



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-VI		BAI13601 : Deep Learning & NLP			
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: Sampling Method & Estimation Theory, AI, Machine Learning.					
Course Objectives:					
1	To optimize neural networks using deep learning techniques.				
2	To analyze CNNs, RNNs, and transfer learning for image and sequence processing.				
3	To apply NLP techniques for text processing and representation.				
4	To analyze Transformers and attention mechanisms for NLP applications.				
5	To evaluate LLMs and generative models for responsible AI applications.				
Course Content					
Unit I	Foundations of Deep Learning Review of neural networks: perceptron, multilayer perceptron (MLP), and activation functions (sigmoid, tanh, ReLU, softmax). Loss functions (MSE, cross-entropy), forward propagation, backpropagation, and gradient descent variants (SGD, mini-batch, momentum, RMSProp, Adam). Weight initialization, vanishing and exploding gradients. Regularization and generalization: L1/L2 penalties, dropout, batch normalization, early stopping, and hyperparameter tuning.				
	Activity 1: Students manually perform one forward pass and one backpropagation weight update on a tiny 2-2-1 network, using given inputs, weights, and learning rate.				
Unit II	Convolutional and Recurrent Architectures Convolutional Neural Networks (CNNs): convolution, stride, padding, pooling, feature maps, and landmark architectures (LeNet, AlexNet, VGG, ResNet). Transfer learning and fine-tuning. Image Processing Fundamentals: image representation, preprocessing, resizing, normalization, filtering, and edge detection. Vision Models: image classification, object detection, image segmentation, and an overview of Vision Transformers (ViT). Sequence modelling with Recurrent Neural Networks (RNNs): backpropagation through time, the vanishing gradient problem, LSTM, GRU, bidirectional RNNs, and applications to sequential data.				
	Activity 1: Students apply a 3×3 filter to a 5×5 pixel grid on paper, then apply ReLU and 2×2 max pooling to obtain the final feature map.				
Unit III	NLP Fundamentals and Text Representation Introduction to NLP: tasks, challenges, and applications. Text preprocessing: tokenization, stop-word removal, stemming, lemmatization, and regular expressions. N-gram language models, smoothing, and perplexity. Text representation: Bag-of-Words, TF-IDF, and word embeddings (Word2Vec, GloVe, FastText). Basics of POS tagging, Named Entity Recognition (NER), and syntactic parsing.				
	Activity 1: Students are given three short sentences and manually compute term frequencies and TF-IDF scores, then identify which words carry the most weight and why.				

Unit IV	Deep Learning for NLP: Attention and Transformers Sequence-to-sequence models and the encoder-decoder framework. Attention mechanism: additive and dot-product attention. The Transformer architecture: self-attention, multi-head attention, positional encoding, and feed-forward layers. Subword tokenization (BPE, WordPiece). Pretrained language models (BERT, GPT, T5), pretraining versus fine-tuning, and applications such as text classification, sentiment analysis, machine translation, summarization, and question answering.		
	Activity 1: Students compute scaled dot-product attention by hand for a 3-word sentence with small given Query, Key, and Value vectors, and interpret which words attend most strongly to each other.		
Unit V	Large Language Models, Generative Models and Responsible AI Large Language Models (LLMs): scaling, in-context learning, prompt engineering, Retrieval-Augmented Generation (RAG), parameter-efficient fine-tuning (LoRA), and an overview of RLHF. Evaluation metrics: BLEU, ROUGE, METEOR, and BERTScore. Overview of generative models: autoencoders, VAEs, and GANs. Ethics and limitations: bias, hallucination, privacy, safety, and responsible deployment of AI systems. AI Guardrails and Safeguards: prompt injection and jailbreak prevention, input/output filtering, harmful content detection, data privacy protection, secure LLM application design, and responsible AI monitoring.		
	Activity 1: Prompt Refinement Exercise: Students write a vague prompt for a task (e.g., summarizing a news article), then rewrite it in three iterations by adding role, context, format, and constraints. They compare outputs and justify which changes improved the result.		
Text Books			
T.1	ARTIFICIAL INTELLIGENCE, BHATTACHARYA,SHARBANI, UNIVERSITY SCIENCE PRESS1 , EDITION REPRINT 2.		
T.2	ARTIFICIAL INTELLIGENCE,RUSSELL,STUART;NORVIG,PETER,PEARSON EDUCATION2, EDITION 1.		
Reference Books			
R.1	ARTIFICIAL INTELLIGENCE, RICH ELAINE, KNIGHT KEVIN ; NAIR SHIVASHANKAR B.,MC GRAW HILL,EDITION 3		
R.2	NATURAL LANGUAGE PROCESSING AND INFORMATION RETRIEVAL SIDDIQUI TANVEER;TIWARY U.S. OXFORD UNIVERSITY PRESS,VOUME1		
Useful Links			
1	nptel.ac.in/courses/106105215		
2	nptel.ac.in/courses/128108021		
CO	Course Outcomes	CL	Class Sessions
CO1	Apply deep learning techniques to optimize neural networks for improved performance and generalization.	3	9
CO2	Analyze CNNs, RNNs, and transfer learning to solve image and sequential-data problems.	4	9
CO3	Apply NLP preprocessing, text representation, and linguistic analysis techniques to process textual data.	3	9
CO4	Analyze attention mechanisms, Transformer architectures, and pretrained language models for NLP applications.	4	9
CO5	Analyze LLMs, generative models, evaluation metrics, and responsible AI practices for reliable AI applications.	4	9

	
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Department of Artificial Intelligence & Machine Learning

Program: B. Tech Artificial Intelligence and Machine Learning

Semester-VI **BAI13602 : Deep Learning & NLP 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 Python programming, linear algebra, probability and statistics, calculus, and basic machine learning.

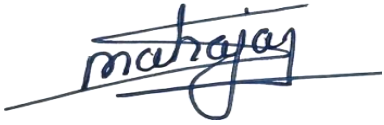
Course Objectives:

1. Apply neural network concepts and activation functions to solve learning problems.
2. Implement deep learning architectures for image classification and sequence prediction.
3. Apply NLP techniques for text preprocessing, language modelling, and text representation.
4. Implement attention mechanisms, transformers, and pretrained language models for NLP tasks.
5. Develop and evaluate deep learning and NLP applications using suitable datasets and tools.

List of Experiments

1	Implement single-neuron and multilayer perceptrons using NumPy and compare activation functions.	CO1
2	Build a feedforward neural network using Keras for MNIST digit classification.	CO1
3	Apply regularization techniques and analyze overfitting using training and validation curves.	CO1
4	Build a CNN using CIFAR-10 and visualize learned feature maps.	CO2
5	Apply transfer learning using VGG16 or ResNet50 and compare model performance.	CO2
6	Apply transfer learning using VGG16 or ResNet50 and compare model performance.	CO2
7	Perform text preprocessing using NLTK and spaCy.	CO3
8	Build unigram and bigram language models with Laplace smoothing.	CO3
9	Apply Bag-of-Words and TF-IDF for text classification and evaluate performance.	CO3
10	Implement Word2Vec embeddings and visualize word relationships using PCA or t-SNE.	CO4
11	Perform POS tagging and named entity recognition using spaCy and NLTK.	CO4
12	Implement scaled dot-product attention and a basic sequence-to-sequence model.	CO4
13	Implement Fine-tune pretrained transformer models using Hugging Face for NLP tasks.	CO5
14	Explore LLMs, prompt engineering, and RAG, and evaluate generated text.	CO5
15	Develop a module using Deep Learning and NLP techniques for sentiment analysis, text	CO5

	classification, or chatbot development in healthcare, agriculture, education, or finance.	
Text Books		
T.1	ARTIFICIAL INTELLIGENCE, BHATTACHARYA,SHARBANI, UNIVERSITY SCIENCE PRESS1 , EDITION REPRINT 2.	

	
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T.2	ARTIFICIAL INTELLIGENCE,RUSSELL,STUART;NORVIG,PETER,PEARSON EDUCATION2, EDITION 1.
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Reference Books

R.1	ARTIFICIAL INTELLIGENCE, RICH ELAINE, KNIGHT KEVIN ; NAIR SHIVASHANKAR B.,MC GRAW HILL,EDITION 3
R.2	NATURAL LANGUAGE PROCESSING AND INFORMATION RETRIEVAL SIDDQUI TANVEER;TIWARY U.S. OXFORD UNIVERSITY PRESS,VOUME1

Useful Links

L.1	nptel. ac. in/courses/108105103
L.2	nptel. ac. in/courses/108103174

CO	Course Outcomes	CL	Class Sessions
C01	Implement perceptrons and neural networks using Python libraries.	3	2
C02	Apply CNNs, transfer learning, and recurrent networks to solve prediction problems.	3	2
C03	Apply text preprocessing, language modelling, and word embedding techniques.	3	2
C04	Implement attention mechanisms, transformers, and LLM-based applications.	3	2
C05	Develop integrated deep learning and NLP applications.	6	2

	
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Department of Artificial Intelligence & Machine Learning

Program: B. Tech Artificial Intelligence and Machine Learning

Semester-VI	BAI13603 : Visual Computing				
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 Linear algebra, probability, Python programming, basic machine learning, and image fundamentals.

Course Objectives:

1	To understand the fundamental concepts of visual computing, image formation, digital image representation, color models, image enhancement, and spatial filtering techniques.
2	To develop an understanding of feature extraction, edge detection, image segmentation, morphological operations, and image analysis techniques.
3	To apply machine learning algorithms and feature descriptors for image classification, object recognition, dimensionality reduction, and performance evaluation.
4	To study and implement deep learning architectures, including Convolutional Neural Networks, transfer learning, object detection, and image segmentation techniques for computer vision applications.
5	To explore advanced visual computing techniques such as stereo vision, depth estimation, optical flow, generative models, vision-language models, and multimodal learning while understanding ethical and responsible AI practices.

Course Content

Unit I	Foundations of Visual Computing and Image Processing Introduction to visual computing: image processing, computer vision and computer graphics, and their role in AI. Human visual system. Image formation: pinhole camera model, lenses, sampling and quantization. Digital image representation: pixels, resolution, bit depth. Color models (grayscale, RGB, HSV, CMYK) and common image file formats. Point operations: negative, thresholding, contrast stretching, histogram and histogram equalization. Spatial filtering: convolution and correlation, smoothing (mean, Gaussian, median) and sharpening filters.
Activity 1: Students are given a small grayscale pixel matrix (e.g., 5×5) and manually compute its histogram, apply a 3×3 averaging filter to an interior pixel, and apply a threshold to produce a binary image.	
Unit II	Feature Extraction and Image Analysis Frequency-domain basics: Fourier transform, low-pass and high-pass filtering. Edge detection (Sobel, Prewitt, Laplacian, Canny). Morphological operations (erosion, dilation, opening, closing). Image segmentation: thresholding (Otsu), region growing, watershed, clustering-based segmentation. Corner and interest-point detection (Harris). Feature descriptors: SIFT, SURF, ORB, HOG. Feature matching and image pyramids.
Activity 1: Students apply the Sobel horizontal and vertical masks to a given 5×5 pixel matrix, compute the gradient magnitude, and mark the edge pixels using a threshold.	

Unit III	Machine Learning for Visual Recognition Image classification pipeline and feature-based classification. Classifiers for vision: K-Nearest Neighbors, Support Vector Machines, Naïve Bayes, decision trees. Bag of Visual Words. Dimensionality reduction (PCA, eigenfaces). Classical object detection: Viola-Jones, HOG + SVM. Overfitting, regularization and data augmentation. Evaluation metrics: confusion matrix, accuracy, precision, recall, F1-score, ROC, IoU, mAP.		
Activity 1: Students are given ground-truth and predicted bounding boxes and a confusion matrix, and manually calculate IoU, precision, recall and F1-score to judge detection quality.			
Unit IV	Deep Learning for Computer Vision Neural network basics: perceptron, MLP, backpropagation, activation functions. Convolutional Neural Networks: convolution, stride, padding, pooling, batch normalization, dropout. Architectures: LeNet, AlexNet, VGG, ResNet. Transfer learning and fine-tuning. Pre-trained models for computer vision: MobileNet, EfficientNet, Inception, and their applications in image classification. Object detection with deep networks (R-CNN family, SSD, YOLO). Semantic and instance segmentation (FCN, U-Net, Mask R-CNN). Overview of Vision Transformers.		
Activity 1: Students manually perform a convolution with a 3×3 kernel on a 6×6 input, apply ReLU and 2×2 max pooling, and calculate the output size and number of parameters of the layer.			
Unit V	Case Studies and Applications Camera geometry and calibration, stereo vision and depth estimation, structure from motion. Optical flow, video analysis and object tracking (mean shift, Kalman filter). Generative models for vision: autoencoders, GANs, diffusion models. Vision-language models (e.g., CLIP) and multimodal learning. Overview of visual SLAM, AR/VR. Case studies and practical applications of Visual Computing: medical image analysis for disease detection, agricultural image analysis for crop disease identification, object detection for autonomous vehicles, and face recognition for access control. Ethics: bias, privacy, deepfakes and responsible AI.		
Activity 1: Stereo Depth Estimation: Students are given the focal length, baseline and pixel disparities of a few matched points from a stereo pair, and manually compute the depth of each point using $Z = (f \times B) / d$, then rank the points from nearest to farthest.			
Text Books			
T.1	COMPUTER VISION A MODERN APPROACH FORSYTH,DAVID,A;PONCE,JEAN PRENTICE HALL OF INDIA		
T.2	ARTIFICIAL INTELLIGENCE,DESHPANDE NEETA,TECHNICAL PUBLICATIONS		
Reference Books			
R.1	COMPUTER VISION A MODERN APPROACH FORSYTH,DAVID;PONCE,JEAN PEARSON EDUCATION		
R.2	ARTIFICIAL INTELLIGENCE RICH ELAINE & OTHERS TATA MCGRAW HILL Edition 3 REPRINT		
Useful Links			
1	nptel.ac.in/courses/108105103		
2	nptel.ac.in/courses/108103174		
CO	Course Outcomes	CL	Class Sessions
CO1	Explain the fundamentals of visual computing, image formation, digital image representation, color models, image enhancement, and spatial filtering techniques.	3	9

CO2	Apply frequency-domain filtering, edge detection, morphological operations, image segmentation, feature extraction, and feature matching techniques for image analysis	3	9
CO3	Implement machine learning algorithms for image classification and object recognition, and evaluate their performance using appropriate classification and detection metrics.	3	9
CO4	Analyze deep learning architectures to solve computer vision problems.	4	9
CO5	Analyze advanced visual computing techniques considering ethical issues such as bias, privacy, and deepfakes.	4	9

	
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Department of Artificial Intelligence & Machine Learning

Pogram: B. Tech Artificial Intelligence and Machine Learning

Semester-VI BAI13604 Visual Computing 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 Linear algebra, probability, Python programming, basic machine learning, and image fundamentals.

Course Objectives:

1. Apply image processing techniques for image enhancement and transformation.
2. Implement edge detection, segmentation, and feature extraction techniques.
3. Apply machine learning and deep learning techniques for image classification and recognition.
4. Implement object detection, segmentation, depth estimation, and tracking techniques.
5. Develop and evaluate visual computing applications using appropriate tools and datasets.

List of Experiments

1	Install OpenCV and NumPy; perform image loading, display, saving, and color space conversion.	CO1
2	Perform image enhancement using point operations, histogram equalization, and contrast stretching.	CO1
3	Apply smoothing and sharpening filters to reduce noise and enhance images.	CO1
4	Perform image frequency analysis using Fourier transforms and low-pass/high-pass filters.	CO2
5	Detect image edges using Sobel, Prewitt, Laplacian, and Canny operators.	CO2
6	Apply morphological operations and image segmentation techniques.	CO2
7	Detect and match image features using Harris, ORB, and SIFT.	CO3
8	Implement image classification using HOG features, KNN, and SVM.	CO3
9	Apply PCA and eigenfaces for face recognition.	CO3
10	Implement face and pedestrian detection using Haar cascades and HOG-SVM.	CO4
11	Build a CNN for image classification using Fashion-MNIST.	CO4
12	Compare the classification accuracy of pre-trained VGG16, ResNet50, and MobileNetV2 models using a common image dataset.	CO4
13	Perform object detection and instance segmentation using YOLO and Mask R-CNN.	CO5
14	Implement depth estimation, optical flow, and object tracking using OpenCV.	CO5
15	Develop and evaluate a domain-specific visual computing mini-project using image processing and computer vision techniques.	CO5

Text Books

T.1	COMPUTER VISION A MODERN APPROACH FORSYTH,DAVID,A;PONCE,JEAN PRENTICE HALL OF INDIA		
T.2	ARTIFICIAL INTELLIGENCE,DESHPANDE NEETA,TECHNICAL PUBLICATIONS		
Reference Books			
R.1	COMPUTER VISION A MODERN APPROACH FORSYTH,DAVID;PONCE,JEAN PEARSON EDUCATION		
R.2	ARTIFICIAL INTELLIGENCE RICH ELAINE & OTHERS TATA MCGRAW HILL Edition 3 REPRINT		
Useful Links			
L.1	nptel. ac. in/courses/108105103		
L.2	nptel. ac. in/courses/108103174		
CO	Course Outcomes	CL	Class Sessions
CO1	Apply image processing techniques using OpenCV and NumPy.	3	2
CO2	Implement image segmentation, edge detection, and feature extraction algorithms.	3	2
CO3	Develop image classification and face recognition models using machine learning and CNNs.	3	2
CO4	Implement object detection, instance segmentation, and object tracking techniques.	3	2
CO5	Develop and evaluate visual computing applications using suitable performance metrics.	6	2

	
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Department of Artificial Intelligence & Machine Learning

Program: B. Tech Artificial Intelligence and Machine Learning

Semester-VI	BAI13605: Intelligent Decision 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: Basics knowledge in a Programming in Python Discrete mathematics and logic

Course Objectives:

1	To Understand the foundations of decision-making and how intelligent systems support it
2	To Apply AI, soft computing, and data-driven techniques to build decision support tools
3	To Evaluate and deploy intelligent decision systems in real-world domains

Course Content

Unit I	Foundations of Decision Making and Decision Support Systems Decision-making process: types of decisions (structured, semi-structured, unstructured), phases (Simon's model: intelligence, design, choice, implementation), Decision-making under certainty, risk, and uncertainty, Introduction to Decision Support Systems (DSS): components, architecture, classification, Group Decision Support Systems (GDSS) and Executive Information Systems, From DSS to Intelligent Decision Support Systems (IDSS): need and evolution, Role of AI in decision-making; human vs. machine decision-making.
	Activity 1 : Case study analysis of a real DSS (e.g., hospital bed allocation, crop advisory); classroom debate on human vs. AI decision-making
Unit II	Knowledge Representation and Expert Systems Knowledge-based systems: data, information, knowledge, Knowledge representation: logic, semantic networks, frames, production rules, Expert system architecture: knowledge base, inference engine, user interface, explanation facility, Inference mechanisms: forward chaining, backward chaining, Knowledge acquisition and engineering, Case-based reasoning and rule-based reasoning, Expert system tools and case studies (e.g., MYCIN, medical diagnosis, fault diagnosis)
	Activity 2: Build a small rule-based expert system (e.g., crop disease or fault diagnosis) using CLIPS, Prolog, or Python
Unit III	Reasoning Under Uncertainty and Soft Computing Probability theory and Bayesian decision theory, Bayesian networks and probabilistic reasoning, Fuzzy logic: fuzzy sets, membership functions, fuzzy inference systems, defuzzification, Dempster -Shafer theory of evidence, Artificial neural networks for decision support, Genetic algorithms and evolutionary optimization, Hybrid systems: neuro-fuzzy and genetic-fuzzy systems
	Activity 3 : Design a fuzzy controller (e.g., washing machine, AC); build a simple Bayesian network for medical diagnosis
Unit IV	Data-Driven Decision Systems: Machine Learning and Analytics Data warehousing, OLAP, and data mining for decision support, Machine learning for decision-making: classification, regression, clustering, Decision trees, random forests, support vector machines, Reinforcement learning and Markov Decision Processes (MDPs), Predictive and prescriptive analytics, Multi-Criteria Decision Making (MCDM): AHP, TOPSIS, ELECTRE, PROMETHEE, Optimization techniques: linear programming, game theory basics

	Activity 4 : Solve a supplier selection problem with AHP and TOPSIS; train and compare ML classifiers on a Kaggle or UCI dataset		
Unit V	Applications, Explainability, and Ethical Issues Applications: healthcare, finance, agriculture, supply chain, smart cities, cybersecurity, e-governance, Real-time and agent-based decision systems; multi-agent systems, Explainable AI (XAI) in decision systems: LIME, SHAP, interpretability, Evaluation of decision systems: accuracy, robustness, usability, trust, Ethical, legal, and societal issues: bias, fairness, accountability, transparency, Emerging trends: generative AI and LLM-based decision support, digital twins, edge AI		
	Activity 5 : Apply SHAP or LIME to explain a model's predictions; group discussion on a bias and fairness case (e.g., loan approval)		
Text Books			
T.1	ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS,JANAKIRAMAN,V.S;OTHERS,MCMILLAN INDIA LTD		
T.2	FOUNDATION OF ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS, JANAKIRAMAN V. S. ; SARUKESI K. ; GOPALAKRISHNAN P.,MCMILLAN INDIA LTD		
Reference Books			
R.1	INTRO. TO ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS PATTERSON DAN W.,PRENTICE HALL OF INDIA		
R.2	FOUNDATIONS OF ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS, JANKIRAMAN,V.S.; SARUKESI,K;GOPALKRISHNAN P. MCMILLAN INDIA LTD, REPRINT		
Useful Links			
1	https://nptel.ac.in > courses You visit often		
2	https://swayam.gov.in		
CO	Course Outcomes	C L	Class Sessions
CO1	Explain decision-making models and the architecture of intelligent decision systems	3	10
CO2	Build knowledge-based and expert systems .	4	10
CO3	Apply probabilistic and fuzzy reasoning to uncertain problems	3	10
CO4	Apply machine learning and MCDM techniques for data-driven decisions	3	10
CO5	Analyze intelligent decision systems for explainability, ethics, and real-world deployment	4	10

	
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Department of Artificial Intelligence & Machine Learning

Program: B. Tech Artificial Intelligence and Machine Learning

Semester-VI	BAI13606 : Human-Computer Interaction(HCI)				
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	4	CA	10 Marks	-	-
Duration of ESE: 3 Hrs.		ESE	60 Marks	-	-
		Total Marks	100 Marks	-	-

Pre-Requisites: Basic computer literacy and familiarity with using websites, mobile applications, and desktop interfaces.

Course Objectives:

1	To introduce the fundamentals, scope, and importance of Human-Computer Interaction and usability.
2	To explain human cognitive, perceptual, and physical factors that influence interaction design.
3	To explain human cognitive, perceptual, and physical factors that influence interaction design.
4	To introduce usability evaluation methods, user testing, accessibility, and inclusive design.
5	To explore contemporary HCI topics, including mobile, web, ubiquitous, and emerging interactive systems.

Course Content

Unit I	Introduction to HCI: definition, goals, scope, and importance of HCI; evolution of interfaces; HCI and related disciplines; usability and user experience (UX); usability goals and user experience goals; understanding users, tasks, and context of use; basic principles of user-centred design.
	Activity 1: Students examine two everyday interfaces (such as a ticket-booking website and a mobile app), identify usability strengths and problems, and suggest improvements.
Unit II	Human Factors in HCI: human information processing; perception, attention, memory, learning, and mental models; human error; motor skills and physical capabilities; individual differences; interaction with visual, auditory, and haptic feedback; implications of human factors for interface design.
	Activity 1: Students review a sample interface and identify design choices that support or hinder perception, memory, and error prevention.
Unit III	Interaction Design and Interface Design: interaction styles (command line, menu selection, form fill-in, direct manipulation, and natural language); interface design principles; consistency, feedback, constraints, mapping, affordances, and visibility; navigation and information architecture; design process; personas, scenarios, task analysis, storyboards, wireframes, and prototypes.
	Activity 1: In groups, students create a persona and low-fidelity wireframe for a simple campus-related application, then explain the design decisions.
Unit IV	Usability Evaluation: usability inspection and evaluation; heuristic evaluation; cognitive walkthrough; usability testing; test planning and task design; think-aloud protocol; observation and interviews; questionnaires and surveys; collecting and interpreting qualitative and quantitative data; usability metrics such as task completion, time, errors, and satisfaction; iterative design.

	Activity 1: Students conduct a brief usability test of a prototype with peers, record task completion and observed difficulties, and recommend changes		
Unit V	Accessibility and Contemporary HCI: accessibility principles and inclusive design; universal design; assistive technologies; web and mobile usability; responsive interfaces; collaborative and social computing; ubiquitous and context-aware interaction; virtual and augmented reality; conversational interfaces; ethical considerations, privacy, safety, and responsible design; future trends in HCI		
	Activity 1: Students perform an accessibility review of a website or mobile interface, checking readability, contrast, navigation, labels, and keyboard access.		
Text Books			
T.1	HUMAN-COMPUTER INTERACTION DIX ALAN; JANET FINLAY; ABOWD GREGORY D;BEALE RESSELL PEARSON EDUCATION, Edition3		
T.2	ARTIFICIAL INTELLIGENCE, BHATTACHARYA,SHARBANI, UNIVERSITY SCIENCE PRESS1 , EDITION REPRINT 2.		
Reference Books			
R.1	NATURAL LANGUAGE PROCESSING AND INFORMATION RETRIEVAL,SIDDIQUI TANVEER;TIWARY U.S.,OXFORD UNIVERSITY PRESS,VOUME1		
R.2	ARTIFICIAL INTELLIGENCE,DESHPANDE NEETA,TECHNICAL PUBLICATIONS		
Useful Links			
1	https://onlinecourses-archive.nptel.ac.in/noc18_cs23/preview?utm_source		
2	https://onlinecourses.nptel.ac.in/e-learning/course/noc26_cs26?utm_source		
CO	Course Outcomes	CL	Class Sessions
CO1	Explain the fundamental concepts, goals, and principles of Human-Computer Interaction.	3	10
CO2	Analyze human cognitive and physical factors affecting interaction and usability.	4	10
CO3	Apply user-centred design methods to develop interface sketches, wireframes, and prototypes.	3	10
CO4	Analyze interfaces using appropriate usability inspection and user-testing methods.	4	10
CO5	Analyze accessibility, inclusive design, and contemporary HCI issues in interactive systems.	4	10

	
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Department of Artificial Intelligence & Machine Learning

Program: B. Tech Artificial Intelligence and Machine Learning

Semester-VI	BAI13607 : No SQL using Mongo DB				
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 databases, programming fundamentals, and data structures is recommended.

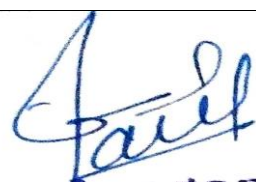
Course Objectives:

1	To introduce NoSQL database concepts, the need for non-relational databases, and the MongoDB architecture.
2	To explain document-oriented data modelling, BSON, collections, documents, and CRUD operations.
3	To develop skills in querying, filtering, sorting, projection, and using MongoDB operators.
4	To introduce aggregation pipelines, indexing, and performance optimization for MongoDB applications.
5	To explain data relationships, schema validation, transactions, replication, sharding, security, and application connectivity.

Course Content

Unit I	Introduction to NoSQL and MongoDB Database fundamentals and limitations of relational databases for selected modern workloads; introduction to NoSQL; characteristics and types of NoSQL databases (key-value, document, column-family, graph); use cases and comparison of SQL and NoSQL; introduction to MongoDB, features, architecture, installation options, MongoDB Shell and Compass; databases, collections, documents, BSON, and basic database commands.
	Activity 1: In groups, students classify sample applications (e-commerce catalogue, social network, banking records, and sensor data) by data requirements and justify whether a relational or NoSQL approach may be suitable.
Unit II	MongoDB Documents, Data Modelling, and CRUD Operations Document structure and BSON data types; embedded documents and arrays; designing documents for application requirements; choosing embedding or referencing; creating and selecting databases and collections; insertOne and insertMany; find and findOne; updateOne, updateMany, replaceOne; deleteOne and deleteMany; upsert; handling missing fields and null values.
	Activity 1: Create a small student or library database and perform insert, read, update, and delete operations using MongoDB Shell or Compass.
Unit III	Queries, Operators, and Data Manipulation Query filters; comparison operators (\$eq, \$ne, \$gt, \$gte, \$lt, \$lte, \$i and, \$or, \$not, \$nor); element and array query operators; projection; sorting, limiting, and skipping results; updating arrays and selected fields; regular-expression queries; writing clear and efficient queries.

	Activity 1: Given a sample product or student collection, write queries to filter records, select required fields, sort results, and retrieve records that meet multiple conditions .		
Unit IV	Aggregation, Indexing, and Performance Aggregation framework and pipeline stages; \$match, \$project, \$group, \$sort, \$limit, \$unwind, and \$lookup; common aggregation expressions; indexes and index types; creating and removing indexes; compound indexes; explain plans and introductory query-performance analysis; schema design considerations and common performance issues..		
	Activity 1: Use an aggregation pipeline to summarize sales, marks, or library transactions by category, and compare query behavior with and without an appropriate index		
Unit V	Advanced MongoDB and Application Development Relationships and schema validation; atomicity and transactions (overview and supported use cases); replication and replica sets; sharding and horizontal scaling; backup and restore concepts; authentication, authorization, role-based access, and basic database security; connecting MongoDB to an application using a suitable driver (such as Python PyMongo or Node.js); error handling and responsible handling of database credentials; overview of deployment and monitoring		
	Activity 1: Build a small database-backed application or command-line prototype that connects to MongoDB, performs CRUD operations, and demonstrates basic validation and access-control considerations.		
Text Books			
T.1	ADVANCED COURSE IN DATABASE SYSTEMS,DIETRICH SUZANNE W. ; URBAN SUSAN D. PRENTICE HALL OF INDIA,EDITION 2		
T.2	BIG DATA , BLACK BOOK,DT EDITORIAL SER.,DREAMTECH		
Reference Books			
R.1	AN ADVANCED COURSE IN DATABASE SYSTEMS,DIETRICH,SUZANNE,W;URBAN,SUSAN,D,PRENTICE HALL OF INDIA		
R.2	DATABASE SYSTEMS,ROB,PETER;CORONEL,CARLOS,CENGAGE LEARNING		
Useful Links			
1	https://elearn.nptel.ac.in/category/ongoing-workshops?utm_source		
2	https://nptel.ac.in/courses/106105175?utm_source		
CO	Course Outcomes	C L	Class Sessions
CO1	Explain NoSQL database concepts, MongoDB architecture, and document-oriented storage.	2	10
CO2	Design simple MongoDB documents and collections and perform CRUD operations.	3	10
CO3	Construct queries using filters, operators, projection, sorting, and update operations.	3	10
CO4	Apply aggregation pipelines and indexing concepts to summarize data and examine query performance.	4	10
CO5	Describe introductory MongoDB application connectivity, validation, security, replication, and scaling concepts.	4	10

	
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Department of Artificial Intelligence & Machine Learning

Program: B. Tech Artificial Intelligence and Machine Learning

Semester-VI **BAI13608 : Cryptography and Network Security**

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: Programming basics (Python, C, or Java), Computer networks (TCP/IP model) .

Course Objectives:

- 1 Understand the principles of security, common threats, and attack models
- 2 Learn symmetric and asymmetric cryptographic algorithms, hashing, and digital signatures
- 3 Apply authentication, key management, and network security protocols to secure systems

Course Content

Unit I	Classical & Symmetric Cryptography Overview of security goals (Confidentiality, Integrity, Availability), Classical encryption techniques (Substitution and Transposition ciphers), Symmetric block ciphers and stream ciphers, Data Encryption Standard (DES) and Advanced Encryption Standard (AES), Block cipher modes of operation (ECB, CBC, CFB, OFB, CTR)
	Activity 1: Implement Caesar, Playfair, Hill, and Vigenère ciphers; break a classical cipher using frequency analysis; hide a message in an image (steganography)
Unit II	Public-Key Cryptography & Number Theory Introduction to number theory (Prime numbers, Fermat's and Euler's theorems, modular arithmetic), Asymmetric cryptography concepts, RSA cryptosystem (algorithm, key generation, security of RSA), Diffie-Hellman key exchange algorithm, Elliptic Curve Cryptography (ECC) basics
	Activity 2 : Code and run the Extended Euclidean Algorithm to find modular inverses, and apply the Fermat's Little Theorem checking mechanism to generate large prime numbers for asymmetric keys
Unit III	Message Authentication & Hash Functions Authentication requirements and functions, Message authentication codes (MAC), Hash functions (MD5 message digest algorithm, SHA family), Digital signatures and digital signature standards (DSS), Key management and distribution infrastructure (PKI)
	Activity 3 : Use public data libraries to execute an adversarial data-poisoning attack on a basic classification model. Then, apply a standard secure hash function (SHA-256) to create a secure data-verification ledger, proving that the dataset integrity has not been compromised
Unit IV	Network & Email/Internet Security Electronic mail security: Pretty Good Privacy (PGP) and S/MIME, IP Security (IPSec): Architecture, Authentication Header (AH), Encapsulating Security Payload (ESP), and security associations, Transport-level security: Secure Sockets Layer (SSL) / Transport Layer Security (TLS), Web security considerations

	Activity4 : Configure a local web server using an open-source framework and implement a secure TLS/SSL handshake to handle encrypted inference payloads.
Unit V	Applied & Operational Security Critical infrastructure security, Industrial Control Systems (ICS) and Supervisory Control and Data Acquisition (SCADA), IT vs. OT (Operational Technology) security, Wireless network security: IEEE 802.11i, WEP, and WPA/WPA2, Basics of mobile/automotive security, Introduction to ethical hacking, blockchain, and machine learning applications in cybersecurity
	Activity 1: Program the Diffie-Hellman Key Exchange algorithm to securely establish a shared secret key over an insecure simulated channel.

Text Books			
T.1	CRYPTOGRAPHY AND NETWORK SECURITY,KAHATE ATUL,MC GRAW HILL EDITION 2		
T.2	CRYPTOGRAPHY AND NETWORK SECURITY,STALLINGS,WILLIAM,TATA MCGRAW HILL,EDITION5		
Reference Books			
R.1	CRYPTOGRAPHY AND NETWORK SECURITY : PRINCIPLES AND PRACTICESTALLINGS,WILLIAM,PEARSON EDUCATION		
R.2	INFORMATION THEORY CODING AND CRYPTOGRAPHY BOSE, RAJAN,TATA MCGRAW HILL		
Useful Links			
1	Swayam NPTEL Enrollment Page.		
2	NPTEL IIT Kharagpur Course Page		
CO	Course Outcomes	CL	Class Sessions
CO1	Analyze Cryptographic Fundamentals & Vulnerabilities	4	10
CO2	Apply Asymmetric & Key Management Primitives	3	10
CO3	Design Secure Data and Model Infrastructures	3	10
CO4	Analyze End-to-End Network Security Frameworks	4	10
CO5	Formulate Intelligent Threat Defense Strategies	3	10

	
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Department of Artificial Intelligence & Machine Learning

Program: B. Tech Artificial Intelligence and Machine Learning

Semester-VI **BAI13609: Generative AI and Intelligent Business Systems**

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: Artificial Intelligence, Python programming, database management systems, web technologies, and fundamental business processes.

Course Objectives:

1	Introduce enterprise systems, ERP architecture, and business process automation.
2	Explain Generative AI, Large Language Models (LLMs), and their applications in enterprise environments.
3	Develop an understanding of AI-powered chatbots, conversational interfaces, and retrieval-augmented generation (RAG).
4	Explain the integration of AI solutions with ERP modules, databases, APIs, and business workflows.
5	Develop awareness of responsible AI, enterprise security, governance, and deployment of AI solutions.

Course Content

Unit I	Introduction to Enterprise Systems and ERP: Enterprise systems: meaning, objectives, characteristics, and importance. Introduction to Enterprise Resource Planning (ERP), ERP architecture, components, modules, and business processes. Functional modules of ERP: Finance and Accounting, Human Resource Management (HRM), Sales and Distribution, Procurement, Inventory Management, Production Planning, and Customer Relationship Management (CRM). ERP implementation life cycle, cloud-based ERP, traditional ERP versus AI-enabled ERP, and the role of AI in enterprise transformation.
	Activity 1: Identify ERP modules required for a manufacturing company, college, or retail business.
Unit II	Generative AI and Large Language Models for Enterprises: Introduction to Artificial Intelligence, Machine Learning, Deep Learning, and Generative AI. Fundamentals of Large Language Models (LLMs), transformer architecture, tokens, embeddings, and context windows. Prompt engineering techniques, zero-shot and few-shot prompting, structured output generation, summarization, information extraction, content generation, and natural-language-to-SQL concepts. Introduction to enterprise AI assistants, foundation models, model selection, and business applications of Generative AI.
	Activity 1: Design prompts to summarize business reports, extract invoice information, and generate a professional business email.
Unit III	AI Chatbots and Conversational Enterprise Applications: -Fundamentals of chatbots and conversational AI. Rule-based chatbots versus AI-powered chatbots. Natural Language Processing (NLP), intent recognition, entity extraction, dialogue management, context handling, and conversation history. Chatbot architecture, chatbot development frameworks, API integration, document-based question answering, Retrieval-Augmented Generation (RAG), embeddings, vector databases, semantic search, and hallucination reduction. Design of HR, customer-support, finance, and ERP help-desk chatbots.

	Activity 1: Develop a chatbot that answers employee FAQs or student queries using a predefined document collection.
Unit IV	<p>Integration of Generative AI with ERP and Business Automation: Enterprise application integration, REST APIs, webhooks, database connectivity, authentication, and data exchange formats such as JSON. Integration of LLMs and chatbots with ERP systems. AI-assisted ERP workflows for purchase orders, invoice processing, inventory inquiries, sales reporting, employee leave queries, and customer records. Introduction to AI agents, tool calling, workflow orchestration, approval mechanisms, and human-in-the-loop automation. ERP integration examples using SAP, Oracle ERP, Microsoft Dynamics 365, and low-code automation platforms.</p> <p>Activity 1: Design an ERP chatbot workflow that retrieves purchase-order status through a mock API and routes purchase requests for approval.</p>
Unit V	<p>Enterprise AI Deployment, Security, Ethics, and Case Studies: Deployment of enterprise AI applications using cloud platforms and APIs. Introduction to application hosting, monitoring, logging, versioning, and performance evaluation. AI solution evaluation using accuracy, response time, relevance, reliability, and user satisfaction. Data privacy, access control, authentication, authorization, prompt injection, data leakage, hallucinations, and responsible AI. Enterprise AI governance, auditability, explainability, cost management, scalability, and maintenance. Case studies in smart manufacturing, banking, retail, healthcare administration, education, and supply-chain management</p> <p>Activity 1: Evaluate a prototype enterprise chatbot for response quality, security, reliability, and business usefulness</p>

Text Books

T.1	INTRODUCTION TO MACHINE LEARNING, DR. SHELKE, NILESH; DR. CHAUDHARI, NARENDRA, OTHERS DAS, GANU PRAKASHAN, EDITION 1
T.2	A FIRST COURSE IN MACHINE LEARNING, ROGERS, SIMMON, VIKAS PUBLICATION, EDITION 2

Reference Books

R.1	MACHINE LEARNING IN DATA SCIENCE USING PYTHON RAO NAGESWARA, DREAMTECH
R.2	ENTERPRISE RESOURCE PLANNING GARG, VINOD KUMAR; VENKITAKRISHNAN, N.K., PRENTICE HALL OF INDIA

Useful Links

1	https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_cs95?utm_source
2	https://nptel.ac.in/courses/110105756?utm_source

CO	Course Outcomes	CL	Class Sessions
CO1	Explain ERP architecture, modules, and enterprise business processes	3	10
CO2	Apply Generative AI and prompt engineering techniques to business problems.	3	10
CO3	Design and develop conversational AI chatbots for enterprise applications.	3	10
CO4	Integrate AI applications with ERP data, APIs, and business workflows.	3	10
CO5	Analyze enterprise AI solutions based on reliability, security, ethics, and business value.	4	10

	
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Department of Artificial Intelligence & Machine Learning

Program: B. Tech Artificial Intelligence and Machine Learning

Semester-VI **BAI13610 : Fundamentals of Augmented realities**

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: computer graphics, computer fundamentals, and programming concepts. Familiarity with 3D graphics and digital media tools is desirable but not mandatory.

Course Objectives:

1	To Identify and examine fundamental techniques for the design and deployment of Virtual and Augmented reality applications
2	To Describe how Virtual and Augmented reality systems works
3	To Understand virtual world space and various modal used as input and output interface in virtual reality
4	To Perform animation in virtual environment and physical simulation.
5	To Explain the use of designs for augmented reality experiences.

Course Content

Unit I	Introduction to Virtual Reality- Fundamental Concept and Components of Virtual Reality, Primary Features and Present Development on Virtual Reality, Computer graphics, Real time computer graphics, Flight Simulation, requirements of virtual environment, benefits of virtual reality, Hardware technologies for 3D user interface: Visual Displays Auditory Displays, Haptic Displays, Choosing Output Devices for 3D User Interfaces.
	Activity 1: Students will explore a VR application or watch a VR simulation video, such as a flight simulator or virtual museum tour. They will identify the hardware components and features that help create a realistic virtual environment.
Unit II	3D Computer Graphics- The Virtual world space, the perspective projection, human vision, 3D clipping, Colour theory, Simple 3D modeling, Illumination models, Reflection models, Shading algorithms, Hidden Surface Removal Multiple Modals of Input and Output Interface in Virtual Reality: Input - Tracker, Sensor, Digital Glove, Movement Capture, Video-based Input, 3D Menus & 3DScanner Output- Visual / Auditory / Haptic Devices
	Activity1: Create a simple 3D virtual room using a 3D modeling tool such as Blender. Apply perspective projection, colour theory, illumination, shading, and hidden surface removal to make the environment realistic
Unit III	Environment Modeling- Geometric Modeling, behavior simulation, from 2D to 3D, 3D space curves, 3D boundary representation Geometrical Transformations: Frames of reference, Modeling transformations, Instances, Picking, Flying, Scaling the VE, Collision detection Generic VR system: Introduction, Virtual environment, Computer environment, VR technology, Model of interaction, VR Systems.

	Activity1: Convert basic 2D shapes into 3D objects and apply translation, rotation, and scaling transformations.
Unit IV	Animating the Virtual Environment -Introduction, The dynamics of numbers, Linear and Nonlinear interpolation, the animation of objects, linear and non-linear translation, free from deformation, particle system. Physical Simulation Introduction, Objects falling in a gravitational field, Rotating wheels, Elastic collisions, projectiles, simple pendulum, springs, Flight dynamics of an aircraft.
	Activity1: Create a rain or snow effect in a virtual environment using Unity, Blender, or another animation tool.
Unit V	Augmented Reality Introduction to Augmented reality technology, technology and features of augmented reality Augmented reality in everyday world, Types of augmented reality, The similarities and differences between AR and VR, Multimodal displays, Challenges with AR, AR systems and functionality, Augmented reality methods, visualization techniques for augmented reality. Augmented Reality Applications Wireless displays in educational augmented reality applications, mobile projection interfaces, marker-less tracking for augmented reality, evaluating AR systems.
	Activity 1: Draw a neat, labelled diagram showing the camera, sensors, processor, display, and tracking system of an AR device.

Text Books

T.1	COMPUTER GRAPHICS : PRINCIPLES AND PRACTICE, FOLEY JAMES D. ; DAM ANDRIES VAN ; FEINER STEVEN K. AND OTHERS, PEARSON EDUCATION, EDITION 2
T.2	COMPUTER GRAPHICS A PROGRAMMING APPROACH, HARRINGTON STEVEN, MC GRAW HILL, EDITION 2

Reference Books

R.1	NATURAL LANGUAGE PROCESSING AND INFORMATION RETRIEVAL, SIDDIQUI TANVEER; TIWARY U.S., OXFORD UNIVERSITY PRESS, VOLUME 1
R.2	MACHINE LEARNING USING PYTHON, PRADHAN MANARANJAN, WILEY INDIA

Useful Links

1	https://nptel.ac.in/courses/106106699?utm_source
2	https://nptel.ac.in/courses/106103842?utm_source

CO	Course Outcomes	CL	Class Sessions
CO1	Analyze architectures and input/ output devices of virtual reality systems .	4	10
CO2	Perform environmental modeling in terms of geometric modeling and transformation	3	10
CO3	Develop virtual reality applications incorporating physical simulation for various real life scenarios	3	10
CO4	Analyze augmented reality applications.	4	10
CO5	Analyze AR Performance and Usability.	4	10

	
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Department of Artificial Intelligence & Machine Learning

Program: B. Tech Artificial Intelligence and Machine Learning

Semester-VI **BAI13611: Big Data Analytics**

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: database management systems, Python programming, data structures, and fundamental concepts of data analytics.

Course Objectives:

1	To analyze big data using machine learning techniques.
2	To understand the basic concepts of big data analytics and the Big Data landscape.

Course Content

Unit I	Introduction to Big Data: Introduction to Big Data, its types and characteristics, Big Data Analytics, Importance of Big Data Analytics, Technologies used in Big data Environments, Few Top Analytical Tools, Hadoop. History of Hadoop, Apache Hadoop, Analysing Data with Hadoop, Hadoop Streaming, Hadoop Technology Landscape, advantages, Hadoop: Features, advantages, Hadoop1.0-Hadoop2.0, overview of Hadoop ecosystems
	Activity 1: Study and compare document, key-value, column-family, and graph databases with suitable examples.
Unit II	Hadoop Distributed Processing and Resource Management Introduction to Hadoop, Hadoop Distributed File System (HDFS), HBase architecture and data model, Hadoop MapReduce, MapReduce-based solution design with examples, managing resources and applications using Hadoop YARN (Yet Another Resource Negotiator), HDFS data access and file operations, data locality, fault tolerance, and job scheduling in Hadoop.
	Activity1: Write queries to find students by name, department, marks, and multiple conditions.
Unit III	Cassandra: Architecture, Data Replication in Cassandra, Data model: cluster, keyspace, column family, Cassandra Keyspace Operations: Create, Alter, drop, Table Operations: create, alter, drop, truncate, index, CURD Operations, Cassandra CQL: data types, collections.
	Activity1: Draw a neat, labelled diagram showing the camera, sensors, processor, display, and tracking system of an AR device.
Unit IV	Introduction to Hive: What is Hive, Hive Architecture, Hive data types, Hive file formats, Hive Query Language (HQL), RC File implementation, User Defined Function (UDF). Introduction to Pig: What is Pig, Anatomy of Pig, Pig on Hadoop, Pig Philosophy, Use case for Pig, Pig Latin Overview, Data types in Pig, Running Pig, Execution Modes of Pig, HDFS Commands, Relational Operation.
	Activity1: Identify and classify primitive and complex data types in Hive with suitable examples.
Unit V	Spark and Big Data Analytics: Spark, Introduction to Data Analysis with Spark. Text, Web Content and Link Analytics: Introduction, Text Mining, Web Mining, Web Content and Web Usage Analytics, Page Rank, Structure of Web and Analyzing a Web Graph.
	Activity 1: Study the features, architecture, and applications of Apache Spark in big data processing

Text Books	
T.1	BIG DATA , BLACK BOOKDT EDITORIAL SER.,DREAMTECH
T.2	BIG DATA ANALYTICS,KAMAL RAJ; SAXENA PREETI,MC GRAW HILL
Reference Books	
R.1	BIG DATA AND ANALYTICS,ACHARYA SEEMA WILEY INDIA
R.2	BIG DATA AND ANALYTICS,ACHARYA SEEMA; CHELLAPPAN SUBHASHINI,WILEY INDIA
Useful Links	
1	https://onlinecourses-archive.nptel.ac.in/noc17_mg24/preview?utm_source
2	https://onlinecourses-archive.nptel.ac.in/noc19_cs33/preview?utm_source

CO	Course Outcomes	CL	Class Sessions
CO1	Identify Big Data concepts, tools and applications.	2	10
CO2	Develop programs using HADOOP framework.	3	10
CO3	Analyze NoSql Databases for large data sets	4	10
CO4	Explain Hadoop Cluster to deploy Map Reduce jobs, PIG, HIVE and Spark programs.	3	10
CO5	Analyze the given data set and identify deep insights from the data set.	4	10

	
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Department of Artificial Intelligence & Machine Learning

Program: B. Tech Artificial Intelligence and Machine Learning

Semester-VI **BAI13612: Web Application Security**

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: computer networks, web technologies, HTML, CSS, JavaScript, and database fundamentals. .

Course Objectives:

1	To introduce the fundamental concepts, principles, and importance of web application security.
2	To explain common web vulnerabilities, attack techniques, and methods for securing web applications.
3	To develop an understanding of authentication, authorization, session management, and access control.
4	To introduce secure coding practices, security testing, vulnerability assessment, and web application security tools
5	To explain security standards, risk management, and emerging challenges in web application security.

Course Content

Unit I	Introduction to web application security; importance and objectives of security; web application architecture; client-server model; HTTP and HTTPS protocols; common web threats and attack surfaces; security principles — confidentiality, integrity, and availability (CIA triad); security policies; threat modelling; introduction to OWASP and web security standards. Introduction to AI security, AI-powered web application architecture, and security risks associated with integrating AI models and APIs.
	Activity 1: Students examine a sample online shopping or college website and identify possible security risks, such as weak passwords, insecure login pages, and exposure of personal information.
Unit II	Web Application Vulnerabilities and Attacks Introduction to common web vulnerabilities; SQL Injection; Cross-Site Scripting (XSS); Cross-Site Request Forgery (CSRF); broken access control; security misconfiguration; file upload vulnerabilities; directory traversal; server-side request forgery (SSRF); insecure direct object references; denial-of-service attacks; prevention and mitigation techniques. Topics should be aligned with the current OWASP Top 10 risk categories. AI-specific vulnerabilities: prompt injection, jailbreak attacks, insecure output handling, sensitive information disclosure, and excessive agency in AI-integrated web applications; overview of the OWASP Top 10 for Large Language Model Applications.
	Activity 1: Students analyse prepared, non-production examples of vulnerable web pages and classify the vulnerabilities. They suggest suitable prevention techniques using input validation, parameterized queries, and secure configuration.
Unit III	Authentication, Authorization and Session Security User authentication and authorization; password security and secure password storage; multi-factor authentication; role-based access control (RBAC); session management; cookies and session identifiers; session hijacking and fixation; secure cookie attributes; password reset mechanisms; account lockout and rate limiting; access control policies; JSON Web Tokens (JWT); OAuth 2.0 and OpenID Connect fundamentals. Authentication and access control for AI services, API key

	management, secure handling of model credentials, and authorization for AI-powered chatbots and tools.
	Activity 1: Students design a secure login and registration workflow for a college portal, incorporating password validation, role-based access, session expiry, and multi-factor authentication.
Unit IV	Secure Coding and Web Application Security Testing Secure software development life cycle (SSDLc); security requirements and secure design principles; input validation and output encoding; prepared statements; error handling; encryption and hashing fundamentals; Transport Layer Security (TLS); security headers; Cross-Origin Resource Sharing (CORS); dependency and component security; static application security testing (SAST); dynamic application security testing (DAST); vulnerability scanning; penetration-testing fundamentals; security testing tools such as OWASP ZAP and Burp Suite; remediation and retesting. AI security testing: testing for prompt injection, jailbreaks, unsafe outputs, and sensitive data leakage; input/output guardrails and validation of AI-generated content.
	Activity 1: Students perform a basic security review of a locally hosted practice application using browser developer tools or an approved security testing tool, document their observations, and recommend corrective measures.
Unit V	Web security risk assessment; vulnerability classification and prioritization; security auditing; logging and monitoring; incident response and recovery; backup and disaster recovery; privacy and data protection; secure API development; REST API security; cloud-based web application security; Web Application Firewalls (WAF); DevSecOps; software supply-chain security; security compliance and responsible vulnerability disclosure; AI application security monitoring, secure deployment of AI models, AI guardrails and safeguards, and responsible security practices for Generative AI and AI-powered web applications.
	Activity 1: Students prepare a security audit report for a hypothetical e-commerce or college management application, identifying threats, assessing risks, and proposing preventive and corrective measures.

Text Books

T.1	WEB APPLICATION SECURITY, EXPLOITATION AND COUNTERMEASURES FOR MODERN WEB APPL.,HOFFMAN ANDREW,SHROFF PUBLISHERS AND DISTRIBUTORS PVT. LTD.,EDITION2
T.2	DEVELOPING WEB APPLICATIONS,MOSELEY,RALPH,WILEY INDIA

Reference Books

R.1	SOFTWARE TESTING,DESIKAN,SRINIVASAN;RAMESH,GOPALASWAMY, RAMESH,PEARSON EDUCATION
R.2	CRYPTOGAPHY &NETWORK SECURITY,FOROUZAN BEHROUZ A.,TATA MCGRAW HILL

Useful Links

1	https://nptel.ac.in/courses/106106129?utm_source
2	https://nptel.ac.in/courses/106106234?utm_source

CO	Course Outcomes	CL	Class Sessions
CO1	Explain the fundamental concepts, principles, and architecture of web application security.	3	10
CO2	Identify and analyse common web application vulnerabilities and their countermeasures.	2	10
CO3	Apply authentication, authorization, and session management principles to web applications	3	10
CO4	Analyze secure coding practices and web application security testing techniques..	4	10
CO5	Explain web security risks and recommend appropriate security controls, standards, and incident response measures.	3	10



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-VI **BAI13613 : Machine Learning Operations (MLOps)**

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: Basic knowledge of Python, machine learning basics, FastAPI, REST APIs, Git, data handling.

Course Objectives:

1.	Apply data collection, preprocessing, and exploratory analysis techniques to AI projects.
2.	Implement machine learning pipelines, experiment tracking, and hyperparameter tuning.
3.	Analyze model predictions, bias, fairness, and explainability.
4.	Implement version control, automated testing, containerization, and deployment workflows.
5.	Develop and monitor end-to-end AI applications using appropriate MLOps tools.

List of Experiments

1	Solve the Water Jug Problem and River Crossing Problem using state-space search and problem-solving techniques.	CO1
2	Implement data quality report and collect data from CSV files, public datasets, and APIs; prepare a.	CO1
3	Clean and preprocess data using missing-value handling, outlier treatment, scaling, and encoding.	CO1
4	Perform exploratory data analysis using Pandas, Matplotlib, and Seaborn.	CO2
5	Build Scikit-learn pipelines and compare classifiers using cross-validation.	CO2
6	Track and compare machine learning experiments using MLflow and calculate the CUBE Index for model evaluation.	CO2
7	Tune hyperparameters and evaluate models using classification metrics.	CO3
8	Version datasets, code, and models using Git, GitHub, and DVC.	CO3
9	Explain model predictions using feature importance, SHAP, and LIME.	CO3
10	Evaluate model bias and fairness and apply basic mitigation techniques.	CO4
11	Deploy a machine learning model locally using FastAPI and Docker on an on-premises server.	CO4
12	Automate testing and deployment of an AI application on an on-premises server using pytest and a self-hosted CI/CD runner.	CO4
13	Monitor model performance and data drift using Evidently AI.	CO5
14	Deploy a containerized AI application on an on-premises server using Docker and test its local API endpoints.	CO5
15	Develop an end-to-end AI project covering data preparation, model training, evaluation, on-premises deployment, monitoring, and documentation.	CO5

Text Books

T.1	Designing Machine Learning Systems – Chip Huyen, O'Reilly Media, 1st Edition, 2022.
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T.2	Introducing MLOps – Mark Treveil, Nicolas Omont, Clément Stenac, Kenji Lefevre, Du Phan, Joachim Zentici, Adrien Lavoillotte, Makoto Miyazaki, and Lynn Heidmann, O'Reilly Media, 1st Edition, 2020.
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Reference Books

R.1	Machine Learning Engineering – Andriy Burkov, True Positive Inc., 1st Edition, 2020.
R.2	Building Machine Learning Powered Applications – Emmanuel Ameisen, O'Reilly Media, 1st Edition, 2020.

Useful Links

L.1	nptel.ac.in/courses/106106139
L.2	https://onlinecourses.nptel.ac.in/e-learning/preview/noc22_cs83

CO	Course Outcomes	CL	Class Sessions
CO1	Analyze datasets for AI applications.	4	4
CO2	Evaluate machine learning pipelines and experiments.	5	4
CO3	Analyze model explainability, bias, and fairness.	4	4
CO4	Deploy AI applications using version control, Docker, APIs, and CI/CD tools.	3	4
CO5	Develop, deploy, and monitor end-to-end AI applications using MLOps practices.	3	4

	
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