TECHNO INDIA UNIVERSITY

WEST BENGAL

Syllabus

for

4-Years B.Tech.

in

Computer Science and Engineering
(Specialization in Artificial Intelligence)

Academic Year: 2024-2025

Semester 8

Bioinformatics (TIU-UCS-E460B)

Program: B. Tech. in CSE-AI	**Year, Semester**: 4th Year, 8th Semester
Course Title: Bioinformatics	**Subject Code**: TIU-UCS-E460B
Contact Hours/Week: 3–0–0 (L–T–P)	**Credit**: 3

COURSE OBJECTIVE

Enable the student to:

1. Gain a solid understanding of the core principles and concepts in bioinformatics.
2. Develop skills in DNA, RNA, and protein sequence alignment, similarity searching.
3. Understand how to utilize and navigate biological databases, such as GenBank, PDB, and UniProt, for retrieving biological data.
4. Learn methods for analyzing high-throughput data, including gene expression, microarray, and RNA-Seq data.

COURSE OUTCOME

The student will be able to:

CO-1:	Understand the genesis of Bioinformatics, comparison with its allied disciplines, theoretical and computational models and its significance in biological data analysis.	K2
CO-2:	Explain nucleic acid and protein sequence databases, structural databases, literature databases, genome and organism-specific databases.	K4
CO-3:	Describe retrieval tools of biological data, database similarity searching, biological file formats.	K3
CO-4:	Analysis and development of models for better interpretation of biological data to extract knowledge.	K3
CO-5:	Apply machine learning and statistical techniques for biological data analysis	K3
CO-6:	Develop bioinformatics applications using computational tools and programming.	K2

COURSE CONTENT

MODULE 1:	**INTRODUCTION**	**8 Hours**
Introduction to bioinformatics; Bioinformatics Applications; Central Dogma of Molecular Biology; Genome projects; Sequence analysis, Homology and Analogy.		
MODULE 2:	**BIOLOGICAL RESOURCES**	**7 Hours**

Protein Information Resources**:** Introduction; Biological databases; Primary Sequence Databases; Composite Protein Sequence Databases; Secondary Databases; Composite protein pattern databases; Structure classification databases Genome Information Resources: Introduction; DNA sequence databases; Specialized Genomic Resources		
MODULE 3:	**DNA SEQUENCE ANALYSIS**	**6 Hours**
Gene structure and DNA sequence; Features of DNA sequence analysis; Issues in interpretation of EST searches; Different approaches to EST analysis; Effects of EST data on DNA databases.		
MODULE 4:	**PAIRWISE SEQUENCE ALIGNMENT**	**7 Hours**
Database searching; Alphabet and Complexity; Algorithms and Programs; Comparing two sequences; Identity and Similarity; Local and global similarity; Global alignment: the Needleman and Wunsch algorithm; Local alignment: the Smith-Waterman algorithm; Dynamic Programming; Pairwise database searching; Basic Local Alignment Search Tool (BLAST).		
MODULE 5:	**MULTIPLE SEQUENCE ALIGNMENT**	**7 Hours**
Goal of Multiple Sequence Alignment (MSA); Purpose of MSA; Dynamic programming solution for multiple alignment; Methods of alignment.		
MODULE 6:	**PROTEIN SECONDARY STRUCTURE PREDICTIONS**	**5 Hours**
Structure of protein; Different level of protein structure; Basics of machine learning; Methods for predicting secondary structure: Chou-Fasman method, Garnier-Osguthorpe-Robson method, Neural Network based method.		
MODULE 7:	**BIOMEDICAL TEXT MINING**	**5 Hours**
Named entity recognition; Document classification and clustering; Relationship discovery; Information extraction; Information retrieval and question answering; Applications of biomedical text mining.		
	TOTAL LECTURES	**45 hours**

Books:

1. T K Attwood, D J Parry-Smith, Samiron Phukan; Introduction to bioinformatics, Pearson
2. S. C. Rastogi, P. Rastogi, N. Mendiratta; Bioinformatics Methods And Applications: Genomics Proteomics And Drug Discovery, PHI.
3. Bryan Bergeron, Bioinformatics Computing, Pearson
4. S. Harisha, Fundamentals of Bioinformatics, I.K International

Deep Learning (TIU-UCS-E460A)

Program: B. Tech. in CSE-AI	**Year, Semester:** 4th Yr., 8th Sem.
Course Title: Deep Learning	**Subject Code:** TIU-UCS-E460A
Contact Hours/Week: 3–0–0 (L–T–P)	**Credit:** 3

COURSE OBJECTIVE :

Enable the student to:

1. Grasp the core concepts, architectures, and mathematical foundations of deep neural networks.
2. Develop and train deep learning models using frameworks like TensorFlow and PyTorch.
3. Apply techniques such as backpropagation, dropout, and batch normalization for improved performance.
4. Analyze CNNs, RNNs, GANs, and Transformers for specialized applications.

COURSE OUTCOME :

The student will be able to:

CO-1:	Explain deep learning concepts, neural network architectures, and activation functions with real-world applications.	K2
CO-2:	Apply training algorithms and optimization techniques to enhance neural network performance.	K3
CO-3:	Implement CNNs for image classification, leveraging architectures and transfer learning	K3
CO-4:	Analyze RNNs and sequence models for processing sequential data like text and time series.	K3
CO-5:	Develop generative models (autoencoders, GANs) for data generation and feature extraction.	K4
CO-6:	Evaluate ethical considerations, model interpretability, and responsible AI deployment.	K4

COURSE CONTENT :

MODULE 1:	**INTRODUCTION TO TENSORFLOW AND FEATURE ENGINEERING**	**10 Hours**
Feature Selection vs Feature Extraction, Introduction to TensorFlow and Keras Framework: Computational Graph, creating a Graph, Regression example, Gradient Descent, Modularity, Sharing Variables.		
MODULE 2:	**ACTIVATION FUNCTIONS, ANN, AND OPTIMIZATION TECHNIQUES**	**12 Hours**
Activation Functions Sigmoid, ReLU, Hyperbolic Fns, SoftMax, Artificial Neural Networks: Introduction, Perceptrons, Gradient Descent Rule: Stochastic Gradient Descent, Backpropagation, ANN Optimization and Regularization: Overfitting and Capacity, Cross Validation, Bias Variance Tradeoff, Regularization, Hyperparameters.		

MODULE 3:	**DEEP LEARNING APPLICATIONS AND NEURAL NETWORKS**	**12 Hours**
Deep Learning applications: Image Processing, Natural Language Processing, Speech Recognition, Introduction to Convolutional Neural Networks, Kernel, Multiple Filters, CNN applications, Introduction to Recurrent Neural Networks: Introduction to RNNs, Unfolded RNNs, Seq2Seq RNNs, vanishing vs Exploding Gradient Problem in RNN, LSTM, RNN applications.		
MODULE 4:	**AUTOENCODERS AND THEIR VARIANTS**	**6 Hours**
Auto Encoder: Types of Auto Encoder (Stacked AE, Denoising AE, Convolutional AE, Deep Autoencoders),		
MODULE 5:	**TRANSFER LEARNING IN TEXT AND IMAGE PROCESSING**	**5 Hours**
Concept of Transfer Learning in Text (BERT) and Image Processing (ALEXNET, VGG16, VGG19).		
	TOTAL LECTURES	**45 Hours**

Books:

1. Goodfellow, I., Bengio,Y., and Courville, A., Deep Learning, MIT Press, 2016.
2. Bishop, C. ,M., Pattern Recognition and Machine Learning, Springer, 2006.
3. Yegnanarayana, B., Artificial Neural Networks PHI Learning Pvt. Ltd, 2009.
4. Golub, G.,H., and Van Loan,C.,F., Matrix Computations, JHU Press,2013.
5. Satish Kumar, Neural Networks: A Classroom Approach, Tata McGraw-Hill Education, 2004.

Information Retrieval (TIU-UCS-E460C)

Program: B. Tech. in CSE-AI	**Year, Semester:** 4th Yr., 7th Sem.
Course Title: Information Retrieval	**Subject Code:** TIU-UCS-E460C
Contact Hours/Week: 3–0–0 (L–T–P)	**Credit:** 3

COURSE OBJECTIVE:

Enable the student to:

1. Introduce the core concepts, principles, and architecture of information retrieval systems.
2. Study and compare classical and modern retrieval methods
3. Develop and evaluate search engines and retrieval systems using algorithms.
4. Examine emerging trends such as semantic search, deep learning-based retrieval, question-answering systems etc.

COURSE OUTCOME (COs):

The students will be able to:

CO1:	Understand the fundamentals of Information Retrieval (IR) systems, including corpus and IR techniques.	K2
CO2:	Learn about IR data structures such as inverted indexing, dictionaries, and posting lists.	K3
CO3:	Analyze different IR techniques, including Boolean retrieval models.	K3

CO4:	Explore web search paradigms, including the PageRank algorithm.	K4
CO5:	Investigate various applications of IR techniques in real-world scenarios.	K3
CO6:	Implement and evaluate IR systems using metrics like precision, recall, and F-measure.	K3

COURSE CONTENT:

MODULE 1:	**INTRODUCTION TO INFORMATION RETRIEVAL**	**8 Hours**
Basics of Information Retrieval Systems. Differences between Data Retrieval and Information Retrieval. Components of IR System. IR Models: Boolean, Vector Space, and Probabilistic Models. Relevance Feedback & Query Expansion.		
MODULE 2:	**INDEXING AND DATA STRUCTURES**	**8 Hours**
Tokenization, Stop Words, Stemming, Lemmatization. Inverted Index Construction. Index Compression: Dictionary & Posting List Compression. Skip Pointers and Positional Indexes. Signature Files and Suffix Trees		
MODULE 3:	**IR SYSTEM EVALUATION**	**8 Hours**
Performance Measures: Precision, Recall, F-measure, MAP, NDCG. ROC Curves and Evaluation Strategies Experimental Design and Benchmarking Datasets. Relevance Judgment and User Interaction Studies.		
MODULE 4:	**WEB SEARCH AND CRAWLING**	**8 Hours**
Search Engine Architecture. Web Crawlers and Focused Crawling. Link Analysis: PageRank, HITS Algorithm, Handling Duplicates, Spam Detection. Query Log Analysis and Click-through Data		
MODULE 5:	**MACHINE LEARNING IN INFORMATION RETRIEVAL**	**8 Hours**
Text Classification and Clustering. Learning to Rank (LTR) Models: Pointwise, Pairwise, Listwise Approaches Neural IR: Word Embeddings, BERT in Search. Personalization and Context-aware Search. Query Understanding and Auto-suggestions		
MODULE 6:	**ADVANCE TOPICS AND TRENDS IN IR**	**5 HOURS**
Conversational Search and Question Answering Systems. Deep Learning in IR: Transformer-based Models. Cross-Language Information Retrieval (CLIR). Knowledge Graphs and Semantic Search. Privacy and Ethical Considerations in IR.		
	TOTAL LECTURES	**45 Hours**

Books:

1. C. D. Manning, P. Raghavan & H. Schütze – "Introduction to Information Retrieval", Cambridge University Press

2. R. Baeza-Yates & B. Ribeiro-Neto – "Modern Information Retrieval: The Concepts and Technology Behind Search", Pearson Education
3. S. Buttcher, C. L. A. Clarke & G. V. Cormack – "Information Retrieval: Implementing and Evaluating Search Engines", MIT Press
4. D. A. Grossman & O. Frieder – "Information Retrieval: Algorithms and Heuristics", Springer

Game Theory for AI and Data Science (TIU-UCS-E460D)

Program: B. Tech. in CSE-AI	**Year, Semester:** 4th Yr., 7th Sem.
Course Title: Game Theory for AI & Data Science	**Subject Code:** TIU-UCS-E460D
Contact Hours/Week: 3–0–0 (L–T–P)	**Credit:** Theory–3

COURSE OBJECTIVE :

Enable the student to:

1. Learn key concepts like Nash equilibrium, dominant strategies, and payoff matrices.
2. Apply game-theoretic models to AI, machine learning, and multi-agent systems.
3. Explore zero-sum, non-zero-sum, and cooperative games in data-driven environments.
4. Solve problems in economics, cybersecurity, auctions, and social networks using game-theoretic approaches.

COURSE OUTCOME :

The student will be able to:

CO-1:	Understand the fundamentals of machine learning, game theory, and reinforcement learning.	K2
CO-2:	Apply machine learning and game theory to real-world optimization and decision-making problems.	K3
CO-3:	Analyze different types of games, strategies, and mixed-strategy solutions.	K3
CO-4:	Design and implement multi-agent AI systems.	K4
CO-5:	Apply reinforcement learning techniques to real-world scenarios.	K3
CO-6:	CO6: Evaluate and optimize machine learning and game theory models.	K4

COURSE CONTENT :

MODULE 1:	**INTRODUCTION**	**8 Hours**
Introduction to Linear Programming, Introduction to Game Theory, Introduction to Different types of Learning including Reinforcement Learning.		
MODULE 2:	**CLASSIFICATION AND CONCEPT LEARNING**	**8 Hours**
Linear Programming Models, The Simplex Method, Concepts of Duality and Sensitivity, Relationship between Linear Programming and Game Theory.		
MODULE 3:	**LINEAR AND PROBABILISTIC MODELS**	**8 Hours**

Terminologies of Game Theory, Different types of games and their strategies, Methods of solving games with mixed strategies, Decision Making in Game Theory.		
MODULE 4:	**DISTANCE BASED MODELS**	**8 Hours**
Multiagent framework, Representation of Games, Computing strategies, Group decision making, Belief networks and other Knowledge-based systems		
MODULE 5:	**RULE BASED AND TREE BASED MODELS**	**8 Hours**
Fundamentals of Reinforcement Learning, Value Based and Policy Based, Multi-Agent Reinforcement Learning, Markov Decision Process & Dynamic Programming, Application of Game Theory in Deep Reinforcement Learning.		
MODULE 6:	**TRENDS IN MACHINE LEARNING**	**5 Hours**
Generative Models, Discriminative models, Different types of GANs, Application of Game Theory in GAN.		
	TOTAL LECTURES	**45 Hours**

Books:

1. An Introduction to Linear Programming and Game Theory - Paul R. Thie, G. E. Keough, A JOHN WILEY & SONS, INC., PUBLICATION
2. A Gentle Introduction to Game Theory – Saul Stahl, American Mathematical Society
3. Reinforcement Learning Algorithms with Python – Andrea Lonza, Packt Publishing
4. GANs in Action: Deep learning with Generative Adversarial Networks - Jakub Langr, Vladimir Bok, Manning Publications

Project-II (Final Thesis/Dissertation) (TIU-UCS-D498)

Program: B.Tech. in CSE-AI	**Year, Semester:** 4th, 8th.
Course Title: Project-II (Final Thesis/Dissertation)	**Subject Code:**TIU-UCS-D498
Contact Hours/Week: 0–4–8	**Credit:** 8

COURSE OBJECTIVE :

Enable the student to:

1. Introduce students to research methodologies and techniques for identifying and formulating research problems in computer science.
2. Equip students with the ability to conduct a structured literature review and critically analyze existing research.
3. Develop students' skills in identifying research gaps and formulating clear, well-defined research objectives aligned with industry and academic needs..

COURSE OUTCOME :

On completion of the course, the student will be able:

CO-1	Design and develop a technical solution using programming, algorithms, or frameworks.	K6
CO-2	Implement appropriate methodologies for research-driven software or hardware solutions.	K3
CO-3	Evaluate and validate project performance using relevant benchmarks.	K5
CO-4	Analyze and interpret research findings based on computational experiments.	K4
CO-5	Identify potential areas for improvement and propose future research directions.	K4
CO-6	Document and present research findings effectively through reports and presentations.	K6

COURSE CONTENT :

Module-1	**SOFTWARE/AI MODEL DEVELOPMENT & THEORETICAL FRAMEWORK**
Developing AI-based solutions, software applications, or network security models. Selecting appropriate datasets, tools, and programming languages. Evaluating model/system performance using metrics like accuracy, latency, security level, etc.	
Module-2	**RESEARCH IMPLEMENTATION & EXPERIMENTATION**
Experimenting with algorithms, software design, or system architecture. Performance benchmarking, debugging, and optimization. Comparing results with existing research to validate improvements.	
Module-3	**CONCLUSION & FUTURE SCOPE**
Summarizing research findings and project outcomes. Discussing industry impact and real-world applications. Identifying future advancements and open research problems.	

Career Advancement & Skill Development-VII: Values and Ethics (TIU-UMG-S400)

Program: B. Tech. in CSE-AI	**Year, Semester: 4th**Yr., 8th Sem.
Course Title: Career Advancement & Skill Development-VIII: Values and Ethics	**Subject Code:** TIU-UMG-S400
Contact Hours/Week: 2–0–0 (L–T–P)	**Credit:** Sessional–2

COURSE OBJECTIVE :

Enable the student to:

1. prepare students for job interviews by understanding recruiter expectations and effective communication.
2. develop skills in resume writing, cover letter drafting, and SOP preparation for career opportunities.

3. familiarize students with corporate expectations, workplace etiquette, and professional growth strategies.

COURSE OUTCOME :

The student will be able to:

CO-1	Describe the interview process and the recruiter's perspective on candidate evaluation.	K1
CO-2	Identify various job roles and the associated skills required in the Electronics and Communication Engineering (ECE) domain.	K1
CO-3	Apply resume writing, cover letter drafting, and statement of purpose (SOP) preparation techniques.	K3
CO-4	Analyze common interview and written test questions for specific job roles and develop response strategies.	K4
CO-5	Explain corporate expectations from newly joined employees and the importance of workplace etiquette.	K2
CO-6	Develop strategies to adapt to corporate culture, manage time effectively, and build professional networks.	K3

COURSE CONTENT :

Module-1:	**INTERVIEW PROCESS AND APPROACH**	**8 Hours**
Interview Process from Recruiter's Perspective, Types of Interviews (HR, Technical, Behavioral, Case-Based), Job Description Analysis, Role-Specific Interview Preparation, Effective Communication and Body Language, Mock Interviews and Feedback.		
Module-2:	**JOB ROLES AND INTERVIEW PREPARATION**	**6 Hours**
Job Roles in Electronics and Communication Engineering (ECE), Responsibilities and Required Skills, Common Interview and Written Test Questions, Technical and Aptitude-Based Question Strategies, Industry Expectations from Fresh Graduates.		
Module-3:	**RESUME, COVER LETTER, AND SOP WRITING**	**8 Hours**
Resume Structure and Key Components, Tailoring Resumes for Different Roles, Common Resume Mistakes, Cover Letter Writing (Format and Customization), Statement of Purpose (SOP) Writing (Purpose and Structure), Resume and SOP Review Sessions.		
Module-4:	**CORPORATE EXPECTATIONS AND SUCCESS STRATEGIES**	**8 Hours**
Employer Expectations from New Employees, Workplace Etiquette and Professionalism, Adapting to Corporate Culture, Time Management and Productivity, Networking and Professional Relationship Building, Overcoming Common Workplace Challenges.		
	TOTAL LECTURE	**30 Hours**

Books:

1. Bolles, R. N. (2018). What color is your parachute? A practical manual for job-hunters and career-changers. Ten Speed Press.
2. Yate, M. (2017). Knock 'em dead: The ultimate job search guide. Adams Media.

3. Guffey, M. E., & Loewy, D. (2016). Essentials of business communication (10th ed.). Cengage Learning.
4. Carnegie, D. (2011). How to win friends and influence people in the digital age. Simon & Schuster.
5. Weiss, J. (2014). Welcome to the real world: Finding your place, perfecting your work, and turning your job into your dream career. Hachette Books.