



ANNAMACHARYA INSTITUTE OF TECHNOLOGY & SCIENCES

(AUTONOMOUS)

UTUKUR (P), C. K. DINNE (V&M), KADAPA, YSR DIST.

Approved by AICTE, New Delhi & Affiliated to JNTUA, Anantapuramu.

Approved by S.B.T.E.T. Andhra Pradesh.

Accredited by NAAC with 'A' Grade, Bangalore & NBA (EEE, ECE & CSE).



B. Tech (Regular-Full time)

(Effective for the students III YEAR from the Academic B.Tech 2025-26 onwards)

CSE(ARTIFICIAL INTELLIGENCE & MACHINE LEARNING)

COURSE STRUCTURE

&

SYLLABUS



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III B.Tech I Semester CSE (AI & ML)

S.No	Course Code	Title	L	T	P	Credits
1	23HPC3303	Natural Language Processing	3	0	0	3
2	23HPC3304	System Software Programming	3	0	0	3
3	23HPC3305	Computer Vision & Image Processing	3	0	0	3
4	23HES0505	Introduction To Quantum Technologies And Applications	3	0	0	3
5	23HPE331a 23HPE331b 23HPE331c 23HPE331d	Professional Elective-I 1. Data Visualization 2. Soft computing 3. Exploratory Data Analysis with Python 4. Computational Intelligence	3	0	0	3
6		Open Elective- I	3	0	0	3
7	23HPC3306	Computer Vision & Machine Learning Lab	0	0	3	1.5
8	23HPC3307	AI & System Programming Lab	0	0	3	1.5
9	23HSC0504	Skill Enhancement course Full Stack Development-II	0	1	2	2
10	23HSC0402	Tinkering Lab	0	0	2	1
11	23HCSP33I	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	23HOE011a	Green Buildings	CIVIL
2	23HOE011b	Construction Technology and Management	
3	23HOE0201	Electrical Safety Practices and Standards	EEE
4	23HOE0301	Sustainable Energy Technologies	ME
5	23HOE0401	Electronic Circuits	ECE
6	23HOE051a	Java Programming	CSE & Allied/IT
7	23HOE051b	Fundamentals of Artificial Intelligence	
8	23HOE051C	Quantum Technologies and Applications	
9	23HOE991a	Mathematics for Machine Learning and AI	Mathematics
7	23HOE991b	Materials Characterization Techniques	Physics
8	23HOE991c	Chemistry of Energy Systems	Chemistry
9	23HOE991d	English for Competitive Examinations	Humanities
10	23HOE991e	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.



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III B.Tech II Semester –CSE (AI & ML)

S.No	Course Code	Title	L	T	P	Credits
1	23HPC3308	Cloud Computing for AI	3	0	0	3
2	23HPC3309	Big Data Analytics & AI Applications	3	0	0	3
3	23HPC3310	Full Stack AI Development	3	0	0	3
4	23HPE332a 23HPE332b 23HPE332c 23HPE332d	Professional Elective-II 1. Graph Neural Networks 2. Recommender Systems 3. Predictive Analytics 4. Block chain for AI	3	0	0	3
5	23HPE333a 23HPE333b 23HPE333c 23HPE333d	Professional Elective-III 1. Quantum Computing 2. AI for Finance 3. Social Network Analysis 4. Cyber security & AI-driven Threat Detection	3	0	0	3
6		Open Elective – II	3	0	0	3
7	23HPC3311	Big Data & Cloud Computing Lab	0	0	3	1.5
8	23HPC3312	Full Stack AI Lab	0	0	3	1.5
9	23HSC1E01	Skill Enhancement course Soft skills	0	1	2	2
10	23HAC9902	Audit Course Technical Paper Writing & IPR	2	0	0	-
Total			19	1	06	23
Mandatory Industry Internship of 08 weeks duration during summer vacation						

S.No.	Course Code	Course Name	Offered by the Dept.
1	23HOE012a	Disaster Management	CIVIL
2	23HOE012b	Sustainability In Engineering Practices	
3	23HOE0202	Renewable Energy Sources	EEE
4	23HOE0302	Automation and Robotics	ME
5	23HOE0402	Digital Electronics	ECE
6	23HOE992a	Optimization Techniques	Mathematics
8	23HOE992b	Physics Of Electronic Materials And Devices	Physics
9	23HOE992c	Chemistry Of Polymers And Applications	Chemistry
10	23HOE992d	Academic Writing and Public Speaking	Humanities
11	23HOE052a	Operating Systems	CSE & Allied/IT
12	23HOE052b	Introduction of Machine Learning	



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B.TECH - CSE (ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING)

III YEAR I SEMESTER COURSE STRUCTURE & SYLLABUS

SNO	CSE (ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING)
1	Natural Language Processing
2	System Software Programming
3	Computer Vision & Image Processing
4	Exploratory Data Analysis with Python
5	Data Visualization
6	Soft Computing
7	Computational Intelligence
8	Introduction To Quantum Technologies And Technologies
9	Computer Vision & Machine Learning Lab
10	AI & System Programming Lab
11	Full Stack Development
12	Tinkering Lab
13	Evaluation of Community Service Internship



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III B.Tech I Semester

23HPC3303	NATURAL LANGUAGE PROCESSING (Professional Core)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To provide a strong foundation in the fundamentals of NLP.
2. To introduce classical and deep learning-based approaches to NLP tasks.
3. To enable students to build and evaluate models for various NLP applications.
4. To expose students to modern tools and libraries used in NLP.
5. To provide insights into the challenges of multilingual NLP and ethical concerns.

COURSE OUTCOMES:

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

1. Understand the fundamentals and challenges of natural language understanding.
2. Apply linguistic preprocessing techniques such as tokenization, stemming.
3. Implement NLP algorithms for tasks like classification, translation, and information retrieval.
4. Develop deep learning models using RNNs, LSTMs for NLP.
5. Use NLP tools and libraries to analyze and interpret natural language data in real-world scenarios.

UNIT I: Fundamentals of Natural Language Processing

Introduction to NLP: Definitions, Applications, Challenges, Linguistic Essentials: Syntax, Semantics, Pragmatics, Text Processing: Tokenization, Lemmatization, Stemming, Stopword Removal, Normalization, and N-gram Generation, POS Tagging and Named Entity Recognition, NLP Libraries: NLTK, SpaCy Overview.

UNIT II: Text Representation and Statistical NLP

Bag of Words and TF-IDF, Language Modeling: Unigrams, Bigrams, N-gram Models, Word Embeddings: Word2Vec, GloVe, FastText, Cosine Similarity and Distance Measures, Text Classification using Naive Bayes and SVM, Evaluation Metrics: Accuracy, Precision, Recall, F1.

UNIT III: Deep Learning for NLP

Neural Network Basics for NLP, Recurrent Neural Networks (RNNs) and Limitations, LSTM and GRU Networks, Sequence Labeling: POS Tagging, NER using Bi-LSTM, Text Classification using CNNs and RNNs, Model Evaluation and Hyperparameter Tuning.

UNIT IV: Transformers and Advanced NLP

Attention Mechanism and Self-Attention, Transformer Architecture: Encoder-Decoder Models, Pretrained Language Models: BERT, RoBERTa, GPT, Fine-tuning Transformers for Text Classification, Question Answering and Text Summarization using Transformers, Sentiment Analysis and Zero-shot Classification.



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UNIT V: Applications, Ethics, and Multilingual NLP

Machine Translation: Rule-based vs Neural MT, Chatbots and Conversational AI, Information Retrieval and Question Answering, Speech-to-Text and Text-to-Speech Overview, Multilingual NLP and Low- Resource Languages, Bias, Fairness, and Ethics in NLP.

TEXTBOOKS:

1. Daniel Jurafsky and James H. Martin, Speech and Language Processing, Pearson Education.
2. Steven Bird, Ewan Klein, Edward Loper, Natural Language Processing with Python, O'Reilly Media.
3. Yoav Goldberg, Neural Network Methods in NLP, Morgan & Claypool.

REFERENCE BOOKS:

1. Jacob Eisenstein, Introduction to Natural Language Processing, MIT Press.
2. Delip Rao and Brian McMahan, Natural Language Processing with PyTorch, O'Reilly.
3. Thushan Ganegedara, Transformers for Natural Language Processing, Packt Publishing.



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III B.Tech I Semester

23HPC3304	SYSTEM SOFTWARE PROGRAMMING (Professional Core)	L	T	P	C
		3	0	0	3

Course Objectives :

- To understand the architecture and design of system software including compilers, assemblers, linkers, loaders, and macro processors.
- To gain in-depth knowledge of programming tools, shell environments, and low-level system utilities.
- To apply principles of system programming in Unix/Linux environments.
- To explore process creation, inter-process communication, signal handling, and multi-threading using C/C++.
- To enable development of foundational tools like simple compilers, parsers, and loaders.

Course Outcomes :

By the end of the course, students will be able to:

1. Explain the architecture and functions of system software like assemblers, loaders, linkers, and macro processors. *(BTL 2 – Understand)*
2. Apply scanning and parsing techniques for programming language processing. *(BTL 3 – Apply)*
3. Develop and analyze assembly-level programs and understand compilation techniques. *(BTL 4 – Analyze)*
4. Implement Unix/Linux system programming tasks such as process creation, pipes, signals, and thread management. *(BTL 4 – Analyze)*
5. Demonstrate hands-on experience in shell scripting, debugging, and low-level system tools. *(BTL 3 – Apply)*

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

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**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

Reference Books:

- i. **D.M. Dhamdhere**, *System Programming and Operating Systems*, McGraw Hill.
- ii. **Neil Matthew, Richard Stones**, *Beginning Linux Programming*, Wrox.
- iii. **Andrew S. Tanenbaum**, *Modern Operating Systems*, Pearson Education.
- iv. **Yashwant Kanetkar**, *Unix Shell Programming*, BPB Publications.

Textbooks:

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).



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III B.Tech I Semester

23HPC3305	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:

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

1. Understand image formation, and apply basic enhancement and restoration techniques.
2. Apply edge detection, segmentation, and texture analysis techniques for extraction.
3. Analyze 3D vision and motion using stereo vision, optical flow, and calibration.
4. Evaluate object recognition using traditional and deep learning models.
5. Implement applications like image compression, face recognition, and medical analysis.

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.

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**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.

Textbooks:

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](#)



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III B.Tech I Semester

23HPE331C	Exploratory Data Analysis with Python (Professional Elective-I)	L	T	P	C
		3	0	0	3

Course Objectives:

- Introduce the fundamentals and significance of (EDA) in Data Science.
- Develop Skills for data cleaning, preprocessing and transformation using python.
- Apply statistical techniques and visual tools to uncover patterns and insights from data
- Gain hands-on experience with Python libraries such as NumPy, Pandas, Matplotlib etc.,
- Prepare datasets effectively for machine learning and predictive modeling tasks.

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

- Understand and apply the key concepts of EDA and data preprocessing.
- Perform exploratory data analysis using Python libraries and interpret the results.
- Handle missing values, outliers, and categorical data effectively.
- Create meaningful visualizations to derive and support data-driven insights.
- Use EDA techniques to prepare datasets for Machine Learning and predictive modelling.

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)

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**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
Coursera – Applied Data Science with Python Specialization (University of Michigan)



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III B.Tech I Semester

23HPC3306	COMPUTER VISION & MACHINE LEARNING LAB (Professional Core)	L	T	P	C
		0	0	3	1.5

Course Objectives:

- To impart practical knowledge of computer vision concepts using OpenCV and image processing libraries.
- To implement core machine learning algorithms and evaluate model performance.
- To work with real-world datasets for classification, regression, and image processing tasks.
- To train, test, and validate models using Python, TensorFlow, and Scikit-learn.
- To understand the integration of ML models in vision applications.

Course Outcomes:

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

- Apply computer vision techniques to solve real-time image processing problems. (Apply - L3)
- Train and evaluate machine learning models for classification and regression tasks. (Analyze - L4)
- Design and test feature extraction techniques from images. (Create - L6)
- Use OpenCV, Scikit-learn, TensorFlow/PyTorch for practical implementations. (Apply - L3)
- Integrate vision-based features with ML algorithms for end-to-end solutions. (Evaluate - L5)

List of Experiments (12 Total)

1. Image preprocessing techniques: resizing, filtering, thresholding using OpenCV
2. Edge detection using Sobel, Canny, and Laplacian operators
3. Object detection using contour detection and bounding boxes
4. Feature extraction using HOG, SIFT, and ORB
5. Implement face detection using Haar cascades or DNN models
6. Train a machine learning model (SVM / KNN) for image classification
7. Build and evaluate a decision tree classifier using scikit-learn
8. Implement a logistic regression model for binary classification on numerical dataset
9. Apply PCA for feature reduction and visualization
10. Design a simple neural network using TensorFlow/Keras for image classification
11. Train and evaluate a CNN model for digit recognition using MNIST dataset



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12. Real-time emotion recognition using webcam input and pre-trained model integration

Textbooks:

1. Simon J. D. Prince, Computer Vision: Models, Learning, and Inference, Cambridge University Press.
2. Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, 2nd Edition, O'Reilly.
3. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer.

Reference Books:

1. Adrian Rosebrock, Practical Python and OpenCV (PyImageSearch).
2. Ian Goodfellow, Yoshua Bengio, and Aaron Courville, Deep Learning, MIT Press.
3. Bishop C. M., Pattern Recognition and Machine Learning, Springer.

Online Learning Resources:

1. <https://opencv.org>
2. <https://www.tensorflow.org/tutorials>
3. <https://www.kaggle.com/learn/intro-to-machine-learning>
4. <https://www.pyimagesearch.com>
5. NPTEL Course on Deep Learning
6. <https://github.com/ultralytics/yolov5>
7. <https://colab.research.google.com/>



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III B.Tech I Semester

23HPC3307	AI & SYSTEM PROGRAMMING LAB (Professional Core)	L	T	P	C
		0	0	3	1.5

Course Objectives:

- Hands-on experience with foundational AI algorithms and system programming.
- Ability to design and implement intelligent systems and low-level software components.
- To enable the integration of AI techniques with system programming.

Course Outcomes:

- Implement AI search algorithms and logic programming using tools like prolog and Python.
- Design System software components suchn as assemblers, macro processors, and shells using C.
- Write Shell scripts for Automation and System management tasks.
- Integrate AI Logic with system utilities to demonstrate real-time automation
- Develop intelligentutilities combining scripting , systemprogramming and AI Techniques.

List of Experiments (12 Total)

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. 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



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Online Learning Resources:

<https://www.kaggle.com/learn/python>

<https://www.tutorialspoint.com/prolog/index.htm>

<https://www.tutorialspoint.com/cprogramming/index.htm>

<https://www.w3schools.com/c/index.php>



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III B.Tech I Semester

23HPE331a	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. **(Understand, Analyze)**
- CO2: Design effective and interactive data visualizations using various tools. **(Apply, Create)**
- CO3: Apply visual encoding and perceptual principles in presenting complex data. **(Apply, Evaluate)**
- CO4: Analyze and visualize real-world data sets using Python libraries and dashboards. **(Analyze, Evaluate)**
- CO5: Create visual stories and dashboards for effective communication of insights. **(Create, Apply)**

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.

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**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.

Textbooks:

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 Knafl, **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](#)



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III B.Tech I Semester

23HPE331b	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:

- Understand the components and applications of soft computing.
- Apply fuzzy logic concepts to real-world problems.
- Build and train various neural network models.
- Implement genetic algorithms for problem-solving and optimization.
- 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).



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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)



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III B.Tech I Semester

23HSC0504	FULL STACK DEVELOPMENT-II (Skill Enhancement course)	L	T	P	C
		0	1	2	2

Course Objectives:

The main objectives of the course are to

- Make use of Modern- day JavaScript with ES6 standards for designing Dynamic web pages
- Building robust & responsive User Interfaces using popular JavaScript library '**React.js**'.
- Building robust backend APIs using '**Express. js**'
- Establishing the connection between frontend (React) User interfaces and backend APIs (Express) with Data Bases(My SQL)
- Familiarize students with GitHub for remote repository hosting and collaborative development.

Course Outcomes:

- CO1: Building fast and interactive UIs
- CO2: Applying Declarative approach for developing web apps
- CO3: Understanding ES6 features to embrace modern JavaScript
- CO4: Building reliable APIs with Express. Js
- CO5: Create and manage Git repositories, track changes, and push code to GitHub.

Experiments covering the Topics:

- Introduction to DOM (Document Object Model), Ecma Script (ES6) standards and features like Arrow functions, Spread operator, Rest operator, Type coercion, Type hoisting, String literals, Array and Object Destructuring.
- Basics of React. js like React Components, JSX, Conditional rendering Differences between Real DOM and Virtual DOM.
- Important React.js concepts like React hooks, Props, React forms, Fetch API, Iterative rendering using JavaScript map() function.
- JavaScript runtime environment node. js and its uses, Express. js and Routing, Micro-Services architecture and MVC architecture, database connectivity using (My SQL)
- Introduction to My SQL, setting up MySQL and configuring, Databases, My SQL queries, subqueries, creating My SQL driver for database connectivity to Express. js server.
- Introduction to Git and GitHub and upload project& team collaboration

Sample Experiments:

1. Introduction to Modern JavaScript and DOM

- a. Write a JavaScript program to link JavaScript file with the HTML page
- b. Write a JavaScript program to select the elements in HTML page using selectors
- c. Write a JavaScript program to implement the event listeners
- d. Write a JavaScript program to handle the click events for the HTML button elements
- e. Write a JavaScript program to With three types of functions

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- i. Function declaration
- ii. Function definition
- iii. Arrow functions

2. Basics of React. Js

- a. Write a React program to implement a counter button using react class components
- b. Write a React program to implement a counter button using react functional components
- c. Write a React program to handle the button click events in functional component
- d. Write a React program to conditionally render a component in the browser
- e. Write a React program to display text using String literals

3. Important concepts of React. Js

- a. Write a React program to implement a counter button using React use State hook
- b. Write a React program to fetch the data from an API using React use Effect hook
- c. Write a React program with two react components sharing data using Props.
- d. Write a React program to implement the forms in react
- e. Write a React program to implement the iterative rendering using map() function.

4. Introduction to Git and GitHub**a. Setup**

- o Install Git on local machine.
- o Configure Git (user name, email).
- o Create GitHub account and generate a personal access token.

b. Basic Git Workflow

- o Create a local repository using git init
- o Create and add files → git add .
- o Commit files → git commit -m "Initial commit"
- o Connect to GitHub remote → git remote add origin <repo_url>
- o Push to GitHub → git push -u origin main

c. Branching and Collaboration

- o Create a branch → git checkout -b feature1
- o Merge branch to main → git merge feature1
- o Resolve merge conflicts (guided)

5. Upload React Project to GitHub

- o Create a new React app using npx create-react-app myapp
- o Initialize a git repo and push to GitHub
- o Use .gitignore to exclude node_modules
- o Create multiple branches: feature/navbar, feature/form
- o Practice merge and pull requests (can use GitHub GUI)

6. Introduction to Node. js and Express. Js

- a. Write a program to implement the 'hello world' message in the route through the browser using Express



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- b. Write a program to develop a small website with multiple routes using Express. js
- c. Write a program to print the 'hello world' in the browser console using Express. js
- d. Write a program to implement the CRUD operations using Express. js
- e. Write a program to establish the connection between API and Database using Express – My SQL driver

6. Introduction to My SQL

- a. Write a program to create a Database and table inside that database using My SQL Command line client
- b. Write a My SQL queries to create table, and insert the data, update the data in the table
- c. Write a My SQL queries to implement the subqueries in the My SQL command line client
- d. Write a My SQL program to create the script files in the My SQL workbench
- e. Write a My SQL program to create a database directory in Project and initialize a database. sql file to integrate the database into API

8.Team Collaboration Using GitHub

- o Form groups of 2–3 students
- o Create a shared GitHub repo
- o Assign tasks and work in branches
- o Use Issues, Pull Requests, and Code Reviews
- o Document code with README.md

Textbooks:

1. Web Design with HTML, CSS, JavaScript and JQuery Set Book by Jon Duckett Professional JavaScript for Web Developers Book by Nicholas C. Zakas
2. John Dean, Web Programming with HTML5, CSS and JavaScript, Jones & Bartlett Learning, 2019.
3. Pro MERN Stack: Full Stack Web App Development with Mongo, Express, React, and Node, Vasam Subramanian, 2nd edition, APress, O'Reilly.
4. Learning PHP, MySQL, JavaScript, CSS & HTML5: A Step-by-Step Guide to Creating Dynamic Websites by Robin Nixon
5. AZAT MARDAN, Full Stack Java Script: Learn Back bone. js, Node.js and Mongo DB.2015

Reference Books:

1. Full-Stack JavaScript Development by Eric Bush.
2. Programming the World Wide Web, 7th Edition, Robert W Sebesta, Pearson, 2013.
3. Tomasz Dyl ,KamilPrzeorski , MaciejCzarnecki, Mastering Full Stack React Web Development 2017

Online Learning Resources:

1. <https://ict.iitk.ac.in/product/full-stack-developer-html5-css3-js-bootstrap-php-4/>
2. <https://www.w3schools.com/html>
3. <https://www.w3schools.com/css>
4. <https://www.w3schools.com/js/>



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5. <https://www.w3schools.com/nodejs>
6. <https://www.w3schools.com/typescript>
7. <https://docs.github.com/>
8. <https://education.github.com/git-cheat-sheet-education.pdf>
9. <https://www.freecodecamp.org/>
10. <https://www.theodinproject.com/>
11. <https://www.coursera.org/specializations/full-stack-react>
12. <https://www.udemy.com/>
13. <https://lab.github.com/>



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III B.Tech I Semester

23HES0505	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 I: 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 II: 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 III: 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



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Unit IV: 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 V: 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. **Giuliano Benenti, Giulio Casati, Giuliano Strini**, *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.



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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](#)



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III B.Tech I Semester

23HPE331d	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:

- Describe and differentiate neural networks, fuzzy logic, and evolutionary computation. (Understand)
- Apply neural and fuzzy systems for real-time decision-making. (Apply)
- Analyze complex problems using soft computing tools. (Analyze)
- Develop hybrid intelligent systems. (Create)
- Evaluate and compare the performance of CI-based systems. (Evaluate)

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

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**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



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III B.Tech I Semester

23HOE051a	JAVAPROGRAMMING (OpenElective-I)	L	T	P	C
		3	0	0	3

CourseObjectives:

The main objective of the course is to identify Java language components and how they work together in applications

- Learn the fundamentals of object-oriented programming in Java, including defining classes, invoking methods, using class libraries.
- Learn how to extend Java classes with inheritance and dynamic binding and how to use exception handling in Java applications
- Understand how to design applications with threads in Java
- Understand how to use Java APIs for program development

CourseOutcomes:

After completion of the course, students will be able to

CO1: Analyze problems, design solutions using OOP principles, and implement them efficiently in Java.

CO2: Design and implement classes to model real-world entities, with a focus on attributes, behaviors, and relationships between objects

CO3: Demonstrate an understanding of inheritance hierarchies and polymorphic behaviour, including method overriding and dynamic method dispatch.

CO4: Apply Competence in handling exceptions and error to write robust and fault-tolerant code.

CO5: Perform file input/output operations, including reading from and writing to files using Java I/O classes, graphical user interface (GUI) programming using JavaFX.

Unit – I: Object Oriented Programming:

Basic concepts, Principles, Program Structure in Java: Introduction, Writing Simple Java Programs, Elements or Tokens in Java Programs, Java Statements, Command Line Arguments, User Input to Programs, Escape Sequences Comments, Programming Style. Data Types, **Variables, and Operators:** Introduction, Data Types in Java, Declaration of Variables, Data Types, Type Casting, Scope of Variable Identifier, Literal Constants, Symbolic Constants, Formatted Output with printf() Method, Static Variables and Methods, Attribute Final, **Introduction to Operators,** Precedence and Associativity of Operators, Assignment Operator (=), Basic Arithmetic Operators, Increment (++) and Decrement (--) Operators, Ternary Operator, Relational Operators, Boolean Logical Operators, Bitwise Logical Operators.

Control Statements: Introduction, if Expression, Nested if Expressions, if–else Expressions, Ternary Operator? :, Switch Statement, Iteration Statements, while Expression, do–while Loop, for Loop, Nested for Loop, For–Each for Loop, Break Statement, Continue Statement.



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Unit II: Classes and Objects:

Introduction, Class Declaration and Modifiers, Class Members, Declaration of Class Objects, Assigning One Object to Another, Access Control for Class Members, Accessing Private Members of Class, Constructor Methods for Class, Overloaded Constructor Methods, Nested Classes, Final Class and Methods, Passing Arguments by Value and by Reference, Keyword this.

Methods: Introduction, Defining Methods, Overloaded Methods, Overloaded Constructor Methods, Class Objects as Parameters in Methods, Access Control, Recursive Methods, Nesting of Methods, Overriding Methods, Attributes Final and Static.

Unit III: Arrays:

Introduction, Declaration and Initialization of Arrays, Storage of Array in Computer Memory, Accessing Elements of Arrays, Operations on Array Elements, Assigning Array to Another Array, Dynamic Change of Array Size, Sorting of Arrays, Search for Values in Arrays, Class Arrays, Two-dimensional Arrays, Arrays of Varying Lengths, Three-dimensional Arrays, Arrays as Vectors. **Inheritance:** Introduction, Process of Inheritance, Types of Inheritances, Universal Super Class Object Class, Inhibiting Inheritance of Class Using Final, Access Control and Inheritance, Multilevel Inheritance, Application of Keyword Super, Constructor Method and Inheritance, Method Overriding, Dynamic Method Dispatch, Abstract Classes, Interfaces and Inheritance.

Interfaces: Introduction, Declaration of Interface, Implementation of Interface, Multiple Interfaces, Nested Interfaces, Inheritance of Interfaces, Default Methods in Interfaces, Static Methods in Interface, Functional Interfaces, Annotations.

Unit IV: Packages and Java Library:

Introduction, Defining Package, Importing Packages and Classes into Programs Path and Class Path, Access Control, Packages in Java SE, Java.lang Package and its Classes, Class Object, Enumeration, class Math, Wrapper Classes, Auto-boxing and Auto-unboxing, Java.util Classes and Interfaces, Formatter Class, Random Class, Time Package, Class Instant (java.time.Instant), Formatting for Date/Time in Java, Temporal Adjusters Class, Temporal Adjusters Class.

Exception Handling: Introduction, Hierarchy of Standard Exception Classes, Keywords throws and throw, try, catch, and finally Blocks, Multiple Catch Clauses, Class Throwable, Unchecked Exceptions, Checked Exceptions.

Java I/O and File: Java I/O API, standard I/O streams, types, Byte streams, Character streams, Scanner class, Files in Java (Text Book 2)

Unit V: String Handling in Java:

Introduction, Interface Char Sequence, Class String, Methods for Extracting Characters from Strings, Comparison, Modifying, Searching; Class String Buffer.

Multithreaded Programming: Introduction, Need for Multiple Threads Multithreaded Programming for Multi-core Processor, Thread Class, Main Thread Creation of New Threads, Thread States, Thread Priority-Synchronization, Deadlock and Race Situations, Inter thread Communication - Suspending, Resuming, and Stopping of Threads. Java Database Connectivity: Introduction, JDBC Architecture, Installing MySQL and MySQL Connector/J, JDBC Environment Setup, Establishing JDBC Database Connections, ResultSet Interface

Java FX GUI: Java FX Scene Builder, Java FX App Window Structure, displaying text and image, event handling, laying out nodes in scene graph, mouse events (Text Book 3)



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Learning Resources:

Textbooks :

1. JAVA onestepahead, AnithaSeth, B.L.Juneja, Oxford.
2. JoywithJAVA, Fundamentals of Object Oriented Programming, Debasis Samanta, Monalisa Sarma, Cambridge, 2023.
3. JAVA9forProgrammers, PaulDeitel, HarveyDeitel, 4thEdition, Pearson.

Reference Books:

1. ThecompleteReferenceJava, 11thedition, HerbertSchildt, TMH
2. IntroductiontoJavaprogramming, 7thEdition, YDanielLiang, Pearson Online Learning

Resources:

1. <https://nptel.ac.in/courses/106/105/106105191/>
2. https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_012880464547618816347_shared/overview



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III B.Tech I Semester

23HOE051b	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 earch,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:

- Learn the distinction between optimal reasoning Vs human like reasoning and formulate an efficient problem space for a problem expressed in natural language. Also select a search algorithm for a problem and estimate its time and space complexities.
- Apply AI techniques to solve problems of game playing,theorem proving,and machine learning.
- Learn different knowledge representation techniques.
- Understand the concepts of state space representation, exhaustive search, heuristic search together with the time and space complexities.
- Comprehend the applications of Probabilistic Reasoning and Bayesian Networks.
- Analyze Supervised Learning Vs.Learning Decision Trees

UNIT-I IntroductiontoAI:

IntelligentAgents,Problem-SolvingAgents,

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.



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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.

TEXTBOOK:

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

REFERENCEBOOKS:

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



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III B.Tech I Semester

23HOE991a	QUANTUM TECHNOLOGIES AND APPLICATIONS Open Elective-I	L	T	P	C
		3	0	0	3

- To introduce the fundamentals of quantum mechanics relevant to quantum technologies.
- To explain key quantum phenomena and their role in enabling novel technologies.
- To explore applications in quantum computing, communication, and sensing.
- To encourage understanding of emerging quantum-based technologies and innovations.

UNIT I: Fundamentals of Quantum Mechanics (7 Hours)

- Classical vs Quantum Paradigm
- Postulates of Quantum Mechanics
- Wave function and Schrödinger Equation (Time-independent)
- Quantum states, Superposition, Qubits
- Measurement, Operators, and Observables
- Entanglement and Non-locality

UNIT II: Quantum Computing

- Qubits and Bloch Sphere
- Quantum Logic Gates: Pauli, Hadamard, CNOT, and Universal Gates
- Quantum Circuits
- Basic Algorithms: Deutsch-Jozsa, Grover's, Shor's (conceptual)
- Error Correction and Decoherence

UNIT III: Quantum Communication and Cryptography (7 Hours)

- Teleportation & No-Cloning
- BB84 Protocol
- Quantum Networks & Repeaters
- Classical vs Quantum Cryptography
- Challenges in Implementation

UNIT IV: Quantum Sensors and Metrology

- Quantum Sensing: Principles and Technologies
- Quantum-enhanced Measurements
- Atomic Clocks, Gravimeters
- Magnetometers, NV Centers
- Industrial Applications

UNIT V: Quantum Materials and Emerging Technologies

Quantum Materials: Superconductors, Topological Insulators

Quantum Devices: Qubits, Josephson Junctions

National Quantum Missions (India, EU, USA, China)

Quantum Careers and Industry Initiatives



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Textbooks and References

Primary Textbooks:

"Quantum Computation and Quantum Information" by Michael A. Nielsen and Isaac L. Chuang (Cambridge University Press)

"Quantum Mechanics: The Theoretical Minimum" by Leonard Susskind and Art Friedman (Basic Books)



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III B.Tech – I semester

23HSC0402	TINKERING LAB	L	T	P	C
		2	0	0	1

The aim of tinkering lab for engineering students is to provide a hands-on learning environment where students can explore, experiment, and innovate by building and testing prototypes. These labs are designed to demonstrate practical skills that complement theoretical knowledge.

Course objectives: The objectives of the course are to	
1	Encourage Innovation and Creativity
2	Provide Hands-on Learning and Impart Skill Development
3	Foster Collaboration and Teamwork
4	Enable Interdisciplinary Learning, Prepare for Industry and Entrepreneurship
5	Impart Problem-Solving mind-set

These labs bridge the gap between academia and industry, providing students with the practical experience. Some students may also develop entrepreneurial skills, potentially leading to start-ups or innovation-driven careers. Tinkering labs aim to cultivate the next generation of engineers by giving them the tools, space, and mind-set to experiment, innovate, and solve real-world challenges.

List of experiments:

- 1) Make your own parallel and series circuits using breadboard for any application of your choice.
- 2) Design and 3D print a Walking Robot
- 3) Design and 3D Print a Rocket.
- 4) Temperature & Humidity Monitoring System (DHT11 + LCD)
- 5) Water Level Detection and Alert System
- 6) Automatic Plant Watering System
- 7) Bluetooth-Based Door Lock System
- 8) Smart Dustbin Using Ultrasonic Sensor
- 9) Fire Detection and Alarm System
- 10) RFID-Based Attendance System
- 11) Voice-Controlled Devices via Google Assistant
- 12) Heart Rate Monitoring Using Pulse Sensor
- 13) Soil Moisture-Based Irrigation
- 14) Smart Helmet for Accident Detection
- 15) Milk Adulteration Detection System.
- 16) Water Purification via Activated Carbon
- 17) Solar Dehydrator for Food Drying

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- 18) Temperature-Controlled Chemical Reactor
- 19) Ethanol Mini-Plant Using Biomass
- 20) Smart Fluid Flow Control (Solenoid + pH Sensor)
- 21) Portable Water Quality Tester
- 22) AI Crop Disease Detection
- 23) AI-based Smart Irrigation
- 24) ECG Signal Acquisition and Plotting
- 25) AI-Powered Traffic Flow Prediction
- 26) Smart Grid Simulation with Load Monitoring
- 27) Smart Campus Indoor Navigator
- 28) Weather Station Prototype
- 29) Firefighting Robot with Sensor Guidance
- 30) Facial Recognition Dustbin
- 31) Barcode-Based Lab Inventory System
- 32) Growth Chamber for Plants
- 33) Biomedical Waste Alert System
- 34) Soil Classification with AI
- 35) Smart Railway Gate
- 36) Smart Bin Locator via GPS and Load Sensors
- 37) Algae-Based Water Purifier
- 38) Contactless Attendance via Face Recognition

- **Note:** The students can also design and implement their own ideas, apart from the list of experiments mentioned above.
- **Note:** A minimum of 8 to 10 experiments must be completed by the students.



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III B. TECH II SEMESTER Course Structure & Syllabus

Branch Name: CSE (ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING)

S.NO	Course Code	List of Courses
1	23HPC3308	Cloud Computing for AI
2	23HPC3309	Big Data Analytics & AI Applications
3	23HPC3310	Full Stack AI Development
4.	Professional Elective-II 23HPE332a 23HPE332b 23HPE332c 23HPE332d	Graph neural network Recommender system Predictive Analysis Block chain for AI
5.	Professional Elective-III 23HPE333a 23HPE332b 23HPE332c 23HPE333d	Introduction to Quantum Computing AI for Finance Social network analysis Cyber security & AI-Driven Threat Detection
6	23HPC3311	Big Data and Cloud Computing Lab
7	23HPC3312 Skill Enhancement course	Full Stack AI Lab

Open-Electives-II Offered by CSE/Allied Department to Other Branches

S. NO.	Course Code	List of Courses
8.	23HOE052a 23HOE052b	Operating Systems Introduction of Machine Learning



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III B. Tech II Semester

23HPC3308	Cloud Computing for AI (Professional Core)	L	T	P	C
		3	0	0	3

Course Objectives:

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

Course Outcomes:

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

- Explain cloud computing architecture, services, and deployment models.
- Utilize cloud platforms (AWS, GCP, Azure) for training and deploying AI models.
- Handle large-scaled at a storage and processing in the cloud environment.
- Integrate AI workflows using server less and container-based architectures.
- Analyze challenges insecurity, 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, Big Query, 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 (Sage Maker), Azure ML, GCP Vertex AI, Training and Deploying Models on Cloud, Auto ML and Custom ML Model Workflows, GPUs/TPUs for Model Training, Experiment Tracking and Model Evaluation, Integration of Notebooks (Jupyter, Collab) 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.



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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. Raj kumar Buyya, Christian Vecchiola, S.Thamarai Selvi, Mastering Cloud Computing, McGraw-Hill.
2. Judith Hurwitzetal., Cloud Computing for Dummies, Wiley.
3. AurélienGéron, Hands-On Machine Learning with Scikit-Learn,Keras, and Tensor Flow, O'Reilly.

Reference Books:

1. KaiHwang, Geoffrey C.Fox, JackG.Dongarra, Distributed and Cloud Computing, Morgan Kaufmann.
2. Tomasz Kajdanowiczetal.,Practical Cloud AI, Springer.
3. MarkWilkins, AI and Machine Learning for Coders in Cloud, Packet Publishing.

Online Learning Resources:

- AWS Cloud Practitioner & Machine Learning Path–AWS Training
- Google Cloud AI and ML Specialization–Coursera
- Microsoft Azure AI Engineer Associate–Learn Portal
- IBM Cloud and AI Learning–Cognitive Class
- Cloud Computing and Distributed Systems (CLOUDS) Lab–University of Melbourne



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III B. Tech II Semester

23HPC3309	Big Data Analytics & AI Applications (Professional Core)	L	T	P	C
		3	0	0	3

Course Objectives:

- To help students understand the basics of big data and AI-based applications.
- To introduce popular big data tools like Hadoop, Spark, and No SQL databases.
- To build scalable AI systems for data analysis.
- To show AI&ML can be used in real-time and batch processing.
- Hands-on experience for big data and AI in areas domains like healthcare, finance, and IoT.

Course Outcomes:

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

- Explain how Big Data systems work and understand their components.
- Hadoop and Spark to process and analyze large datasets.
- Apply AI&ML techniques to gain insights from big data.
- Build scalable data pipelines using tools like Spark and Kafka.
- Solve problems using AI with Big Data in domains like healthcare & finance etc.,

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, Map Reduce, 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, Data Frames, 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.



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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.

Textbooks:

1. Big Data: Principles and Paradigms by Raj kumar Buyya, Rodrigo N.Calheiros, AmirVahid Dastjerdi – Wiley
2. Learning Spark: Lightning-Fast Big Data Analysis by Jules S.Damjietal.–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–Packet 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
- <https://www.edx.org/course/big-data-analysis- with-python-edX>
- <https://www.udacity.com/course/ai-for-business-leaders--nd088>–Udacity AI for Business
- <https://www.kaggle.com/learn/intro-to-machine-learning>–KaggleMLTutorials
- <https://data-flair.training/blogs/apache-spark-tutorial/>–SparkTutorials



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III B. Tech II Semester

23HPC3310	Full Stack AI Development (Professional Core)	L	T	P	C
		3	0	0	3

Course Objectives:

- To equip students with proficiency of building end-to-end AI-powered web applications.
- To provide hands-on experience in integrating machine learning models.
- To teach model deployment, version control, and ML Ops best practices.
- To expose students to full stack frame works and cloud-based deployment platforms.
- To prepare students for real-world AI applications in production settings.

Course Outcomes:

Up on completion of this course, the student will be able to:

- Understand and apply full stack development principles in the context of AI solutions.
- Build and serve machine learning models via REST ful APIs.
- Design front end interfaces for interaction with AI models.
- Deploy AI applications using modern DevOps tools and cloud platforms.
- Manage datasets, model versioning, and workflows in production-grade systems.

UNIT I: Introduction to Full Stack AI Development

Overview of Full Stack Development in AI Context, Layers: Frontend, Backend, ML Layer, and Deployment Layer, Tools and Technology Stack (React, Node.js, Flask, Django, Fast API, Tensor Flow, Py Torch, MongoDB, PostgreSQL), Understanding Model Lifecycle and ML Ops

UNIT II: Back end Development and API Integration

Introduction to Flask / Fast API for model serving, Restful API design and documentation (Swagger/Open-air), Connecting AI/ML models to APIs, Authentication, request handling, and session management, Error handling and response structuring

UNIT III: Front end Development for AI Interfaces

Overview of frontend frameworks (React/Angular/Vue), Creating dynamic forms and dashboards for AI input/output, Data visualization using Chart.js, D3.js, Connecting frontend to API endpoints, Responsive design for AI application UX

UNIT IV: Model Deployment and ML Ops

Basics of CI/CD pipelines for AI models, Using Docker for containerization, Deployment on cloud platforms (Heroku, AWS, GCP), Introduction to ML flow, DVC, and model versioning, Logging, monitoring, and performance metrics



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UNIT V: Capstone Project and Case Studies

Full Stack AI Project Planning & Implementation, Use cases: Chatbot, Recommendation System, Image Classification App, NLP Web App, Industry-oriented workflows and best practices, Ethical considerations and data governance in AI applications

Textbooks:

1. **"Full Stack Deep Learning"** by Hame IHusainet al. (*online version available at full stack deeplearning.com*)
2. **"Building Machine Learning Powered Applications"** by Emmanuel Ameisen, O'Reilly.
3. **"Flask Web Development"** by Miguel Grinberg.

Reference Books:

1. **"Machine Learning Engineering"** by Andriy Burkov.
2. **"Designing Data-Intensive Applications"** by Martin Kleppmann.
3. **"Hands-On Machine Learning with Scikit-Learn, Keras, and Tensor Flow"** by Aurélien Géron.

Online Resources:

- [Full Stack Deep Learning Course](#)
- [Fast API Documentation](#)
- [Flask Mega-Tutoria](#)



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III B. Tech II Semester

23HPE332a	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 frame works like PyTorch Geometric and DGL.

Course Outcomes:

- Up on completion of the course, students will be able to:
- Understand the basics of graph structures and their significance in machine learning.
- Learn and implement different types of GNN architectures.
- Apply GNN store-world structured data problems.
- Use modern libraries and tools to train and evaluate GNNs.
- Analyze 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, Palladian), 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 Convolution Networks (GCNs), Graph Attention Networks (GATs), Graph SAGE: 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, Cite seer), 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.



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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, Hyper parameter 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. Hamilton, 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> Stanford GNN Projects
3. <https://www.coursera.org/learn/graph-neural-networks-Coursera> GNN Course by Stanford



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III B.Tech II Semester

23HPE332b	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:

Up on completion of the course, students will be able to:

- Explain the core concepts and types of recommender systems.
- Implement basic collaborative and content-based filtering techniques.
- Apply matrix factorization and deep learning model store commendation problems.
- Evaluate and optimize recommender systems using appropriate metrics.
- Design scalable and context-aware recommender systems for diverse applications.

UNIT-I An Introduction to Recommender Systems, Neighborhood-Based Collaborative Filtering

Introduction, Goals of Recommender Systems, Basic Models of Recommender Systems, Domain Specific Challenges in Recommender Systems. Advanced Topics and Applications. Introduction, Key Properties of Ratings Matrices, Predicting Ratings with Neighborhood- Neighborhood-Based Collaborative Filtering: Based Methods, Clustering and Neighborhood-Based Methods, Dimensionality Reduction and Neighborhood Methods, Graph Models for Neighborhood-Based Methods, A Regression Modelling View of Neighborhood Methods.

UNIT-II Model-Based Collaborative Filtering, Content-Based Recommender Systems

Introduction, Decision and Regression Trees, Rule-Based Collaborative Filtering, Naive Bayes Collaborative Filtering, Using an Arbitrary Classification Model as a Black-Box, Latent Factor Models, Integrating Factorization and Neighborhood Models. Content-Based Recommender Systems: Introduction, Basic Components of Content-Based Systems, Preprocessing and Feature Extraction, Learning User Profiles and Filtering, Content-Based Versus Collaborative Recommendations, Using Content-Based Models for Collaborative Filtering, Summary.

UNIT-III Knowledge-Based Recommender Systems, Ensemble Based and Hybrid Recommender Systems

Introduction, Constraint-Based Recommender Systems, Case-Based Recommenders, Persistent Personalization in Knowledge-Based Systems, Summary. Introduction, Ensemble Methods from the Classification Perspective, Weighted Hybrids, Switching Hybrids, Cascade Hybrids, Feature Augmentation Hybrids, Meta-Level Hybrids, Feature Combination Hybrids, Summary.



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UNIT-IV : Evaluating Recommender Systems, Context-Sensitive Recommender Systems

Introduction, Evaluation Paradigms, General Goals of Evaluation Design, Design Issues in Offline Recommender Evaluation, Accuracy Metrics in Offline Evaluation, Limitations of Evaluation Measures, Limitations of Evaluation Measures. Introduction, The Multidimensional Approach, Contextual Pre-filtering: A Reduction-Based Approach, Contextual Pre-filtering: A Reduction-Based Approach, Contextual Modelling. UNIT V: Evaluation, Ethics, and Industrial Applications

UNIT-V :Time- and Location-Sensitive Recommender Systems

Introduction, Temporal Collaborative Filtering, Discrete Temporal Models, Location-Aware Recommender Systems, Location-Aware Recommender Systems Location-Aware Recommender Systems, Summary.

Textbooks: 1. Charu C. Aggarwal, —Recommender Systems, Springer, 2016.

Reference Books:

1. Francesco Ricci, Lior Rokach, —Recommender Systems Handbook, 2nd ed., Springer, 2015 Edition
2. Online Learning Resources:
 1. Recommendation System -Understanding The Basic Concepts (analyticsvidhya.com)
 2. Recommender Systems | Coursera Reference Books:

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



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III B. Tech II Semester

23HPE332c	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:

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

- Understand the principles and importance of predictive analytics.
- Apply regression and classification models for predictive tasks.
- Perform data preprocessing, feature selection, and transformation.
- Evaluate and validate model using standard metrics.
- 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 Over fitting, Hyper parameter 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.



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Textbooks:

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 Shmuelietal.**, Data Mining for Business Analytics : Concepts, Techniques, and Applications in R, Wiley, 2017.
2. **EricSiegel**, Predictive Analytics:The Power to Predict Who Will Click, Buy, Lie,orDie,Wiley, 2016.
3. **Trevor Hastie,Robert Tibshirani, Jerome Friedman**,The Elements of Statistical Learning, Springer, 2009.

Online Learning Resources:

1. <https://www.coursera.org/specializations/predictive-analytics-Coursera> Specialization
2. <https://www.edx.org/course/data-science-and-machine-learning-capstone-edX> Predictive Analytics Courses
3. <https://www.kaggle.com/learn/intro-to-machine-learning-KaggleTutorials>



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III B. Tech II Semester

23HPE332d	BLOCK CHAIN FOR AI (Professional Elective-II)	L	T	P	C
		3	0	0	3

Course Objectives:

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

Course Outcomes:

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

- Explain the fundamentals of block chain and Its components.
- Analyze the role of consensus mechanisms in maintaining trust and decentralization.
- Apply block chain for secure data sharing in AI systems.
- Develop and deploy smart contracts using Ethereum/Solidity.
- Evaluate block chain-based AI applications in healthcare, finance ,and supply chains.

UNIT I: Block chain Fundamentals and Architecture

Introduction to Block chain Technology, Components: Blocks, Hashing, Merkle Trees, Types of Block chains: Public, Private, Consortium, Distributed Ledger Technology (DLT) and P2P Networks, Block chain 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 Block chain and AI

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



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UNIT IV: Applications of Block chain in AI Systems

Block chain for Explainable and Trusted AI, Applications in Health care and Genomics, Block chain 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 Block chain-AI, Ethical and Legal Concerns in AI with Block chain, Interoperability of Block chain Platforms, Future Trends: Quantum-Resistant Block chain- AI.

Textbooks:

1. Imran Bashir, Mastering Block chain: Unlocking the Power of Cryptocurrencies, Smart Contracts, and Decentralized Applications, Packt, 2020.
2. Melanie Swan, Block chain :Blue print for a New Economy, O'ReillyMedia, 2015.
3. Joseph Holbrook, Architecting AI Solutions on Blockchain, PacktPublishing, 2020.

Reference Books:

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

Online Learning Resources:

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



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III B. Tech II Semester

23HPE333a	INTRODUCTION TO 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:

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

- Explain the fundamental concepts of quantum mechanics used in computing.
- Construct and analyze quantum circuits using standard gates.
- Apply quantum algorithms like Deutsch-Jozsa, Grover's, and Shor's.
- Develop simple quantum programs using Qiskit or similar platforms.
- Analyze 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.



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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:

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.

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*



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III B.Tech II Semester

23HPE332b	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:

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

- Describe the fundamentals of AI techniques applicable to finance.
- Analyze financial time series data using AI-based models.
- Apply machine learning for fraud detection and credit risk analysis.
- Build predictive models for stock prices, trading, and customer segmentation.
- 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 Back testing 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, Block chain and AI Integration for Financial Security, Case Studies: AI in Wealth Management & Insurance.



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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 Lecher, Machine Learning for Finance, Packet Publishing, 2021.

Reference Books:

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

Online Learning Resources:

- eddy: Artificial Intelligence in Finance—NYIF
- Demy: Machine Learning and AI in Finance
- Data Camp: Financial Trading with Python
- You Tube : AI for Finance by Sent den, Two Minute Papers, and Data Professor



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III B. Tech II Semester

23HPE332c	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:

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

- Understand basic network models and social network structures.
- Analyze key properties like centrality, clustering, and small-world effect.
- Apply community detection algorithms and influence maximization.
- Interpret diffusion models for viral marketing and information spread.
- 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 Sub group 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.



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UNIT V: Tools, Applications, and Ethics in SNA

SNA Tools: Gopher, Pajek, NetworkX, SNAP, Case Study: Twitter and Hashtag Analysis, Linked In 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 (free Code Camp, The Net Ninja)]
- edX– Networks: Friends, Money, and Bytes (University of California , Berkeley)
- Khan Academy– Graph Theory



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III B. Tech II Semester

23HPE333d	CYBERSECURITY & AI-DRIVEN THREAT DETECTION (Professional Elective-III)	L	T	P	C
		3	0	0	3

Course Objectives:

- To provide a foundational understanding of cyber security 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 simplifications of AI-driven security systems.

Course Outcomes:

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

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

UNIT I: Fundamentals of Cyber security

Introduction to Cyber security: 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 Cyber security, RNNs and LSTMs for Log and Sequence Data, Auto encoders for Anomaly Detection, CNNs for Malware Classification using Binary Analysis, Adversarial Attacks on AI-based Security Systems, Case Study: Threat Detection using Deep Learning.



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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, Mc Graw Hill.
3. Emmanuel Tsukerman, Machine Learning for Cyber security Cook book, Packet 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. ShaiShalev-Shwartz and Shai Ben-David, Understanding Machine Learning, Cambridge University Press.

Online Learning Resources:

- Coursera –AI for Cyber security (IBM)
- edX–Cyber security Fundamentals by Rochester Institute of Technology
- MIT Open Course Ware–Computer and Network Security
- [YouTube–Cyber security & AI Tutorials by Simple, Great Learning]
- Udemy–Machine Learning for Cybersecurity



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III B. Tech II Semester

23HPC3311	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 work flows with cloud infrastructure for scalable, distributed data processing.

Course Outcomes:

- Students will be able to implement big data pipelines and cloud-based solutions using tools like Hadoop, Spark, and cloud platforms such as AWS, Azure, or GCP.
- Students gain proficiency in managing distributed data processing, scalable storage, cloud service provisioning, and deploying applications using containers and orchestration platforms.
- Students will understand the synergy between big data technologies and cloud computing to solve real-world problems efficiently.

List of Lab Experiments:

- Installation and Configuration of Hadoop Cluster (Single Node & Multi-node) Hadoop HDFS setup, Name Node & Data Node configuration
- Working with HDFS :File Operations
Upload, read, delete, and replicate files in HDFS
- Map Reduce Programming Basics
Word count, sorting ,and filtering examples in Java / Python
- Apache Hive & Pig for Querying Large Datasets Creation of tables, data loading, and running queries
- Apache Spark Basics :RDDs and Data Frames Implement Spark transformations and actions
- Data Preprocessing and Machine Learning using PySpark ML lib Classification or regression using ML lib pipelines
(Cognitive Level : Apply & Evaluate)
- Introduction to Cloud Computing and AWS/Azure/GCP Console Creating virtual machines, basic compute and storage services
- Cloud Storage and Database Services
Using S3 (AWS), Blob (Azure), or GCP buckets and Cloud SQL / No SQL
- Deploying Big Data Workload son Cloud (EMR, HD Insight, Data proc)



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- Running Hadoop / Spark jobs in cloud-managed services
- Cloud Function / Serverless Deployment
- Building and deploying a serverless function (e.g., AWS Lambda)
- Containerization with Docker
- Building, running, and managing Docker containers
- Orchestration Kubernetes in the Cloud Deploy and manage a containerized application using

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, Packet Publishing.
2. Benjamin Bengfort, Data Analytics with Hadoop, O'Reilly.
3. Srinivasan & J. Shrinivasan, Cloud Computing – A Hands-on Approach, Wiley India.

Online Courses:

1. Big Data Specialization – Coursera (University of California San Diego)
2. Cloud Computing Basics – edX (LearnQuest)
3. Data Engineering with Google Cloud – Coursera (Google)

Online Resources:

<https://www.coursera.org/specializations/big-data>

<https://www.coursera.org/professional-certificates/gcp-data-engineering>

<https://www.edx.org/masters/micromasters/usmx-umgc-cloud-computing>



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III B. Tech II Semester

23HPC3312	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:

- Design frontend interfaces using React/HTML/CSS.
- Build backend logic using Flask or Node.js APIs.
- Integrate and deploy ML models with web services.
- Store and retrieve data using MongoDB/MySQL.
- 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



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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

Online resources

<https://fullstackdeeplearning.com/>

<https://www.deeplearning.ai/programs/mlops/>

<https://www.coursera.org/specializations/machine-learning-engineering-for-production-mlops>

<https://www.cloudskillsboost.google/paths/11>

<https://learn.microsoft.com/en-us/training/paths/build-ai-solutions-with-azure/>



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III B. Tech II Sem

23HOE052a	OPERATING SYSTEMS (Open Elective-II)	L	T	P	C
		3	0	0	3

Course Objectives: The main objectives of the course is to make student

- Understand the basic concepts and principles of operating systems, including process management, memory management, file systems, and Protection
- Make use of process scheduling algorithms and synchronization techniques to achieve better performance of a computer system.
- Illustrate different conditions for deadlock and their possible solutions.

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

CO1: Describe the basics of the operating systems, mechanisms of OS to handle processes, threads, and their communication. (L1)

CO2: Understand the basic concepts and principles of operating systems, including process management, memory management, file systems, and Protection. (L2)

CO3: Make use of process scheduling algorithms and synchronization techniques to achieve better performance of a computer system. (L3)

CO4: Illustrate different conditions for deadlock and their possible solutions. (L2) □Analyze the memory management and its allocation policies. (L4)

CO5: Able to design and implement file systems, focusing on file access methods, directory structure, free space management, and also explore various protection mechanisms,

UNIT - I Operating Systems Overview, System Structures

Operating Systems Overview: Introduction, Operating system functions, Operating systems operations, Computing environments, Open-Source Operating Systems System Structures: Operating System Services, User and Operating-System Interface, systems calls, Types of System Calls, system programs, Operating system Design and Implementation, Operating system structure, Operating system debugging, System Boot.

UNIT - II Process Concept, Multithreaded Programming, Process Scheduling, Inter-process Communication

Process Concept: Process scheduling, Operations on processes, Inter-process communication, Communication in client server systems. Multithreaded Programming: Multithreading models, Thread libraries, Threading issues, Examples. Process Scheduling: Basic concepts, Scheduling criteria, Scheduling algorithms, Multiple processor scheduling, Thread scheduling, Examples. Inter-process Communication: Race conditions, Critical Regions, Mutual exclusion with busy waiting, Sleep and wakeup, Semaphores, Mutexes, Monitors, Message passing, Barriers, Classical IPC Problems - Dining philosophers problem, Readers and writers problem.

UNIT - III Memory-Management Strategies, Virtual Memory Management

Memory-Management Strategies: Introduction, Swapping, Contiguous memory allocation, Paging, Segmentation, Examples. Virtual Memory Management: Introduction, Demand paging, Copy on-write, Page replacement, Frame allocation, Thrashing, Memory-mapped files, Kernel memory allocation, Examples.



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UNIT - IV Deadlocks, File Systems

Deadlocks: Resources, Conditions for resource deadlocks, Ostrich algorithm, Deadlock detection And recovery, Deadlock avoidance, Deadlock prevention. File Systems: Files, Directories, File system implementation, management and optimization. Secondary-Storage Structure: Overview of disk structure, and attachment, Disk scheduling, RAID structure, Stable storage implementation.

UNIT - V System Protection, System Security

System Protection: Goals of protection, Principles and domain of protection, Access matrix, Access control, Revocation of access rights. System Security: Introduction, Program threats, System and network threats, Cryptography as a security, User authentication, implementing security defenses, firewalling to protect systems and networks, Computer security classification. Case Studies: Linux, Microsoft Windows.

Textbooks:

1. Silberschatz A, Galvin P B, and Gagne G, Operating System Concepts, 9th edition, Wiley, 2016.
2. Tanenbaum A S, Modern Operating Systems, 3rd edition, Pearson Education, 2008. (Topics: Inter-process Communication and File systems.)

Reference Books:

1. Tanenbaum A S, Woodhull A S, Operating Systems Design and Implementation, 3rd edition, PHI, 2006.
2. Dhamdhare D M, Operating Systems A Concept Based Approach, 3rd edition, Tata McGraw Hill, 2012.
3. Stallings W, Operating Systems -Internals and Design Principles, 6th edition, Pearson Education, 2009
4. Nutt G, Operating Systems, 3rd edition, Pearson Education, 2004

Online Learning Resources:

<https://nptel.ac.in/courses/106/106/106106144/>

<http://peterindia.net/OperatingSystems.html>



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III B. Tech – II Sem

23HOE052b	INTRODUCTION TO MACHINE LEARNING (Open Elective-II)	L	T	P	C
		3	0	0	3

Course Objectives:

- To introduce the fundamental concepts and types of machine learning.
- To develop a deep understanding of supervised and unsupervised learning algorithms.
- To understand mathematical foundations of learning models and algorithms.
- To evaluate model performance using appropriate statistical and analytical tools.
- To apply machine learning techniques to solve real-world problems using tools such as Scikit-learn.

Course Outcomes:

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

- Understand and distinguish among different types of learning methods.
- Apply supervised and unsupervised learning algorithms to datasets.
- Analyze model performance using cross-validation and error metrics.
- Build, test, and improve machine learning models for classification and prediction.
- Use Python-based libraries (e.g., Scikit-learn) to implement ML algorithms.

UNIT I: Introduction to Machine Learning and Linear Models

Definition and Scope of Machine Learning, Applications and Types of Learning: Supervised, Unsupervised, Reinforcement, Linear Regression: Least Squares, Cost Function, Gradient Descent, Polynomial Regression and Overfitting, Evaluation Metrics: RMSE, MAE, R^2 Score, Bias-Variance Trade off.

UNIT II: Classification Algorithms

Classification Overview and Decision Boundaries, Logistic Regression: Sigmoid Function and Cost, K-Nearest Neighbors (KNN), Naïve Bayes Classifier, Decision Trees and Random Forests, Model Evaluation: Confusion Matrix, Precision, Recall, F1-Score.

UNIT III: Support Vector Machines and Ensemble Methods

Support Vector Machines: Concepts, Kernels, Hyperplane and Margin Concepts, Kernel Tricks: RBF and Polynomial, Ensemble Learning: Bagging, Boosting, and Voting, Gradient Boosting, AdaBoost, and XGBoost, Model Tuning and Hyperparameter Optimization.

UNIT IV: Unsupervised Learning Techniques

Clustering Overview: Applications, K-Means Clustering Algorithm, Hierarchical Clustering, DBSCAN and Density-Based Methods, Principal Component Analysis (PCA) for Dimensionality Reduction, Silhouette Score, Davies-Bouldin Index for Cluster Validation.

UNIT V: Advanced Topics and Applications

Reinforcement Learning Basics and Markov Decision Processes, Introduction to Neural Networks and Deep Learning, Cross-Validation Techniques: k-Fold, Leave-One-Out, Feature Engineering and Feature Selection, Deployment of ML Models (Flask, Streamlit, etc.), Case Studies: Medical Diagnosis, Spam Detection, Credit Scoring.



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Textbooks:

1. Tom Mitchell, **Machine Learning**, McGraw-Hill Education.
2. Aurélien Géron, **Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow**, O'Reilly Media.
3. Ethem Alpaydin, **Introduction to Machine Learning**, MIT Press.

Reference Books:

1. Trevor Hastie, Robert Tibshirani, Jerome Friedman, **The Elements of Statistical Learning**, Springer.
2. Kevin P. Murphy, **Machine Learning: A Probabilistic Perspective**, MIT Press.
3. Christopher Bishop, **Pattern Recognition and Machine Learning**, Springer.

Online Learning Resources:

1. [Coursera – Machine Learning by Andrew Ng \(Stanford University\)](#)
2. [Scikit-learn Documentation](#)
3. [Kaggle Learn – Machine Learning](#)
4. [Google's Machine Learning Crash Course](#)
[YouTube – StatQuest with Josh Starmer](#)