understanding Bioinformatics by Jeremy Baum and Marketa J. Zvelebil
4. A First Course in Systems Biology Book by Eberhard Voit

F. Lesson Plan

Lecture	Topic	CO	Text Book Ref
1	Introduction to Molecular Biology and Bioinformatics, Introduction to	CO1	

	genomic technologies, History of Bioinformatics		
2	Finding Origin of Replication	CO1	
3+4	Finding Regulatory Motifs	CO2	
5	Genome Assembly: De bruijn Graphs		
6+7	Understanding Sequencing Data, Error and Read Mapping		
8	Sequence Alignment: Global and Local, Blast, Gapped Blast, Dynamic Programming		
9	Hidden Markov Models and Predictions, Coding Region Prediction, HMM Profile	CO3	
10	Gene Expression Analysis: Clustering, Visualization, Dimensionality Reduction	CO2	
11	Single Cell RNA-Seq Data and Spatial Transcriptomics Data: Data Processing Pipeline	CO2	
	Mid Exam		
7	Phylogenetic Trees	CO3	
8	Biological Networks	CO4	
9	Gene Ontology and Biological Pathways	CO4	
10	Evolutionary Genomics, Comparative Genomics	CO4	
11	Deep Learning in Bioinformatics	CO1	
12	Drug and Protein Structures, Proteomics, Generative AI	CO3	
	Final Exam		

G. Assessment Tools:

Assessment Tools	**Weightage (%)**
Quiz	15
Assignment	10
Term Project	20
Midterm	25
Final	30

H. CO Attainment Policy: As per the course outcome attainment policy of the Department of Computer Science and Engineering.

I. Grading policy: As per the grading policy of the Department of Computer Science and Engineering.