Gates Institute of Technology
(Autonomous)

Affiliated to

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR
(Established by Govt. of A.P., ACT No.30 of 2008)
ANANTHAPURAMU – 515 002 (A.P) INDIA

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B. Tech (Regular-Full time)

(Effective for the students admitted into I B.Tech from the Academic B.Tech 2023-24 onwards)

CSE-ARTIFICIAL INTELLIGENCE

COURSE STRUCTURE

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SYLLABUS

III B.Tech I Semester

S.No	Course Code	Title	L	T	P	Credits
1	23AIT03	Natural Language Processing	3	0	0	3
2	23AIT04	System Software Programming	3	0	0	3
3	23AIT05	Computer Vision & Image Processing	3	0	0	3
4	23CST12	Introduction to quantum technologies and Applications	3	0	0	3
5	23AIT06a 23AIT06b 23AIT06c 23AIT06d	**Professional Elective-I** 1. Data Visualization 2. Soft computing 3. Exploratory Data Analysis with Python 4. Computational Intelligence	3	0	0	3
		Open Elective- I	3	0	0	3
6	23AIP02	Computer Vision & NLP Lab	0	0	3	1.5
7	23AIP03	AI & System Programming Lab	0	0	3	1.5
8	23CSP12	**Skill Enhancement course** Full Stack Development-II	0	1	2	2
9	23ECP09	Tinkering Lab	0	0	2	1
10	23AICSP	Evaluation of Community Service Internship	-	-	-	2
		Total	**18**	**1**	**10**	**26**

Open Elective – I

S.No.	Course Code	Course Name	Offered by the Dept.
1	23CET12	Green Buildings	CIVIL
2	23CET13	Construction Technology and Management	
3	23EET13	Electrical Safety Practices and Standards	EEE
4	23MET14	Sustainable Energy Technologies	ME
5	23ECT17	Electronic Circuits	ECE
6	23CST12	Quantum Technologies And Applications	CSE & Allied
7	23BST19	Mathematics for Machine Learning and AI	Mathematics
8	23BST20	Materials Characterization Techniques	Physics
9	23BST21	Chemistry of Energy Systems	Chemistry
10	23BST22	English for Competitive Examinations	Humanities
11	23BST23	Entrepreneurship and New Venture Creation	

Note:

1. A student is permitted to register for Honours or a Minor in IV semester after the results of III Semester are declared and students may be allowed to take maximum two subjects per semester pertaining to their Minor from V Semester onwards.
2. A student shall not be permitted to take courses as Open Electives/Minor/Honours with content substantially equivalent to the courses pursued in the student's primary major.
3. A student is permitted to select a Minor program only if the institution is already offering a Major degree program in that discipline.

III B.Tech II Semester

S.No	Course Code	Title	L	T	P	Credits
1	23AIT08	Cloud Computing for AI	3	0	0	3
2	23AIT09	Big Data Analytics & AI Applications	3	0	0	3
3	23AIT10	Full Stack AI Development	3	0	0	3
4	23AIT11a 23AIT11b 23AIT11c 23AIT11d	**Professional Elective-II** 1. Graph Neural Networks 2. Recommender Systems 3. Predictive Analytics 4. Blockchain for AI	3	0	0	3
5	23AIT12a 23AIT12b 23AIT12c 23AIT12d	**Professional Elective-III** 1. AI for Finance 2. Introduction to Quantum Computing 3. Social Network Analysis 4. Cybersecurity & AI-driven Threat Detection	3	0	0	3
6		**Open Elective – II**	3	0	0	3
7	23AIP04	Big Data & Cloud Computing Lab	0	0	3	1.5
8	23AIP05	Full Stack AI Lab	0	0	3	1.5
9	23BSP07	**Skill Enhancement course** Soft skills	0	1	2	2
10	23BST28	**Audit Course** Technical Paper Writing & IPR	2	0	0	-
		Total	**20**	**1**	**8**	**23**
Mandatory Industry Internship of 08 weeks duration during summer vacation						

Open Elective – II

S.No.	Course Code	Course Name	Offered by the Dept.
1	23CET19	Disaster Management	CIVIL
2	23CET20	Sustainability In Engineering Practices	
3	23EET18	Renewable Energy Sources	EEE
4	23MET19	Automation and Robotics	ME
5	23ECT25	Digital Electronics	ECE
6	23BST24	Operations Research	Mathematics
7	23BST29	Mathematical Foundation of Quantum Technologies	
8	23BST25	Physics of Electronic Materials and Devices	Physics
9	23BST26	Chemistry of Polymers and Applications	Chemistry
10	23BST27	Academic Writing and Public Speaking	Humanities

COURSES OFFERED FOR HONOURS DEGREE IN CSE- AI

S. No	Course Code	Course Name	Contact Hours Per Week			Credits
			L	T	P	
1	23AIHT1	Advanced Machine Learning & AI Systems	3	0	0	3
2	23AIHT2	Deep Learning & Neural Networks Architectures	3	0	0	3
3	23AIHT3	Reinforcement Learning & Decision Making	3	0	0	3
4	23AIHT4	AI for Robotics & Automation	3	0	0	3
5	23AIHT5	AI Ethics, Fairness & Explainability	3	0	0	3
6	23AIHP1	AI & Machine Learning Lab	0	0	3	1.5
7	23AIHP2	Robotics & Autonomous Systems Lab	0	0	3	1.5

III B.Tech I Semester

23AIT03	NATURAL LANGUAGE PROCESSING (Professional Core)	L	T	P	C
		3	0	0	3

Course Objective

- Explain and apply fundamental algorithms and techniques in the area of Natural Language Processing (NLP)
- Discuss approaches to syn tax and semantics in NLP.
- Examine current methods for statistical approaches of machine translation.
- Teach machine learning techniques used in NLP.

Course Out comes:

After completion of the course, students will be able to

CO1: Understand the various NLP Applications and Organization of Natural language, able to learn and implement realistic applications using Python.

CO2: Apply the various Parsing techniques, Bayes Rule, Shannon game, Entropy and Cross Entropy.

CO3: Understand the fundamentals of CFG and parsers and mechanisms in ATN's.

CO4: Apply Semantic Interpretation and Language Modelling.

CO5: Apply the concept of Machine Translation and multilingual Information Retrieval systems and Automatic Summarization

UNIT- I Introduction to Natural language

The Study of Language, Applications of NLP, Evaluating Language Understanding Systems, Different Levels of Language Analysis, Representations and Understanding, Organization of Natural language Under standing Systems, Linguistic Back ground: An outline of English Syn tax.

UNIT-II Grammars and Parsing

Grammars and Parsing – Top – Down and Bottom-Up Parsers, Transition Network Grammars, Feature Systems and Augmented Grammars, Morphological Analysis and the Lexicon, Parsing with Features, Augmented Transition Networks, Bayes Rule, Shannon game Entropy and Cross Entropy.

UNIT-III Grammars for Natural Language

Grammars for Natural Language, Movement Phenomenon in Language, Gap Threading, Human Preferences in Parsing, Shift Reduce Parsers, Deterministic Parsers.

UNIT-IV Semantic Interpretation

Semantic &Logical form, Word senses &ambiguity, the basic logical form language, Encoding ambiguity in the logical Form, Verbs &States in logical form, Thematic roles, Speech acts & embedded sentences, Defining semantics structure model theory.

Language Modelling

Introduction, n-Gram Models, Language model Evaluation, Parameter Estimation, Language Model Adaption, Types of Language Models, Language-Specific Modelling Problems, Multilingual and Cross lingual Language Modelling.

UNIT-V Machine Translation

Survey: Introduction, Problems of Machine Translation, Is Machine Translation Possible, Brief History, Possible Approaches, Current Status. Anusaraka or Language Accessor: Background, Cutting the Gordian Knot, The Problem, Structure of Anusaraka System, User Interface, Linguistic Area, Giving up Agreement in Anusarsaka Output, Language Bridges.

Text books:

1. James Allen, Natural Language Understanding, 2nd Edition, 2003, Pearson Education.
2. Multilingual Natural Language Processing Applications: From Theory To Practice- Daniel M.Bikel and Imed Zitouni, Pearson Publications.
3. Natural Language Processing, A paninian perspective, Akshar Bharathi, Vineet chaitanya, Prentice –Hall of India.

Reference Books:

1. Charniack, Eugene, Statistical Language Learning, MITPress,1993.
2. Jurafsky, Dan and Martin, James, Speech and Language Processing, 2nd Edition, Prentice Hall,2008.
3. Manning, Christopher and Hen rich, Schutze, Foundations of Statistical Natural Language Processing, MIT Press,1999.

Online Learning Resources:

https://nptel.ac.in/courses/106/105/106105158/http://www.nptelvideos.in/2012/11/natural-language-processing.html

III B.Tech I Semester

23AIT04	System Software Programming (Professional Core)	L	T	P	C
		3	0	0	3

Course Objectives:

1.To understand the architecture and design of system software including compilers, assemblers, linkers, loaders, and macro processors.

2. To gain in-depth knowledge of programming tools, shell environments, and low-level system utilities.

3. To apply principles of system programming in Unix/Linux environments.

4. To explore process creation, inter-process communication, signal handling, and multi-threading using C/C++.

5.To enable development of foundational tools like simple compilers, parsers, and loaders.

Course Outcomes (COs):

After completion of the course, students will be able to

CO1. Explain the architecture and functions of system software like assemblers, loaders, linkers, and macro processors.
CO2. Apply scanning and parsing techniques for programming language processing.
CO3. Develop and analyze assembly-level programs and understand compilation techniques.
CO4. Implement Unix/Linux system programming tasks such as process creation, pipes, signals, and thread management.
CO5. Demonstrate hands-on experience in shell scripting, debugging, and low-level system tools.

UNIT I: Language Processors and Assemblers

Language processing system overview, Phases of compilation and data structures, Assemblers – features, single pass and two-pass assembler, Intermediate code generation, Literal and symbol tables, Relocation and linking concepts

UNIT II: Macro Processors and Loaders

Macro instruction and features, Nested macros and macro expansion, Macro processing in two-pass assemblers, Design of macro processors, Loaders: absolute, relocating, and linking, Dynamic loading and linking, bootstrap loader

UNIT III: Scanning, Parsing, and Compilers

Language grammars and ambiguity, Lexical analysis – regular expressions, token generation, Syntax analysis – parsing techniques (top-down, bottom-up), Semantic analysis and intermediate code generation, Code optimization techniques – constant folding, dead code elimination

UNIT IV: Linkers, Debuggers, and Shell Programming

Symbol resolution and relocation, Linking (static vs dynamic), relocation records, Debugging techniques and breakpoints, Unix/Linux shell environment, Shell commands, variables, redirection, pipes, control statements, Shell script functions and script-based automation

UNIT V: Unix/Linux System Programming

Introduction to system-level programming in C, File I/O system calls (open, read, write, close), Process creation using fork(), exec(), wait(), Inter-process communication (pipes, FIFO), Signal handling and POSIX threads (pthread_create, pthread_join), Case studies: background processes, daemon creation, mini shell

Text books:

1. Leland L. Beck, D. Manjula, *System Software: An Introduction to Systems Programming*, 3rd Edition, Pearson.
2. Silberschatz, Galvin, Gagne, *Operating System Concepts*, 10th Edition, Wiley (selectively for system calls & programming).

Reference Books:

1. D.M. Dhamdhere, *System Programming and Operating Systems*, McGraw Hill.
2. Neil Matthew, Richard Stones, *Beginning Linux Programming*, Wrox.
3. Andrew S. Tanenbaum, *Modern Operating Systems*, Pearson Education.
4. Yashwant Kanetkar, *Unix Shell Programming*, BPB Publications.

III B.Tech I Semester

23AIT05	COMPUTER VISION AND IMAGE PROCESSING (Professional Core)	L	T	P	C
		3	0	0	3

Course Objectives:

- Introduce fundamental concepts of image processing and computer vision.
- Develop proficiency in applying algorithms for image analysis and interpretation.
- Explore techniques for feature extraction, object recognition, and scene understanding.
- Understand the integration of machine learning methods in computer vision applications.

Course Outcomes:

After completion of the course, students will be able to

CO1: Apply basic image processing and frequency domain techniques for image enhancement and restoration.

CO2: Apply edge detection, segmentation, morphological, and texture analysis techniques for extracting features from images.

CO3: Analyze 3D vision and motion using techniques like stereo vision, optical flow, and camera calibration for scene understanding and depth estimation.

CO4: Evaluate object recognition approaches and machine learning models.

CO5: Implement advanced computer vision applications.

UNIT I: Introduction to Computer Vision and Image Processing

Overview of Computer Vision and Image Processing:Definitions and scope, Historical development and applications, Image Formation and Representation: Image acquisition methods, Sampling and quantization, Color spaces and models, Fundamentals of Image Processing:Point operations (brightness and contrast adjustments), Histogram processing, Spatial filtering techniques Fourier Transform and Frequency Domain Processing:Discrete Fourier Transform (DFT), Filtering in the frequency domain, Image restoration concept.

UNIT II: Image Analysis Techniques

Edge Detection and Feature Extraction:Gradient operators (Sobel, Prewitt), Canny edge detector, Corner and interest point detection, Image Segmentation:Thresholding methods, Region-based segmentation, Clustering techniques (K-means, Mean-Shift), Morphological Image Processing:Erosion and dilation, Opening and closing operations, Applications in shape analysis, Texture Analysis, Statistical methods (co-occurrence matrices), Transform-based methods (Gabor filters), Applications in pattern recognition

UNIT III: 3D Vision and Motion Analysis

Stereo Vision: Epipolar geometry, Disparity mapping, Depth estimation techniques, Structure from Motion (SfM):Feature tracking across frames, 3D reconstruction from motion, Applications in scene understanding, Optical Flow and Motion Analysis:Lucas-Kanade method, Horn-Schunck method, Motion segmentation, Camera Calibration and 3D Reconstruction: Intrinsic and extrinsic parameters, Calibration techniques, 3D point cloud generation

UNIT IV: Object Recognition and Machine Learning in Vision

Feature Descriptors and Matching: Scale-Invariant Feature Transform (SIFT), Speeded-Up Robust Features (SURF), Feature matching algorithms, Object Detection and Recognition:Template matching , Deformable part models, Convolutional Neural Networks (CNNs), Introduction to Machine Learning for Vision:Supervised and unsupervised learning, Support Vector Machines (SVMs), Decision trees and random forests, Deep Learning Architectures:Autoencoders, Recurrent Neural Networks (RNNs), Generative Adversarial Networks (GANs)

UNIT V: Applications and Advanced Topics

Image Compression: Lossy and lossless compression techniques, Standards (e.g., JPEG, PNG), Morphological Image Processing: Dilation, erosion, opening, and closing operations., Applications in shape analysis, Case Studies: Face recognition systems., Automated visual inspection, medical image analysis.

Reference Books

1. Forsyth, D. A., & Ponce, J. (2002). Computer Vision: A Modern Approach. Prentice Hall.
2. Shapiro, L. G., & Stockman, G. C. (2001). Computer Vision. Prentice Hall.

Text books:

1. Gonzalez, R. C., & Woods, R. E. (2008). Digital Image Processing (3rd ed.). Pearson Prentice Hall.Stony Brook University
2. Szeliski, R. (2010). Computer Vision: Algorithms and Applications. Springer.

Online Learning Resources:

1. Coursera: Introduction to Computer Vision and Image Processing. LinkCoursera
2. Stanford University: CS231n: Deep Learning for Computer Vision. Linkcs231n.stanford.edu
3. MIT OpenCourseWare: Introduction to Computer Vision. Link

III B.Tech I Semester

23AIT06a	DATA VISUALIZATION (Professional Elective-I)	L	T	P	C
		3	0	0	3

Course Objectives:

- To understand the principles, techniques, and tools of data visualization.
- To develop the ability to transform data into visual insights using different types of charts and plots.
- To introduce the cognitive and perceptual foundations of effective data visualization.
- To apply tools and programming environments (like Python, Tableau, or Power BI) for creating interactive and dynamic visualizations.
- To analyze real-world datasets and effectively communicate data-driven findings visually.

Course Outcomes:

After completion of the course, students will be able to

CO1: Interpret different types of data and recognize the appropriate visualization methods.

CO2: Design effective and interactive data visualizations using various tools.

CO3: Apply visual encoding and perceptual principles in presenting complex data.

CO4: Analyse and visualize real-world data sets using Python libraries and dashboards.

CO5: Create visual stories and dashboards for effective communication of insights.

UNIT I: Introduction to Data Visualization & Perception

Introduction to Data Visualization, Importance and Scope of Data Visualization, Data Types and Sources, Visual Perception: Pre-attentive Processing, Gestalt Principles, Data-Ink Ratio, Data Density, Lie Factor, Visualization Process and Design Principles, Tools Overview: Tableau, Power BI, Python Libraries

UNIT II: Visualization Techniques for Categorical & Quantitative Data

Charts for Categorical Data: Bar Charts, Pie Charts, Column Charts, Charts for Quantitative Data: Histograms, Line Charts, Boxplots, Scatter Plots, Bubble Charts, Heatmaps, Choosing the Right Chart Type, Best Practices in Labeling, Coloring, and Scaling.

UNIT III: Multidimensional, Temporal and Hierarchical Data Visualization

Visualizing Multivariate Data: Parallel Coordinates, Radar Charts, Time-Series Visualization: Time Plots, Animation over Time, Geographic Data Visualization: Maps, Choropleths, Hierarchical Data: Treemaps, Sunburst Charts, Network and Graph Visualization.

UNIT IV: Data Visualization Using Python and Dashboards

Introduction to Matplotlib, Seaborn, and Plotly, Creating Static and Interactive Charts, Pandas Visualization Capabilities, Dashboards with Dash, Streamlit, Power BI, Case Studies: Real-world Dataset Visualization.

UNIT V: Storytelling with Data and Ethical Visualization

Storytelling and Narrative Techniques in Visualization, Dashboards and Reporting, Misleading Visualizations and Bias, Ethical Principles in Data Visualization, Final Project: Create a Storytelling Dashboard with Real Data.

Text books:

1. Tamara Munzner, Visualization Analysis and Design, CRC Press, 2014.
2. Nathan Yau, Data Points: Visualization That Means Something, Wiley, 2013.

Reference Books:

1. Alberto Cairo, The Truthful Art: Data, Charts, and Maps for Communication, New Riders, 2016.
2. Cole Nussbaumer Knaflic, Storytelling with Data: A Data Visualization Guide for Business Professionals, Wiley, 2015.
3. Claus O. Wilke, Fundamentals of Data Visualization, O'Reilly, 2019.
4. Rohan Chopra, Hands-On Data Visualization with Bokeh, Packt Publishing, 2019.

Online Learning Resources:

1. NPTEL: Data Visualization - IIT Madras
2. Coursera: Data Visualization with Python by IBM

III B.Tech I Semester

23AIT06b	SOFT COMPUTING (Professional Elective-I)	L	T	P	C
		3	0	0	3

Course Objectives:

- Understand the concepts of soft computing techniques and how they differ from traditional AI techniques.
- Introduce the fundamentals of fuzzy logic and fuzzy systems.
- Familiarize with artificial neural networks and their architectures.
- Learn genetic algorithms and their role in optimization.
- Explore hybrid systems integrating fuzzy logic, neural networks, and genetic algorithms.

Course Outcomes:

After completion of the course, students will be able to

CO1: Understand the components and applications of soft computing.
CO2: Apply fuzzy logic concepts to real-world problems.
CO3: Build and train various neural network models.
CO4: Implement genetic algorithms for problem-solving and optimization.
CO5: Design hybrid systems using soft computing techniques.

UNIT I: Introduction to Soft Computing and Fuzzy Logic

Introduction to Soft Computing: Definition, Components, Differences with Hard Computing, Applications of Soft Computing, Fuzzy Logic: Crisp Sets vs Fuzzy Sets, Membership Functions, Fuzzy Set Operations, Fuzzy Rules and Fuzzy Reasoning, Fuzzy Inference Systems: Mamdani and Sugeno Models, Defuzzification Techniques.

UNIT II: Artificial Neural Networks – I

Introduction to Neural Networks: Biological Neurons vs Artificial Neurons, Architecture of Neural Networks: Feedforward, Feedback, Learning Rules: Hebbian, Delta, Perceptron Learning Rule, Single Layer Perceptron and its Limitations, Multi-Layer Perceptron: Backpropagation Algorithm, Applications of Neural Networks

UNIT III: Artificial Neural Networks – II

Hopfield Networks and Associative Memories, Radial Basis Function Networks, Self-Organizing Maps (SOM), Recurrent Neural Networks (RNNs) – Basic Concepts, Convolutional Neural Networks (CNNs) – Overview and Applications, Practical Use Cases in Image and Pattern Recognition,

UNIT IV: Genetic Algorithms and Optimization

Introduction to Genetic Algorithms, GA Operators: Selection, Crossover, Mutation, Fitness Function and Evaluation, Schema Theorem, Elitism, Applications in Function Optimization, Scheduling, and Robotics, Introduction to Particle Swarm Optimization (PSO).

UNIT V: Hybrid Systems and Advanced Topics

Hybrid Systems: Neuro-Fuzzy Systems, Fuzzy-GA, GA-ANN, ANFIS: Architecture and Learning, Case Studies on Hybrid Systems, Introduction to Deep Learning in Soft Computing, Real-World Applications: Forecasting, Control Systems, Medical Diagnosis, Image Processing.

Textbooks:

1. S. N. Sivanandam, S. N. Deepa, "Principles of Soft Computing", Wiley India, 3rd Edition
2. Timothy J. Ross, "Fuzzy Logic with Engineering Applications", Wiley, 4th Edition
3. S. Rajasekaran and G. A. Vijayalakshmi Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis and Applications", PHI

Reference Books:

1. Laurene Fausett, "Fundamentals of Neural Networks: Architectures, Algorithms and Applications", Pearson
2. David E. Goldberg, "Genetic Algorithms in Search, Optimization and Machine Learning", Pearson
3. Simon Haykin, "Neural Networks and Learning Machines", Pearson, 3rd Edition
4. Bart Kosko, "Neural Networks and Fuzzy Systems", Prentice Hall

Online Learning Resources:

1. NPTEL – Soft Computing by Prof. S. Sengupta (IIT Kharagpur)
2. Coursera – Neural Networks and Deep Learning (Andrew Ng)

III B.Tech I Semester

23AIT06c	Exploratory Data Analysis with Python (Professional Elective-I)	L	T	P	C
		3	0	0	3

Course Objectives:

- To introduce the principles and practices of Exploratory Data Analysis (EDA) using Python.
- To teach techniques for data cleaning, preprocessing, transformation, and visualization.
- To apply statistical techniques and visual methods to discover patterns and relationships.
- To gain experience using popular Python libraries such as NumPy, Pandas, Matplotlib, and Seaborn.
- To prepare datasets for further machine learning and predictive modeling.

Course Outcomes:

After completion of the course, students will be able to:

CO1: Understand and apply key concepts of EDA and data preprocessing.
CO2: Perform exploratory analysis using Python libraries and interpret results.
CO3: Handle missing data, outliers, and categorical features effectively.
CO4: Create meaningful visualizations to support data-driven insights.
CO4: Use EDA as a foundation for data science workflows.

UNIT I – Introduction to EDA and Python Environment
Introduction to Data Science and EDA, Importance of EDA in Data Science Life Cycle, Setting up Python Environment: Jupyter, Anaconda, VS Code, Introduction to NumPy and Pandas: Arrays, Series, DataFrames, Data loading, viewing, basic operations (info, describe, shape)

UNIT II – Data Wrangling and Preprocessing
Handling Missing Data (mean, median, drop, interpolation), Dealing with Duplicates, Outliers, and Anomalies, Encoding Categorical Variables (Label, One-hot), Data Transformation: Scaling, Normalization, Binning, Data Types Conversion and Data Type Casting.

UNIT III – Univariate and Bivariate Analysis
Measures of Central Tendency and Dispersion, Distribution Plots: Histograms, Boxplots, KDE, Bar Charts, Count Plots, Pie Charts, Bivariate Analysis: Scatter Plots, Pair Plots, Heatmaps, Correlation and Covariance Analysis

UNIT IV – Data Visualization Techniques
Visualization with Matplotlib and Seaborn, Customizing Plots: Titles, Legends, Labels, Themes, Advanced Visuals: Violin Plots, Strip Plots, Swarm Plots, Multivariate Visualization and Subplots, Plotly and Interactive Visualizations (basic overview)

UNIT V – EDA Case Studies and Real-Time Datasets
Step-by-step EDA on Sample Datasets (Titanic, Iris, Sales, etc.), Outlier Detection Techniques, Feature Engineering Techniques in EDA, EDA Report Generation using Python Notebooks, Preparing Data for Machine Learning Models

Textbooks:

1. **Jake VanderPlas**, Python Data Science Handbook: Essential Tools for Working with Data, O'Reilly, 2016.
2. **Wes McKinney**, Python for Data Analysis, 2nd Edition, O'Reilly, 2018.

Reference Books:

1. **Joel Grus**, Data Science from Scratch, O'Reilly, 2019.
2. **Aurelien Geron**, Hands-On Machine Learning with Scikit-Learn, Keras & TensorFlow, 2nd Edition, O'Reilly, 2019.
3. **Allen B. Downey**, Think Stats: Probability and Statistics for Programmers, O'Reilly, 2014.

Online Learning Resources:

1. NPTEL Course – Data Science for Engineers
2. Coursera – Applied Data Science with Python Specialization (University of Michigan)

III B.Tech I Semester

23AIT06d	COMPUTATIONAL INTELLIGENCE (Professional Elective-I)	L	T	P	C
		3	0	0	3

Course Objectives:

- Understand the concepts and foundations of computational intelligence.
- Study neural networks, fuzzy logic systems, and evolutionary algorithms.
- Explore hybrid systems and their applications.
- Apply computational intelligence techniques to real-world problem-solving.
- Analyze the effectiveness of various computational intelligence approaches.

Course Outcomes:

After completion of the course, students will be able to:

CO1: Describe and differentiate neural networks, fuzzy logic, and evolutionary computation.
CO2: Apply neural and fuzzy systems for real-time decision-making.
CO3: Analyse complex problems using soft computing tools.
CO4: Develop hybrid intelligent systems.
CO5: Evaluate and compare the performance of CI-based systems.

UNIT I: Introduction to Computational Intelligence and Artificial Neural Networks

Definition and Scope of Computational Intelligence (CI), Components of CI: Neural Networks, Fuzzy Logic, Evolutionary Computation, Biological Neuron vs. Artificial Neuron, McCulloch-Pitts Model, Perceptron, Adaline and Madaline, Multilayer Feedforward Networks, Backpropagation Algorithm, Applications of ANN in Pattern Recognition and Classification.

UNIT II: Fuzzy Logic and Fuzzy Systems

Introduction to Fuzzy Logic and Fuzzy Sets, Membership Functions, Fuzzy Set Operations, Fuzzy Rules and Inference Systems, Fuzzification and Defuzzification, Fuzzy Control Systems, Fuzzy Reasoning and Approximate Reasoning

UNIT III: Evolutionary Computation Techniques

Basics of Evolutionary Algorithms (EA), Genetic Algorithms (GA): Operators, Encoding, Fitness Function, Selection, Crossover and Mutation, Convergence Criteria, Genetic Programming (GP), Differential Evolution (DE), Applications of GA and GP

UNIT IV: Swarm Intelligence and Hybrid Systems

Swarm Intelligence: Ant Colony Optimization (ACO), Particle Swarm Optimization (PSO), Behavior of Swarms and Collective Intelligence, Comparison of Evolutionary Algorithms and Swarm Techniques, Hybrid Systems: Neuro-Fuzzy, Fuzzy-GA, ANN-GA Systems, Case Studies in Hybrid Systems

UNIT V: Applications of Computational Intelligence

CI in Image and Signal Processing, CI for Optimization Problems and Robotics, CI in Biomedical Engineering and Finance, Intelligent Agents and Decision-Making Systems, Real-time Applications and Emerging Trends in CI.

Textbooks:

1. S. Rajasekaran and G. A. Vijayalakshmi Pai, Neural Networks, Fuzzy Logic, and Genetic Algorithms: Synthesis and Applications, PHI Learning.
2. Timothy J. Ross, Fuzzy Logic with Engineering Applications, Wiley India.

Reference Books:

1. S.N. Sivanandam, S. N. Deepa, Principles of Soft Computing, Wiley India.
2. Simon Haykin, Neural Networks and Learning Machines, Pearson.
3. James Kennedy and Russell C. Eberhart, Swarm Intelligence, Morgan Kaufmann.
4. Andries P. Engelbrecht, Computational Intelligence: An Introduction, Wiley.

Online Learning Resources:

1. NPTEL - Computational Intelligence
2. Coursera – Computational Intelligence
3. YouTube: IIT Lectures on Soft Computing and CI

III B.Tech I Semester

23AIP02	Computer Vision and NLP Lab (Professional Core)	L	T	P	C
		0	0	3	1.5

Course Objectives:

- To provide hands-on experience in implementing image processing and computer vision algorithms.
- To familiarize students with natural language processing techniques using Python libraries.
- To enable the integration of CV and NLP for building intelligent applications.

Course Outcomes:

After completion of the course, students will be able to

CO1: Apply image processing techniques for feature extraction and classification.
CO2: Implement NLP techniques such as tokenization, POS tagging, and sentiment analysis.
CO3: Construct a simple sentiment analysis classifier
CO4: Analyse visual and textual data using open-source tools.
CO5: Develop applications that combine Computer Vision and NLP for real-world tasks.

List of Experiments:

1. Load and display an image using OpenCV and perform basic operations like resizing, cropping, and rotation.

2. Apply edge detection (Sobel, Canny) and thresholding techniques on grayscale and color images.

3. Implement image filtering operations: Gaussian, Median, and Bilateral filters.

4. Perform object detection using contour detection and bounding boxes.

5. Detect faces using Haar Cascade or DNN-based pre-trained models in OpenCV.

6. Implement color-based object tracking using HSV space and CamShift algorithm.

7. Preprocess text data (tokenization, stopword removal, stemming, lemmatization) using NLTK/spaCy.

8. Implement Part-of-Speech (POS) tagging and Named Entity Recognition (NER) using spaCy.

9. Build a simple sentiment analysis classifier using bag-of-words or TF-IDF and Naïve Bayes.

10. Perform topic modeling using Latent Dirichlet Allocation (LDA).

11. Extract text from an image using Optical Character Recognition (OCR) with Tesseract and perform text summarization.

12. Final Mini Project: Integrate CV and NLP (e.g., Read text from signboards or documents and translate/summarize it).

Lab Software Requirements:

- **Languages/Tools:** Python, OpenCV, NLTK, spaCy, Tesseract OCR, scikit-learn, NumPy, Pandas, Matplotlib
- **Platforms:** Jupyter Notebook / Google Colab / PyCharm / VS Code

Virtual lab: https://nlp-iiith.vlabs.ac.in/

III B.Tech I Semester

23AIP03	AI & SYSTEM PROGRAMMING LAB (Professional Core)	L	T	P	C
		0	0	3	1.5

Course Objectives:

- To provide practical exposure to foundational AI algorithms and system programming.
- To develop skills to write intelligent systems and low-level programs.
- To integrate concepts of AI and system programming for automation and optimization.

Course Outcomes:

After successful completion of the lab, students will be able to

CO1: Develop a prolog based expert system for medical diagnosis or animal identification
CO2: Implement search algorithms and logic programming using AI tools.
CO3: Construct assemblers, macro processors, and shell scripts.
CO4: Develop system utilities using C and integrate them with AI tools.
CO5: Demonstrate real-time intelligent system automation using scripting and AI logic.

List of experiments:

1. Write simple programs in Prolog for facts, rules, and queries.

2. Develop a Prolog-based expert system for medical diagnosis or animal identification.

3. Implement Depth-First Search (DFS) and Breadth-First Search (BFS) in Python.

4. Implement A* Search Algorithm using heuristics in Python.

5. Implement the Minimax algorithm for a simple game (e.g., Tic Tac Toe).

6. Design and implement a two-pass assembler in C.

7. Implement a Macro Processor using C for assembly language programs.

8. Develop a simple Linux Shell (command interpreter) using C.

9. Write shell scripts for file operations, process creation, and monitoring.

10. Demonstrate inter-process communication using pipes and signals in Linux.

11. Integrate AI logic (search/expert system) into a shell script or system utility for task automation.

12.Final Mini Project: Develop an AI-powered system utility (e.g., Intelligent File Manager, AI Bot for CLI commands).

Lab Software Requirements:

- **Languages:** Python, Prolog, C
- **Tools:** GCC, SWI-Prolog, Linux (Ubuntu/WSL), Shell, Lex/Yacc (optional)
- **IDEs:** Code::Blocks / VS Code / Geany / Terminal-based compilation

Virtual labs: https://www.vlab.co.in/ba-nptel-labs-computer-science-and-engineering

III B.Tech I Semester

23CST12	**INTRODUCTION TO QUANTUM TECHNOLOGIES AND APPLICATIONS** (Qualitative Treatment)	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives (COBJ):

- Introduce fundamental quantum concepts like superposition and entanglement.
- Understand theoretical structure of qubits and quantum information.
- Explore conceptual challenges in building quantum computers.
- Explain principles of quantum communication and computing.
- Examine real-world applications and the future of quantum technologies.

Course Outcomes (CO):

- Explain core quantum principles in a non-mathematical manner.
- Compare classical and quantum information systems.
- Identify theoretical issues in building quantum computers.
- Discuss quantum communication and computing concepts.
- Recognize applications, industry trends, and career paths in quantum technology.

Unit 1: Introduction to Quantum Theory and Technologies

The transition from classical to quantum physics, Fundamental principles explained conceptually: Superposition, Entanglement, Uncertainty Principle, Wave-particle duality, Classical vs Quantum mechanics – theoretical comparison, Quantum states and measurement: nature of observation, Overview of quantum systems: electrons, photons, atoms, The concept of quantization: discrete energy levels, Why quantum? Strategic, scientific, and technological significance, A snapshot of quantum technologies: Computing, Communication, and Sensing, National and global quantum missions: India's Quantum Mission, EU, USA, China

Unit 2: Theoretical Structure of Quantum Information Systems

What is a qubit? Conceptual understanding using spin and polarization, Comparison: classical bits vs quantum bits, Quantum systems: trapped ions, superconducting circuits, photons (non-engineering view),Quantum coherence and decoherence – intuitive explanation, Theoretical concepts: Hilbert spaces, quantum states, operators – only interpreted in abstract,The role of entanglement and non-locality in systems, Quantum information vs classical information: principles and differences, Philosophical implications: randomness, determinism, and observer role

Unit 3: Building a Quantum Computer – Theoretical Challenges and Requirements

What is required to build a quantum computer (conceptual overview)?,Fragility of quantum systems: decoherence, noise, and control, Conditions for a functional quantum system: Isolation, Error management, Scalability, Stability, Theoretical barriers:

Why maintaining entanglement is difficult, Error correction as a theoretical necessity, Quantum hardware platforms (brief conceptual comparison),Superconducting circuits, Trapped ions, Photonics, Vision vs reality: what's working and what remains elusive, The role of quantum software in managing theoretical complexities

Unit 4: Quantum Communication and Computing – Theoretical Perspective

Quantum vs Classical Information, Basics of Quantum Communication, Quantum Key Distribution (QKD),Role of Entanglement in Communication, The Idea of the Quantum Internet – Secure Global Networking, Introduction to Quantum Computing, Quantum Parallelism (Many States at

Once),Classical vs Quantum Gates, Challenges: Decoherence and Error Correction, Real-World Importance and Future Potential

Unit 5: Applications, Use Cases, and the Quantum Future

Real-world application domains: Healthcare (drug discovery),Material science, Logistics and optimization, Quantum sensing and precision timing, Industrial case studies: IBM, Google, Microsoft, PsiQuantum, Ethical, societal, and policy considerations, Challenges to adoption: cost, skills, standardization, Emerging careers in quantum: roles, skillsets, and preparation pathways, Educational and research landscape – India's opportunity in the global quantum race

Textbooks:

1. Michael A. Nielsen, Isaac L. Chuang, *Quantum Computation and Quantum Information*, Cambridge University Press, 10th Anniversary Edition, 2010.
2. Eleanor Rieffel and Wolfgang Polak, *Quantum Computing: A Gentle Introduction*, MIT Press, 2011.
3. Chris Bernhardt, *Quantum Computing for Everyone*, MIT Press, 2019.

Reference Books:

1. David McMahon, *Quantum Computing Explained*, Wiley, 2008.
2. Phillip Kaye, Raymond Laflamme, Michele Mosca, *An Introduction to Quantum Computing*, Oxford University Press, 2007.
3. Scott Aaronson, *Quantum Computing Since Democritus*, Cambridge University Press, 2013.
4. **Alastair I.M. Rae**, *Quantum Physics: A Beginner's Guide*, Oneworld Publications, Revised Edition, 2005.
5. **Eleanor G. Rieffel, Wolfgang H. Polak**, *Quantum Computing: A Gentle Introduction*, MIT Press, 2011.
6. **Leonard Susskind, Art Friedman**, *Quantum Mechanics: The Theoretical Minimum*, Basic Books, 2014.
7. **Bruce Rosenblum, Fred Kuttner**, *Quantum Enigma: Physics Encounters Consciousness*, Oxford University Press, 2nd Edition, 2011.
8. **GiulianoBenenti, GiulioCasati, GiulianoStrini**, *Principles of Quantum Computation and Information, Volume I: Basic Concepts*, World Scientific Publishing, 2004.
9. **K.B. Whaley et al.**, *Quantum Technologies and Industrial Applications: European Roadmap and Strategy Document*, Quantum Flagship, European Commission, 2020.
10. **Department of Science & Technology (DST), Government of India**, *National Mission on Quantum Technologies & Applications – Official Reports and Whitepapers*, MeitY/DST Publications, 2020 onward.

Online Learning Resources:

- IBM Quantum Experience and Qiskit Tutorials
- Coursera – Quantum Mechanics and Quantum Computation by UC Berkeley
- edX – The Quantum Internet and Quantum Computers
- YouTube – Quantum Computing for the Determined by Michael Nielsen
- Qiskit Textbook – IBM Quantum

CSE(AI) III B.Tech II Sem Courses

III B.Tech II Semester

23AIT08	Cloud Computing for AI (Professional Core)	L	T	P	C
		3	0	0	3

Course Objectives:

1. To introduce the concepts, models, and services of cloud computing and its role in AI.
2. To explore the architecture and deployment of AI applications on cloud platforms.
3. To equip students with skills in using cloud-based tools and services for AI/ML workloads.
4. To understand data storage, processing, and security in cloud for AI tasks.
5. To apply cloud computing principles to real-world AI-based solutions.

Course Outcomes:

After completion of this course, students will be able to

CO1: Explain cloud computing architecture, services, and deployment models.
CO2: Utilize cloud platforms (AWS, GCP, Azure) for training and deploying AI models.
CO3: Handle large-scale data storage and processing in the cloud environment.
CO4: Integrate AI workflows using serverless and container-based architectures.
CO5: Analyse challenges in security, cost, scalability, and performance of cloud-based AI systems.

UNIT I: Introduction to Cloud Computing and AI Integration

Basics of Cloud Computing: Characteristics, Models, and Services, Cloud Service Models: IaaS, PaaS, SaaS, Deployment Models: Public, Private, Hybrid, Community, AI and Cloud Convergence: Benefits and Challenges, Use Cases of AI in Cloud: NLP, Vision, Analytics, Overview of Cloud Providers for AI: AWS, Azure, GCP.

UNIT II: Storage, Computing, and Data Processing in the Cloud

Cloud Storage Services: S3, Blob, BigQuery, Virtualization and Elastic Computing, Distributed Computing with Hadoop and Spark, Data Ingestion and Processing Pipelines, Data Lakes and Warehousing in the Cloud, Cost Optimization for Storage and Compute Resources.

UNIT III: Cloud-based Machine Learning and Deep Learning

ML Services on AWS (SageMaker), Azure ML, GCP Vertex AI, Training and Deploying Models on Cloud, AutoML and Custom ML Model Workflows, GPUs/TPUs for Model Training, Experiment Tracking and Model Evaluation, Integration of Notebooks (Jupyter, Colab) with Cloud Storage.

UNIT IV: Advanced Cloud Concepts for AI Applications

Containers and Docker for AI Applications, Kubernetes and Cloud-native AI Workflows, Serverless Computing: AWS Lambda, Azure Functions, CI/CD Pipelines for AI Models in Cloud, Scaling AI Applications using Load Balancers and Auto-Scaling. Monitoring and Logging in Cloud for AI Workflows.

UNIT V: Security, Ethics, and Case Studies in Cloud AI

Security and Privacy in Cloud-based AI, Identity and Access Management (IAM) in Cloud, Cost Management and Billing for AI Services, Ethical Issues and Fairness in Cloud AI, Case Study: AI in Healthcare Cloud Solutions, Case Study: Real-Time Analytics in Financial Cloud Services.

Text books:

1. Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi, Mastering Cloud Computing, McGraw-Hill.
2. Judith Hurwitz et al., Cloud Computing for Dummies, Wiley.
3. Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, O'Reilly.

III B.Tech II Semester

23AIT09	Big Data Analytics & AI Applications (Professional Core)	L	T	P	C
		3	0	0	3

Course Objectives:

1. To introduce the fundamentals of big data and its role in AI-driven applications.
2. To explore big data tools and technologies such as Hadoop, Spark, and NoSQL databases.
3. To enable students to build scalable AI pipelines for data analytics.
4. To apply AI/ML algorithms for real-time and batch processing environments.
5. To demonstrate use cases of big data in domains like healthcare, finance, and IoT using AI.

Course Outcomes:

After completion of the course, students will be able to

CO1: Understand the architecture and ecosystem of big data processing.
CO2: Analyse and manage large-scale datasets using Hadoop and Spark.
CO3: Apply AI/ML techniques to extract insights from big data.
CO4: Design and implement scalable data pipelines using distributed frameworks.
CO5: Solve real-world domain problems with AI-powered big data solutions.

UNIT I: Introduction to Big Data and Analytics Ecosystem
Definition and Characteristics of Big Data – Volume, Velocity, Variety, Veracity, Value, Types of Analytics: Descriptive, Diagnostic, Predictive, Prescriptive, Big Data Challenges and Opportunities, Hadoop Ecosystem Overview: HDFS, MapReduce, YARN, NoSQL Databases: Key-Value, Columnar, Document, Graph Models, Data Lake vs. Data Warehouse.

UNIT II: Big Data Tools and Frameworks
Apache Spark Architecture and RDDs, Spark SQL, DataFrames, and Datasets, Spark Streaming for Real-Time Analytics, Kafka for Data Ingestion and Message Queues, Hive, Pig, and Impala for Big Data Querying, Comparative Analysis of Hadoop vs. Spark.

UNIT III: Machine Learning on Big Data
Introduction to MLlib and Scikit-learn, Data Preprocessing for Big Data ML Pipelines, Supervised Learning: Classification and Regression on Large Datasets, Unsupervised Learning: Clustering and Dimensionality Reduction, Model Evaluation and Validation Techniques, Distributed Training and Optimization Techniques.

UNIT IV: AI Applications on Big Data
Predictive Maintenance using Big Data & AI, Fraud Detection in Banking with Machine Learning, AI in Healthcare: Diagnosis, Genomics, Patient Monitoring, Retail and E-commerce Analytics, AI for Smart Cities and IoT Sensor Data Analysis, Evaluation of Real-Time AI Applications on Streaming Data.

UNIT V: Advanced Topics and Case Studies
Deep Learning on Big Data using TensorFlow on Spark, Explainable AI (XAI) in Big Data Environments, Ethical Issues and Data Governance in Big Data AI, Edge Computing and AI for Low Latency Applications, Case Study 1: AI-Powered Big Data in Healthcare, Case Study 2: Big Data AI Solution in Smart Manufacturing.

Text books:

1. Big Data: Principles and Paradigms by Rajkumar Buyya, Rodrigo N. Calheiros, Amir Vahid Dastjerdi – Wiley
2. Learning Spark: Lightning-Fast Big Data Analysis by Jules S. Damji et al. – O'Reilly
3. Data Science and Big Data Analytics by EMC Education Services – Wiley

Reference Books:

1. Designing Data-Intensive Applications by Martin Kleppmann – O'Reilly
2. Machine Learning with Spark by Rajdeep Dua, Tathagata Das – Packt Publishing
3. Streaming Systems by Tyler Akidau – O'Reilly Media
4. Artificial Intelligence for Big Data by Anand Deshpande – Packt

Online Learning Resources:

- https://www.coursera.org/specializations/big-data – Coursera Big Data Specialization
- https://spark.apache.org/docs/latest/ – Apache Spark Documentation

III B.Tech II Semester

23AIT10	Full stack AI Development (Professional Core)	L	T	P	C
		3	0	0	3

Course Objectives

The course aims to:

1. Introduce students to full stack web development using modern technologies like React, Node.js, and MongoDB.
2. Develop the ability to design, build, and deploy responsive and data-driven web applications.
3. Equip students with knowledge of integrating AI and ML models into full-stack systems for intelligent automation.
4. Provide hands-on experience in Python-based data analysis, visualization, and AI integration.
5. Enable students to apply algorithmic thinking and AI techniques to solve real-world problems using web platforms.

Course Outcomes:

After completion of the course, the student will be able to	
CO1	Explain cloud computing architecture, services, and deployment models.
CO2	Utilize cloud platforms (AWS, GCP, Azure) for training and deploying AI models.
CO3	Handle large-scale data storage and processing in the cloud environment.
CO4	Integrate AI workflows using serverless and container-based architectures.
CO5	Analyse challenges in security, cost, scalability, and performance of cloud-based AI systems.

UNIT - I – Web Foundations using HTML, CSS, JavaScript & GitHub

Overview of Web Development & Full Stack Architecture,HTML5: Structure, Forms, Tables, Multimedia, Semantic Tags,CSS3: Selectors, Layouts, Flexbox, Grid, Responsive Design, Tailwind CSS, JavaScript: Variables, Functions, Arrays, Events, DOM Manipulation, ES6+ Features, Form Elements & Validation: Input types, form handling, and client-side checks, Debugging: Console tools and browser developer utilities, Version Control: Git essentials, branching, merging, pull requests, Project Hosting: GitHub Pages, repository management.

UNIT - II – Backend Development with Node.js, Express, Angular & MongoDB

Introduction to Server-Side Programming using Node.js, Express.js Framework: Routing, Middleware, Body Parsing, CORS, MongoDB: Database setup, Collections, CRUD Operations with Mongoose, AJAX & JSON: Asynchronous data exchange between client

and server, Angular: Components, Forms, Two-Way Data Binding, API Integration, Connecting Frontend → Node.js Server → MongoDB, Authentication (JWT), Optimization Essentials: Query optimization, indexing basics.

UNIT - III – React Framework & Full-Stack Integration

React Fundamentals: Components, Props, State, Hooks, Lifecycle, Forms in React: Controlled vs Uncontrolled Components, Form Validation using React Hook Form / Formik, API Communication with Fetch/Axios, Connecting React → Express → MongoDB, Routing with React Router, State Management using Redux/Context API, Error Handling & Form Submission Feedback, Deployment using Netlify / Render

UNIT IV – Advanced Frontend & Backend Integration

API Design Principles: REST structure, endpoint planning, Data Flow in Full Stack Applications: Client → Server → Database → UI update, Authentication Workflow: Login, protected routes, token handling in frontend, Authorization Basics: Role-based UI control, API access control, File Handling in Full Stack Apps: Image/file upload using Multer, Pagination & Filtering Techniques: Server-side pagination, query filtering in MongoDB, Reusable UI Components: Navigation bars, forms, cards, modals

UNIT V – Full-Stack Application Development & Deployment

Full-Stack Project Architecture: Folder structure for React/Angular + Node + MongoDB, Routing Strategy: Nested routes, layout routes, public vs private paths, Form Modules: Advanced form validation flows, error messaging, user feedback, State Persistence: Local Storage/session storage handling, Media Handling: Serving static images/files from backend, Search & Filter Modules: Frontend search + server-side filtering integration, Notifications & Alerts: Toast, modal-based feedback systems, Project Deployment Steps.

Text Books:

1. Vasan Subramanian, Pro MERN Stack: Full Stack Web App Development with Mongo, Express, React, and Node, 2nd Edition, APress, 2019
2. Node.js, Express & MongoDB Web Development by Brad Dayley, Brendan Dayley & Caleb Dayley, Pearson Education, Latest Edition.

Reference Books:

1. Full-Stack React, TypeScript & Node by David Choi, Packt Publishing.
2. Web Development with Node and Express by Ethan Brown, O'Reilly Media.
3. React Explained by Zac Gordon, LeanPub.
4. MongoDB: The Definitive Guide by Shannon Bradshaw, Eoin Brazil & Kristina Chodorow, O'Reilly Media.

Online Learning Resources:

- https://fullstackopen.com/en/ – Full Stack Open
- https://www.coursera.org/specializations/full-stack – Coursera Full Stack Development

III B.Tech II Semester

23AIT11a	Graph Neural Networks (Professional Elective-II)	L	T	P	C
		3	0	0	3

Course Objectives:

- To introduce the fundamentals of graph theory and graph-structured data.
- To explore the concepts of neural networks extended to non-Euclidean domains.
- To understand architectures and algorithms behind various types of GNNs.
- To apply GNN models in real-world applications such as recommendation, social networks, and bioinformatics.
- To enable students to build and evaluate GNN models using frameworks like PyTorch Geometric and DGL.

Course Outcomes:

After completion of the course, students will be able to

CO1: Understand the basics of graph structures and their significance in machine learning.
CO2: Learn and implement different types of GNN architectures.
CO3: Apply GNNs to real-world structured data problems.
CO4: Use modern libraries and tools to train and evaluate GNNs.
Co5: Analyse the effectiveness and limitations of GNNs in different domains.

UNIT I: Fundamentals of Graph Theory and Machine Learning on Graphs
Introduction to Graphs: Nodes, Edges, Adjacency Matrix, Types of Graphs: Directed, Undirected, Weighted, Bipartite, Graph Traversal Algorithms (BFS, DFS), Graph Representations for ML (Adjacency List, Matrix, Laplacian), Node, Edge, and Graph-level Prediction Problems, Motivation and Challenges for Learning on Graphs.

UNIT II: Spectral and Spatial Methods for Graph Learning
Spectral Graph Theory Basics, Graph Convolution via Spectral Methods, Chebyshev and First-order Approximations, Spatial Graph Convolutions, Comparison of Spectral vs Spatial GNNs, Graph Laplacian and Eigenvalue Properties.

UNIT III: Graph Neural Network Architectures
Graph Convolutional Networks (GCNs), Graph Attention Networks (GATs), GraphSAGE: Sampling and Aggregation, Graph Isomorphism Networks (GIN), Message Passing Neural Networks (MPNNs), Inductive vs Transductive GNN Learning.

UNIT IV: Applications of GNNs
Node Classification (e.g., Cora, Citeseer), Link Prediction (e.g., Recommender Systems), Graph Classification (e.g., Molecule Property Prediction), Traffic Forecasting and Social Network Modeling, GNNs in Healthcare and Bioinformatics, Explainability and Interpretability in GNNs.

UNIT V: Implementation, Optimization, and Recent Advances
Overview of PyTorch Geometric and DGL, Data Loading and Preprocessing for Graph Datasets, Model Training, Loss Functions, and Evaluation Metrics, Hyperparameter Tuning in GNNs, Recent Research Trends and Architectures (e.g., Heterogeneous GNNs, Graph Transformers), Challenges and Future Directions in GNNs.

Text books:

1. Zonghan Wu, Shirui Pan, Fengwen Chen, Guodong Long, Chengqi Zhang, Philip S. Yu, A Comprehensive Survey on Graph Neural Networks, IEEE Transactions on Neural Networks and Learning Systems, 2021.
2. Yao Ma, Jiliang Tang, Deep Learning on Graphs, Cambridge University Press, 2021.
3. William L. Hamilto**n**, Graph Representation Learning, Morgan & Claypool Publishers, 2020.

Reference Books:

1. Barrett, Jure Leskovec, Mining of Massive Datasets, Cambridge University Press.
2. Thomas Kipf, GCN and related papers and tutorials (arXiv).
3. Petar Veličković, Graph Attention Networks (original paper and slides).
4. Michael Bronstein et al.**,**Geometric Deep Learning: Grids, Groups, Graphs, Geodesics, and Gauges (arXiv preprint).

Online Learning Resources:

1. https://pytorch-geometric.readthedocs.io/ – PyTorch Geometric Docs
2. https://cs.stanford.edu/people/jure/ – Stanford GNN Projects
3. https://www.coursera.org/learn/graph-neural-networks – Coursera GNN Course by Stanford

III B.Tech II Semester

23AIT11b	RECOMMENDER SYSTEMS (Professional Elective-II)	L	T	P	C
		3	0	0	3

Course Objectives:

- To understand the theoretical foundations and practical techniques behind recommender systems.
- To explore collaborative, content-based, and hybrid recommendation methods.
- To apply matrix factorization and deep learning for building intelligent recommenders.
- To analyze system performance using standard evaluation metrics.
- To design and implement recommender systems for real-world applications.

Course Outcomes:

After completion of the course, students will be able to

CO1: Explain the core concepts and types of recommender systems.
CO2: Implement basic collaborative and content-based filtering techniques.
CO3: Apply matrix factorization and deep learning models to recommendation problems.
CO4: Evaluate and optimize recommender systems using appropriate metrics.
CO5: Design scalable and context-aware recommender systems for diverse applications.

UNIT I: Introduction to Recommender Systems

Introduction to Information Filtering Systems, Types of Recommender Systems: Content-based, Collaborative, Hybrid, Data Sources: Explicit vs Implicit Feedback, Applications and Challenges in Recommendation, User and Item Profiling, Popularity, Personalization, and Serendipity Trade-offs.

UNIT II: Collaborative Filtering Techniques

User-based Collaborative Filtering, Item-based Collaborative Filtering, Similarity Measures: Cosine, Pearson, Jaccard, Neighborhood Selection and k-NN, Cold-start and Data Sparsity Issues, Memory-based vs Model-based Collaborative Filtering.

UNIT III: Content-based and Hybrid Systems

Item Feature Extraction and Vector Representation, TF-IDF and Cosine Similarity in Recommendations, User Profile Learning, Limitations of Content-based Filtering, Hybrid Recommender Architectures, Case Study: Netflix, Amazon Hybrid Systems.

UNIT IV: Matrix Factorization and Deep Learning Approaches

Latent Factor Models and SVD, ALS and SGD for Matrix Factorization, Non-negative Matrix Factorization (NMF), Neural Collaborative Filtering (NCF), Deep Learning Models: Autoencoders, CNNs, RNNs for Recommendations, Graph-based and Knowledge Graph Recommenders.

UNIT V: Evaluation, Ethics, and Industrial Applications

Evaluation Metrics: Precision, Recall, F1, NDCG, MAP, A/B Testing in Recommender Systems, Explainability in Recommendations, Fairness, Bias, and Privacy in Recommenders, Scalability and Real-time Recommendations, Deploying Recommender Systems at Scale (e.g., Spotify, YouTube).

Text books:

1. **Charu C. Aggarwal**, Recommender Systems: The Textbook, Springer, 2016.
2. **Francesco Ricci, Lior Rokach, and Bracha Shapira**, Recommender Systems Handbook, Springer, 2nd Ed., 2015.

Reference Books:

1. **Jannach, Dietmar et al.**, Recommender Systems: An Introduction, Cambridge University Press, 2010.
2. **Michael Ekstrand, Joseph A. Konstan**, Collaborative Filtering Recommender Systems, Now Publishers, 2011.
3. Research papers from ACM RecSys Conference proceedings.

Online Learning Resources:

- https://www.coursera.org/learn/recommender-systems – Coursera: University of Minnesota
- https://www.kaggle.com/learn/recommendation-systems – Kaggle Course
- https://developers.google.com/machine-learning/recommendation – Google Developers

III B.Tech II Semester

23AIT11c	PREDICTIVE ANALYTICS (Professional Elective-II)	L	T	P	C
		3	0	0	3

Course Objectives:

- To introduce the fundamental concepts and techniques of predictive analytics.
- To apply statistical models and machine learning algorithms for prediction.
- To interpret model performance using evaluation metrics.
- To explore feature engineering, model tuning, and cross-validation.
- To implement predictive solutions for real-world business and research problems.

Course Outcomes:

After completion of the course, students will be able to

CO1: Understand the principles and importance of predictive analytics.
CO2: Apply regression and classification models for predictive tasks.
CO3: Perform data preprocessing, feature selection, and transformation.
CO4: Evaluate and validate models using standard metrics.
CO5: Design predictive solutions to solve domain-specific challenges.

UNIT I: Introduction to Predictive Analytics
Introduction to Predictive Analytics and Business Intelligence, Types of Predictive Models: Classification, Regression, Time Series, Supervised vs Unsupervised Learning, Predictive Modeling Workflow, Applications in Marketing, Finance, Healthcare, Challenges in Predictive Analytics.

UNIT II: Data Preparation and Feature Engineering
Data Cleaning: Handling Missing, Noisy, and Inconsistent Data, Feature Selection and Dimensionality Reduction (PCA, LDA), Feature Scaling: Normalization, Standardization, Encoding Categorical Variables, Feature Extraction and Construction, Dealing with Imbalanced Datasets.

UNIT III: Predictive Modeling with Regression and Classification
Linear Regression and Polynomial Regression, Logistic Regression for Binary Classification, Decision Trees and Random Forest, k-Nearest Neighbors (k-NN) and Naïve Bayes, Support Vector Machines (SVM), Model Selection and Comparison.

UNIT IV: Model Evaluation and Validation
Training, Testing, and Validation Sets, Cross-Validation Techniques (k-Fold, Stratified, LOOCV), Evaluation Metrics: Accuracy, Precision, Recall, F1 Score, ROC-AUC, Confusion Matrix and Classification Report, Bias-Variance Trade-off and Overfitting, Hyperparameter Tuning: Grid Search, Random Search.

UNIT V: Advanced Topics and Applications
Ensemble Learning: Bagging, Boosting (AdaBoost, XGBoost), Predictive Analytics with Time Series (ARIMA, Prophet), Deep Learning for Predictive Modeling (ANNs, LSTM), Use of Predictive Analytics in IoT, Retail, and Healthcare, Ethics and Privacy in Predictive Analytics, Building and Deploying End-to-End Predictive Systems.

Text books:

1. **Dean Abbott**, Applied Predictive Analytics: Principles and Techniques for the Professional Data Analyst, Wiley, 2014.
2. **John D. Kelleher, Brendan Tierney**, Data Science: Predictive Analytics and Data Mining, MIT Press, 2018.

Reference Books:

1. **Galit Shmueli et al.**, Data Mining for Business Analytics: Concepts, Techniques, and Applications in R, Wiley, 2017.
2. **Eric Siegel**, Predictive Analytics: The Power to Predict Who Will Click, Buy, Lie, or Die, Wiley, 2016.
3. **Trevor Hastie, Robert Tibshirani, Jerome Friedman**, The Elements of Statistical Learning, Springer, 2009.

Online Learning Resources:

- https://www.coursera.org/specializations/predictive-analytics – Coursera Specialization
- https://www.edx.org/course/data-science-and-machine-learning-capstone – edX Predictive Analytics Courses
- https://www.kaggle.com/learn/intro-to-machine-learning – Kaggle Tutorials

III B.Tech II Semester

23AIT11d	BLOCKCHAIN FOR AI (Professional Elective-II)	L	T	P	C
		3	0	0	3

Course Objectives:

- To understand the foundational concepts of blockchain technology and its architecture.
- To explore smart contracts, consensus algorithms, and distributed ledger technology.
- To investigate the integration of AI with blockchain for secure, decentralized applications.
- To develop blockchain-enabled AI solutions for real-world use cases.
- To understand the ethical, security, and scalability challenges in Blockchain-AI ecosystems.

Course Outcomes:

After completion of the course, students will be able to

CO1: Explain the fundamentals of blockchain and its components.
CO2: Analyse the role of consensus mechanisms in maintaining trust and decentralization.
CO3: Apply blockchain for secure data sharing in AI systems.
CO4: Develop and deploy smart contracts using Ethereum/Solidity.
CO5: Evaluate blockchain-based AI applications in healthcare, finance, and supply chains.

UNIT I: Blockchain Fundamentals and Architecture

Introduction to Blockchain Technology, Components: Blocks, Hashing, Merkle Trees, Types of Blockchains: Public, Private, Consortium, Distributed Ledger Technology (DLT) and P2P Networks, Blockchain Structure and Mining, Use Cases and Evolution of Blockchain.

UNIT II: Smart Contracts and Consensus Mechanisms

Smart Contracts: Definition, Features, Use Cases, Ethereum and Solidity Basics, Consensus Algorithms: PoW, PoS, DPoS, PBFT, Gas, Transactions, and Events in Ethereum, Hyperledger Fabric: Architecture and Chaincode, Deployment and Testing of Smart Contracts.

UNIT III: Integration of Blockchain and AI

Motivation for Integrating Blockchain with AI, Decentralized AI Models and Federated Learning, Secure Model Sharing and Provenance, Blockchain for Data Integrity in AI Systems, AI for Blockchain (e.g., optimizing consensus), Case Study: Decentralized AI Marketplace.

UNIT IV: Applications of Blockchain in AI Systems

Blockchain for Explainable and Trusted AI, Applications in Healthcare and Genomics, Blockchain for Autonomous Vehicles and IoT, Financial AI Systems with Smart Contracts, Supply Chain and Logistics Intelligence, NFT-based AI Applications (Digital Identity, IP).

UNIT V: Security, Privacy and Challenges in Blockchain-AI

Security Challenges: Sybil Attacks, 51% Attacks, Privacy Preservation and Zero Knowledge Proofs, Scalability and Energy Concerns in Blockchain-AI, Ethical and Legal Concerns in AI with Blockchain, Interoperability of Blockchain Platforms, Future Trends: Quantum-Resistant Blockchain-AI.

Text books:

1. Imran Bashir, Mastering Blockchain: Unlocking the Power of Cryptocurrencies, Smart Contracts, and Decentralized Applications, Packt, 2020.
2. Melanie Swan, Blockchain: Blueprint for a New Economy, O'Reilly Media, 2015.
3. Joseph Holbrook, Architecting AI Solutions on Blockchain, Packt Publishing, 2020.

Reference Books:

1. Arshdeep Bahga, Vijay Madisetti, Blockchain Applications: A Hands-On Approach, VPT, 2017.
2. Karamjit Singh, Blockchain for AI: Use Cases and Implementation, Springer, 2023.
3. Roger Wattenhofer, The Science of the Blockchain, 2016.

Online Learning Resources:

- Coursera: Blockchain Specialization – University at Buffalo
- edX: Blockchain Fundamentals – UC Berkeley
- Coursera: AI and Blockchain – IBM

III B.Tech II Semester

23AIT12a	AI FOR FINANCE (Professional Elective-III)	L	T	P	C
		3	0	0	3

Course Objectives:

- To introduce the role of Artificial Intelligence (AI) in financial applications and decision-making.
- To understand financial data types, sources, and processing methods.
- To apply machine learning and deep learning models in various finance sectors.
- To analyze risk, fraud detection, credit scoring, and portfolio management using AI.
- To evaluate ethical and regulatory challenges in AI-enabled finance.

Course Outcomes:

After completion of the course, students will be able to

CO1: Describe the fundamentals of AI techniques applicable to finance.
CO2: Analyse financial time series data using AI-based models.
CO3: Apply machine learning for fraud detection and credit risk analysis.
CO4: Build predictive models for stock prices, trading, and customer segmentation.
CO5: Evaluate the limitations and ethical implications of AI in financial systems.

UNIT I: Introduction to Finance and AI Applications
Introduction to Financial Markets and Instruments, Overview of AI Techniques in Finance, Types of Financial Data: Market, Transactional, Customer, Financial Statements and Key Indicators, AI Use Cases in Banking, Insurance, and Investment, FinTech and the Rise of Robo-Advisors.

UNIT II: Machine Learning in Finance
Supervised Learning for Credit Scoring, Unsupervised Learning for Customer Segmentation, Feature Engineering for Financial Data, Handling Imbalanced Datasets in Fraud Detection, Time Series Forecasting with Regression and ARIMA, Model Validation and Backtesting in Finance.

UNIT III: Deep Learning and NLP in Finance
Introduction to Deep Learning for Finance, Stock Price Prediction using LSTM and RNNs, Sentiment Analysis from Financial News and Tweets, NLP for Document Classification: Earnings Reports, Chatbots and Virtual Assistants in Banking, Reinforcement Learning for Portfolio Optimization.

UNIT IV: AI-Driven Financial Applications
Fraud Detection Systems using ML and DL, Credit Risk and Loan Default Prediction, AI in Algorithmic and High-Frequency Trading, Robo-Advisors: Architecture and Optimization, Blockchain and AI Integration for Financial Security, Case Studies: AI in Wealth Management & Insurance.

UNIT V: Ethics, Regulation, and Future of AI in Finance
Regulatory Frameworks in AI-based Finance, Explainability and Interpretability of Financial Models, Ethical Issues: Bias, Fairness, Transparency, Data Privacy and GDPR in Financial AI, Responsible AI Practices in Finance, Emerging Trends: Quantum AI, Decentralized Finance (DeFi).

Text books:

1. Yves Hilpisch, Artificial Intelligence in Finance: A Python-Based Guide, O'Reilly, 2020.
2. Yves Hilpisch, Python for Finance: Mastering Data-Driven Finance, O'Reilly, 2018.
3. Markus Loecher, Machine Learning for Finance, Packt Publishing, 2021.

Reference Books:

1. A. W. Lo, The Evolution of Technical Analysis, Wiley Finance, 2010.
2. Tony Guida, Big Data and Machine Learning in Quantitative Investment, Wiley, 2019.
3. Tucker Balch, AI for Trading – Georgia Tech Specialization, Coursera.

Online Learning Resources:

- Coursera: AI for Trading – by NYIF and Google Cloud
- edX: Artificial Intelligence in Finance – NYIF
- Udemy: Machine Learning and AI in Finance
- DataCamp: Financial Trading with Python
- YouTube: AI for Finance by Sentdex, Two Minute Papers, and DataProfessor

III B.Tech II Semester

23AIT12b	QUANTUM COMPUTING (Professional Elective-III)	L	T	P	C
		3	0	0	3

Course Objectives:

- To introduce the principles and mathematical foundations of quantum computation.
- To understand quantum gates, circuits, and computation models.
- To explore quantum algorithms and their advantages over classical ones.
- To develop the ability to simulate and write basic quantum programs.
- To understand real-world applications and the future of quantum computing in AI, cryptography, and optimization.

Course Outcomes:

After completion of this course, students will be able to

CO1: Explain the fundamental concepts of quantum mechanics used in computing.
CO2: Construct and analyse quantum circuits using standard gates.
CO3: Apply quantum algorithms like Deutsch-Jozsa, Grover's, and Shor's.
CO4: Develop simple quantum programs using Qiskit or similar platforms.
CO5: Analyse applications and challenges of quantum computing in real-world domains.

UNIT I: Fundamentals of Quantum Mechanics and Linear Algebra

Classical vs Quantum Computation, Complex Numbers, Vectors, and Matrices, Hilbert Spaces and Dirac Notation, Quantum States and Qubits, Superposition and Measurement, Tensor Products and Multi-Qubit Systems.

UNIT II: Quantum Gates and Circuits

Quantum Logic Gates: Pauli, Hadamard, Phase, Controlled Gates and CNOT, Unitary Operations and Reversibility, Quantum Circuit Representation, Quantum Teleportation, Simulation of Quantum Circuits.

UNIT III: Quantum Algorithms and Complexity

Quantum Parallelism and Interference, Deutsch and Deutsch-Jozsa Algorithms, Grover's Search Algorithm, Shor's Factoring Algorithm, Quantum Fourier Transform, Complexity Classes: BQP, P, NP, and QMA.

UNIT IV: Quantum Programming and Simulation Platforms

Introduction to Qiskit and IBM Quantum Experience, Writing Quantum Circuits in Qiskit, Measuring Qubits and Results, Classical-Quantum Hybrid Programs, Noisy Intermediate-Scale Quantum (NISQ) Systems, Limitations and Current State of Quantum Hardware.

UNIT V: Applications and Future of Quantum Computing

Quantum Machine Learning: Basics and Models, Quantum Cryptography and Quantum Key Distribution, Quantum Algorithms in AI and Optimization, Quantum Advantage and Supremacy,

Ethical and Societal Impact of Quantum Technologies, Future Trends and Research Directions.

Text books:

4. Michael A. Nielsen, Isaac L. Chuang, Quantum Computation and Quantum Information, Cambridge University Press, 10th Anniversary Edition, 2010.
5. Eleanor Rieffel and Wolfgang Polak, Quantum Computing: A Gentle Introduction, MIT Press, 2011.
6. Chris Bernhardt, Quantum Computing for Everyone, MIT Press, 2019.

Reference Books:

11. David McMahon, Quantum Computing Explained, Wiley, 2008.
12. Phillip Kaye, Raymond Laflamme, Michele Mosca, An Introduction to Quantum Computing, Oxford University Press, 2007.
13. Scott Aaronson, Quantum Computing Since Democritus, Cambridge University Press, 2013.

Online Learning Resources:

- IBM Quantum Experience and Qiskit Tutorials
- Coursera – Quantum Mechanics and Quantum Computation by UC Berkeley
- edX – The Quantum Internet and Quantum Computers
- YouTube – Quantum Computing for the Determined by Michael Nielsen
- Qiskit Textbook – IBM Quantum

III B.Tech II Semester

23AIT12c	SOCIAL NETWORK ANALYSIS (Professional Elective-III)	L	T	P	C
		3	0	0	3

Course Objectives:

- To introduce the fundamentals and key concepts of social network theory and graph theory.
- To analyze the structure and properties of large-scale social networks.
- To apply centrality, influence, and community detection measures.
- To model information diffusion and network dynamics.
- To implement real-world social network analysis using tools and datasets.

Course Outcomes:

After completion of the course, the student will be able to

CO1: Understand basic network models and social network structures.
CO2: Analyse key properties like centrality, clustering, and small-world effect.
CO3: Apply community detection algorithms and influence maximization.
CO4: Interpret diffusion models for viral marketing and information spread.
CO5: Use tools such as Gephi, NetworkX, or SNAP for real-world SNA.

UNIT I: Introduction to Social Networks and Graph Theory

Basic Concepts: Graphs, Nodes, Edges, Directed/Undirected Graphs, Real-world Examples: Facebook, Twitter, LinkedIn, Adjacency Matrix and Graph Representation, Types of Social Networks: Ego, Bipartite, Multilayer, Degree Distribution, Path Length, and Connectivity, Random Graph Models: Erdős–Rényi and Watts-Strogatz.

UNIT II: Structural Properties of Networks

Network Centrality Measures: Degree, Closeness, Betweenness, Eigenvector Centrality and PageRank, Network Clustering and Community Detection Basics, Triadic Closure and Clustering Coefficient, Small-world Phenomenon and Milgram's Experiment, Homophily, Influence, and Structural Balance.

UNIT III: Community Detection and Subgroup Analysis

Girvan–Newman Algorithm and Modularity, Label Propagation and Louvain Method, Clique Detection and k-Core Decomposition, Overlapping Communities and Fuzzy Clustering, Cohesive Subgroups and Structural Equivalence, Evaluation Metrics: NMI, Modularity Score.

UNIT IV: Information Diffusion and Influence in Networks

Models of Diffusion: Linear Threshold and Independent Cascade, Influence Maximization and Viral Marketing, Contagion Models and Epidemic Spreading, Rumor Propagation and Cascade Models, Information Bottlenecks and Bridges, Measuring Influence and Reach.

UNIT V: Tools, Applications, and Ethics in SNA

SNA Tools: Gephi, Pajek, NetworkX, SNAP, Case Study: Twitter and Hashtag Analysis, LinkedIn Network Mining and Graph Features, Applications in Marketing, Security, and Epidemiology, Ethical Issues in Social Network Data Mining, Building and Visualizing Your Own Social Graph.

Text books:

1. Wasserman, S., & Faust, K., Social Network Analysis: Methods and Applications, Cambridge University Press, 1994.
2. Easley, D., & Kleinberg, J., Networks, Crowds, and Markets: Reasoning About a Highly Connected World, Cambridge University Press, 2010.
3. Newman, M., Networks: An Introduction, Oxford University Press, 2010.

Reference Books:

1. Borgatti, S. P., Everett, M. G., & Johnson, J. C., Analyzing Social Networks, SAGE Publications, 2018.
2. Barabási, A.-L., Linked: How Everything Is Connected to Everything Else, Basic Books, 2014.
3. Hansen, D., Shneiderman, B., & Smith, M. A., Analyzing Social Media Networks with NodeXL, Elsevier, 2020.

Online Learning Resources:

- Coursera – Social Network Analysis (University of Michigan)
- [YouTube – NetworkX and Gephi Tutorials (freeCodeCamp, TheNetNinja)]
- edX – Networks: Friends, Money, and Bytes (University of California, Berkeley)
- Khan Academy – Graph Theory

III B.Tech II Semester

23AIT12d	CYBERSECURITY & AI-DRIVEN THREAT DETECTION (Professional Elective-III)	L	T	P	C
		3	0	0	3

Course Objectives:

- To provide a foundational understanding of cybersecurity principles and threat landscapes.
- To explore the application of AI and machine learning techniques in detecting cyber threats.
- To analyze malware behavior, intrusion patterns, and anomaly detection using intelligent systems.
- To evaluate and build automated systems for real-time security analytics.
- To understand the ethical, legal, and societal implications of AI-driven security systems.

Course Outcomes:

After completion of the course, students will be able to

CO1: Understand cybersecurity frameworks, threat types, and vulnerabilities.
CO2: Apply AI/ML techniques for cyber threat identification and classification.
CO3: Analyze patterns in malware, network traffic, and security logs.
CO4: Design and evaluate intelligent intrusion detection and prevention systems.
CO5: Explore ethical hacking practices and policy aspects in AI-based security.

UNIT I: Fundamentals of Cybersecurity

Introduction to Cybersecurity: CIA Triad, Threats & Vulnerabilities, Types of Attacks: Malware, Phishing, DDoS, Insider Threats, Security Policies and Access Controls, Risk Assessment and Vulnerability Management, Cryptography Basics: Symmetric, Asymmetric, Hash Functions, Cybersecurity Frameworks: NIST, ISO 27001, OWASP.

UNIT II: Machine Learning for Cyber Threat Detection

Supervised and Unsupervised Learning in Security Contexts, Feature Engineering for Security Data, Classification Models for Intrusion Detection (SVM, RF, KNN), Clustering Techniques for Anomaly Detection, Evaluation Metrics: Accuracy, Precision, ROC, F1 Score, Case Study: AI for Email Phishing Detection.

UNIT III: Deep Learning in Threat Intelligence

Deep Neural Networks for Cybersecurity, RNNs and LSTMs for Log and Sequence Data, Autoencoders for Anomaly Detection, CNNs for Malware Classification using Binary Analysis, Adversarial Attacks on AI-based Security Systems, Case Study: Threat Detection using Deep Learning.

UNIT IV: Real-Time Threat Detection and SIEM Systems

Security Information and Event Management (SIEM), Log Analysis and Real-Time Alerting, Threat Intelligence Platforms (TIPs), Integration of AI in SIEM Tools (Splunk, ELK Stack), Network Traffic and Packet Inspection using ML, SOC Operations and Automation using AI

UNIT V: Ethical Hacking, Privacy, and Legal Aspects

Penetration Testing & Ethical Hacking with AI Tools, Red Team vs. Blue Team Simulation, Data Privacy Regulations: GDPR, HIPAA, Cyber Laws, AI Bias and Fairness in Security Decision-Making, Case Study: Ethical Dilemmas in AI Security Systems, Future Trends: Zero Trust, AI SOC, Federated Threat Detection.

Text books:

1. Stallings, W., Network Security Essentials: Applications and Standards, Pearson Education.
2. Shon Harris & Fernando Maymi, CISSP All-in-One Exam Guide, McGraw Hill.
3. Emmanuel Tsukerman, Machine Learning for Cybersecurity Cookbook, Packt Publishing.
4. Clarence Chio & David Freeman, Machine Learning and Security, O'Reilly Media.

Reference Books:

1. John Paul Mueller, Luca Massaron, Machine Learning for Dummies, Wiley.
2. Mark Stamp, Information Security: Principles and Practice, Wiley.
3. Bruce Schneier, Secrets and Lies: Digital Security in a Networked World, Wiley.
4. Shai Shalev-Shwartz and Shai Ben-David, Understanding Machine Learning, Cambridge University Press.

Online Learning Resources:

- Coursera – AI for Cybersecurity (IBM)
- edX – Cybersecurity Fundamentals by Rochester Institute of Technology
- MIT OpenCourseWare – Computer and Network Security
- [YouTube – Cybersecurity & AI Tutorials by Simplilearn, Great Learning]
- Udemy – Machine Learning for Cybersecurity
- Splunk Documentation – AI & Threat Detection

III B.Tech II Semester

23AIP04	BIG DATA & CLOUD COMPUTING LAB (Professional Core)	L	T	P	C
		0	0	3	1.5

Course Objectives:

- To provide hands-on experience in working with big data tools and cloud computing environments.
- To equip students with practical skills in data ingestion, transformation, analysis, and visualization using Hadoop and Spark ecosystems.
- To enable deployment and management of cloud services using AWS, Azure, or GCP.
- To expose students to cloud-native storage, computing, and container orchestration techniques.
- To integrate big data workflows with cloud infrastructure for scalable, distributed data processing.

Course Outcomes:
After completion of the course, students will be able to

CO1: Implement big data pipelines and cloud-based solutions using tools like Hadoop, Spark, and cloud platforms.
CO2: Gain proficiency in managing distributed data processing, scalable storage, cloud service provisions
CO3: Deploy applications using containers and orchestration platforms.
CO4: Understand the synergy between big data technologies and cloud computing to solve real-world problems efficiently.
CO5: Build and deploy serverless function

List of Lab Experiments:

1. Installation and Configuration of Hadoop Cluster (Single Node & Multi-node)
   Hadoop HDFS setup, NameNode & DataNode configuration
2. Working with HDFS: File Operations
   Upload, read, delete, and replicate files in HDFS
3. MapReduce Programming Basics
   Word count, sorting, and filtering examples in Java/Python
4. Apache Hive & Pig for Querying Large Datasets
   Creation of tables, data loading, and running queries
5. Apache Spark Basics: RDDs and DataFrames
   Implement Spark transformations and actions
6. Data Preprocessing and Machine Learning using PySpark MLlib
   Classification or regression using MLlib pipelines
7. Introduction to Cloud Computing and AWS/Azure/GCP Console
   Creating virtual machines, basic compute and storage services
8. Cloud Storage and Database Services
   Using S3 (AWS), Blob (Azure), or GCP buckets and Cloud SQL/NoSQL
9. Deploying Big Data Workloads on Cloud (EMR, HDInsight, Dataproc)
   Running Hadoop/Spark jobs in cloud-managed services
10. Cloud Function/Serverless Deployment
11. Building and deploying a serverless function (e.g., AWS Lambda)
    Containerization with Docker
12. Building, running, and managing Docker containers
    Orchestration with Kubernetes in the Cloud

Deploy and manage a containerized application using GKE/EKS/AKS

Text Books:

1. Tom White, Hadoop: The Definitive Guide, O'Reilly Media.
2. Rajkumar Buyya et al., Mastering Cloud Computing, McGraw-Hill Education.
3. Holden Karau et al., Learning Spark: Lightning-Fast Big Data Analysis, O'Reilly Media.

Reference Books:

1. Vignesh Prajapati, Big Data Analytics with R and Hadoop, Packt Publishing.
2. Benjamin Bengfort, Data Analytics with Hadoop, O'Reilly.
3. Srinivasan & J.Shrinivasan, Cloud Computing – A Hands-on Approach, Wiley India.

Virtual Lab: https://cloudlabs.ai/virtual-labs/

III B.Tech II Semester

23AIP05	FULL STACK AI LAB (Professional Core)	L	T	P	C
		0	0	3	1.5

Course Objectives:

- Enable students to build end-to-end AI-powered web applications.
- Integrate frontend, backend, database, and AI models in real-time.
- Provide hands-on experience with Flask, Express, MongoDB, React, and ML models.
- Develop and deploy AI applications using industry-standard practices.

Course Outcomes:

After completion fo the course, the students will be able to

CO1: Design frontend interfaces using React/HTML/CSS.
CO2: Build backend logic using Flask or Node.js APIs.
CO3: Integrate and deploy ML models with web services.
CO4: Store and retrieve data using MongoDB/MySQL.
CO5: Test, debug, and deploy AI-based web applications.

List of Lab Experiments:

Lab Experiments (12 Total)

1. Setup Flask or Node.js server with React/HTML frontend.
2. Create login/signup system with Express/Flask and MongoDB.
3. Train and save ML model (e.g., Naive Bayes, Logistic Regression).
4. Build API to serve ML model predictions via Flask.
5. Integrate ML predictions in frontend using fetch/AJAX.
6. Create dynamic dashboard using Chart.js/Plotly.
7. Implement JWT tokens or sessions for authentication.
8. Add file upload functionality (image/text for prediction).
9. Store interactions/predictions in database and visualize history.
10. Create CI/CD pipeline using GitHub Actions/Heroku.
11. Build mini-project: News Classifier / Spam Detector / Fake News Detector.
12. Final Demo & Deployment on Render/Heroku/Vercel/localhost.

Text Books:

1. **"Full Stack Deep Learning"** by Emmanuel Ameisen, O'Reilly, 2020
2. **"Flask Web Development"** by Miguel Grinberg, O'Reilly, 2018
3. **"Python Machine Learning"** by Sebastian Raschka, Packt Publishing

Reference Books:

1. **"Hands-On Machine Learning with Scikit-Learn, Keras & TensorFlow"** by Aurélien Géron
2. **"MongoDB: The Definitive Guide"** by Kristina Chodorow
3. **"Node.js Design Patterns"** by Mario Casciaro

Online Courses:

1. Full Stack Web Development with Flask and Python- Udemy

OPEN ELECTIVES

III B.Tech I Sem

23AIT07	FUNDAMENTALS OF ARTIFICIAL INTELLIGENCE (Open Elective-I)	L	T	P	C
		3	0	0	3

Course Objectives:

- To learn the distinction between optimal reasoning Vs. human like reasoning.
- To understand the concepts of state space representation, exhaustive search, heuristic search together with the time and space complexities.
- To learn different knowledge representation techniques.
- To understand the applications of AI, namely game playing, theorem proving, and machine learning.

Course Outcomes:

After completion of the course, students will be able to

CO1: Understand AI agents and find solutions for different searching strategies.
CO2: Analyse game theorem and propositional logic.
CO3: Apply first order logic and understand knowledge representation.
CO4: Analyse different types of planning approaches.
CO5: Understand the uncertainty using probability concepts

UNIT - I

Introduction to AI - Intelligent Agents, Problem-Solving Agents,

Searching for Solutions - Breadth-first search, Depth-first search, Hill-climbing search, Simulated annealing search, Local Search in Continuous Spaces.

UNIT-II

Games - Optimal Decisions in Games, Alpha–Beta Pruning, Defining Constraint Satisfaction Problems, Constraint Propagation, Backtracking Search for CSPs, Knowledge-Based Agents, **Logic-** Propositional Logic, Propositional Theorem Proving: Inference and proofs, Proof by resolution, Horn clauses and definite clauses.

UNIT-III

First-Order Logic - Syntax and Semantics of First-Order Logic, Using First Order Logic, Knowledge Engineering in First-Order Logic. Inference in First-Order Logic: Propositional vs. First-Order Inference, Unification, Forward Chaining, Backward Chaining, Resolution.

Knowledge Representation: Ontological Engineering, Categories and Objects, Events.

UNIT-IV

Planning - Definition of Classical Planning, Algorithms for Planning with State Space Search, Planning Graphs, other Classical Planning Approaches, Analysis of Planning approaches. Hierarchical Planning.

UNIT-V

Probabilistic Reasoning:

Acting under Uncertainty, Basic Probability Notation Bayes' Rule and Its Use, Probabilistic Reasoning, Representing Knowledge in an Uncertain Domain, The Semantics of Bayesian Networks, Efficient Representation of Conditional Distributions, Approximate Inference in Bayesian Networks, Relational and First- Order Probability.

TEXT BOOK:

1. Artificial Intelligence: A Modern Approach, Third Edition, Stuart Russell and Peter Norvig, Pearson Education.

REFERENCE BOOKS:

1. Artificial Intelligence, 3rd Edn., E. Rich and K. Knight (TMH)
2. Artificial Intelligence, 3rd Edn., Patrick Henny Winston, Pearson Education.
3. Artificial Intelligence, Shivani Goel, Pearson Education.
4. Artificial Intelligence and Expert systems – Patterson, Pearson Education.

III B.Tech I Semester

Course Code	**GREEN BUILDINGS (OPEN ELECTIVE - I)**	L	T	P	C
23CET12		3	0	0	3

Course Objectives :

The objectives of this course are to make the student:

1. **To understand** the fundamental concepts of green buildings, their necessity, and sustainable features.
2. **To analyze** green building concepts, rating systems, and their benefits in India.
3. **To apply** green building design principles, energy efficiency measures, and renewable energy sources.
4. **To evaluate** air conditioning systems, HVAC designs, and energy modeling for sustainable buildings.
5. **To assess** material conservation strategies, waste management, and indoor environmental quality in green buildings.

Course Outcomes (COs)

Upon successful completion of the course, students will be able to:

1. **Understand** the importance of green buildings, their necessity, and sustainable features.
2. **Analyze** various green building practices, rating systems, and their impact on environmental sustainability.
3. **Apply** principles of green building design to enhance energy efficiency and incorporate renewable energy sources.
4. **Evaluate** HVAC systems, energy-efficient air conditioning techniques, and their role in sustainable building design.
5. **Assess** material conservation techniques, waste reduction strategies, and indoor air quality management in green buildings.

CO - PO Articulation Matrix

Course Outcomes	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
CO -1	3	-	-	-	-	2	3	-	-	-	-	-	3	3
CO -2	-	3	-	-	2	-	3	-	-	-	-	2	3	3
CO -3	-	-	3	3	3	-	3	-	-	-	-	-	3	3
CO -4	-	-	3	3	3	-	3	-	-	-	-	-	3	3
CO -5	-	-	-	-	-	3	3	3	2	-	-	-	-	3

UNIT – I

Introduction to Green Building– Necessity of Green Buildings, Benefits of Green Buildings, Green Building Materials and Equipment in India, Key Requisites for Constructing A Green Building, Important Sustainable Features for Green Buildings.

UNIT – II

Green Building Concepts and Practices– Indian Green Building Council, Green Building Movement in India, Benefits Experienced in Green Buildings, Launch of Green Building Rating Systems, Residential Sector, Market Transformation; Green Building Opportunities

and Benefits: Opportunities of Green Buildings, Green Building Features, Material and Resources, Water Efficiency, Optimum Energy Efficiency, Typical Energy-Saving Approaches in Buildings, LEED India Rating System, and Energy Efficiency.

UNIT – III

Green Building Design– Introduction, Reduction in Energy Demand, Onsite Sources and Sinks, Maximizing System Efficiency, Steps to Reduce Energy Demand and Use Onsite Sources and Sinks, Use of Renewable Energy Sources, Eco-Friendly Captive Power Generation for Factories, Building Requirements.

UNIT – IV

Air Conditioning– Introduction, CII Godrej Green Business Centre, Design Philosophy, Design Interventions, Energy Modeling, HVAC System Design, Chiller Selection, Pump Selection, Selection of Cooling towers, Selection of Air Handling Units, Pre-Cooling of Fresh Air, Interior Lighting Systems, Key Features of The Building, Eco-Friendly Captive Power Generation for Factories, Building Requirements.

UNIT – V

Material Conservation– Handling of Non-Process Waste, Waste Reduction During Construction, Materials With Recycled Content, Local Materials, Material Reuse, Certified Wood, Rapidly Renewable Building Materials and Furniture. Indoor Environment Quality and Occupational Health– Air Conditioning, Indoor Air Quality, Sick Building Syndrome, tobacco Smoke.

TEXT BOOKS:

1. Handbook on Green Practices published by Indian Society of Heating Refrigerating and Air conditioning Engineers, 2009.
2. Green Building Hand Book by tom woolley and Sam kimings, 2009.

REFRENCE BOOKS:

1. Complete Guide to Green Buildings by Trish riley
2. Standard for the design for High Performance Green Buildings by Kent Peterson, 2009
3. Energy Conservation Building Code –ECBC-2020, published by BEE

Online Learning Resources:

https://archive.nptel.ac.in/courses/105/102/105102195/

III B.Tech – I Semester

Course Code	**CONSTRUCTION TECHNOLOGY AND MANAGEMENT (OPEN ELECTIVE – I)**	L	T	P	C
23CET12		3	0	0	3

Course Objectives:

The objectives of this course are to make the student :

1. To understand project management fundamentals, organizational structures, and leadership principles in construction.
2. To analyze manpower planning, equipment management, and cost estimation in civil engineering projects.
3. To apply planning, scheduling, and project management techniques such as CPM and PERT.
4. To evaluate various contract types, contract formation, and legal aspectsin construction management.
5. To assess safety management practices, accident prevention strategies, and quality management systemsin construction.

Course Outcomes (COs):

Upon successful completion of the course, students will be able to:

1. Understand (Cos)project management fundamentals, organizational structures, and leadership principles in construction.
2. Analyze manpower planning, equipment management, and cost estimationin civil engineering projects.
3. Apply planning, scheduling, and project management techniques such as CPM and PERT.
4. Evaluate various contract types, contract formation, and legal aspectsin construction management.
5. Assess safety management practices, accident prevention strategies, and quality management systems in construction.

CO – PO Articulation Matrix

Course Outcomes	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
CO -1	3	-	-	-	-	2	-	2	2	-	-	-	3	3
CO -2	-	3	-	-	2	-	-	-	-	-	-	2	3	3
CO -3	-	-	3	3	3	-	-	-	-	2	-	-	3	3
CO -4	-	-	3	3	3	-	-	2	-	-	-	-	3	3
CO -5	-	-	-	-	-	3	3	3	2	-	-	-	-	3

UNIT – I

Introduction: Project forms, Management Objectives and Functions; Organizational Chart of A Construction Company; Manager's Duties and Responsibilities; Public Relations; Leadership and Team - Work; Ethics, Morale, Delegation and Accountability.

UNIT – II

Man and Machine: Man-Power Planning, Training, Recruitment, Motivation, Welfare Measures and Safety Laws; Machinery for Civil Engineering., Earth Movers and Hauling

Costs, Factors Affecting Purchase, Rent, and Lease of Equipment, and Cost Benefit Estimation.
UNIT – III
Planning, Scheduling andProject Management: Planning Stages, Construction Schedules and Project Specification, Monitoring and Evaluation; Bar-Chart, CPM, PERT, Network-formulation and Time Computation.
UNIT – IV
Contracts: Types of Contracts, formation of Contract – Contract Conditions – Contract forLabour, Material, Design, Construction – Drafting of Contract Documents Based On IBRD/ MORTH Standard Bidding Documents – Construction Contracts – Contract Problems – Arbitration and Legal Requirements Computer Applications in Construction Management: Software for Project Planning, Scheduling and Control.
UNIT – V
Safety Management – Implementation and Application of QMS in Safety Programs, ISO 9000 Series, Accident Theories, Cost of Accidents, Problem Areas in Construction Safety, Fall Protection, Incentives, Zero Accident Concepts, Planning for Safety, Occupational Health and Ergonomics.
TEXT BOOKS:
1. Construction Project Management, SK. Sears, GA. Sears, RH. Clough, John Wiley and Sons, 6th Edition, 2016. 2. Construction Project Scheduling and Control by Saleh Mubarak, 4th Edition, 2019 3. Pandey, I.M (2021) Financial Management 12th edition. Pearson India Education Services Pvt. Ltd.
REFRENCE BOOKS:
1. Brien, J.O. andPlotnick, F.L., CPMin Construction Management, Mcgraw Hill, 2010. 2. Punmia, B.C., andKhandelwal, K.K., Project Planning and control with PERT and CPM, Laxmi Publications, 2002. 3. Construction Methods and Management: Pearson New International Edition 8 th Edition Stephens Nunnally. 4. Rhoden, M and Cato B, Construction Management andOrganisational Behaviour, Wiley-Blackwell, 2016.
Online Learning Resources:
https://archive.nptel.ac.in/courses/105/104/105104161/ https://archive.nptel.ac.in/courses/105/103/105103093/

III B.Tech I Semester

L	T	P	C
3	0	0	3

23EET13 ELECTRICAL SAFETY PRACTICES AND STANDARDS
(Open Elective-I)

Course Outcomes:

CO1: Understanding the Fundamentals of Electrical Safety -L2
CO2: Identifying and Applying Safety Components -L3
CO3: Analyzing Grounding Practices and Electrical Bonding
CO4: Applying Safety Practices in Electrical Installations and Environments- L4
CO5: Evaluating Electrical Safety Standards and Regulatory Compliance -L5

UNIT I Introduction To Electrical Safety:
Fundamentals of Electrical safety-Electric Shock- physiological effects of electric current - Safety requirements –Hazards of electricity- Arc - Blast- Causes for electrical failure.

UNIT II Safety Components:
Introduction to conductors and insulators- voltage classification -safety against over voltages- safety against static electricity-Electrical safety equipment's - Fire extinguishers for electrical safety.

UNIT III Grounding:
General requirements for grounding and bonding- Definitions- System grounding- Equipment grounding - The Earth - Earthing practices- Determining safe approach distance-Determining arc hazard category.

UNIT IV Safety Practices:
General first aid- Safety in handling hand held electrical appliances tools- Electrical safety in train stations-swimming pools, external lighting installations, medical locations-Case studies.

UNIT V Standards For Electrical Safety:
Electricity Acts- Rules & regulations- Electrical standards-NFPA 70 E-OSHA standards-IEEE standards-National Electrical Code 2005 – National Electric Safety code NESC-Statutory requirements from electrical inspectorate

TEXT BOOKS:

1. Massimo A.G.Mitolo, "Electrical Safety of Low-Voltage Systems", McGraw Hill, USA, 2009.
2. Mohamed El-Sharkawi, "Electric Safety - Practice and Standards", CRC Press, USA, 2014

REFERENCES:

1. Kenneth G.Mastrullo, Ray A. Jones, "The Electrical Safety Program Book", Jones and Bartlett Publishers, London, 2nd Edition, 2011.
2. Palmer Hickman, "Electrical Safety-Related Work Practices", Jones & Bartlett Publishers, London, 2009.
3. Fordham Cooper, W., "Electrical Safety Engineering", Butterworth and Company, London, 1986.
4. John Cadick, Mary Capelli-Schellpfeffer, Dennis K. Neitzel, "Electrical Safety Hand book, McGraw-Hill, New York, USA, 4th edition, 2012.

3 0 0 3

23MET14 SUSTAINBLE ENERGY TECHNOLOGIES
(Open Elective-I)

Course objectives: The objectives of the course are to	
1	demonstrate the importance the impact of solar radiation, solar PVmodules
2	understand the principles of storage in PV systems
3	discuss solar energy storage systems and their applications.
4	get knowledge in wind energy and bio-mass
5	gain insights in geothermal energy, ocean energy and fuel cells.

COURSE OUTCOMES On successful completion of this course the student will be able to		
CO1	Illustrate the importance of solar radiation and solar PV modules.	L1, L2
CO2	Discuss the storage methods in PV systems	L2,L3
CO3	Explain the solar energy storage for different applications	L2,L3
CO4	Understand the principles of wind energy, and bio-mass energy.	L2, L3
CO5	Attain knowledge in geothermal energy, ocean energy and fuel cells.	L1, L2,L3, L4

UNIT – 1

SOLAR RADIATION: Role and potential of new and renewable sources, the solar energy option, Environmental impact of solar power, structure of the sun, the solar constant, sun-earth relationships, coordinate systems and coordinates of the sun, extraterrestrial and terrestrial solar radiation, solar radiation on titled surface, instruments for measuring solar radiation and sun shine, solar radiation data, numerical problems.

SOLAR PV MODULES AND PV SYSTEMS:

PV Module Circuit Design, Module Structure, Packing Density, Interconnections, Mismatch and Temperature Effects, Electrical and Mechanical Insulation, Lifetime of PV Modules, Degradation and Failure, PV Module Parameters, Efficiency of PV Module, Solar PV Systems-Design of Off Grid Solar Power Plant. Installation and Maintenance.

UNIT – 2

STORAGE IN PV SYSTEMS:

Battery Operation, Types of Batteries, Battery Parameters, Application and Selection of Batteries for Solar PV System, Battery Maintenance and Measurements, Battery Installation for PV System.

UNIT – 3

SOLAR ENERGY COLLECTION: Flat plate and concentrating collectors, classification of concentrating collectors, orientation.

SOLAR ENERGY STORAGE AND APPLICATIONS: Different methods, sensible, latent heat and stratified storage, solar ponds, solar applications- solar heating/cooling technique, solar distillation and drying, solar cookers, central power tower concept and solar chimney.

UNIT – 4

WIND ENERGY: Sources and potentials, horizontal and vertical axis windmills, performance characteristics, betz criteria, types of winds, wind data measurement.

BIO-MASS: Principles of bio-conversion, anaerobic/aerobic digestion, types of bio-gas digesters, gas yield, utilization for cooking, bio fuels, I.C. engine operation and economic aspects.

UNIT – 5

GEOTHERMAL ENERGY: Origin, Applications, Types of Geothermal Resources, Relative Merits

OCEAN ENERGY: Ocean Thermal Energy; Open Cycle & Closed Cycle OTEC Plants, Environmental Impacts, Challenges

FUEL CELLS: Introduction, Applications, Classification, Different Types of Fuel Cells Such as Phosphoric Acid Fuel Cell, Alkaline Fuel Cell, PEM Fuel Cell, MC Fuel Cell.

Text Books:

1. Solar Energy – Principles of Thermal Collection and Storage/Sukhatme S.P. and J.K.Nayak/TMH

2. Non-Conventional Energy Resources- Khan B.H/ Tata McGraw Hill, New Delhi, 2006

References:

1. Principles of Solar Engineering - D.Yogi Goswami, Frank Krieth& John F Kreider / Taylor &Francis

2. Non-Conventional Energy - Ashok V Desai /New Age International (P) Ltd

3. Renewable Energy Technologies -Ramesh & Kumar /Narosa

4. Non-conventional Energy Source- G.D Roy/Standard Publishers

Online Learning Resources:

https://nptel.ac.in/courses/112106318

https://youtube.com/playlist?list=PLyqSpQzTE6M-ZgdjYukayF6QevPv7WE-r&si=-mwIa2X-SuSiNy13

https://youtube.com/playlist?list=PLyqSpQzTE6M-ZgdjYukayF6QevPv7WE-r&si=Apfjx6oDfz1Rb_N3

https://youtu.be/zx04Kl8y4dE?si=VmOvp_OgqisILTAF

III B.Tech I Sem **L – T – P – C**
3 – 0 – 0 – 3

23ECT17 ELECTRONIC CIRCUITS
(Open Elective –I)

Course Objectives:

1. To understand semiconductor diodes, their characteristics and applications.
2. To explore the operation, configurations, and biasing of BJTs.
3. To study the operation, analysis, and coupling techniques of BJT amplifiers.
4. To learn the operation, applications and uses of feedback amplifiers and oscillators.
5. To analyze the characteristics, configurations, and applications of operational amplifiers.

Course Outcomes:
At the end of this course, the students will be able to

1. Understand semiconductor diodes, their characteristics and applications.
2. Explore the operation, configurations, and biasing of BJTs.
3. Gain knowledge about the operation, analysis, and coupling techniques of BJT amplifiers.
4. Learn the operation, applications and uses of feedback amplifiers and oscillators.
5. Analyze the characteristics, configurations, and applications of operational amplifiers.

UNIT-I

Semiconductor Diode and Applications: Introduction, PN junction diode – structure, operation and VI characteristics, Half-wave, Full-wave and Bridge Rectifiers with and without Filters, Positive and Negative Clipping and Clamping circuits (Qualitative treatment only).

Special Diodes: Zener and Avalanche Breakdowns, VI Characteristics of Zener diode, Zener diode as voltage regulator, Construction, operation and VI characteristics of Tunnel Diode, LED, Varactor Diode, Photo Diode .

UNIT-II

Bipolar Junction Transistor (BJT): Principle of Operation, Common Emitter, Common Base and Common Collector Configurations, Transistor as a switch and Amplifier, Transistor Biasing and Stabilization - Operating point, DC & AC load lines, Biasing - Fixed Bias, Self Bias, Bias Stability, Bias Compensation using Diodes.

UNIT-III

Single stage amplifiers: Classification of Amplifiers - Distortion in amplifiers, Analysis of CE, CC and CB configurations with simplified hybrid model.

Multistage amplifiers: Different Coupling Schemes used in Amplifiers - RC coupled amplifiers, Transformer Coupled Amplifier, Direct Coupled Amplifier; Multistage RC coupled BJT amplifier (Qualitative treatment only).

UNIT-IV

Feedback amplifiers: Concepts of feedback, Classification of feedback amplifiers, Effect of feedback on amplifier characteristics, Voltage Series, Voltage Shunt, Current Series and Current Shunt Feedback Configurations (Qualitative treatment only).

Oscillators: Classification of oscillators, Condition for oscillations, RC Phase shift Oscillators, Generalized analysis of LC Oscillators-Hartley and Colpitts Oscillators, Wien Bridge Oscillator.

UNIT-V

Op-amp: Classification of IC'S, basic information of Op-amp, ideal and practical Op-amp, 741 op-amp and its features, modes of operation-inverting, non-inverting, differential.

Applications of op-amp : Summing, scaling and averaging amplifiers, Integrator, Differentiator, phase shift oscillator and comparator.

TEXT BOOKS:

1. Electronics Devices and Circuits, J.Millman and Christos. C. Halkias, 3rd edition, Tata McGraw Hill, 2006.
2. Electronics Devices and Circuits Theory, David A. Bell, 5th Edition, Oxford University press. 2008.

REFERENCE BOOKS:

1. Electronics Devices and Circuits Theory, R.L.Boylestad, LousisNashelsky and K.Lal Kishore, 12th edition, 2006, Pearson, 2006.
2. Electronic Devices and Circuits, N.Salivahanan, and N.Suresh Kumar, 3rd Edition, TMH, 2012
3. Microelectronic Circuits, S.Sedra and K.C.Smith, 5th Edition, Oxford University Press.

III B.Tech I Sem

L	T	P	C
3	0	0	3

23BST19 MATHEMATICS FOR MACHINE LEARNING AND AI
(Open Elective 1)

Course Objectives:

- To provide a strong mathematical foundation for understanding and developing AI/ML algorithms.
- To enhance the ability to apply linear algebra, probability, and calculus in AI/ML models.
- To equip students with optimization techniques and graph-based methods used in AI applications.
- To develop critical problem-solving skills for analysing mathematical formulations in AI/ML.

Course Outcomes:

After successful completion of this course, the students should be able to:

COs	Statements	Blooms level
CO1	Apply linear algebra concepts to ML techniques like PCA and regression.	L3 (Apply)
CO2	Analyze probabilistic models and statistical methods for AI applications.	L4 (Analyze)
CO3	Implement optimization techniques for machine learning algorithms.	L3 (Apply)
CO4	Utilize vector calculus and transformations in AI-based models.	L3 (Apply)
CO5	Develop graph-based AI models using mathematical representations.	L5 (Evaluate)

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	1	-	-	-	-	-	-	1
CO2	3	3	2	3	2	-	-	-	-	-	-	2
CO3	3	3	3	3	2	1	-	-	-	-	-	2
CO4	3	3	2	2	1	-	-	-	-	-	-	1
CO5	3	3	3	3	2	-	-	-	-	-	-	2

• **3** = Strong Mapping, **2** = Moderate Mapping, **1** = Slight Mapping, **-** = No Mapping

UNIT I: Linear Algebra for Machine Learning(08)

Review of Vector spaces, basis, linear independence, Vector and matrix norms, Matrix factorization techniques, Eigenvalues, eigenvectors, diagonalization, Singular Value Decomposition (SVD) and Principal Component Analysis (PCA).

UNIT II: Probability and Statistics for AI(08)

Probability distributions: Gaussian, Binomial, Poisson. Bayes' Theorem, Maximum Likelihood Estimation (MLE), and Maximum a Posteriori (MAP).Entropy and Kullback-Leibler (KL) Divergence in AI, Cross entropy loss, Markov chains.

UNIT III: Optimization Techniques for ML(08)

Multivariable calculus: Gradients, Hessians, Jacobians. Constrained optimization: Lagrange multipliers and KKT conditions.Gradient Descent and its variants (Momentum, Adam) Newton's method, BFGS method.

UNIT IV: Vector Calculus & Transformations(08)

Vector calculus: Gradient, divergence, curl. Fourier Transform & Laplace Transform in ML applications.

UNIT V: Graph Theory for AI(08)

Graph representations: Adjacency matrices, Laplacian matrices. Bayesian Networks & Probabilistic Graphical Models. Introduction to Graph Neural Networks (GNNs).

Textbooks:

1. Mathematics for Machine Learning by Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, Cambridge University Press, 2020.
2. Pattern Recognition and Machine Learningby Christopher Bishop, Springer.

Reference Books:

1. Gilbert Strang, Linear Algebra and Its Applications, Cengage Learning, 2016.
2. Jonathan Gross, Jay Yellen, Graph Theory and Its Applications, CRC Press, 2018.

Web References:

- MIT– Mathematics for Machine Learning https://ocw.mit.edu
- Stanford CS229 – Machine Learning Course https://cs229.stanford.edu/

DeepAI – Mathematical Foundations for AI https://deepai.org

III B.Tech I Sem

23BST20	**MATERIALS CHARACTERIZATION TECHNIQUES** (Common to all branches) (Open Elective-Interdisciplinary) **(Open Elective-I)**	Credits 3-0-0:3

COURSE OBJECTIVES	
1	To provide exposure to different characterization techniques.
2	To explain the basic principles and analysis of different spectroscopic techniques.
3	To elucidate the working of Scanning electron microscope - Principle, limitations and applications.
4	To illustrate the working of the Transmission electron microscope (TEM) - SAED patterns and its applications.
5	To educate the uses of advanced electric and magnetic instruments for characterization.

UNIT I Structure analysis by Powder X-Ray Diffraction 9H

Introduction, Bragg's law of diffraction, Intensity of Diffracted beams, Factors affecting Diffraction, Intensities, Structure of polycrystalline Aggregates, Determination of crystal structure, Crystallite size by Scherer and Williamson-Hall (W-H) Methods, Small angle X-ray scattering (SAXS) (in brief).

UNIT II Microscopy technique -1 –Scanning Electron Microscopy (SEM) 9H

Introduction, Principle, Construction and working principle of Scanning Electron Microscopy, Specimen preparation, Different types of modes used (Secondary Electron and Backscatter Electron), Advantages, limitations and applications of SEM.

UNIT III Microscopy Technique -2 - Transmission Electron Microscopy (TEM) 9H

Construction and Working principle, Resolving power and Magnification, Bright and dark fields, Diffraction and image formation, Specimen preparation, Selected Area Diffraction, Applications of Transmission Electron Microscopy, Difference between SEM and TEM, Advantage and Limitations of Transmission Electron Microscopy

UNIT IV Spectroscopy techniques 9H

Principle, Experimental arrangement, Analysis and advantages of the spectroscopic techniques – (i) UV-Visible spectroscopy (ii) Raman Spectroscopy, (iii) Fourier Transform infrared (FTIR) spectroscopy, (iv) X-ray photoelectron spectroscopy (XPS).

UNIT V Electrical & Magnetic Characterization techniques 9H

Electrical Properties analysis techniques (DC conductivity, AC conductivity) Activation Energy, Effect of Magnetic field on the electrical properties (Hall Effect). Magnetization measurement by induction method, Vibrating sample Magnetometer (VSM) and SQUID.

Textbooks:

1. Material Characterization: Introduction to Microscopic and Spectroscopic Methods – Yang Leng – John Wiley & Sons (Asia) Pvt. Ltd. 2013.
2. Microstructural Characterization of Materials - David Brandon, Wayne D Kalpan, John Wiley & Sons Ltd., 2008

Reference Books:

1. Fundamentals of Molecular Spectroscopy – IV Ed. – Colin Neville BanwellandElaine M. McCash, Tata McGraw-Hill, 2008.
2. Elements of X-ray diffraction – Bernard Dennis Cullity& Stuart R Stocks, Prentice Hall , 2001 – Science.
3. Practical Guide to Materials Characterization: Techniques and Applications - Khalid Sultan – Wiley – 2021.
4. **Materials Characterization Techniques -**Sam Zhang, Lin Li, Ashok Kumar -CRC Press - 2008

NPTEL courses link :

1. https://nptel.ac.in/courses/115/103/115103030/
2. https://nptel.ac.in/content/syllabus_pdf/113106034.pdf
3. https://nptel.ac.in/noc/courses/noc19/SEM1/noc19-mm08/

	Course Outcomes	Blooms Level
CO1	Analyze the crystal structure and crystallite size by various methods	L1,L2, L3, L4
CO2	Analyze the morphology of the sample by using a Scanning Electron Microscope	L1,L2, L4
CO3	Analyze the morphology and crystal structure of the sample by using Transmission Electron Microscope	L1,L2, L3
CO4	Explain the principle and experimental arrangement of various spectroscopic Techniques	L1,L2
CO5	Identify the construction and working principle of various Electrical & Magnetic Characterization technique	L1,L2

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	1							
CO2	3	3	2	1	1							
CO3	3	3	2	1	1							
CO4	3	2	1	1	-							
CO5	3	3	1	1	-							

1-Slightly, 2-Moderately, 3-Substantially.

III B.Tech I Sem

Course Code	Title of the Subject	L	T	P	C
23BST21	**CHEMISTRY OF ENERGY SYSTEMS**	3		-	3

COURSE OBJECTIVES	
1	To make the student understand basic electrochemical principles such as standard electrode potentials, emf and applications of electrochemical principles in the design of batteries.
2	To understand the basic concepts of processing and limitations of Fuel cells & their applications.
3	To impart knowledge to the students about fundamental concepts of photo chemical cells, reactions and applications
4	Necessarily of harnessing alternate energy resources such as solar energy and its basic concepts.
5	To impart knowledge to the students about fundamental concepts of hydrogen storage in different materials and liquification method.

COURSE OUTCOMES	
CO1	➢ Solve the problems based on electrode potential, Describe the Galvanic Cell ➢ Differentiate between Lead acid and Lithium ion batteries, Illustrate the electrical double layer
CO2	➢ Describe the working Principle of Fuel cell, Explain the efficiency of the fuel cell ➢ Discuss about the Basic design of fuel cells, Classify the fuel cell
CO3	➢ Differentiate between Photo and Photo electrochemical Conversions, Illustrate the photochemical cells, Identify the applications of photochemical reactions, ➢ Interpret advantages of photoelectron catalytic conversion.
CO4	➢ Apply the photo voltaic technology, Demonstrate about solar energy and prospects ➢ Illustrate the Solar cells, Discuss about concentrated solar power
CO5	➢ Differentiate Chemical and Physical methods of hydrogen storage, Discuss the metal organic frame work, Illustrate the carbon and metal oxide porous structures ➢ Describe the liquification methods.

Mapping between Course Outcomes and Programme Outcomes

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

UNIT-1: Electrochemical Systems: Galvanic cell, Nernst equation, standard electrode potential, application of EMF, electrical double layer, polarization, Batteries- Introduction ,Lead-acid ,Nickel- cadmium, Lithium ion batteries and their applications**.**

UNIT-2: Fuel Cells: Fuel cell- Introduction, Basic design of fuel cell, working principle, Classification of fuel cells, Polymer electrolyte membrane (PEM) fuel cells, Solid-oxide fuel cells (SOFC), Fuel cell efficiency and applications.

UNIT-3: Photo and Photo electrochemical Conversions: Photochemical cells Introduction and applications of photochemical reactions, specificity of photo electrochemical cell, advantage of photoelectron catalytic conversions and their applications.

UNIT-4: Solar Energy: Introduction and prospects, photovoltaic (PV) technology, concentrated solar power (CSP), Solar cells and applications. .

UNIT-5: Hydrogen Storage: Hydrogen storage and delivery: State-of-the art, Established technologies, Chemical and Physical methods of hydrogen storage, Compressed gas storage, Liquid hydrogen storage, Other storage methods, Hydrogen storage in metal hydrides, metal organic frameworks (MOF), Metal oxide porous structures, hydrogel , and Organic hydrogen carriers.

Text books

1. Physical chemistry by Ira N. Levine
2. Essentials of Physical Chemistry, Bahl and Bahl and Tuli.
3. Inorganic Chemistry, Silver and Atkins

Reference Books:

1. Fuel Cell Hand Book 7th Edition, by US Department of Energy (EG&G technical services
And corporation)
2. Hand book of solar energy and applications by ArvindTiwari and Shyam.
3. Solar energy fundamental, technology and systems by Klaus Jagar et.al.
4.Hydrogen storage by Levine Klebonoff

III B.Tech I Sem

Course Code	**ENGLISH FOR COMPETITIVE EXAMINATIONS**	L	T	P	C
23BST22	**(Open Elective-I)** (Common to All Branches of Engineering)	3	0	0	3

Course Objectives:

1. To enable the students to learn about the structure of competitive English
2. To understand the grammatical aspects and identify the errors
3. To enhance verbal ability and identify the errors
4. To improve word power to answer competitive challenges
5. To make them ready to crack competitive exams

Course Outcomes (CO): Blooms Level

By the end of the program students will be able to

- Identify the basics of English grammar and its importance L1, L2
- Explain the use of grammatical structures in sentences L1, L2
- Demonstrate the ability to use various concepts in grammar and vocabulary and their applications in everyday use and in competitive exams L3
- Analyze an unknown passage and reach conclusions about it. L4
- Choose the appropriate form of verbs in framing sentences L5
- Develop speed reading and comprehending ability thereby perform better in competitive exams L3

UNIT – I	**GRAMMAR-1**	Lecture Hrs

Nouns-classification-errors-Pronouns-types-errors-Adjectives-types-errors-Articles-definite-indefinite-Degrees of Comparison-Adverbs-types- errors-Conjunctions-usage-Prepositions-usage-Tag Questions, types-identifying errors- Practice

UNIT – II	**GRAMMAR-2**	Lecture Hrs

Verbs-tenses- structure-usages- negatives- positives- time adverbs-Sequence of tenses--If Clause-Voice-active voice and passive voice- reported Speech-Agreement- subject and verb-Modals-Spotting Errors-Practices

UNIT – III	**VERBAL ABILITY**	Lecture Hrs

Sentence completion-Verbal analogies-Word groups-Instructions-Critical reasoning-Verbal deduction-Select appropriate pair-Reading Comprehension-Paragraph-Jumbles-Selecting the proper statement by reading a given paragraph.

UNIT – IV	**READING COMPREHENSION AND VOCUBULARY**	Lecture Hrs

Competitive Vocabulary :Word Building – Memory techniques-Synonyms, Antonyms, Affixes-Prefix &Suffix-One word substitutes-Compound words-Phrasal Verbs-Idioms and Phrases-Homophones-Linking Words-Modifiers-Intensifiers - Mastering Competitive Vocabulary- Cracking the unknowing passage-speed reading techniques- Skimming & Scanning-types of answering–Elimination methods

UNIT – V	**WRITING FOR COMPETITIVE EXAMINATIONS**	Lecture Hrs

Punctuation- Spelling rules- Word order-Sub Skills of Writing- Paragraph meaning-salient features-types - Note-making, Note-taking, summarizing-precise writing- Paraphrasing-Expansion of proverbs-Essay writing-types

Textbooks:

1. **Wren & Martin,** ***English for Competitive Examinations,*** **S.Chand & Co, 2021**
2. *Objective English for Competitive Examination***,** Tata McGraw Hill, New Delhi, 2014.

Reference Books:

1. Hari Mohan Prasad, *Objective English for Competitive Examination,* Tata McGraw Hill, New Delhi, 2014.
2. Philip Sunil Solomon, *English for Success in Competitive Exams*, Oxford 2016
3. Shalini Verma , *Word Power Made Handy*, S Chand Publications
4. Neira, Anjana Dev & Co. *Creative Writing: A Beginner's Manual.* Pearson Education India, 2008.
5. Abhishek Jain,Vocabulary Learning Techniques Vol.I&II,RR Global Publishers 2013.
6. Michel Swan, *Practical English Usage*,Oxford,2006.

Online Resources

1. https://www.grammar.cl/english/parts-of-speech.htm
2. https://academicguides.waldenu.edu/writingcenter/grammar/partsofspeech
3. https://learnenglish.britishcouncil.org/grammar/english-grammar-reference/active-passive-voice
4. https://languagetool.org/insights/post/verb-tenses/
5. https://www.britishcouncil.in/blog/best-free-english-learning-resources-british-council
6. https://www.careerride.com/post/social-essays-for-competitive-exams-586.aspx

Course Code	ENTREPRENEURSHIP AND NEW VENTURE CREATION (Open Elective-I)	L	T	P	C
23BST23		3	0	0	3

COURSE OBJECTIVES: The objectives of this course are	
1	To foster an entrepreneurial mind-set for venture creation and intrapreneurial leadership.
2	To encourage creativity and innovation
3	To enable them to learn pitching and presentation skills
4	To make the students understand MVP development and validation techniques to determine Product-Market fit and Initiate Solution design, Prototype for Proof of Concept.
5	To enhance the ability of analyzing Customer and Market segmentation, estimate Market size, develop and validate Customer Persona

UNIT-I: Entrepreneurship Fundamentals and context

Meaning and concept, attributes and mindset of entrepreneurial and intrapreneurial leadership, role models in each and their role in economic development. An understanding of how to build entrepreneurial mindset, skill sets, attributes and networks while on campus.

Core Teaching Tool: Simulation, Game, Industry Case Studies (Personalized for students – 16industries to choose from), Venture Activity

LEARNING OUTCOMES

At the end of the Unit, the learners will be able to

- Understand theconcept of Entrepreneur and Entrepreneurship in India
- Analyze recent trends in Entrepreneurship role in economic development
- Develop a creative mind set and personality in starting a business.

Unit II: Problem & Customer Identification

Understanding and analysing the macro-Problem and Industry perspective - technological, socioeconomic and urbanization trends and their implication on new opportunities - Identifying passion - identifying and defining problem using Design thinking principles - Analysing problem and validating with the potential customer - Understanding customer segmentation, creating and validating customer personas.

Core Teaching Tool: Several types of activities including Class, game, Gen AI, 'Get out of the Building' and Venture Activity.

LEARNING OUTCOMES

At the end of the Unit, the learners will be able to

- Understand the problem and Customer identification.
- Analyze problem and validating with potential customer
- Evaluate customer segmentation and customer personas

Unit III: Solution design, Prototyping & Opportunity Assessment and Sizing

Understanding Customer Jobs-to-be-done and crafting innovative solution design to map to customer's needs and create a strong value proposition - Understanding prototyping and Minimum Viable product (MVP) - Developing a feasibility prototype with differentiating value, features and benefits - Assess relative market position via competition analysis - Sizing the market and assess scope and potential scale of the opportunity.

Core Teaching Tool: Venture Activity, no-code Innovation tools, Class activity

LEARNING OUTCOMES

At the end if the Unit, the learners will be able to

- Analyze jobs-to-be-done
- Evaluate customer needs to create a strong value proposition
- Design and draw prototyping and MVP

UNIT-IV: Business & Financial Model, Go-to-Market Plan

Introduction to Business model and types, Lean approach, 9 block lean canvas model, riskiest assumptions to Business models. Importance of Build - Measure – Lean approach.

Business planning: components of Business plan- Sales plan, People plan and financial plan. Financial Planning: Types of costs, preparing a financial plan for profitability using financial template, understanding basics of Unit economics and analysing financial performance.

Introduction to Marketing and Sales, Selecting the Right Channel, creating digital presence, building customer acquisition strategy.

Choosing a form of business organization specific to your venture, identifying sources of funds: Debt& Equity, Map the Start-up Life-cycle to Funding Options.

Core Teaching Tool: Founder Case Studies – Sama and Securely Share; Class activity and discussions; Venture Activities.

LEARNING OUTCOMES

At the end of the Unit, the learners will be able to:

- Understand lean approach in business models
- Apply business plan, sales plan and financial plan
- Analyze financial planning, marketing channels of distribution.
- Design their own venture and source of funds.

UNIT-V: Scale Outlook and Venture Pitch readiness

Understand and identify potential and aspiration for scale vis-a-vis your venture idea. Persuasive Storytelling and its key components. Build an Investor ready pitch deck.

Core Teaching Tool: Expert talks; Cases; Class activity and discussions; Venture Activities.

LEARNING OUTCOMES

At the end of the Unit, the learners will be able to

- Understand aspiration for scale
- Analyze venture idea and its key components
- Evaluate and build investors ready pitch

TEXT BOOKS

1. Robert D. Hisrich, Michael P. Peters, Dean A. Shepherd, Sabyasachi Sinha . *Entrepreneurship*, McGrawHill, 11th Edition.(2020)
2. Ries, E. *The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses*. Crown Business,(2011).
3. Osterwalder, A., & Pigneur, Y. *Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers.* John Wiley & Sons. (2010).

REFERENCES

1. Simon Sinek,*Start with Why,* Penguin Books limited. (2011)
2. Brown Tim,*Change by Design Revised & Updated: How Design Thinking*
3. *Transforms Organizations and Inspires Innovation,* Harper Business.(2019)

4. Namita Thapar (2022) The Dolphin and the Shark: Stories on Entrepreneurship, Penguin Books Limited
5. Saras D. Sarasvathy, (2008) Effectuation: Elements of Entrepreneurial Expertise, Elgar Publishing Ltd.

E-RESOURCES

Learning resource- Ignite 5.0 Course Wadhwani platform (Includes 200+ components of

custom created modular content + 500+ components of the most relevant curated content)

COURSE OUTCOMES: At the end of the course, students will be able to		**BTL**
CO1	Develop an entrepreneurial mindset and appreciate the concept of entrepreneurship	L3
CO2	Comprehend the process of problem-opportunity identification through design thinking, identify market potential and customers while developing a compelling value proposition solution	L3
CO3	Analyze and refine business models to ensure sustainability and profitability	L3
CO4	Build Prototype for Proof of Concept and validate MVP of their practice venture idea	L4
CO5	Create business plan, conduct financial analysis and feasibility analysis to assess the financial viability of a venture	L5
CO6	Prepare and deliver an investible pitch deck of their practice venture to attract stakeholders	L6

BTL: Bloom’s Taxonomy Level

III B.Tech. II Semester

Course Code	**DISASTER MANAGEMENT (Open Elective – II)**	L	T	P	C
23CET19		3	0	0	3

Course Objectives:

The objectives of this course are to make the student :

1. To understand the fundamental concepts of natural disasters, their occurrence, and disaster risk reduction strategies.
2. To analyze the impact of cyclones on structures and explore retrofitting techniques for adaptive reconstruction.
3. To apply wind engineering principles and computational techniques in designing wind-resistant structures.
4. To evaluate earthquake effects on buildings and develop strategies for seismic retrofitting.
5. To assess seismic safety planning, design considerations, and innovative construction materials for disaster-resistant structures.

Course Outcomes:

After successful completion of this course, students will be able to:

1. Understand the fundamental concepts of natural disasters, their occurrence, and disaster risk reduction strategies.
2. Analyze the impact of cyclones on structures and explore retrofitting techniques for adaptive reconstruction.
3. Apply wind engineering principles and computational techniques in designing wind-resistant structures.
4. Evaluate earthquake effects on buildings and develop strategies for seismic retrofitting.
5. Assess seismic safety planning, design considerations, and innovative construction materials for disaster-resistant structures.

CO – PO Articulation Matrix

Course Outcomes	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
CO -1	3	-	-	-	-	2	-	2	2	-	-	-	3	3
CO -2	-	3	-	-	2	-	-	-	-	-	-	2	3	-
CO -3	3	-	-	3	-	-	3	-	-	2	-	-	-	3
CO -4	-	-	3	-	3	-	-	2	-	-	-	-	3	-
CO -5	-	-	-	3	-	3	3	3	2	-	-	-	-	3

UNIT – I

Introduction to Natural Disasters– Brief Introduction to Different Types of Natural Disasters, Occurrence of Disasters in Different Climatic and Geographical Regions, Hazard Maps (Earthquake and Cyclone) of The World and India, Regulations for Disaster Risk Reduction, Post-Disaster Recovery and Rehabilitation (Socioeconomic Consequences).

UNIT – II

Cyclones and Their Impact– Climate Change and Its Impact On Tropical Cyclones, Nature of Cyclonic Wind, Velocities and Pressure, Cyclone Effects, Storm Surges, Floods, and Landslides. Behavior of Structuresin Past Cyclones and Windstorms, Case Studies. Cyclonic

Retrofitting, Strengthening of Structures, and Adaptive Sustainable Reconstruction. Life-Line Structures Such as Temporary Cyclone Shelters.

UNIT – III

Wind Engineering and Structural Response– Basic Wind Engineering, Aerodynamics of Bluff Bodies, Vortex Shedding, and Associated Unsteadiness Along and Across Wind forces. Lab: Wind Tunnel Testing and Its Salient Features. Introduction to Computational Fluid Dynamics (CFD). General Planning and Design Considerations Under Windstorms and Cyclones. Wind Effects On Buildings, towers, Glass Panels, Etc., and Wind-Resistant Features in Design. Codal Provisions, Design Wind Speed, Pressure Coefficients. Coastal Zoning Regulations for Construction and Reconstruction in Coastal Areas. Innovative Construction Materials and Techniques, Traditional Construction Techniques in Coastal Areas.

UNIT – IV

Seismology and Earthquake Effects– Causes of Earthquakes, Plate Tectonics, Faults, Seismic Waves; Magnitude, Intensity, Epicenter, Energy Release, and Ground Motions. Earthquake Effects– On Ground, Soil Rupture, Liquefaction, Landslides. Performance of Ground and Buildings in Past Earthquakes– Behavior of Various Types of Buildings and Structures, Collapse Patterns; Behavior of Non-Structural Elements Such as Services, Fixtures, and Mountings – Case Studies. Seismic Retrofitting– Weakness in Existing Buildings, Aging, Concepts in Repair, Restoration, and Seismic Strengthening.

UNIT – V

Planning and Design Considerations for Seismic Safety– General Planning and Design Considerations; Building forms, Horizontal and Vertical Eccentricities, Mass and Stiffness Distribution, Soft Storey Effects, Etc.; Seismic Effects Related to Building Configuration. Plan and Vertical Irregularities, Redundancy, and Setbacks. Construction Details– Various Types of Foundations, Soil Stabilization, Retaining Walls, Plinth Fill, Flooring, Walls, Openings, Roofs, Terraces, Parapets, Boundary Walls, Underground and Overhead Tanks, Staircases, and Isolation of Structures. Innovative Construction Materials and Techniques. Local Practices– Traditional Regional Responses. Computational Investigation Techniques.

TEXT BOOKS:

1. David Alexander, *Natural Disasters*, 1st Edition, CRC Press, 2017.
2. Edward A. Keller and Duane E. DeVecchio, *Natural Hazards: Earth's Processes as Hazards, Disasters, and Catastrophes*, 5th Edition, Routledge, 2019.

REFRENCE BOOKS:

1. Ben Wisner, J.C. Gaillard, andIlanKelman (Editors), *Handbook of Hazards and Disaster Risk Reduction and Management*, 2nd Edition, Routledge, 2012.
2. Damon P. Coppola, *Introduction to International Disaster Management*, 4th Edition, Butterworth-Heinemann, 2020.
3. BimalKanti Paul, *Environmental Hazards and Disasters: Contexts, Perspectives and Management*, 2nd Edition, Wiley-Blackwell, 2020.

Online Learning Resources:

https://nptel.ac.in/courses/124107010
https://onlinecourses.swayam2.ac.in/cec19_hs20/preview

III B.Tech – II Semester

Course Code	**SUSTAINABILITY IN ENGINEERING PRACTICES (OE – II)**	L	T	P	C
23CET20		3	0	0	3

Course Objectives:

The objectives of this course are to make the student :

1. To understand the fundamentals of sustainability, the carbon cycle, and the environmental impact of construction materials.
2. To analyze sustainable construction materials, their durability, and life cycle assessment.
3. To apply energy calculations in construction materials and assess their embodied energy.
4. To evaluate green building standards, energy codes, and performance ratings.
5. To assess the environmental effects of energy use, climate change, and global warming.

Course Outcomes:

After successful completion of this course, students will be able to:

1. Understand the fundamentals of sustainability, the carbon cycle, and the environmental impact of construction materials.
2. Analyze sustainable construction materials, their durability, and life cycle assessment.
3. Apply energy calculations in construction materials and assess their embodied energy.
4. Evaluate green building standards, energy codes, and performance ratings.
5. Assess the environmental effects of energy use, climate change, and global warming.

CO – PO Articulation Matrix

Course Outcomes	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
CO -1	3	-	-	-	-	2	3	2	-	-	-	-	3	3
CO -2	-	3	-	-	2	-	3	-	-	-	-	2	3	3
CO -3	-	-	3	3	3	-	2	-	-	2	-	-	3	3
CO -4	-	-	3	3	3	-	3	2	-	-	-	-	3	3
CO -5	-	-	-	-	-	3	3	3	-	-	-	-	-	3

UNIT – I

INTRODUCTION

Introduction and Definition of Sustainability - Carbon Cycle - Role of Construction Material: Concrete and Steel, Etc. - CO_2Contribution From Cement and Other Construction Materials.

UNIT – II

MATERIALS USED in SUSTAINABLE CONSTRUCTION

Construction Materials and Indoor Air Quality - No/Low Cement Concrete - Recycled and Manufactured Aggregate - Role of QC and Durability - Life Cycle and Sustainability.

UNIT – III

ENERGY CALCULATIONS

Components of Embodied Energy - Calculation of Embodied Energy for Construction Materials - Energy Concept and Primary Energy - Embodied Energy Via-A-Vis Operational Energy in Conditioned Building - Life Cycle Energy Use

UNIT – IV

GREEN BUILDINGS

Control of Energy Use in Building - ECBC Code, Codes in Neighboring Tropical Countries - OTTV Concepts and Calculations – Features of LEED and TERI – GRIHA Ratings - Role of Insulation and Thermal Properties of Construction Materials - Influence of Moisture Content and Modeling - Performance Ratings of Green Buildings - Zero Energy Building

UNIT – V

ENVIRONMENTAL EFFECTS

Non-Renewable Sources of Energy and Environmental Impact– Energy Norm, Coal, Oil, Natural Gas - Nuclear Energy - Global Temperature, Green House Effects, Global Warming - Acid Rain: Causes, Effects and Control Methods - Regional Impacts of Temperature Change.

TEXT BOOKS:

1. Charles J Kibert, Sustainable Construction: Green Building Design & Delivery, 4th Edition , Wiley Publishers 2016.
2. Steve Goodhew, Sustainable Construction Process, Wiley Blackwell,UK, 2016.

REFRENCE BOOKS:

1. Craig A. Langston & Grace K.C. Ding, Sustainable Practicesin the Built Environment, Butterworth Heinemann Publishers, 2011.
2. William P Spence, Construction Materials, Methods & Techniques (3e), Yesdee Publication Pvt. Ltd, 2012.

Online Learning Resources:

https://archive.nptel.ac.in/courses/105/105/105105157/

III B.Tech. II Semester

L	T	P	C
3	0	0	3

23EET18 RENEWABLE ENERGY SOURCES
(Open Elective-II)

Course Outcomes (CO): At the end of the course the student will be able to:

CO 1: Understand principle operation of various renewable energy sources. L1
CO 2: Identify site selection of various renewable energy sources. L2
CO 3: Analyze various factors affecting on solar energy measurements, wind energy conversion techniques, Geothermal, Biomasss, Tidal Wave and Fuel cell energies L3
CO 4: Design of Solar PV modules and considerations of horizontal and vertical axis Wind energy systems. L5
CO 5: Apply the concepts of Geo Thermal Energy, Ocean Energy, Bio mass and Fuel Cells for generation of power. L4

UNIT I Solar Energy:

Solar radiation - beam and diffuse radiation, solar constant, Sun at Zenith, attenuation and measurement of solar radiation, local solar time, derived solar angles, sunrise, sunset and day length. flat plate collectors, concentrating collectors, storage of solar energy-thermal storage.

UNIT II PV Energy Systems:

Introduction, The PV effect in crystalline silicon basic principles, the film PV, Other PV technologies, Solar PV modules from solar cells, mismatch in series and parallel connections design and structure of PV modules, Electrical characteristics of silicon PV cells and modules, Stand-alone PV system configuration, Grid connected PV systems.

UNIT III Wind Energy:

Principle of wind energy conversion; Basic components of wind energy conversion systems; wind mill components, various types and their constructional features; design considerations of horizontal and vertical axis wind machines: analysis of aerodynamic forces acting on wind mill blades; wind data and energy estimation and site selection considerations.

UNIT IV Geothermal Energy:

Estimation and nature of geothermal energy, geothermal sources and resources like hydrothermal, geo-pressured hot dry rock, magma. Advantages, disadvantages and application of geothermal energy, prospects of geothermal energy in India.

UNIT – V Miscellaneous Energy Technologies:

Ocean Energy: Tidal Energy-Principle of working, Operation methods, advantages and limitations. Wave Energy-Principle of working, energy and power from waves, wave energy conversion devices, advantages and limitations.
Bio mass Energy: Biomass conversion technologies, Biogas generation plants, Classification, advantages and disadvantages, constructional details, site selection, digester design consideration
Fuel cell: Principle of working of various types of fuel cells and their working, performance and limitations.

Text books:

1.G. D. Rai, “Non-Conventional Energy Sources”, 4th Edition, Khanna Publishers, 2000.

2.Chetan Singh Solanki “Solar Photovoltaics fundamentals, technologies and applications” 2nd Edition PHI Learning Private Limited. 2012.

Reference Books:

1.Stephen Peake, “Renewable Energy Power for a Sustainable Future”, Oxford International Edition, 2018.

2.S. P. Sukhatme, “Solar Energy”,3rd Edition, Tata Mc Graw Hill Education Pvt. Ltd, 2008.

3.B H Khan , “ Non-Conventional Energy Resources”, 2nd Edition, Tata Mc Graw Hill Education Pvt Ltd, 2011.

4.S. Hasan Saeed and D.K.Sharma,“Non-Conventional Energy Resources”,3rd Edition, S.K.Kataria& Sons, 2012.

5.G. N. Tiwari and M.K.Ghosal, “Renewable Energy Resource: Basic Principles and Applications”, Narosa Publishing House, 2004.

Online Learning Resources:

1. https://nptel.ac.in/courses/103103206
2. https://nptel.ac.in/courses/108108078

III B. Tech -II Sem

L	T	P	C
3	0	0	3

23MET19 AUTOMATION AND ROBOTICS

(Open Elective – II)

Course objectives: The objectives of the course are to	
1	Fundamentals of industrial automation, production types, automation strategies, and hardware elements used in modern manufacturing processes.
2	Understanding of automated manufacturing systems, and strategies for improving productivity and flexibility in industrial automation.
3	Knowledge of industrial automation and robotics, sensors, and end-effector design for modern manufacturing environments.
4	Explain industrial automation and robotics, and trajectory planning for intelligent and efficient manufacturing applications.
5	Familiarity of industrial automation and robotics, and practical applications in manufacturing processes.

COURSE OUTCOMES On successful completion of this course the student will be able to		
1	derstand and analyze the structure and functions of automated manufacturing systems, and evaluate hardware components for efficient production.	*L2,L4,L5*
2	alyze and design automated flow lines with or without buffer storage, perform quantitative evaluations, apply assembly line balancing techniques.	L4,L5,L6
3	ssify robot configurations, select suitable actuators and sensors, analyze and apply automation and robotics principles to optimize production efficiency and flexibility.	L2,L3,L4
4	ply kinematic and dynamic modeling using D-H notation and select appropriate hardware and control strategies for real-world industrial scenario to analyze and design automated and robotic systems.	L3,L4,L5
5	sign, program, and implement robotic systems, understand and apply robotics technology to manufacturing tasks.	L1,L3,L6

UNIT-I

Introduction to Automation:

Introduction to Automation, Need, Types, Basic elements of an automated system, Manufacturing Industries, Types of production, Functions in manufacturing, Organization and information processing in manufacturing, Automation strategies and levels of automation, Hardware components for automation and process control, mechanical feeders, hoppers, orienters, high speed automatic insertion devices.

UNIT –II

Automated flow lines:

Automated flow lines, Part transfer methods and mechanisms, types of Flow lines, flow line with/without buffer storage, Quantitative analysis of flow lines. Assembly line balancing: Assembly process and systems assembly line, line balancing methods, ways of improving line balance, flexible assembly lines.

UNIT- III

Introduction to Industrial Robotics:

Introduction to Industrial Robotics, Classification of Robot Configurations, functional line diagram, degrees of freedom. Components common types of arms, joints grippers, factors to be considered in the design of grippers.

Robot actuators and Feedback components: Actuators, Pneumatic, Hydraulic actuators, Electric & Stepper motors, comparison. Position sensors - potentiometers, resolvers, encoders - velocity sensors, Tactile sensors, Proximity sensors.

UNIT- IV

Manipulator Kinematics:

Manipulator Kinematics, Homogenous transformations as applicable to rotation and transition - D-H notation, Forward inverse kinematics.

Manipulator Dynamics: Differential transformations, Jacobians, Lagrange - Euler and Newton – Euler formations. Trajectory Planning: Trajectory Planning and avoidance of obstacles path planning, skew motion, joint integrated motion - straight line motion.

UNIT- V

Robot Programming:

Robot Programming, Methods of programming - requirements and features of programming languages, software packages. Problems with programming languages.

Robot Application in Manufacturing: Material Transfer - Material handling, loading and unloading - Process - spot and continuous arc welding & spray painting - Assembly and Inspection.

Text Books:

1. Automation , Production systems and CIM,M.P. Groover /Pearson Edu.
2. Industrial Robotics - M.P. Groover, TMH.
3.

References:

1. Robotics , Fu K S, McGraw Hill, 4th edition, 2010.
2. An Introduction to Robot Technology, P. Coiffet and M. Chaironze, Kogam Page Ltd. 1983 London.
3. Robotic Engineering , Richard D. Klafter, Prentice Hall
4. Robotics, Fundamental Concepts and analysis – Ashitave Ghosal ,Oxford Press, 1/e, 2006
5. Robotics and Control , Mittal R K &Nagrath I J , TMH.

Online Learning Resources:

https://www.youtube.com/watch?v=yxZm9WQJUA0&list=PLRLB5WCqU54UJG45UnazSYmnmhl-gt76o

https://www.youtube.com/watch?v=6f3bvIhSWyM&list=PLRLB5WCqU54X5Vy4DwjfSODT3ZJgwEjyE

III B.Tech II Sem

L – T – P – C **3 – 0 – 0 – 3**

23CET25 DIGITAL ELECTRONICS
(Open Elective –II)

Course Objectives:

1. To Learn Boolean algebra, logic simplification techniques, and combinational circuit design.
2. To analyze combinational circuits like adders, subtractors, and code converters.
3. To explore combinational logic circuits and their applications in digital design.
4. To understand sequential logic circuits, including latches, flip-flops, counters, and shift registers.
5. To gain knowledge about programmable logic devices and digital IC's.

Course Outcomes:

At the end of this course, the students will be able to

1. Learn Boolean algebra, logic simplification techniques, and combinational circuit design.
2. Analyze combinational circuits like adders, subtractors, and code converters.
3. Explore combinational logic circuits and their applications in digital design.
4. Understand sequential logic circuits, including latches, flip-flops, counters, and shift registers.
5. Gain knowledge about programmable logic devices and digital IC's.

UNIT-I

Logic Simplification and Combinational Logic Design: Review of Boolean Algebra and De Morgan's Theorem, SOP & POS forms, Canonical forms, Introduction to Logic Gates, Ex-OR, Ex-NOR operations, Minimization of Switching Functions: Karnaugh map method, Logic function realization: AND-OR, OR-AND and NAND/NOR realizations.

UNIT-II

Introduction to Combinational Design 1: Binary Adders, Subtractors and BCD adder, Code converters - Binary to Gray, Gray to Binary, BCD to excess3, BCD to Seven Segment display.

UNIT-III

Combinational Logic Design 2: Decoders, Encoders, Priority Encoder, Multiplexers, Demultiplexers, Comparators, Implementations of Logic Functions using Decoders and Multiplexers.

UNIT-IV

Sequential Logic Design: Latches, Flip-flops, S-R, D, T, JK and Master-Slave JK FF, Edge triggered FF, set up and hold times, Ripple counters, Shift registers.

UNIT-V

Programmable Logic Devices:ROM, Programmable Logic Devices (PLA and PAL).

Digital IC's: Decoder (74x138), Priority Encoder (74x148), multiplexer (74x151) and de-multiplexer (74x155), comparator (74x85).

TEXT BOOKS:

1. Digital Design, M.Morris Mano & Michel D. Ciletti, 5th Edition, Pearson Education, 1999.
2. Switching theory and Finite Automata Theory, ZviKohavi and NirahK.Jha, 2nd Edition, Tata McGraw Hill, 2005.

REFERENCE BOOKS:

1. Fundamentals of Logic Design, Charles H Roth,Jr., 5th Edition, Brooks/cole Cengage Learning, 2004.
2.

III B.Tech II Sem

L	T	P	C
3	0	0	3

23BST24 Operations Research
(Open Elective -II)

Course Outcomes:

After successful completion of this course, the students should be able to:

COs	Statements	Blooms level
CO1	Understand the meaning, purpose, tools of Operations Research and linear programming in solving practical problems in industry.	L2, L3
CO2	Interpret the transportation models' solutions and infer solutions to the real-world problems.	L3, L5
CO3	Develop mathematical skills to analyze and solve nonlinear programming models arising from a wide range of applications.	L3
CO4	Apply the concept of non-linear programming for solving the problems involving non-linear constraints and objectives	L2, L3
CO5	Apply the concept of unconstrained geometric programming for solving the problems involving non-linear constraints and objectives.	L3,L5

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	-	-	-	-	-	-	-	1
CO2	3	2	2	2	-	-	-	-	-	-	-	1
CO3	3	2	2	1	-	-	-	-	-	-	-	1
CO4	2	2	2	1	-	-	-	-	-	-	-	1
CO5	3	3	2	1	-	-	-	-	-	-	-	1

1-Slightly, 2-Moderately, 3-Substantially.

UNIT – I: Linear programming I (08)

Introduction, Applications of Linear Programming, Standard form of a Linear Programming Problem, Geometry of Linear Programming Problems, Basic Definitions in Linear Programming. Simplex Method, Simplex Algorithm and Two phase Simplex Method, Big-M method.

UNIT – II Linear programming II: Duality in Linear Programming (08)

Symmetric Primal-Dual Relations, General Primal-Dual Relations, Duality Theorem, Dual Simplex Method, Transportation Problem and assignment problem, Complementary slackness Theorem

UNIT – III Non-linear programming: Unconstrained optimization techniques (08)

Introduction: Classification of Unconstrained minimization methods,

Direct Search Methods: Random Search Methods: Descent Method and Fletcher Powell Method, Grid Search Method

UNIT – IV Non-linear programming: Constrained optimization techniques (08)

Introduction, Characteristics of a constrained problem, Random Search Methods, complex method, Sequential linear programming, Basic approach in methods of Feasible directions, Zoutendijk's method of feasible directions: direction finding problem, determination of step length, Termination criteria.

UNIT-V Geometric Programming **(08)**

Unconstrained Minimization Problems: solution of unconstrained geometric programming using differential calculus and arithmetic-geometric inequality.

Constrained minimization Problems: Solution of a constrained geometric programming problem, primal-dual programming in case of less-than inequalities, geometric programming with mixed inequality constraints.

TEXT BOOK:

1. Singiresu S Rao., Engineering Optimization: Theory and Practices, New Age Int. (P) Ltd. Publishers, New Delhi.
2. J. C. Panth, Introduction to Optimization Techniques, (7-e) Jain Brothers, New Delhi.

REFERENCES:

1. Harvey M. Wagner, Principles of Operation Research, Printice-Hall of India Pvt. Ltd. New Delhi.
2. Peressimi A.L., Sullivan F.E., Vhl, J. J. Mathematics of Non-linear Programming, Springer – Verlag.

Web Reference:

- https://onlinecourses.nptel.ac.in/noc24_ee122/preview
- https://archive.nptel.ac.in/courses/111/105/111105039/
- https://onlinecourses.nptel.ac.in/noc21_ce60/preview

III B.Tech II Sem

23BST29	MATHEMATICAL FOUNDATION OF QUANTUM TECHNOLOGIES Open Elective – II	L	T	P	C
		3	0	0	3

Course Objectives:

- To provide students with essential linear algebra foundations including vector spaces, inner products, and operators for quantum mechanical applications.
- To develop understanding of the transition from finite-dimensional systems to infinite-dimensional function spaces and Hilbert space concepts.
- To establish quantum mechanical formalism including measurement theory, uncertainty relations, and time evolution principles.
- To enable students to apply quantum mechanical principles to solve problems in simple quantum systems and understand statistical interpretation.
- To introduce advanced concepts in composite systems, measurement processes, and modern perspectives in quantum mechanics.

Course Outcomes:

After successful completion of this course, the students should be able to:

COs	Statements	Blooms level
CO1	Understand vector spaces, inner products, and linear operators with applications to quantum systems.	L1, L2 (Understand, Comprehend)
CO2	Apply linear algebra concepts to function spaces and analyze the transition from finite to infinite dimensional systems.	L3, L4 (Apply, Analyze)
CO3	Analyze quantum mechanical formalism including measurement theory, uncertainty relations, and time evolution.	L4 (Analyze)
CO4	Apply quantum mechanical principles to solve problems in simple quantum systems and evaluate statistical interpretations.	L3, L5 (Apply, Evaluate)
CO5	Evaluate advanced concepts in composite systems and synthesize understanding of measurement processes and modern quantum theory.	L5, L6 (Evaluate, Create)

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	1	-	-	-	-	-	-	2
CO2	3	3	2	3	2	-	-	-	-	-	-	2
CO3	3	3	3	3	2	-	-	-	-	-	-	2
CO4	3	3	3	3	2	-	-	-	-	-	-	2
CO5	3	3	3	3	2	1	-	-	-	-	-	3

• **3** = Strong Mapping, **2** = Moderate Mapping, **1** = Slight Mapping, **-** = No Mapping

UNIT I: Linear Algebra Foundation for Quantum Mechanics (10 hours)

Vector spaces definition and examples (R^2, R^3, function spaces), Inner products (dot product, orthogonality, normalization), Linear operators (matrices, eigenvalues, eigenvectors), Finite-dimensional examples (2×2 matrices, spin-1/2 systems), Dirac notation introduction ($|\psi\rangle$, $\langle\varphi|$, $\langle\varphi|\psi\rangle$), Change of basis (transformations, unitary matrices).

UNIT II: From Finite to Infinite Dimensions (08 hours)

Function spaces (L^2 space, square-integrable functions), Inner products for functions ($\int\psi^*\varphi\, dx$), Orthogonal function sets (Fourier series, basis functions), Introduction to Hilbert space concept (complete inner product spaces), Position and momentum representations (wave functions), Operators on functions (d/dx, multiplication by x).

UNIT III: Quantum Mechanical Formalism (08 hours)

Mathematical formulation (states as vectors, observables as operators), Measurement theory (Born rule, expectation values, probabilities), Uncertainty relations (mathematical derivation from commutators), Time evolution (Schrödinger equation, unitary evolution).

UNIT IV: Applications and Statistical Interpretation (06 hours)

Simple applications (infinite square well, harmonic oscillator), Statistical interpretation (ensembles, pure vs mixed states), Measurement process (von Neumann measurement scheme).

UNIT V: Advanced Topics (08 hours)

Composite systems (tensor products basic introduction), Reversibility and irreversibility (unitary evolution vs measurement), Thermodynamic connections (equilibrium states, entropy), Modern perspectives (decoherence, measurement problem conceptual).

Textbooks:

1. David J. Griffiths, Darrell F. Schroeter, “Introduction to Quantum Mechanics”, 3rd Edition, Cambridge University Press (2018).
2. R. Shankar, Principles of Quantum Mechanics, 2nd Edition, Kluwer Academy/Plenum Publishers (1994).

Reference Books:

1. George. F. Simmons, “Introduction to Topology and Modern Analysis”,MedTech Science Press.
2. Gilbert Strang, Linear Algebra and Its Applications, 4th Edition, Cengage Learning (2006).
3. John von Neumann and Robert T Beyer, Mathematical Foundations of Quantum Mechanics,Princeton Univ. Press (1996).

Web Resources

1. https://eclass.uoa.gr/modules/document/file.php/CHEM248/Griffiths%20-%20Introduction%20to%20Quantum%20Mechanics%203rd%20ed%202018.pdf
2. https://fisica.net/mecanica-quantica/Shankar%20-%20Principles%20of%20quantum%20mechanics.pdf

III B.Tech II Sem

23BST25	**PHYSICS OF ELECTRONIC MATERIALS AND DEVICES** (Common to all branches) Open Elective-II	Credits 3-0-0:3

Course Objectives	
1	To make the students to understand the concept of crystal growth, defects in crystals and thin films.
2	To provide insight into various semiconducting materials and their properties.
3	To develop a strong foundation in semiconductor physics and device engineering.
4	To elucidate excitonic and luminescent processes in solid-state materials.
5	To understand the principles, technologies, and applications of modern display systems.

Syllabus:

UNIT-I Fundamentals of Materials Science **9H**

Introduction, Phase rule, Phase Diagram, Elementary idea of Nucleation and Growth, Methods of crystal growth. The basic idea of point, line, and planar defects. Concept of thin films, preparation of thin films, Deposition of thin film using sputtering methods (RF and glow discharge).

UNIT II Semiconductors **9H**

Introduction, charge carriers in semiconductors, effective mass, Diffusion and drift, Diffusion and recombination, Diffusion length. The Fermi level & Fermi-Dirac distribution, Electron and Hole in quantum well, Change of electron-hole concentration- Qualitative analysis, Temperature dependency of carrier concentration, Conductivity and mobility, Effects of temperature and doping on mobility, High field effects.

UNIT III Physics of Semiconductor Devices: **9H**

Introduction, Band structure, PN junctions and their typical characteristics under equilibrium and under bias, Heterojunctions, Transistors, MOSFETs.

UNIT IV Excitons and Luminescence: **9H**

Luminescence: Different types of luminescence, basic definitions, Light emission in solids, Inter-band luminescence, Direct and indirect gap materials.

Photoluminescence : General Principles of photoluminescence, Excitation and relaxation, OLED, Quantum-dot.

Electro-luminescence : General Principles of electroluminescence, light emitting diode, diode laser.

UNIT V Display devices : **9H**

LCD, three-dimensional display: Holographic display, light-field displays: Head-mounted display, MOEMS (Micro-Opto-Electro-Mechanical Systems) and MEMS displays.

Textbooks:

1. Principles of Electronic Materials and Devices-S.O. Kasap, McGraw-Hill Education (India) Pvt. Ltd.,4thedition, 2021.
2. Semiconductor physics & devices: basic principles, 4th Edition, McGraw-Hill, 2012.

Reference Books:

1. Solid State Electronic Devices -B.G. Streetman and S. Banerjee, PHI Learning,6th edition
2. Electronic Materials Science- Eugene A. Irene, Wiley, 2005
3. Electronic Components and Materials, Grover and Jamwal, Dhanpat Rai and Co., New Delhi., 2012.
4. An Introduction to Electronic Materials for Engineers-Wei Gao, Zhengwei Li, Nigel Sammes, World Scientific Publishing Co. Pvt. Ltd. 2nd Edition,2011

NPTEL course links:
https://nptel.ac.in/courses/113/106/113106062/

https://onlinecourses.nptel.ac.in/noc20_ph24/preview

	Course Outcomes	Blooms Level
CO1	Understand crystal growth and thin film preparation	L1,L2
CO2	Summarize the basic concepts of semiconductors	L1, L2
CO3	Illustrate the working of various semiconductor devices	L1, L2, L3
CO4	Analyze various luminescent phenomena and the devices based on these concepts	L1, L2, L3
CO5	Explain the working of different display devices	L1, L2

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	1							
CO2	3	3	2	1	1							
CO3	3	3	2	1	1							
CO4	3	2	1	1	-							
CO5	3	3	1	1	-							

1-Slightly, 2-Moderately,3-Substantially.

III B.Tech –II Sem

23BST27	**CHEMISTRY OF POLYMERS AND APPLICATIONS** (Common to all branches) Open Elective-II	Credits 3-0-0:3

Course Objectives	
1	To understand the basic principles of polymers
2	To understand natural polymers and their applications.
3	To impart knowledge to the students about synthetic polymers, their preparation and importance.
4	To enumerate the applications of hydogel polymers
5	To enumerate applications of conducting and degradable polymers in engineering.

Course Outcomes	
CO1	Classify the polymers, Explain polymerization mechanism, Differentiate addition, condensation polymerizations, Describe measurement of molecular weight of polymer
CO2	Describe the physical and chemical properties of natural polymers and Modified cellulosics.
CO3	Differentiate Bulk, solution, Suspension and emulsion polymerization, Describe fibers and elastomers, Identify the thermosetting and thermo polymers.
CO4	Identify types of polymer networks, Describe methods involve in hydrogel preparation, Explain applications of hydrogels in drug delivery,
CO5	Explain classification and mechanism of conducting and degradable polymers.

Mapping between Course Outcomes and Programme Outcomes

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

Unit – I: Polymers-Basics and Characterization

Basic concepts: monomers, repeating units, degree of polymerization, linear, branched and network polymers, classification of polymers, Polymerization: addition, condensation, copolymerization and coordination polymerization. Average molecular weight concepts: number, weight and viscosity average molecular weights, polydispersity and molecular weight distribution. Measurement of molecular weight: End group, viscosity, light scattering, osmotic and ultracentrifugation methods, analysis and testing of polymers.

Unit – II: Natural Polymers & Modified cellulosics

Natural Polymers: Chemical & Physical structure, properties, source, important chemical modifications, applications of polymers such as cellulose, lignin, starch, rosin, shellac, latexes, vegetable oils and gums, proteins.

Modified cellulosics: Cellulose esters and ethers such as Ethyl cellulose, CMC, HPMC, cellulose acetals, Liquid crystalline polymers; specialty plastics- PES, PAES, PEEK, PEA.

Unit – III: Synthetic Polymers

Addition and condensation polymerization processes– Bulk, Solution, Suspension and Emulsion polymerization. Preparation and significance, classification of polymers based on physical properties. Thermoplastics, Thermosetting plastics, Fibers and elastomers, General Applications. Preparation of Polymers based on different types of monomers, Olefin polymers(PE,PVC), Butadiene polymers(BUNA-S,BUNA-N), nylons, Urea-formaldehyde, phenol – formaldehyde, Melamine Epoxy and Ion exchange resins.

Unit-IV: Hydrogels of Polymer networks

Definitions of Hydrogel, polymer networks, Types of polymer networks, Methods involved in hydrogel preparation, Classification, Properties of hydrogels**,** Applications of hydrogels in drug delivery.

Unit – V: Conducting and Degradable Polymers:

Conducting polymers: Introduction, Classification, Mechanism of conduction in Poly Acetylene, Poly Aniline, Poly Thiophene, Doping,Applications.

Degradable polymers: Introduction, Classifications, Examples, Mechanism of degradation, poly lactic acid, Nylon-6, Polyesters, applications.

Text Books:

1. A Text book of Polymer science, Billmayer
2. Polymer Chemistry – G.S.Mishra
3. Polymer Chemistry – Gowarikar

References Books:

1. Organic polymer Chemistry, K.J.Saunders, Chapman and Hall
2.Advanced Organic Chemistry, B.Miller, Prentice Hall
3. Polymer Science and Technology by Premamoy Ghosh, 3rd edition, McGraw-Hill, 2010.

III B.Tech –II Sem

23BST27	**ACADEMIC WRITING AND PUBLIC SPEAKING (Common to All Branches of Engineering) OPEN ELECTIVE - II**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives:

- To encourage all round development of the students by focusing on writing skills
- To make the students aware of non-verbal skills
- To develop analytical skills
- To deliver effective public speeches

Course Outcomes (CO):	Blooms Level
By the end of the program students will be able to	
• Understand various elements of Academic Writing	L1, L2
• Identify sources and avoid plagiarism	L1, L2
• Demonstrate the knowledge in writing a Research paper	L3
• Analyse different types of essays	L4
• Assess the speeches of others and know the positive strengths of speakers	L5
• Build confidence in giving an impactful presentation to the audience	L3

UNIT – I	Introduction to Academic Writing	Lecture Hrs

Introduction to Academic Writing – Essential Features of Academic Writing – Courtesy – Clarity – Conciseness – Correctness – Coherence – Completeness – Types – Descriptive, Analytical, Persuasive, Critical writing

UNIT – II	**Academic Journal Article**	Lecture Hrs

Art of condensation- summarizing and paraphrasing - Abstract Writing, writing Project Proposal, writing application for internship, Technical/Research/Journal Paper Writing – Conference Paper writing - Editing, Proof Reading - Plagiarism

UNIT – III	**Essay & Writing Reviews**	Lecture Hrs

Compare and Contrast – Argumentative Essay – Exploratory Essay – Features and Analysis of Sample Essays – Writing Book Report, Summarizing, Book/film Review- SoP

UNIT – IV	Public Speaking	Lecture Hrs

Introduction, Nature, characteristics, significance of Public Speaking – Presentation – 4 Ps of Presentation – Stage Dynamics – Answering Strategies –Analysis of Impactful Speeches- Speeches for Academic events

UNIT – V	Public Speaking and Non-Verbal Delivery	Lecture Hrs

Body Language – Facial Expressions-Kinesics – Oculesics – Proxemics – Haptics – Chronomics - Paralanguage - Signs

Textbooks:

1. *Critical Thinking, Academic Writing and Presentation Skills*: MG University Edition Paperback – 1 January 2010 Pearson Education; First edition (1 January 2010)
2. Pease, Allan & Barbara. *The Definitive Book of Body Language*RHUS Publishers, 2016

ference Books:

1. Alice Savage, Masoud Shafiei *Effective Academic Writing,**2Ed.,***2014 .Oxford University Press
2. Shalini Verma, *Body Language*, S Chand Publications 2011.
3. Sanjay Kumar and Pushpalata,*Communication Skills* 2E 2015, Oxford.
4. Sharon Gerson, Steven Gerson,*Technical Communication Process and Product,* Pearson, New Delhi, 2014
5. *Elbow, Peter. Writing with Power. OUP USA, 1998*

Online Learning Resources:
1. https://youtu.be/NNhTIT81nH8 2. phttps://www.youtube.com/watch?v=478ccrWKY-A 3. https://www.youtube.com/watch?v=nzGo5ZC1gMw 4. https://www.youtube.com/watch?v=Qve0ZBmJMh4 5. https://courses.lumenlearning.com/publicspeakingprinciples/chapter/chapter-12-nonverbal-aspects-of-delivery/ 6. https://onlinecourses.nptel.ac.in/noc21_hs76/preview 7. https://archive.nptel.ac.in/courses/109/107/109107172/# 8. https://archive.nptel.ac.in/courses/109/104/109104107/

HONOURS

23AIHT1	ADVANCED MACHINE LEARNING & AI SYSTEMS	L	T	P	C
		3	0	0	3

Course Objectives:

- To deepen understanding of advanced machine learning concepts including ensemble learning, probabilistic models, and deep neural architectures.
- To explore scalable machine learning algorithms and their applications in real-world AI systems.
- To equip students with knowledge of interpretability, fairness, and trust in AI.
- To understand deployment, monitoring, and life-cycle management of AI systems.
- To apply machine learning in advanced domains such as natural language processing, vision, and multi-agent systems.

Course Outcomes (COs):
After completion of this course, students will be able to

CO1: Understand the advanced supervised and unsupervised learning techniques.
CO2: Design and implement deep learning architectures for vision and sequential data tasks.
CO3: Analyze and integrate explainability, fairness, and robustness techniques to build trustworthy and ethical AI systems.
CO4: Develop scalable ML pipelines and deploy models in production with proper monitoring, tuning, and retraining mechanisms.
CO5: Implement AI techniques in advanced applications such as natural language processing, computer vision, reinforcement learning, and multi-agent systems.

UNIT I: Advanced Supervised and Unsupervised Learning

Ensemble Learning: Bagging, Boosting, Random Forests, Support Vector Machines: Kernels and Multi-Class SVMs, Probabilistic Graphical Models: Bayesian Networks, HMMs, Expectation-Maximization and Variational Inference, Clustering: Hierarchical, DBSCAN, Gaussian Mixture Models.

UNIT II: Deep Learning Architectures

Deep Neural Networks and Optimization Challenges, Convolutional Neural Networks (CNNs), Recurrent Neural Networks (RNNs), LSTMs, GRUs, Autoencoders, Variational Autoencoders, Attention Mechanisms and Transformer Architectures

UNIT III: Interpretability, Fairness, and Trust in AI

Explainable AI: LIME, SHAP, Saliency Maps, Adversarial Examples and Robustness Techniques, Fairness Metrics and Bias Mitigation. Trustworthy AI Design and Ethical Considerations, Model Compression and Distillation

UNIT IV: Scalable and Production ML Systems

ML Pipelines, Feature Stores, and Model Versioning, Distributed Training with TensorFlow and PyTorch, Hyperparameter Tuning at Scale (Ray Tune, Optuna),Model Deployment with Docker, FastAPI, Flask, Monitoring, Drift Detection, and Model Retraining

UNIT V: Advanced Applications and Multi-Agent AI

Natural Language Understanding with Transformers (BERT, GPT), Vision-based AI Systems (YOLO, Mask R-CNN), Reinforcement Learning and Policy Gradients, AI in Robotics and Autonomous Agents, Multi-Agent Systems and Decentralized Learning

Textbooks:

1. Aurélien Géron – Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, 3rd Edition, O'Reilly
2. Ian Goodfellow, Yoshua Bengio, Aaron Courville – Deep Learning, MIT Press

Reference Books:

1. Kevin P. Murphy – Machine Learning: A Probabilistic Perspective, MIT Press
2. Trevor Hastie, Robert Tibshirani, Jerome Friedman – The Elements of Statistical Learning, Springer
3. Chris Bishop – Pattern Recognition and Machine Learning, Springer
4. Ethem Alpaydin – Introduction to Machine Learning, MIT Press

Online Courses & Resources:

1. CS229 – Machine Learning by Stanford (Andrew Ng)
2. DeepLearning.AI – Advanced Deep Learning Specialization (Coursera)

23AIHT2	DEEP LEARNING & NEURAL NETWORK ARCHITECTURES	L	T	P	C
		3	0	0	3

Course Objectives:

- To introduce the fundamental concepts and mathematical foundations of deep learning.
- To explore different neural network architectures including CNNs, RNNs, LSTMs, and Transformers.
- To enable students to implement, train, and optimize deep neural networks.
- To analyze the performance and limitations of various architectures in different AI tasks.
- To develop the ability to apply deep learning models to real-world applications such as image recognition, language modeling, and autonomous systems.

Course Outcomes (COs):

After completion of the course, the student will be able to

CO1: Understand the theoretical foundations of neural networks and deep learning.
CO2: Implement and train multilayer perceptrons, CNNs, RNNs, and other architectures.
CO3: Analyze and optimize deep learning models using advanced regularization and tuning techniques.
CO4: Evaluate the applicability of different neural network architectures for various AI problems.
CO5: Apply state-of-the-art models such as Transformers and GANs in real-world domains.

UNIT I: Foundations of Neural Networks

Introduction to Artificial Neural Networks, Biological Neuron vs. Artificial Neuron, Perceptron, Multilayer Perceptron (MLP), Activation Functions: ReLU, Sigmoid, Tanh, Softmax, Backpropagation and Gradient Descent, Loss Functions: MSE, Cross Entropy, Overfitting, Regularization (L1/L2), Dropout

UNIT II: Convolutional Neural Networks (CNNs)

Convolution Operation and Feature Maps, Pooling Layers: Max and Average Pooling, CNN Architectures: LeNet, AlexNet, VGG, ResNet, Transfer Learning and Fine-tuning, Image Classification, Object Detection Basics, Implementation with TensorFlow/PyTorch

UNIT III: Recurrent Neural Networks (RNNs) and Variants

Sequential Data and Time Series, RNN Basics and Backpropagation Through Time (BPTT), Vanishing and Exploding Gradients, LSTM and GRU Architectures, Applications in Text, Speech, and Music, Sequence-to-Sequence Models

UNIT IV: Advanced Architectures & Optimization

Autoencoders and Variational Autoencoders (VAEs), Generative Adversarial Networks (GANs), Deep Reinforcement Learning Overview, Batch Normalization, Early Stopping, Hyperparameter Tuning and Optimization, Performance Metrics and Evaluation

UNIT V: Transformer Models & Applications

Attention Mechanism and Self-Attention, Transformers and BERT Architecture, Positional Encoding, Multi-head Attention, Pre-trained Language Models and Fine-Tuning, Applications in NLP: Text Classification, Translation, Large Language Models and Transfer Learning

Text Books:

1. Deep Learning – Ian Goodfellow, Yoshua Bengio, and Aaron Courville (MIT Press)
2. Neural Networks and Deep Learning – Michael Nielsen (Online Book)
3. Hands-On Machine Learning with Scikit-Learn, Keras & TensorFlow – Aurélien Géron (O'Reilly)

Reference Books:

1. Pattern Recognition and Machine Learning – Christopher M. Bishop
2. Deep Learning for Computer Vision – Rajalingappaa Shanmugamani
3. Natural Language Processing with Transformers – Lewis Tunstall, Leandro von Werra, Thomas Wolf
4. Reinforcement Learning: An Introduction – Richard S. Sutton and Andrew G. Barto

Recommended Online Courses:

1. Deep Learning Specialization – Andrew Ng (Coursera)
2. CS231n: Convolutional Neural Networks for Visual Recognition (Stanford)
3. Fast.ai – Practical Deep Learning for Coders
4. Deep Learning with PyTorch (Udacity)
5. Transformers by Hugging Face (free course)

23AIHT3	REINFORCEMENT LEARNING & DECISION MAKING	L	T	P	C
		3	0	0	3

Course Objectives:

- To introduce the fundamentals of reinforcement learning (RL) and its mathematical foundation.
- To understand the Markov Decision Process (MDP) framework for decision making under uncertainty.
- To explore various RL algorithms including value-based, policy-based, and model-based approaches.
- To analyze deep reinforcement learning techniques for real-world applications.
- To study the integration of reinforcement learning with planning, exploration, and control strategies.

Course Outcomes (COs):

After completion of this course, students will be able to

CO1: Understand the fundamentals of reinforcement learning and solving decision-making problems using Markov Decision Processes and Bellman equations.
CO2: Apply dynamic programming and Monte Carlo methods to perform policy evaluation.
CO3: Implement temporal-difference learning algorithms.
CO4: Develop and analyse policy gradient and actor-critic methods.
CO5: Solve complex tasks in robotics, games, and autonomous systems using deep reinforcement learning techniques

UNIT I: Introduction to Reinforcement Learning & MDPs

Foundations of RL: Agent-Environment Interaction, Types of RL: Model-based vs. Model-free, Reward Signals, Return, and Discounting, Markov Decision Processes (MDPs), Bellman Equations and Optimality

UNIT II: Dynamic Programming & Monte Carlo Methods

Policy Evaluation and Policy Improvement, Value Iteration and Policy Iteration, Monte Carlo Prediction and Control, First-visit and Every-visit Methods, Limitations of DP and MC Approaches

UNIT III: Temporal-Difference Learning & Function Approximation

TD(0), Sarsa, and Q-Learning Algorithms, Eligibility Traces: TD(λ), Sarsa(λ), Off-policy vs. On-policy Learning, Linear Function Approximation, Generalization in RL

UNIT IV: Policy Gradient Methods and Actor-Critic Algorithms

Policy Gradient Theorem, REINFORCE Algorithm, Baselines and Variance Reduction, Actor-Critic Architectures, Trust Region and Proximal Policy Optimization (PPO)

UNIT V: Deep Reinforcement Learning and Applications

Deep Q-Networks (DQN) and Experience Replay, DDPG, A3C, and SAC Algorithms, Exploration Techniques: ε-greedy, UCB, Intrinsic Rewards, RL in Robotics, Game AI, and Autonomous Systems, Safety, Ethics, and Fairness in Decision Making

Textbooks:

1. Richard S. Sutton and Andrew G. Barto – Reinforcement Learning: An Introduction, 2nd Edition, MIT Press
2. Ian Goodfellow, Yoshua Bengio, Aaron Courville – Deep Learning, MIT Press

Reference Books:

1. David Silver's RL Course Slides & Lectures – DeepMind, University College London
2. Marco Wiering & Martijn van Otterlo (Eds.) – Reinforcement Learning: State of the Art, Springer
3. Csaba Szepesvári – Algorithms for Reinforcement Learning, Morgan & Claypool
4. Yuxi Li – Deep Reinforcement Learning: An Overview, arXiv survey

Online Courses & Resources:

1. DeepMind x UCL Reinforcement Learning Lectures by David Silver
2. Coursera: Reinforcement Learning Specialization – University of Alberta
3. DeepLearning.AI – Deep Reinforcement Learning with TensorFlow

23AIHT4	AI FOR ROBOTICS & AUTOMATION	L	T	P	C
		3	0	0	3

Course Objectives:

- To introduce the fundamental concepts of robotics and its integration with artificial intelligence (AI).
- To understand perception, motion planning, and control strategies using AI for autonomous robots.
- To explore machine learning and deep learning approaches in robotic automation.
- To develop intelligent systems capable of navigation, manipulation, and decision-making.
- To understand real-time robotic applications in industry and research.

Course Outcomes (COs):

After completion of the course, students will be able to

CO1: Explain the role of AI in robotics and the architecture of intelligent robotic systems.
CO2: Apply computer vision and sensor fusion techniques for robotic perception.
CO3: Design motion planning and control algorithms for robotic navigation.
CO4: Integrate machine learning models for autonomous behaviour and adaptation.
CO5: Analyse applications of AI-powered robots in industrial automation, agriculture, healthcare, and logistics.

UNIT I: Introduction to AI and Robotics

Fundamentals of Robotics and Components, AI Techniques for Robotics, Types of Robots: Mobile, Industrial, Collaborative, Humanoids, Architectures for Intelligent Robots, Sensors and Actuators in Robotics

UNIT II: Robotic Perception and Computer Vision

Perception Pipeline in Robots, Image Processing & Object Detection, Depth Estimation, 3D Mapping (SLAM), Sensor Fusion (Camera, LiDAR, IMU), Vision-based Navigation and Obstacle Avoidance

UNIT III: Motion Planning and Control

Path Planning: Dijkstra, A*, RRT, PRM, Control Strategies: PID, Feedback Linearization. Trajectory Generation. Kinematics & Dynamics for Robot Manipulators. Motion Planning in Dynamic Environments

UNIT IV: Machine Learning in Robotics

Reinforcement Learning for Control, Supervised Learning for Object Recognition, Unsupervised Learning for Clustering and Mapping, Behavior Cloning and Imitation Learning, Online and Adaptive Learning in Robots

UNIT V: Applications and Trends in Robotic Automation

AI in Industrial Automation and Smart Factories, AI for Service Robots and Human-Robot Interaction (HRI), Robots in Agriculture, Healthcare, and Delivery, Ethical and Social Implications of AI in Robotics, Case Studies: Boston Dynamics, Tesla Bots, Warehouse Automation

Textbooks:

1. Robin R. Murphy – Introduction to AI Robotics, MIT Press
2. Peter Corke – Robotics, Vision and Control: Fundamental Algorithms in MATLAB, Springer
3. Oussama Khatib and Bruno Siciliano (Eds.) – Springer Handbook of Robotics, Springer

Reference Books:

1. Kevin M. Lynch & Frank C. Park – Modern Robotics: Mechanics, Planning, and Control, Cambridge University Press
2. Siegwart, Nourbakhsh, Scaramuzza – Introduction to Autonomous Mobile Robots, MIT Press
3. Stuart Russell & Peter Norvig – Artificial Intelligence: A Modern Approach, Pearson

Online Courses & Resources:

1. Coursera – Robotics Specialization (University of Pennsylvania)
2. edX – AI for Robotics (Columbia University)
3. Udacity – AI for Robotics by Sebastian Thrun

23AIHT5	AI ETHICS, FAIRNESS & EXPLAINABILITY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To understand the ethical challenges and responsibilities involved in building and deploying AI systems.
2. To identify and mitigate bias in AI data, algorithms, and models.
3. To explore techniques for interpretability and explainability in machine learning.
4. To critically evaluate AI systems from a legal, social, and philosophical perspective.
5. To analyse real-world case studies involving ethical dilemmas in AI deployment.

Course Outcomes:

After completion of the course, students will be able to

CO1: Demonstrate awareness of ethical and societal concerns associated with AI technologies.
CO2**:** Detect and reduce bias in datasets and machine learning models.
CO3**:** Apply explainable AI (XAI) techniques for model transparency.
CO4**:** Evaluate AI systems based on fairness, accountability, and transparency.
CO5**:** Reflect on policy, legal, and human-centric implications of AI deployment.

Unit I: Foundations of AI Ethics

Introduction to AI Ethics and Responsible AI, Ethical Theories: Utilitarianism, Deontology, Virtue Ethics, Key Ethical Principles: Fairness, Accountability, Transparency, Privacy (FATP), Human-in-the-loop and Ethical Decision Making, AI and the SDGs (Sustainable Development Goals)

Unit II: Bias in Data and Algorithms

Types of Bias: Historical, Representation, Measurement, Aggregation, Sources of Bias in AI: Data Collection, Annotation, Model Training, Metrics for Fairness: Demographic Parity, Equal Opportunity, Predictive Parity, Bias Mitigation Techniques: Pre-processing, In-processing, Post-processing, Case Studies: COMPAS, Hiring Algorithms, Face Recognition Bias

Unit III: Explainable AI (XAI) Techniques

Need for Explainability and Transparency, Global vs Local Explanations, Methods: LIME, SHAP, Anchors, Integrated Gradients, Model-specific vs Model-agnostic Explanations, Visual Explanations and Human-Centric Interpretability

Unit IV: Legal, Regulatory & Societal Aspects

Data Protection Laws: GDPR, CCPA, Indian Digital Personal Data Protection Act, Ethical Guidelines: IEEE, UNESCO, OECD AI Principles, Algorithmic Accountability and Auditing, Intellectual Property and Liability in AI, Ethical Considerations in Surveillance, Military, and Social Scoring

Unit V: Building Responsible AI Systems

Designing Ethical AI Systems: Frameworks and Toolkits, Human-Centered AI and Value Alignment, Responsible AI Lifecycle and Documentation (Model Cards, Data Sheets), AI for Good and Ethical Innovation, Industry Case Studies: Google, Microsoft, IBM’s AI Governance

Textbooks:

1. **Virginia Dignum**, Responsible Artificial Intelligence: How to Develop and Use AI in a Responsible Way, Springer, 2019.
2. **Cathryn Carson and John Zerilli**, Ethics and Data Science, O'Reilly Media, 2021.
3. **Patrick Lin, Keith Abney, Ryan Jenkins**, Robot Ethics 2.0: From Autonomous Cars to Artificial Intelligence, Oxford University Press, 2017.

Reference Books:

1. **Shalini Sharma, B. Ravindran**, Responsible AI: An Indian Perspective, Springer, 2023.
2. **Christopher Kuner et al.**, The GDPR: General Data Protection Regulation (EU) Regulation 2016/679, Oxford University Press.

23AIHP1	AI & MACHINE LEARNING LAB	L	T	P	C
		0	0	3	1.5

Course Objectives

1. To provide hands-on experience in implementing AI and machine learning algorithms.
2. To develop and evaluate models using real-world datasets.
3. To introduce optimization and hyperparameter tuning techniques.
4. To build intelligent systems for classification, prediction, and clustering.

Course Outcomes (CO)

After completing the course, students will be able to

CO1: Implement key machine learning algorithms from scratch and using libraries.

CO2: Preprocess data and select suitable features for modelling.

CO3: Train, test, and evaluate models for accuracy and performance.

CO4: Apply AI techniques to solve classification, regression, and decision-making problems.

CO5: Develop simple AI agents and use neural networks for predictive tasks.

Tools Required

- Python (NumPy, Pandas, Scikit-learn, TensorFlow/Keras, OpenCV)
- Jupyter Notebook / Google Colab
- Datasets from UCI, Kaggle, Scikit-learn
- Anaconda / VS Code

List of 12 Experiments

1. **Data Preprocessing** – Cleaning, normalization, encoding, and splitting data.
2. **Linear Regression** – Implement simple and multiple linear regression.
3. **Logistic Regression** – Binary classification on datasets like breast cancer or Titanic.
4. **K-Nearest Neighbors (KNN)** – Classification task with evaluation metrics.
5. **Decision Trees and Random Forests** – Tree-based classification and visualization.
6. **Support Vector Machines (SVM)** – Margin classification with kernel trick.
7. **Naive Bayes** – Text classification with spam dataset.
8. **K-Means Clustering** – Unsupervised clustering with customer segmentation.
9. **Principal Component Analysis (PCA)** – Dimensionality reduction and visualization.
10. **Artificial Neural Networks (ANNs)** – Implement basic neural network using Keras.
11. **Model Evaluation & Tuning** – Use cross-validation, GridSearchCV, and confusion matrices.
12. **AI Agent Search Algorithms** – Implement A*, DFS, BFS for pathfinding problems.

Virtual Lab:

https://ai1-iiith.vlabs.ac.in/

23AIHP2	ROBOTICS & AUTONOMOUS SYSTEMS LAB	L	T	P	C
		0	0	3	1.5

Course Objectives:

- To introduce students to the fundamental concepts of robotics, control, and autonomous navigation.
- To provide hands-on experience with robotic simulation tools and real-time robot programming.
- To explore sensor integration, motion planning, and autonomous decision-making.
- To familiarize students with ROS (Robot Operating System) and robotic hardware platforms.
- To apply AI and machine learning concepts in robotics for perception and autonomy.

Course Outcomes:

After completion of the course, students will be able to

CO1: Understand and implement kinematics and control algorithms for robotic systems.
CO2: Program robots using ROS and simulate them in environments like Gazebo or Webots.
CO3: Integrate sensors such as LIDAR, cameras, and IMUs for perception.
CO4: Develop algorithms for autonomous navigation, obstacle avoidance, and mapping.
CO5: Apply AI and computer vision techniques in robotic decision-making.

List of 12 Lab Experiments:

1. Experiment 1: Introduction to Robot Operating System (ROS) and workspace setup.
2. Experiment 2: Build a basic ROS publisher and subscriber for robot control.
3. Experiment 3: Simulate a differential drive robot in Gazebo or Webots.
4. Experiment 4: Implement forward and inverse kinematics for a 2-link robotic arm.
5. Experiment 5: Control robot movement using PID control in simulation.
6. Experiment 6: Interface and process data from ultrasonic/IR sensors.
7. Experiment 7: Integrate and visualize LIDAR data for environment sensing.
8. Experiment 8: Implement SLAM (Simultaneous Localization and Mapping) using Gmapping or Cartographer.
9. Experiment 9: Develop a path planning algorithm using A* or Dijkstra.
10. Experiment 10: Obstacle avoidance using sensor data and reactive behavior.
11. Experiment 11: Vision-based object detection and tracking using OpenCV.
12. Experiment 12: Mini project – Build a complete pipeline for autonomous navigation in a mapped environment.

Text books:

1. Roland Siegwart, Illah Nourbakhsh, and Davide Scaramuzza, Introduction to Autonomous Mobile Robots, MIT Press.
2. John J. Craig, Introduction to Robotics: Mechanics and Control, Pearson.

Virtual Lab:

http://vlabs.iitkgp.ernet.in/mr/