TULSIRAMJI GAIKWAD-PATIL COLLEGE OF ENGINEERING & TECHNOLOGY
Wardha Road, Nagpur - 441108
Accredited with NAAC A+ Grade & NBA Accredited (EE, ME, CE & ECE)
Approved by AICTE, New Delhi, Govt. of Maharashtra
(An Autonomous Institution Affiliated to Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur)
Department of Artificial Intelligence & Machine Learning

Program: B. Tech Artificial Intelligence and Machine Learning

Semester-V	**BAI13501: Machine Learning**				
Teaching Scheme		**Examination Scheme (Th)**		**Examination Scheme (P)**	
Theory (Th)	3 Hrs./week	**CT-I**	15 Marks	-	-
Practical (P)	-	**CT-II**	15 Marks	-	-
Total Credits	**3**	**CA**	10 Marks	-	-
Duration of ESE: 3 Hrs.		**ESE**	60 Marks	-	-
		Total Marks	**100 Marks**	-	-

Pre-Requisites: Basic knowledge of mathematics, statistics, Python programming.

Course Objectives:

1	To Introduce foundational ML concepts, hypothesis learning, decision trees, and model evaluation techniques.
2	To Explain KNN, lazy learning methods, and core principles of computational learning theory.
3	To Provide understanding of perceptrons, multilayer networks, backpropagation, and introductory deep learning structures.
4	To Introduce probabilistic reasoning, Bayesian learning, Naïve Bayes, and Bayesian networks.
5	To Cover advanced ML methods such as EM, GMM, clustering, SVM, ensemble models, and basic reinforcement learning.

Course Content

Unit I	Basics of Machine Learning; types of learning (supervised, unsupervised, semi-supervised, reinforcement).Concept Learning: hypothesis representation, general-to-specific search, version spaces, candidate elimination, inductive bias. Decision Trees (ID3, entropy, information gain), rule-based learning, overfitting and regularization basics. Model evaluation: train/test split, cross-validation, common ML performance metrics, and experimental evaluation.
	Activity 1: Students analyze a list of everyday applications (e.g., Netflix recommendations, Spam filters, Face ID) and categorize them into supervised or unsupervised learning with a brief justification.
Unit II	Instance-based learning: lazy learning, K-Nearest Neighbors, RBF networks, and case-based reasoning. Computational Learning Theory: PAC model, sample complexity, training complexity, and VC dimension.
	Activity1: Students are given a small 2D dataset on graph paper and manually calculate the Euclidean distance to classify a new data point using K=1 and K=3.
Unit III	Biological neuron model, linear threshold units, perceptron learning. Multilayer perceptrons (MLP), backpropagation, activation functions. Basics of Recurrent Neural Networks and an overview of deep learning.
	Activity1: Students manually determine the weights and bias needed for a single-layer perceptron to function as a simple logic gate (AND or OR gate).
Unit IV	Probabilistic Machine Learning Probability essentials for ML. MLE, MAP, Bayes classifiers, Naïve Bayes, Bayes optimal classifier, MDL principle. Bayesian networks with exact and approximate inference methods.
	Activity1: Naïve Bayes Weather Predictor: Using a small provided table of "Weather" vs "Play Sports," students use the Naïve Bayes formula on paper to predict if a game will happen on a "Sunny" day.
Unit V	Advanced ML Techniques-EM algorithm, stronger regularization methods, early stopping, dropout, Gaussian Mixture Models, clustering (K-Means, hierarchical). Hidden Markov Models, basics of reinforcement learning (policy, value functions). Support Vector Machines and ensemble methods (bagging, boosting, random forests).

	Activity 1: K-Means Simulation: Students use colored stickers or markers to manually perform two iterations of the K-Means algorithm on a printed set of points to see how centroids move.

Text Books	
T.1	om Mitchell; Machine Learning- an Artificial Intelligence Approach, Volume-II; Morgan Kaufmann, 1986.
T.2	Christopher Bishop, Pattern Recognition and machine learning; Springer Verlag, 2006.
Reference Books	
R.1	Soumen Chakrabarti; Mining the Web: Discovering Knowledge from Hypertext Data, Morgan Kaufmann, 2003.
R.2	A. K. Jain and R. C. Dubes; Algorithms for Clustering Data; Prentice Hall PTR, 1988.
R.3	Ethem Alpaydin, Introduction to Machine Learning, PHI.
Useful Links	
1	https://nptel.ac.in/courses/106105152
2	https://nptel.ac.in/courses/106106213

CO	Course Outcomes	CL	Class Sessions
CO1	**Apply** basic ML models, hypothesis search methods, and performance evaluation metrics.	3	9
CO2	**Analyze** instance-based methods and interpret learning complexity measures.	4	9
CO3	**Implement** simple neural network models using perceptrons and MLP architectures.	3	9
CO4	**Analyze** Bayesian methods for classification and relationships using probabilistic graphical models.	4	9
CO5	**Evaluate** advanced supervised, unsupervised, and sequential learning algorithms.	5	9

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Semester-V | **BAI13502: Machine Learning Lab**

Teaching Scheme		Examination Scheme (Th)		Examination Scheme(P)	
Theory (Th)	-	**INT**	-	**INT**	-
Practical (P)	2 Hrs./week	**ESE**	-	**ESE**	-
Total Credits	**1**	**CA**	-	**CA**	25 Marks
Duration of ESE: 2Hrs		**ESE**	-	**ESE-P**	25 Marks
		Total Marks	-	**Total Marks**	**50 Marks**

Pre-Requisites: Basic knowledge of mathematics, statistics, Python programming.

Course Objectives:

1.	To implement basic machine learning algorithm for solving problem.
2.	To understand the usage of datasets in implementing machine learning problems.
3.	To learn various modern tools, packages and techniques for machine learning.

List of Experiments

1	Implement and compare Supervised, Unsupervised, and Semi-Supervised datasets with visualization using Python.	**CO1**
2	Implement the Candidate Elimination Algorithm and visualize the Version Space boundaries.	**CO1**
3	Implement a supervised machine learning model on a real dataset; demonstrate model selection, performance measurement, and interpretation.	**CO1**
4	Build a Regression Model (Linear Regression / Polynomial Regression) and analyze prediction error using MAE, MSE, RMSE.	**CO2**
5	Implement K-Nearest Neighbor Classification with multiple K values and compare performance metrics.	**CO2**
6	Compute VC Dimension and Sample Complexity for basic hypothesis classes (line, interval, circle).	**CO2**
7	Implement a Radial Basis Function (RBF) Network using Gaussian radial kernels.	**CO3**
8	Implement Single-Layer Perceptron Learning & Linear Threshold Neuron from scratch (NumPy only).	**CO3**
9	Implement a Multi-Layer Perceptron (MLP) trained with Backpropagation using Python.	**CO3**
10	Implement a basic Recurrent Neural Network (RNN) for small sequence prediction (character or time-series).	**CO4**
11	Implement Naïve Bayes Classification with MAP and MLE estimation on a text dataset.	**CO4**
12	Implement a Bayesian Network and compare Exact vs Approximate inference.	**CO4**
13	Implement the EM Algorithm for Gaussian Mixture Models and visualize EM iterations.	**CO5**
14	Implement and compare advanced ML models (Bagging, Boosting, Random Forest, SVM) on the same dataset.	**CO5**
15	Develop a Mini-Application integrating core ML steps: data preprocessing → model training → evaluation → visualization.	**CO5**

Text Books

T.1	Tom Mitchell; Machine Learning- an Artificial Intelligence Approach, Volume-II; Morgan Kaufmann, 1986.
T.2	Christopher Bishop, Pattern Recognition and machine learning; Springer Verlag, 2006.

Reference Books

R.1	Soumen Chakrabarti; Mining the Web: Discovering Knowledge from Hypertext Data, Morgan Kaufmann, 2003.
R.2	A. K. Jain and R. C. Dubes; Algorithms for Clustering Data; Prentice Hall PTR, 1988.

R.3	Ethem Alpaydin, Introduction to Machine Learning, PHI.
Useful Links	
L.1	https://nptel.ac.in/courses/106105152
L.2	https://nptel.ac.in/courses/106106213

CO	Course Outcomes	CL	Class Sessions
CO1	**Implement** fundamental machine learning concepts, hypothesis learning and model evaluation techniques.	3	2
CO2	**Apply** instance-based learning, understand computational learning theory concepts and analyze sample/VC complexity.	3	2
CO3	**Implement** neural network models including perceptron, MLP and RNN with appropriate learning algorithms.	3	2
CO4	**Apply** probabilistic reasoning techniques and implement Bayesian learning models with exact and approximate inference.	3	2
CO5	**Design** a Module on Machine learning Algorithm.	6	2

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Semester-V | **BAI13503: Computer Networks**

Teaching Scheme		Examination Scheme (Th)		Examination Scheme (P)	
Theory (Th)	3 Hrs./week	**CT-I**	15 Marks	-	-
Practical (P)	-	**CT-II**	15 Marks	-	-
Total Credits	**3**	**CA**	10 Marks	-	-
Duration of ESE: 3 Hrs.		**ESE**	60 Marks	-	-
		Total Marks	**100 Marks**	-	-

Pre-Requisites: Basics of computer fundamentals, operating systems

Course Objectives:

1	To Introduce the fundamental concepts of each layer in the OSI and TCP/IPmodels.
2	To implement and troubleshoot network topologies and examine network and transport Layer protocol working.
3	To learn about network security, firewalls, and intrusion detection.
4	To Investigate applications of AI in computer network.
5	To Introduce the fundamental concepts of each layer in the OSI and TCP/IPmodels.

Course Content

Unit I	Data Communication and Network Fundamentals: Data communication components, data representation, and data flow, Network topology, protocols, and standards, OSI model and TCP/IP model overview, Data Link Layer**:** Error detection and correction (Hamming Distance, CRC), Flow control and error control protocols: Stop & Wait, Go-Back-N ARQ, Selective Repeat ARQ, IEEE 802.3 (Ethernet), Switching concepts
	Activity 1: Draw and label the OSI model layers with their functions and examples of protocols used in each layer.
Unit II	Network Layer: Internet Protocol (IP): Logical addressing – IPv4 and IPv6, IP addressing and subnetting, ARP, RARP, BOOTP, and DHCP, Routing concepts and protocols (RIP, OSPF, BGP), Packet delivery and forwarding techniques, Network security basics: IP spoofing, IPsec fundamentals
	Activity 1: Perform simple IPv4 subnetting for a given IP address and identify network ID and host ID.
Unit III	Transport Layer: Elements of transport protocols: Addressing, Connection establishment, and Connection release, UDP and TCP – features and comparison, TCP congestion control, Traffic management: Leaky bucket and token bucket algorithms, Security extensions: TLS/SSL at the transport layer, Port scanning and protection mechanisms.
	Activity 1: Compare TCP and UDP protocols in tabular form based on speed, reliability, and applications.
Unit IV	Application Layer and Network Security: Application layer protocols: DNS, FTP, HTTP, HTTPS, and WWW, Network security principles: Confidentiality, Integrity, Availability (CIA triad), Common network threats: Malware, Phishing, DoS/DDoS, Man-in-the-Middle, Spoofing, Cryptography: Symmetric and Asymmetric encryption, Hashing, Digital signatures, Security protocols: SSL/TLS, HTTPS, S/MIME
	Identify different network threats (phishing, malware, DoS attack) from given real-life examples.
Unit V	Advanced Security and Emerging Trends:

	Firewalls: Types, configuration, and policies, Virtual Private Networks (VPNs), Intrusion Detection and Prevention Systems (IDS/IPS),Bluetooth and Wireless network security, AI/ML in Network Security: Load balancing and optimization, AI-based threat detection and hunting, Predictive analytics for anomaly detection, Zero Trust Architecture and Cloud Network Security (overview)
	Prepare a short chart showing types of firewalls and their basic functions.

Text Books	
T.1	Computer Networks Andrew S. Tanenbaum and David J. Wetherall, 5th Edition (2010), Pearson Education (Prentice Hall imprint)
T.2	Data Communications and Networking by Behrouz A. Forouzan, 5th Edition, McGraw-Hill Education.
T.3	Network Security Essentials: Applications and Standards by William Stallings, 6th Edition, Pearson Education.
Reference Books	
R.1	TCP/IP Protocol Suite by Behrouz A. Forouzan, 4th Edition, McGraw-Hill Education.
R.2	Data and Computer Communications, William Stallings, 10th Edition, Pearson Education.
Useful Links	
1	https://nptel.ac.in/courses/106105183?utm
2	https://nptel.ac.in/courses/106106091?utm

CO	Course Outcomes	CL	Class Sessions
CO1	**Apply** data communication concepts, OSI/TCP-IP models, and error control techniques in computer networks.	3	9
CO2	**Determine** IP addressing, subnetting, routing protocols, and packet forwarding mechanisms in network layer operations.	3	9
CO3	**Apply** transport layer protocols, congestion control, and traffic management techniques for reliable data transmission.	3	9
CO4	**Analyze** application layer protocols, cryptographic methods, and common network security threats in communication systems.	4	9
CO5	**Illustrate** firewall, VPN, IDS/IPS, and AI-based security techniques to enhance modern network security.	4	9

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Semester-V | **BAI13504: Computer Networks Lab.**

Teaching Scheme		Examination Scheme (Th)		Examination Scheme(P)	
Theory (Th)	-	**INT**	-	**INT**	-
Practical (P)	2 Hrs./week	**ESE**	-	**ESE**	-
Total Credits	**1**	**CA**	-	**CA**	25 Marks
Duration of ESE: 2Hrs		**ESE**	-	**ESE-P**	25 Marks
		Total Marks	-	**Total Marks**	**50 Marks**

Pre-Requisites: Basics of computer fundamentals, operating systems

Course Objectives:

1.	To apply networking concepts for designing, configuring, and troubleshooting communication networks using simulation tools.
2.	To analyze network traffic and implement security mechanisms such as VLANs, ACLs, Firewalls, and VPNs.
3.	To evaluate advanced network security solutions including IDS/IPS, SDN, and AI-based threat detection techniques.

List of Experiments

1	Design and simulate basic network topologies (bus, star, ring, mesh) and perform network troubleshooting using Cisco Packet Tracer.	**CO1**
2	Capture and analyze network packets using Wireshark to study protocol headers (Ethernet, IP, TCP, UDP, ARP).	**CO1**
3	Implement Error Detection and Correction techniques (CRC, Hamming Code) at the Data Link Layer.	**CO1**
4	Design and configure Virtual LANs (VLANs) and verify inter-VLAN communication.	**CO2**
5	Perform IP addressing and subnetting, and configure devices accordingly.	**CO2**
6	Configure Static and Dynamic Routing (RIP/OSPF) and verify packet delivery.	**CO2**
7	Implement and test Transport Layer protocols (TCP/UDP) communication using simple Python socket programming.	**CO3**
8	Analyze Software Defined Network (SDN) and perform network virtualization using Mininet or Packet Tracer.	**CO3**
9	Configure DHCP server to assign IP addresses automatically in a simulated network.	**CO3**
10	Configure and test DNS (Domain Name System) for name resolution.	**CO4**
11	Implement Network Address Translation (NAT) – Static and Dynamic.	**CO4**
12	Configure Access Control Lists (ACLs) for basic network security (filtering and packet control).	**CO4**
13	Configure and test Firewall rules using Packet Tracer / GNS3 to secure network traffic.	**CO5**
14	Establish a VPN (Virtual Private Network) connection and demonstrate secure communication.	**CO5**
15	Develop Intrusion Detection/Prevention System (IDS/IPS) using open-source tools (e.g., Snort or Security Onion) or simulation-based demonstration.	**CO5**

Text Books

T.1	Computer Networks" by Andrew S. Tanenbaum, David J. Wetherall (5th Edition), Pearson Education
T.2	Data and Computer Communications" by William Stallings (10th Edition), PearsonEducation

Reference Books

R.1	Computer Networking: A Top-Down Approach" by James F. Kurose, Keith W. Ross(7th Edition), Pearson Education.
R.2	Software-Defined Networking: Design and Deployment" by Patricia A. Morreale, Daniele Ceccarelli, Wiley.
R.3	Computer Networking: A Top-Down Approach" by James F. Kurose, Keith W. Ross(7th Edition), Pearson Education.
Useful Links	
L.1	https://nptel.ac.in/courses/106105081
L.2	https://nptel.ac.in/courses/106105183

CO	Course Outcomes	CL	Class Sessions
CO1	**Implement** the computer network protocols with topologies.	3	2
CO2	**Apply** error detection and correction mechanisms related to data Link Layer and implement Routing algorithm.	3	2
CO3	**Analyze** TCP protocol related to traffic shaping and routing algorithms.	3	2
CO4	**Implement** network security mechanisms to protect data and infrastructure.	3	2
CO5	**Develop** A module based on computer network.	6	2

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Semester-V | **BAI13505: Design and Analysis of Algorithm**

Teaching Scheme		Examination Scheme (Th)		Examination Scheme (P)	
Theory (Th)	2 Hrs./week	**CT-I**	7 Marks	-	-
Practical (P)	-	**CT-II**	7 Marks	-	-
Total Credits	**2**	**CA**	6 Marks	-	-
Duration of ESE: 2 Hrs.		**ESE**	30 Marks	-	-
		Total Marks	**50 Marks**	-	-

Pre-Requisites: Basic knowledge of data structures, discrete mathematics.

Course Objectives:

1	To build understanding of advanced algorithm analysis and correctness principles.
2	To introduce algorithmic techniques used in data summarization, ML foundations, and optimization.
3	To develop awareness of scalable, heuristic, and modern algorithmic approaches for large-scale data.

Course Content

Unit I	**Algorithm Foundations & Complexity**-Mathematical modeling of algorithms**,** Advanced complexity, amortized, probabilistic, and smoothed analysis**,** Lower bounds and correctness proofs**,** Randomized and approximation algorithms (basics, concepts).
	Activity 1: Analyze the time complexity of different sorting algorithms and compare their best, average, and worst-case performance.
Unit II	**Data-Centric Algorithms & Optimization**-Data summarization techniques: sampling, sketches, PCA/SVD**,** Graph & network analysis algorithms: PageRank, centrality, communities**,** Optimization for data analysis: gradient descent variants, regularization**,** Algorithmic foundations of ML, loss functions, clustering/classification (conceptual).
	Activity1: Perform simple data sampling and visualize the effect of data reduction on dataset analysis.
Unit III	**Scalable & Advanced Algorithmic Techniques**-Heuristics and metaheuristics: greedy optimization, GA, simulated annealing**,** Big data algorithms: MapReduce model, streaming, Bloom filters**,** Predictive data algorithms: time-series basics, smoothing, anomaly detection**,** Modern trends: explainable algorithms, fairness and bias, basics of quantum algorithms.
	Activity1: Implement a basic greedy algorithm (e.g., Activity Selection or Fractional Knapsack) and compare its output with brute force approach.

Text Books	
T.1	Introduction to Algorithms by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, 4th Edition, MIT Press.
T.2	Introduction to the Design and Analysis of Algorithms by Anany Levitin, 3rd Edition, Pearson Education.
Reference Books	
R.1	The Design and Analysis of Computer Algorithms by Aho, Hopcroft and Ullman, 1st Edition, Pearson Education.
R.2	Algorithm Design and Applications by Michael T. Goodrich, Roberto Tamassia, 1st Edition, Wiley Publication.
R.3	Genetic Algorithms in Search, Optimization and Machine Learning by David E. Goldberg, 1st Edition, Pearson Education.
Useful Links	
1	https://nptel.ac.in/courses/106105164
2	https://nptel.ac.in/courses/110106072

CO	Course Outcomes	CL	Class Sessions
CO1	**Illustrate** mathematical modeling, complexity analysis, and randomized algorithms to evaluate algorithm efficiency and correctness.	4	9
CO2	**Analyze** data-centric algorithms, optimization methods, and graph analysis techniques for efficient data processing.	4	9
CO3	**Apply** scalable algorithmic techniques, heuristic methods, and predictive data algorithms to solve real-world computational problems.	3	9

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Semester-V **BAI13506 : Soft Computing**

Teaching Scheme		Examination Scheme (Th)		Examination Scheme (P)	
Theory (Th)	4 Hrs./week	**CT-I**	15 Marks	-	-
Practical (P)	-	**CT-II**	15 Marks	-	-
Total Credits	**4**	**CA**	10 Marks	-	-
Duration of ESE: 3 Hrs.		**ESE**	60 Marks	-	-
		Total Marks	**100 Marks**	-	-

Pre-Requisites: Basic knowledge of mathematics, programming concepts, probability & statistics, and fundamentals of artificial intelligence.

Course Objectives:

1	To Introduce new computing paradigms for intelligent machines, focusing on solving complex real-world problems using soft computing techniques.
2	To Provide insight into fuzzy logic, artificial neural networks, and hybrid systems.
3	To Create awareness of soft computing applications.
4	To Offer alternative solutions for image/signal processing, pattern recognition/classification, and control systems

Course Content

Unit I	Biological and artificial neuron models, bias and threshold concepts, McCulloch-Pitts model, Implementation of logical functions (AND, OR, XOR), neural network topologies, Learning paradigms: supervised, unsupervised, reinforcement, Gradient descent, error energy, activation functions, Hebbian/Delta Rule, Perceptron (and limitations), Introduction to linear regression, associative memories.
	Activity 1: Draw biological neuron and artificial neuron models with proper labeling..
Unit II	Multilayer perceptron (MLP) and backpropagation algorithms, MLP applications: classification, regression, feature maps, K-means clustering, learning vector quantization, radial basis function networks, Hopfield network, associative memories, Cover's theorem, mapping functions (Gaussian, Multi-quadrics).
	Activity 1: Perform simple K-means clustering on given student marks data.
Unit III	Fuzzy numbers, fuzzy set theory, operations on fuzzy sets, Membership functions, linguistic terms, fuzzy if-then rules, Fuzzification, membership value assignment, de-fuzzification, Fuzzy inference, implication rules, Mamdani/Zadeh/Sugeno/Tsukamoto models, Fuzzy control system problems, PID control comparison, FLC architecture, applications in real-world control (e.g., aircraft landing).
	Activity 1: Identify membership functions for real-life examples like temperature (cold, warm, hot).
Unit IV	Adaptive Neuro-Fuzzy Inference Systems (ANFIS) architecture, Hybrid learning algorithms, advantages/limitations of ANFIS and CANFIS, Applications for regression and fuzzy modelling.
	Activity 1: Prepare a flowchart of ANFIS architecture and explain its working.
Unit V	Use of soft computing for image/signal processing, pattern recognition/classification, control systems, Survey of industrial/real-world examples and engineering applications.
	Activity 1: Collect and present one real-world application of soft computing in daily life.

Text Books	
T.1	Fundamentals of Neural Networks, Laurene Fausett, Pearson, 2008.
T.2	Fuzzy Logic with Engineering Applications, Timothy Ross, 2010
T.3	Neuro-Fuzzy and Soft Computing, J.S. Jang et al., PHI.
Reference Books	
R.1	Introduction to Neural Computation, John Hertz et al., Addison-Wesley, 1991.
R.2	Neural Networks: A Comprehensive Foundation, Simon Haykin, 1999.
Useful Links	
1	https://nptel.ac.in/courses/106105173
2	https://nptel.ac.in/courses/111105614

CO	Course Outcomes	CL	Class Sessions
CO1	**Explain** neuron models, learning paradigms, perceptron concepts, and neural network fundamentals for implementing basic intelligent systems.	3	9
CO2	**Apply** multilayer neural network architectures and learning algorithms to perform classification, clustering, regression, and associative memory tasks.	3	9
CO3	**Analyze** fuzzy logic concepts and inference models to design intelligent control systems for real-world applications.	4	9
CO4	**Evaluate** adaptive neuro-fuzzy systems and hybrid learning algorithms for regression and fuzzy modeling applications.	5	9
CO5	**Apply** soft computing techniques to solve image processing, signal processing, pattern recognition, and control system problems in engineering applications.	3	9

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Semester-V | **BAI13507 : Computer Graphics**

Teaching Scheme		Examination Scheme (Th)		Examination Scheme (P)	
Theory (Th)	4 Hrs./week	**CT-I**	15 Marks	-	-
Practical (P)	-	**CT-II**	15 Marks	-	-
Total Credits	**3**	**CA**	10 Marks	-	-
Duration of ESE: 3 Hrs.		**ESE**	40 Marks	-	-
		Total Marks	**100 Marks**	-	-

Pre-Requisites: Basic knowledge of computer fundamentals, programming concepts, geometry, matrices, and multimedia fundamentals.

Course Objectives:

1	To Understand the fundamentals, applications, and hardware/software systems of computer graphics and multimedia.
2	To Apply essential algorithms and techniques for graphic primitives, transformations, and image processing.
3	To Implement geometric, viewing, and multimedia operations from 2D to 3D and animation.
4	To Gain exposure to authoring processes, tools, and case studies in multimedia, including software like MatLab.

Course Content

Unit I	An Introduction Graphics System : Computer Graphics and Its Types, Application of computer graphics, Graphics Systems : Video Display Devices, Raster Scan Systems, Random Scan Systems, Graphics Monitors and Work Stations, Input Devices, Hard Copy Devices, Graphics Software.
	Activity 1: Draw and compare Raster Scan and Random Scan display systems.
Unit II	Output Primitives and Attributes of Output Primitives : Output Primitive Points and Lines, Line Drawing Algorithms, Circle Generating Algorithms, Scan-Line Polygon Fill Algorithm, Inside-Outside tests, Boundary-Fill Algorithm, Flood Fill Algorithm, Cell Array, Character Generation, Attributes of Output Primitives : Line Attributes, Color and Grayscale Levels, Area fill Attributes, Character Attributes, Bundled Attributes, Antialiasing.
	Activity1: Implement DDA or Bresenham's Line Drawing Algorithm manually for given coordinates.
Unit III	Two-dimensional Geometric Transformations : Basic Transformations, Matrix Representation and Homogeneous Coordinates, Composite Transformations, Reflection and Shearing. Two-Dimension Viewing : The viewing Pipeline, Window to view port coordinate transformation, Clipping Operations, Point Clipping, Line Clipping, Polygon Clipping, Text Clipping, Exterior Clipping Three-Dimensional Concepts : Three Dimensional Display Methods, 3D Transformations, Parallel Projection and Perspective Projection.
	Activity1: Perform 2D transformations (translation, rotation, scaling) on simple objects using matrix calculations.
Unit IV	Multimedia : Introduction to Multimedia : Classification of Multimedia, Multimedia Software, Components of Multimedia – Audio : Analog to Digital conversion, sound card fundamentals, Audio play backing and recording Video, Text : Hypertext, Hyper media and Hyper Graphics, Graphics and Animation : Classification of Animation. Authoring Process and Tools. Case Study: graphics software MatLab, Use of MatLab in graphics application, Features of MatLab, Generalize application by using MatLab.

	Activity1: Create a simple multimedia presentation using audio, video, text, and animation tools.
Unit V	Real-time rendering and hardware-accelerated graphics, Advanced visualization techniques (volume rendering, mesh simplification), Physically-based modeling and global illumination Special effects and animation (particle systems, procedural animation), Multimedia integration and authoring tools, Case studies on graphics software and optimization, Recent research trends and faculty-selected topics
	Activity1: Prepare a short presentation on recent trends in computer graphics such as virtual reality or real-time rendering.

Text Books	
T.1	Donald Hearn & M. Pauline Baker, "Computer Graphics with OpenGL", Third Edition, 2004, Pearson Education.
T.2	Ze-NianLi and Mark S. Drew, "Fundamentals of Multimedia", First Edition, PHI Learning Pvt. Ltd..
Reference Books	
R.1	Plastock: Theory & Problem of Computer Graphics, Schaum Series.
R.2	Foley & Van Dam: Fundamentals of Interactive Computer Graphics, Addison-Wesley.
R.3	Newman: Principles of Interactive Computer Graphics, McGraw Hill.
Useful Links	
1	https://nptel.ac.in/courses/106103224
2	https://nptel.ac.in/courses/106106090

CO	Course Outcomes	CL	Class Sessions
CO1	**Explain** computer graphics systems, display devices, input/output hardware, and software tools used in graphical applications.	3	9
CO2	**Implement** output primitive generation algorithms and apply graphical attributes for creating and enhancing computer graphics objects.	3	9
CO3	**Apply** two-dimensional and three-dimensional geometric transformations, viewing techniques, and clipping operations in computer graphics systems.	3	9
CO4	**Analyze** multimedia components, animation techniques, and MatLab-based graphics applications for multimedia system development.	4	9
CO5	**Evaluate** advanced computer graphics and multimedia techniques for real-time rendering, visualization, animation, and optimized graphical applications**.**	5	9

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Department of Artificial Intelligence & Machine Learning

Program: B. Tech Artificial Intelligence and Machine Learning

Semester-V | **BAI13508: Next generation databases**

Teaching Scheme		Examination Scheme (Th)		Examination Scheme (P)	
Theory (Th)	4 Hrs./week	**CT-I**	15 Marks	-	-
Practical (P)	-	**CT-II**	15 Marks	-	-
Total Credits	**4**	**CA**	10 Marks	-	-
Duration of ESE: 3 Hrs.		**ESE**	60 Marks	-	-
		Total Marks	**100 Marks**	-	-

Pre-Requisites: Basic knowledge of Database Management Systems (DBMS), SQL, data structures, and programming fundamentals.

Course Objectives:

1	To Understand the evolution of database technologies from traditional RDBMS to NoSQL, NewSQL, and distributed database systems.
2	To Apply concepts of advanced database models including NoSQL, object, in-memory, and multi-model databases for scalable data solutions.
3	To Implement technologies and tools for managing modern, complex, semi-structured, and unstructured data.
4	To Analyze emerging trends such as blockchain, cloud, and quantum databases, focusing on future applications and industry relevance.

Course Content

Unit I	Introduction to Next Generation Databases: Evolution of data storage and management systems, limitations of traditional relational databases, motivation for new database technologies, overview of NoSQL, NewSQL, and distributed databases. Types and characteristics of next generation databases, trends in big data and the need for scalable data solutions, CAP theorem, BASE vs ACID properties, architectural overview.
	Activity 1 Prepare a comparison chart between traditional relational databases and NoSQL databases.
Unit II	NoSQL Databases: Introduction and classification (Key-Value, Document, Columnar, and Graph databases), data models and query languages for NoSQL systems, design principles and use cases, comparison with relational databases, consistency and replication strategies, indexing and data partitioning, popular NoSQL solutions (MongoDB, Cassandra, Redis, Neo4j), query processing and optimization.
	Activity1: Create and perform basic CRUD operations in MongoDB or Redis.
Unit III	In-Memory and Object-Oriented Databases: Characteristics of in-memory databases, architectures and design (SAP HANA, Redis, VoltDB), advantages and limitations, persistence and durability strategies, case studies of in-memory analytics. Object-oriented database concepts, data models, query interfaces (OQL), relationships, inheritance, support for complex objects and multimedia data, comparison with object-relational databases.
	Activity1: Study and present the architecture of an in-memory database like Redis or SAP HANA.
Unit IV	Advanced Topics in Modern Databases: NewSQL Databases (Google Spanner, VoltDB, NuoDB) – architecture, features, and use cases. Introduction to time-series, spatial, and graph databases for specialized applications. Cloud-based and distributed database management: scalability, availability, consistency, partition tolerance, security issues in cloud storage, multi-model databases, real-world application scenarios.
	Activity1: Prepare a case study presentation on cloud-based databases or graph databases.

Unit V	Emerging Technologies and Applications: Blockchain databases and decentralized ledgers – architecture, consensus mechanisms, and use cases. Introduction to quantum databases and post-relational concepts. Integration with programming languages (Java, Python, PHP). JSON data handling, REST APIs, and the role of document stores in modern applications. Case studies: end-to-end solutions with next generation databases, trends in database research, industry best practices, and recent innovations.
	Activity1: Develop a simple JSON-based application connected with a NoSQL database using Python or Java.

Text Books	
T.1	Dan Sullivan, "NoSQL for Mere Mortals", Addison-Wesley, 2015
T.2	Pramod J. Sadalage & Martin Fowler, "NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence", Pearson Education, 2013
T.3	Carlo Zaniolo et al., "Advanced Database Systems", Morgan Kaufmann, 1997.
Reference Books	
R.1	Eric Redmond & Jim R. Wilson, "Seven Databases in Seven Weeks", Pragmatic Bookshelf.
R.2	Guy Harrison, "Next Generation Databases: NoSQL, NewSQL and Big Data", Apress.
R.3	C.J. Date, "An Introduction to Database Systems", Addison-Wesley.
Useful Links	
1	https://nptel.ac.in/courses/106104021
2	http://nptel.ac.in/courses/106106093

CO	Course Outcomes	CL	Class Sessions
CO1	**Explain** the concepts, architectures, and scalability principles of next generation database systems and distributed data management technologies.	3	9
CO2	**Analyze** NoSQL database models, architectures, and query mechanisms for scalable and distributed data management applications.	4	9
CO3	**Illustrate** in-memory and object-oriented database systems for managing complex, high-performance, and multimedia data applications.	4	9
CO4	**Analyze** advanced modern database technologies and distributed cloud-based systems for specialized and scalable data management applications.	4	9
CO5	**Evaluate** emerging database technologies, decentralized systems, and modern data integration techniques for developing innovative data-driven applications.	5	9

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Semester-V | **BAI13509: Information Security Fundamentals**

Teaching Scheme		Examination Scheme (Th)		Examination Scheme (P)	
Theory (Th)	4 Hrs./week	**CT-I**	15 Marks	-	-
Practical (P)	-	**CT-II**	15 Marks	-	-
Total Credits	**4**	**CA**	10 Marks	-	-
Duration of ESE: 3 Hrs.		**ESE**	40 Marks	-	-
		Total Marks	**100 Marks**	-	-

Pre-Requisites: Basic knowledge of computer networks, operating systems, databases, and fundamental programming concepts.

Course Objectives:

1	To Understand the foundational concepts, principles, and goals of information security, including confidentiality, integrity, and availability (CIA triad).
2	To Apply cryptographic techniques and mechanisms to secure information and communication.
3	To Implement access control, authentication, and risk management methods to protect organizational assets.
4	To Analyze network, software, and system vulnerabilities; develop strategies to defend against security threats and attacks.

Course Content

Unit I	Introduction to Information Security Fundamentals: Evolution and importance of information security, principles of the CIA triad (Confidentiality, Integrity, Availability), types of threats and attacks (active and passive), security services and mechanisms, risk management basics, overview of organizational security policies and standards, introduction to security models and frameworks.
	Activity 1: Identify and classify different types of security threats and attacks from real-world examples.
Unit II	Cryptography and Security Mechanisms: Conventional and modern cryptography, symmetric and asymmetric encryption techniques (DES, AES, RSA), hash functions and message authentication, digital signatures and certificates, public key infrastructure (PKI), steganography, cryptanalysis, secure communication protocols (SSL/TLS, IPSec), cryptographic applications in data protection.
	Activity1 : Demonstrate simple encryption and decryption using Caesar Cipher or AES tools.
Unit III	Access Control, Authentication, and Software Security: Access control models (DAC, MAC, RBAC), user authentication methods (passwords, biometrics, tokens), multi-factor authentication, authorization techniques, key management, software vulnerabilities, malware types (viruses, worms, trojans), program and application security, vulnerability assessment, secure coding practices.
	Activity1: Prepare a report on common software vulnerabilities and secure password practices.
Unit IV	Network and System Security: Network security fundamentals, network attacks and defenses (DoS, spoofing, sniffing), security devices (firewalls, IDS/IPS), securing wireless networks, virtual private networks (VPNs), intrusion detection and prevention systems, system hardening, operating system security, backup and recovery methods, endpoint security strategies
	Activity1: Draw and explain the working of firewalls, IDS, and VPN architecture.
Unit V	Physical Security, Cyber Laws, and Emerging Issues: Physical protection mechanisms, securing hardware and media, environmental controls, disaster recovery planning, overview of cybercrime and digital forensics, national/international cyber laws, standards, IT Act, ethical and legal issues in information security, introduction to digital investigation techniques, exposure to current challenges and trends in information security field.
	Activity 1 : Prepare a presentation on recent cybercrime cases and applicable cyber laws/IT Act provisions.

Text Books	
T.1	William Stallings, "Cryptography and Network Security: Principles and Practice", Pearson Education.
T.2	Behrouz A. Forouzan, "Cryptography and Network Security", McGraw Hill.
T.3	W. Pritchard, R. G. Smith, "Introduction to Computer Security", McGraw Hill.
Reference Books	
R.1	Charles P. Pfleeger & Shari Lawrence Pfleeger, "Security in Computing", Pearson Education.
R.2	Rajat Khare, "Network Security and Firewall", CBS Publishers.
R.3	Eric Cole, "Network Security Bible", Wiley.
Useful Links	
1	https://nptel.ac.in/courses/106106129
2	https://nptel.ac.in/courses/106106141

CO	Course Outcomes	CL	Class Sessions
CO1	**Explain** the fundamental principles, threats, security mechanisms, and risk management concepts in information security systems.	3	9
CO2	**Apply** cryptographic techniques and security mechanisms to ensure secure communication and data protection in information systems.	3	9
CO3	**Analyze** access control, authentication methods, and software security practices to identify and mitigate system vulnerabilities and cyber threats.	4	9
CO4	**Implement** network and system security mechanisms to protect computing environments against cyber-attacks and unauthorized access.	3	9
CO5	**Evaluate** physical security measures, cyber laws, digital forensics, and emerging challenges in information security and cybercrime investigation.	5	9

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Semester-V | **BAI13510: AI System Design and Integration Lab.**

Teaching Scheme		Examination Scheme (Th)		Examination Scheme(P)	
Theory (Th)	-	**INT**	-	**INT**	-
Practical (P)	4 Hrs./week	**ESE**	-	**ESE**	-
Total Credits	**2**	**CA**	-	**CA**	50 Marks
Duration of ESE: 2Hrs		**ESE**	-	**ESE-P**	50 Marks
		Total Marks	-	**Total Marks**	**100 Marks**

Pre-Requisites: Basics of computer fundamentals, operating systems

Course Objectives:

1.	To apply the basic AI workflow including data preprocessing, model training, and evaluation.
2.	To analyze and fine-tune pre-trained transformer models using evaluation metrics.
3.	To design and implement RESTful APIs with database integration using FastAPI.
4.	To evaluate authentication and access control mechanisms in AI systems.
5.	To design and evaluate an end-to-end AI microproject integrating model, API, database, and cloud services.

List of Experiments

1	Understand the basic AI workflow — data preprocessing, model training, evaluation, and saving.	**CO1**
2	Exploring Model Optimization — Fine-tuning a Pre-trained Transformer	**CO1**
3	Evaluating Models using BLEU, ROUGE, and BERTScore	**CO1**
4	Creating a REST API for ML Model Prediction	**CO2**
5	Integrating Fast API with a Simple Frontend (HTML Form)	**CO2**
6	Connecting Fast API with MongoDB Atlas (Free Tier)	**CO2**
7	Demonstrate relational data management in local setup.	**CO3**
8	Implementing JWT Authentication in FastAPI	**CO3**
9	Differentiate access levels (admin/user) in API system.	**CO3**
10	Loading and Running an Open-source Model using Hugging Face	**CO4**
11	Running a Local LLM using Ollama (Optional if supported)	**CO4**
12	Accessing AWS S3 via Python (Free Tier)	**CO4**
13	Training a Simple Model using AWS SageMaker (Trial)	**CO5**
14	Building a Complete AI Based Module (Data → Model → API → DB → Auth)	**CO5**
15	Creating and Testing API Endpoints using Postman • Sending GET, POST, PUT, and DELETE requests • Testing FastAPI routes • Understanding client-server communication	**CO5**

Text Books

T.1	Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow (3rd Edition) – *Aurélien Géron* – 2023
T.2	Building Machine Learning Powered Applications: Going from Idea to Product – *Emmanuel Ameisen* – 2020

Reference Books

R.1	Designing Machine Learning Systems – *Chip Huyen* – 2022
R.2	Deep Learning with Python (2nd Edition) – *François Chollet* – 2021
R.3	FastAPI: Modern Python Web Framework for Building APIs – *Sebastián Ramírez* – *(Online Documentation, Latest Edition)*

Useful Links

L.1	https://fastapi.tiangolo.com/

L.2	https://huggingface.co/docs/transformers

CO	Course Outcomes	CL	Class Sessions
CO1	**Apply** the AI development workflow for building and evaluating basic machine learning models.	3	8
CO2	**Analyze** transformer-based models using performance metrics.	4	8
CO3	**Design** RESTful APIs integrated with databases using Fast API.	3	8
CO4	**Evaluate** authentication and role-based access mechanisms in deployed AI systems.	5	8
CO5	**Develop** a complete AI integrating model, API, database, and cloud services..	5	8

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Semester-V | **BAI13511: Advance Machine Learning**

Teaching Scheme		Examination Scheme (Th)		Examination Scheme (P)	
Theory (Th)	2 Hrs./week	**CT-I**	7 Marks	-	-
Practical (P)	-	**CT-II**	7 Marks	-	-
Total Credits	**2**	**CA**	6 Marks	-	-
Duration of ESE: 3 Hrs.		**ESE**	30 Marks	-	-
		Total Marks	**50 Marks**	-	-

Pre-Requisites: Basic knowledge of ML, statistics, Python programming.

Course Objectives:

1	To Apply mathematical and programming foundations to build, analyze, and optimize machine learning models.
2	To Implement supervised, unsupervised, and introductory deep learning algorithms using standard ML libraries.
3	To Analyze and evaluate model performance, ethical issues, and interpretability in real-world machine learning scenarios.

Course Content

Unit I	Supervised Learning Methods: Core algorithms – linear regression, logistic regression, k-nearest neighbors, support vector machines, decision trees, ensemble methods (random forests, boosting). Model evaluation metrics (accuracy, precision, recall, F1-score, ROC curve), cross-validation, bias-variance trade-off, feature selection, and extraction techniques.
	Activity1: Implement supervised learning algorithms such as Linear Regression and Decision Trees. Evaluate models using accuracy, precision, recall, and cross-validation.
Unit II	Unsupervised and Specialized Learning: Clustering (k-means, hierarchical, DBSCAN), dimensionality reduction (PCA, t-SNE), association rule mining, anomaly detection, recommendation systems (collaborative filtering, content-based). Introduction to neural networks and deep learning – perceptron, activation functions, network architectures.
	Activity1: Naïve Bayes Weather Predictor: Apply clustering and dimensionality reduction techniques on datasets. Explore recommendation systems and basic neural network implementation.
Unit III	Model Deployment, Ethics, and Emerging Trends: Model selection, hyperparameter tuning, overfitting and regularization. Fundamentals of deploying ML models – APIs, cloud deployment, model monitoring. Societal and ethical issues – interpretability, fairness, privacy, and AI biases. Overview of recent advances and future directions in machine learning, introduction to current research and applications.
	Activity 1: K-Means Simulation: Deploy ML models using APIs and perform hyperparameter tuning. Discuss ethical issues, AI bias, and emerging trends in Machine Learning.

Text Books

T.1	Tom M. Mitchell, "Machine Learning", McGraw Hill.
T.2	Ethem Alpaydin, "Introduction to Machine Learning", MIT Press.
T.3	Aurélien Géron, "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow", O'Reilly.

Reference Books

R.1	Christopher Bishop, "Pattern Recognition and Machine Learning", Springer.
R.2	Kevin P. Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press.
R.3	Peter Flach, "Machine Learning: The Art and Science of Algorithms that Make Sense of Data", Cambridge.

Useful Links	
1	https://nptel.ac.in/courses/106105152
2	https://nptel.ac.in/courses/106106198

CO	Course Outcomes	CL	Class Sessions
CO1	**Implement** supervised learning algorithms and evaluate model performance using appropriate metrics and feature engineering techniques.	3	9
CO2	**Analyze** unsupervised learning and neural network techniques to solve clustering, dimensionality reduction, recommendation, and pattern recognition problems.	4	9
CO3	**Evaluate** machine learning models for deployment, optimization, ethical considerations, and emerging applications in real-world scenarios.	5	9

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Semester-V | **BEC33518: Embedded System**

Teaching Scheme		Examination Scheme (Th)		Examination Scheme (P)	
Theory (Th)	4 Hrs./week	**CT-I**	15 Marks	-	-
Practical (P)	-	**CT-II**	15 Marks	-	-
Total Credits	**4**	**CA**	10 Marks	-	-
Duration of ESE: 3 Hrs.		**ESE**	60 Marks	-	-
		Total Marks	**100 Marks**	-	-

Pre-Requisites: Basic knowledge of computer organization.

Course Objectives:

1	To understand the architecture, programming, and interfacing concepts of 8051 microcontrollers.
2	To develop knowledge of peripheral interfacing techniques and embedded hardware components.
3	To understand embedded system fundamentals, design challenges, and processor architectures.
4	To study ARM architecture, RTOS concepts, and embedded system programming techniques.
5	To understand kernel architecture, task management, and real-time embedded system applications.

Course Content

Unit I	Comparison of microprocessor & micro-controller, Introduction to 8051 micro controllers, Pin diagram, architecture, features & operation, Ports, memory organization, SFR's, Flags, Counters/Timers, Serial ports. Interfacing of external RAM & ROM with 8051. 8051 ,Interrupt structure, Instruction set of 8051; data transfer, logical, arithmetic & branching instructions, Addressing modes
	Activity 1 Write and execute a simple 8051 assembly program for arithmetic operations.
Unit II	Interfacing of Switches, keyboard, LED & LCD display, ADC & DAC Interface, Stepper motor Interface, DMA.
	Activity1: Interface LEDs with 8051 microcontroller and perform blinking operation.
Unit III	History, Definition, and Classification of Embedded System, Design Metric & Its optimization, Embedded System Design Challenges, Processor selection Criteria, Building blocks of typical Embedded System – Core Types, Memory Architecture, Memory & Its Types, RISC and CISC.
	Activity1: Prepare a comparison chart between RISC and CISC architectures.
Unit IV	Introduction to ARM, features, architecture, instruction set features, Concepts of RTOS ARM processor and Architecture, Register set, instruction set, programming, interrupts, stack, timers on-chip and off chip peripherals, interfacing and programming.
	Activity1: Study ARM processor registers and draw ARM architecture diagram.
Unit V	Architecture of the kernel, Task scheduler, Semaphores, Mailbox , Message queues , Pipes, Events, Timers , Memory Management, Case study- Based on Communication Embedded System, Based on Automation Embedded Systems.
	Activity1: Demonstrate task scheduling concepts using a simple RTOS example.

Text Books	
T.1	Shibu K V, “Introduction to Embedded Systems”, Tata McGraw Hill Education, Private Limited, 2 nd Edition.
T.2	Andrew N Sloss, Dominic Symes and Chris Wright, ARM system developers guide, Elsevier, Morgan Kaufman publishers, 2008.
Reference Books	
R.1	Steve Furber, ARM System-on-Chip Architecture, Second Edition, Pearson, 2015.
R.2	Raghunandan..G.H, Microcontroller (ARM) and Embedded System, Cengage learning Publication,2019
R.3	Raj Kamal, Embedded System, Tata McGraw-Hill Publishers, 2nd Edition, 2008.
Useful Links	
1	https://onlinecourses.nptel.ac.in/e-learning/preview/noc23_cs06
2	https://onlinecourses-archive.nptel.ac.in/noc18_ec03

CO	Course Outcomes	CL	Class Sessions
CO1	**Apply** 8051 microcontroller programming and interfacing techniques for embedded system applications.	3	9
CO2	**Analyze** peripheral interfacing methods and data transfer techniques in microcontroller-based systems.	4	9
CO3	**Apply** embedded system design concepts, processor architectures, and memory organization in real-time applications.	3	9
CO4	**Analyze** ARM architecture, RTOS concepts, and interrupt handling mechanisms for embedded solutions.	4	9
CO5	**Apply** kernel services, task scheduling, and communication mechanisms in automation and communication embedded systems.	3	9

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