Shirpur Education Society's

R. C. Patel Institute of Technology, Shirpur

(An Autonomous Institute)

Course Structure and Syllabus

Third Year B. Tech

Artificial Intelligence & Machine Learning

With effect from Year 2026-27
(RCP23 NEP Scheme: Revision 1)

Shahada Road, Near Nimzari Naka, Shirpur, Maharashtra 425405
Ph: 02563 259 802, Web: www.rcpit.ac.in

Institute Vision

To become a leading Institute in Technical education fostering innovation, research, ethical values, and sustainable development for the betterment of society.

Institute Mission

To impart high quality Technical Education through

1. **Innovative and Interactive learning process and high quality globally recognized instructional programs.**
2. **Fostering a collaborative scientific temper among students with ethical responsibility towards the society.**
3. **Preparing students from diverse backgrounds to have aptitude for employment, entrepreneur ship and research with a spirit of Professionalism.**
4. **To contribute to nation's sustainable development.**

Department Vision

Fostering technical excellence in Artificial Intelligence and Machine Learning through ethics, innovative research, and sustainable education.

Department Mission

1. **Innovative and interactive learning processes with high-quality instructional programs in Artificial Intelligence and Machine Learning.**
2. **Fostering a collaborative scientific temper among students with ethical responsibility towards society in AI and ML applications.**
3. **Preparing students from diverse backgrounds to develop aptitude for employment, entrepreneurship, and research in AI and ML with a spirit of professionalism.**

Programme Educational Objectives (PEOs)

1. **Graduates will have proficiency in Artificial Intelligence and Machine Learning, with lifelong learning skills to advance their careers as professionals, entrepreneurs, and leaders.**
2. **Graduates will possess strong expertise in Artificial Intelligence and Machine Learning, coupled with lifelong learning abilities to excel as professionals, entrepreneurs, and leaders.**
3. **Graduates will apply AI and ML knowledge to solve real-world problems, contributing to sustainable development and societal benefit.**

Program Specific Outcomes (PSOs)

1. **Apply programming, machine learning, statistics, data analysis, and cloud computing skills to develop efficient AI-driven solutions.**
2. **Graduates will excel in Computer Vision, Deep Learning, Natural Language Processing, and Cyber Security while respecting societal values.**

Third Year B. Tech Artificial Intelligence and Machine Learning Semester-V (w.e.f. 2026-27)

Sr	Course Category	Course Code	Course Title	Teaching Scheme			Evaluation Scheme					Total	Credit	
							Continuous Assessment (CA)							
							TA	Term Test 1 (TT1)	Term Test 2 (TT2)	Best of (TT1 & TT2)	ESE			
				L	T	P	[A]			[B]	[C]	[A+B+C]		
1	PC	RCP23APC301	Machine Learning	3			25	15	15	15	60	100	3	4
	PC	RCP23APC301L	Machine Learning Laboratory			2	25				25	50	1	
2	PC	RCP23APC302	Natural Language Processing	3			25	15	15	15	60	100	3	4
	PC	RCP23APC302L	Natural Language Processing Laboratory			2	25				25	50	1	
3	PC	RCP23APC303	Image Processing and Computer Vision	3			25	15	15	15	60	100	3	4
	PC	RCP23APC303L	Image Processing and Computer Vision Laboratory			2	25				25	50	1	
4@	PE	RCP23APE311	Human Machine Interaction	3			25	15	15	15	60	100	3	4
		RCP23APE311L	Human Machine Interaction Laboratory			2	25				25	50	1	
		RCP23APE312	Advanced Data Structures and Algorithms	3			25	15	15	15	60	100	3	
		RCP23APE312L	Advanced Data Structures and Algorithms Laboratory			2	25				25	50	1	
		RCP23APE313	Recommendation Systems	3			25	15	15	15	60	100	3	
		RCP23APE313L	Recommendation Systems Laboratory			2	25				25	50	1	
5	MD	RCP23AMD301	Computer Network	3			25	15	15	15	60	100	3	3
6	PC	RCP23AMD302L	Programming Laboratory-III (Full Stack Development Using NextJs)			2	25				25	50	2	1
7	HS	RCP23XHS331T	Environmental Studies		1		25					25	1	1
8	SC	RCP23XSC301P	Semester Project-III			2	25				25	50	1	1
9	SC	RCP23ASC301	App Development with AI and Flutter	1			40					40	1	1
			Total	16	1	12	340			75	450	865	23	

@Any one course

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Artificial Intelligence and Machine Learning

T. Y. B. Tech.

2026-27

Semester - V

Program: Artificial Intelligence and Machine Learning	T. Y. B.Tech.	Semester: V
Machine Learning (RCP23APC301)		
Machine Learning Laboratory (RCP23APC301L)		

Pre-requisite: Knowledge of basic probability and statistics, Data Mining and Analytics concepts

Course Objectives:

1. To understand key machine learning concepts: hypothesis formation, bias-variance trade-off, and model evaluation metrics.
2. To master regression, classification, and clustering techniques.
3. To apply machine learning algorithms to real-world datasets effectively.

Course Outcomes: On completion of the course, the learner will be able to:

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Explain the types of machine learning and issues in machine learning.	L2	Understand
CO2	Analyse model performance using evaluation metrics.	L4	Analyze
CO3	Implement and tune regression and classification algorithms.	L3	Apply
CO4	Apply knowledge of Bayesian learning principles.	L3	Apply
CO5	Apply association rule mining and clustering techniques.	L3	Apply
CO6	Explain the fundamentals of Neural Networks.	L2	Understand

Machine Learning (RCP23APC301)
Course Contents

Unit-I 06 Hrs.

Introduction to Machine Learning: Types of Machine Learning, Issues in Machine Learning, Application of Machine Learning, Steps involved in developing a Machine Learning Application, Hypothesis and Inductive Bias, Bias-Variance Trade-off, Performance measures, Data Validation. Evaluation & Selection: Metrics for Evaluating Classifier Performance, Holdout Method and Random Subsampling, Cross Validation, Bootstrap, Model Selection Using Statistical Tests of Significance, Comparing Classifiers Based on Cost–Benefit and ROC Curves .

Unit-II 08 Hrs.

Regression: Linear Regression, Least Minimum Slope (LMS) algorithm, Gradient Descent, Lasso and Ridge Regression. Polynomial Regression. Logistic Regression, Maximum Likelihood Function. Classification: Introduction to decision tree, Learning Decision tree using ID3 and Gini index; CART, Overfitting. Ensemble methods: Bagging (Random Forest) and Boosting (XG Boost) .

Unit-III 08 Hrs.

Bayesian Learning: Bayesian Learning, Naïve Bayes, Bayesian Network: Representation in Bayesian, Belief Network, Inference in Bayesian Network, Applications of Bayesian Network. Classification Model

Unit-IV 06 Hrs.

Introduction to Support Vector Machine: Support Vectors, Kernels: Linear, Polynomial and Radial Basis Function (RBF) Kernel Association Rule Mining: Market Basket Analysis, Apriori algorithm and measures of association.

Unit-V 08 Hrs.

Clustering: Cluster Analysis and Requirements of Cluster Analysis Partitioning Methods: k-Means, k-Medoids Hierarchical Methods: Agglomerative, Divisive. Dimensionality Reduction: Dimensionality Reduction Techniques: Principal Component Analysis

Unit-VI 06 Hrs.

Introduction to Neural Networks and Deep Learning: Deep Learning applications, Association of biological neuron with artificial network, activation functions, weights, bias, threshold, learning rate, momentum factor. **McCulloch Pitts Neuron:** Theory and architecture; linear separability;

Hebb Network: Theory and algorithm, ANN architectures. Hyper parameter tuning and batch normalization, Machine Learning vs Deep Learning.

Machine Learning Laboratory (RCP23APC301L)
List of Laboratory Experiments (Any 08)

1. Study and Implementation of Machine Learning Workflow with Model Evaluation, Validation, and Selection Techniques
2. To develop a Linear Regression model by performing data cleaning, exploratory data analysis, data transformation, model training, and performance evaluation.
3. To develop a Logistic Regression classification model by performing data preprocessing, exploratory data analysis, feature transformation, model training, and evaluation.
4. To develop a Decision Tree classification model using the Gini Index by performing data cleaning, exploratory data analysis, data transformation, model training, decision tree visualization, and performance evaluation.
5. To implement the CART (Classification and Regression Tree) Decision Tree algorithm by performing data cleaning, exploratory data analysis, data transformation, model training, decision tree visualization, and performance evaluation.
6. To implement Ensemble Learning methods by performing data cleaning, exploratory data analysis, data transformation, model training, and performance evaluation.
7. To implement a Bayesian Classification model by performing data cleaning, exploratory data analysis, data transformation, model training, and performance evaluation.
8. Implementation of Naïve Bayes Classifier and Bayesian Network for Classification
9. To compare the performance of different classification algorithms through model training and performance evaluation.
10. To implement a Support Vector Machine (SVM) model by performing data cleaning, exploratory data analysis, data transformation, and dimensionality reduction.
11. Perform clustering using K-Means and K-Medoids algorithms.
12. Implement Hierarchical Clustering techniques for data grouping and analysis.
13. Implement an Artificial Neural Network (ANN) model for predictive analysis
14. Mini project based on any machine learning application .

Oral examination will be based on the entire syllabus including, the practicals performed during laboratory sessions.

Text Books:

1. Mitchell, T. M., Machine Learning, McGraw Hill, 1st Edition, 2017
2. Ethem Alpaydın, Introduction to Machine Learning, MIT Press, 4^{th}Edition, 2020.
3. Peter Harrington, 'Machine Learning In Action', DreamTech Press, 1^{st} Edition, 2012.
4. Bruce, P., Bruce, A., & Gedeck, P., Practical statistics for data scientists: 50+ essential concepts using R and Python, O'Reilly Media, 2^{nd} Edition, 2020

Reference Books:

1. "Data Mining for Business Analytics, (An Indian Adaptation): Concepts, Techniques and Applications in Python", Cambridge University Press, ISBN NO. 978-1108727747, 2019.
2. Andreas C. Müller and Sarah Guido, "Introduction to Machine Learning with Python: A Guide for Data Scientists", O'reilly,2016
3. Stephen Marsland, "Machine Learning an Algorithmic Perspective", CRC Press, 2015
4. Han Kamber, "Data Mining Concepts & Techniques", Morgann Kaufmann Publishers, 2012.
5. Kevin P. Murphy, "Machine Learning — A Probabilistic Perspective", 2012.

Web Links:

1. https://onlinecourses.nptel.ac.in/noc21_cs06/preview
2. https://www.datacamp.com/tutorial/tableau-tutorial-for-beginners
3. https://www.kaggle.com/code/ekami66/detailed-exploratory-data-analysis-with python

NPTEL :

1. Introduction to Machine Learning https://nptel.ac.in/courses/106106139
2. Machine Learning for engineering and science applications https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_cs76
3. Mathematical foundation of machine learning https://onlinecourses.nptel.ac.in/e learning/preview/noc26_cs0
4. Machine Learning, ML https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_cs77

Coursera Course :

1. Machine Learning Specialization — Andrew Ng

2. Machine Learning with Python by IBM

3. Mathematics for Machine Learning and Data Science

Program: Artificial Intelligence and Machine Learning	T. Y. B.Tech.	Semester: V
Natural Language Processing (RCP23APC302)		
Natural Language Processing Laboratory (RCP23APC302L)		

Pre-requisite: Python Programming

Course Objectives:

1. To introduce the fundamental concepts and techniques of Natural language Processing for analyzing words based on Morphology and CORPUS.
2. To examine the NLP models and interpret algorithms for classification of NLP sentences by using both the traditional, symbolic and the more recent statistical approach.
3. To get acquainted with the algorithmic description of the main language levels that includes morphology, syntax, semantics, and pragmatics for information retrieval and machine translation applications.

Course Outcomes: On completion of the course, the learner will be able to:

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Explain the Principles and Process of Natural Languages and real-world applications.	L2	Understand
CO2	Demonstrate understanding of state-of-the-art algorithms and techniques for text-based processing of natural language with respect to morphology.	L3	Apply
CO3	Perform POS tagging for a given natural language and select a suitable language modelling technique based on the structure of the language.	L6	Create
CO4	Check the syntactic and semantic correctness of sentences using grammars and labelling.	L5	Evaluate

Natural Language Processing (RCP23APC302)
Course Contents

Unit-I 05 Hrs.

Introduction to Natural Language Processing: Origin & History of NLP, Stages in NLP, Ambiguities and its types in English and Indian Regional Languages; Applications of NLP- Machine Translation, Information Retrieval, Question Answering System, Sentiment Analysis, Text Categorization , Text Summarization, Named Entity Recognition.

Unit-II 08 Hrs.

Word Level Analysis (statistical language model): Inflectional Morphology, Derivational Morphology, Regular expression with types, Morphological Models: finite state morphology, Morphological parsing with FST (Finite State Transducer), Lexicon free FST Porter Stemmer algorithm, Grams and its variation: Bigram, Trigram, Simple (Unsmoothed) N-grams; N-gram Sensitivity to the Training Corpus, Evaluating N-grams: Perplexity, smoothing: Laplace Smoothing, Good-Turing Discounting.

Unit-III 09 Hrs.

Syntax analysis: Part-Of-Speech tagging (POS), Tag set for English (Upenn Treebank), Difficulties /Challenges in POS tagging , Rule-based, Stochastic and Transformation-based tagging, Generative Model: Hidden Markov Model (HMM Viterbi) for POS tagging; Issues in HMM POS tagging, Discriminative Model: Maximum Entropy model, Conditional random Field (CRF), CYK.

Unit-IV 08 Hrs.

Semantic Analysis: Lexical Semantics; Corpus study; Study of Various language dictionaries like WorldNet, Babelnet. Attachment for fragment of English, Relations among lexemes & their senses –Homonymy, Polysemy, Synonymy, Hyponymy, Semantic Ambiguity, Word Sense Disambiguation (WSD), Knowledge based approach (Lesk‘s Algorithm), Supervised (Naïve Bayes, Decision List).

Unit-V 08 Hrs.

Vectorsemantics And Embeddings: Vector Semantics, Words and Vectors, Cosine for measuring similarity, TF-IDF: Weighing terms in the vector, Pointwise Mutual Information (PMI), Applications of the tf-idf or PPMI vector models, Word2vec. Distributed word representations, Word2Vec (CBOW, Skip-gram), GloVe and fastText. Multilingual embeddings with emphasis on Indian languages .

Unit-VI 04 Hrs.

Pragmatic & Discourse Processing: Discourse: Reference Resolution, Reference Phenomena, Syn-

tactic & Semantic constraint on coherence, Anaphora Resolution using Hobbs and Cantering Algorithm, Discourse segmentation, Coreference resolution.

Natural Language Processing Laboratory (RCP23APC302L)
List of Laboratory Experiments (Any 10)

1. Preprocessing steps in NLP: Tokenization, stop word Removal, Lemmatization, stemming using NLTK and SPACY.
2. To perform NLP tasks on Indian Languages.
3. Perform morphological analysis and word generation for any given text
4. Implement Chunking for the given input text.
5. To evaluate N-grams and apply smoothing
6. To implement POS tagging using HMM.
7. CYK parsing (Cocke Younger-Kasami Parsing) or Chart Parsing
8. Implement Named Entity Recognition for any given text
9. a) Word Vector Representation (Bag of Words) b) Cosine Similarity Between Words/Documents c) TF-IDF Vectorization
10. Word Similarity using TF-IDF / PPMI
11. To train Word2Vec using CBOW.
12. Analysis of Discourse and Textual Coherence
13. Co-reference Resolution using Neural Models using spaCy / AllenNLP
14. Mini project

Oral examination will be based on the entire syllabus including, the practicals performed during laboratory sessions.

Text Books:

1. Raymond S. T. Lee, "Natural Language Processing: A Textbook with Python Implementation", 1st Edition, 2023.
2. Lewis Tunstall, Leandro von Werra, Thomas Wolf, "Natural Language Processing with Transformers", O'Reilly , 2022.

3. Thushan Ganegedara, Andrei Lopatenko, “Natural Language Processing with TensorFlow: The definitive NLP book to implement the most sought-after machine learning models and tasks”, 2^{nd} Edition, 2022.

4. Daniel Jurafsky, James H. and Martin, “Speech and Language Processing An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition”, Pearson, 2014.

Reference Books:

1. Masato Hagiwara, “Real-World Natural Language Processing: Practical applications with deep learning”, Mnaning, 2021.

2. Ashish Bansal, “Advanced Natural Language Processing with TensorFlow 2: Build effective real-world NLP applications using NER, RNNs, seq2seq models, Transformers, and more”, Packt Publishing, 2021.

Web Resources Blogs and Websites:

1. POS Tagging Hidden Markov Models (HMM) Viterbi algorithm in NLP maths — Data Science in your pocket (medium.com)

2. Text Generation Using N-Gram Model — by Oleg Borisov — Towards Data Science

3. How to Create Beautiful Word Clouds in Python — by Tia Plagata — Towards Data Science

4. Best NLP Algorithms to get Document Similarity — by Jair Neto — Analytics Vidhya — Medium

5. How to Chunk Text Data — A Comparative Analysis — by Solano Todeschini — Towards Data Science

6. Natural Language Processing. Title :- Morphological Analysis — by Raghvendra Zarkar — Medium

Online Courses and Tutorials:

1. NPTEL Course : Natural Language Processing - Course (nptel.ac.in)

2. Cousera: Natural Language Processing Specialization [4 courses] (DeepLearning.AI) — Coursera

3. Udemy: NLP - Natural Language Processing with Python — Udemy

Program: Artificial Intelligence and Machine Learning	T. Y. B.Tech.	Semester: V
Image Processing and Computer Vision (RCP23APC303)		
Image Processing and Computer Vision Laboratory (RCP23APC303L)		

Pre-requisite: Basic Mathematics, Python Programming.

Course Objectives:

1. To provide a fundamental understanding of image processing concepts, including image representation, enhancement techniques, and transformation methods
2. To equip students with the knowledge of image segmentation, morphological processing, feature detection, and motion analysis for practical applications in computer vision.
3. To introduce various image compression techniques and their significance in reducing storage and transmission costs while maintaining image quality.

Course Outcomes: On completion of the course, the learner will be able to:

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Apply image enhancement in spatial domain.	L3	Apply
CO2	Analyse image in frequency domain through different transforms and enhancement in frequency domain.	L4	Analyse
CO3	Apply different image segmentation, feature detection techniques on images.	L3	Apply
CO4	Examine and apply different morphological operations on an image.	L3	Apply
CO5	Apply geometric transformations on an image and Evaluate optical flow algorithms.	L3	Apply
CO6	Implement and evaluate image compression techniques.	L5	Evaluate

Image Processing and Computer Vision (RCP23APC303)
Course Contents

Unit-I 08 Hrs.

Image Processing Fundamentals and Image Enhancement:

Image types, Image formats, Sampling Quantization.

Spatial Domain Techniques:

Point Processing; Digital Negative, Contrast Stretching, Thresholding, Bit Plane Slicing, Power Law Transformation, Dynamic Range Compression. Histogram Modelling; Histogram Stretching & Histogram Equalization. Neighbourhood Processing; Noise, Smoothing (Low Pass Averaging Filter, Low Pass Median Filter), Sharpening Filters (High Pass Filtering & High Boost Filtering). Mean filters, Order statistic filters.

Unit-II 08 Hrs.

Image Segmentation: Connectivity of Pixels, Detection of discontinuities (Point, Line, Edge), Detection of Edges (Computing Gradients, 1st order Derivative Filters,2nd order Derivative Filters, Laplacian of Gaussian). Region-based segmentation-Region Growing, Region Splitting, Region Merging, Region Split & Merge.

Unit-III 07 Hrs.

Image Transforms & Morphological Processing: Fourier Transform,1D DFT, Frequency domain techniques - 2D-DFT, Low pass Filter (Ideal, Butterworth, Gaussian), High pass Filter (Ideal, Butterworth, Gaussian). Hadamard Transform, Walsh Transform.

Morphological Operations: Dilation, Erosion, Opening, Closing

Unit-IV 08 Hrs.

Geometric Transformations: Translation, Rotation, Scaling, Shearing.

Feature Detection & Description: Interest or Corner Point Detectors- Harris and Hessian. Histogram of Oriented Gradients, Scale Invariant Feature Transform(SIFT), Speeded up Robust Features(SURF), Scale-Space Analysis- Image Pyramids.

Unit-V 06 Hrs.

Object Segmentation & Detection: Canny Edge Detection, Difference of Gaussian (DOG), Graph Technique, Distance Metrics, Global Thresholding, Otsu's Thresholding, Watershed Algorithm.

Motion Analysis & Optical Flow:: Introduction to Motion Detection, Lucas-Kanade, Horn-Schunck .

Unit-VI 05 Hrs.

Image Compression: Run-Length Encoding (RLE), Huffman Coding, LZW (Lempel-Ziv-Welch), Improved Grey Scale coding (IGS) .

Image Processing and Computer Vision Laboratory (RCP23APC303L)
List of Laboratory Experiments (Any 10)

1. Point Processing Techniques (Digital Negative, Thresholding, Intensity Transformation, Contrast Stretching)
2. Sharpening & Smoothing filters
3. Histogram Modelling
4. Frequency Domain Filtering
5. Edge detection
6. Morphological Operations
7. Object Detection
8. Image assessment with NumPy and OpenCV
9. Image Transformation in OpenCV
10. Feature Detection using OpenCV- Corner
11. Image Arithmetic Operations
12. Image Compression
13. Motion analysis and Action detection
14. Project Based Learning
15. Research Article Review

Practical and Oral examination will be based on the entire syllabus including, the practicals performed during laboratory sessions.

Text Books:

1. Rafael C. Gonzalez, Digital Image Processing, 4^{th} Edition, 2018.

2. Christopher M. Bishop, Pattern Recognition and Machine Learning, 1st Edition, 2006.

3. Richard Szeliski, Computer Vision: Algorithms and Applications, 2nd Edition, 2022.

Reference Books:

1. 1. Emanuele Trucco and Alessandro Verri, Introductory Techniques for 3-D Computer Vision, 1st Edition, 1998.

2. William K. Pratt, Digital Image Processing: PIKS Scientific Inside, 4st Edition, 2007.

3. David Forsyth and Jean Ponce, Computer Vision: A Modern Approach, 2nd Edition, 2011.

4. E. R. Davies, Computer and Machine Vision: Theory, Algorithms, Practicalities, 4st Edition, 2012.

5. S. Jayaraman, S. Esakkirajan, and T. Veerakumar, Digital Image Processing, 2nd Edition, 2019.

6. Adrian Kaehler and Gary Bradski, Learning OpenCV: Computer Vision with the OpenCV Library, 1st Edition, 2008.

Web Links:

1. https://opencv.org/

2. https://staff.fnwi.uva.nl/r.vandenboomgaard/IPCV20162017/index.html

3. https://www.geeksforgeeks.org/computer-vision/

4. https://egyankosh.ac.in/handle/123456789/90205

Online Courses:

1. Computer Vision and Image Processing – Fundamentals and Applications
   - https://onlinecourses.nptel.ac.in/noc22$_e$e48/preview/
   - https://www.coursera.org/learn/introduction-computer-vision-watson-opencv
2. Computer Vision
   - https://onlinecourses.nptel.ac.in/noc19$_c$s58/preview
   - https://www.coursera.org/specializations/computer-vision
3. Digital Image Processing
   - https://onlinecourses.nptel.ac.in/noc20$_e$e75/preview
   - https://www.coursera.org/learn/introduction-image-processing

Program: Artificial Intelligence and Machine Learning	T. Y. B.Tech.	Semester: V
Human Machine Interaction (RCP23APE311)		
Human Machine Interaction Laboratory(RCP23APE311L)		

Pre-requisite: Basic knowledge of computer systems, programming fundamentals, and software development concepts.

Course Objectives:

1. To introduce fundamental concepts of Human-Computer Interaction, including human factors, interaction models, and design principles.
2. To develop the ability to design user-centered and accessible interfaces using established design processes and methodologies.
3. To equip students with skills in prototyping, data collection, and usability evaluation for effective interface design.
4. To expose students to emerging trends in HCI such as AI, IoT, and smart interfaces, and their impact on user experience.

Course Outcomes: On completion of the course, the learner will be able to:

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Explain fundamental concepts of Human-Computer Interaction and apply structured design processes, including design thinking, to develop user-centered solutions.	L2	Understand
CO2	Illusrate effective user interfaces by applying principles of visual design, interaction styles, and cognitive aspects.	L4	Analyze
CO3	Demonstrate data collection and analysis using appropriate qualitative and quantitative methods for user research.	L3	Apply
CO4	Develop, test, and evaluate prototypes and interactive systems using usability principles, modern tools, and emerging technologies such as AI and IoT.	L5	Evaluate

Human Machine Interaction (RCP23APE311)
Course Contents

Unit-I: Introduction to HCI Human Factors 07 Hrs.

Introduction to HCI, History of UI Design, Human characteristics, I/O channels, Psychology of everyday actions, Reasoning & problem solving, Human vs Computer capabilities, HCI models & frameworks, Ergonomics, Interaction paradigms, Good vs Bad design, Accessibility basics, Digital transformation, Emerging trends (AI, AR/VR, Wearables), Real-world applications

Unit-II: Design Process, Design Thinking User-Centered Design 08 Hrs.

Design principles, design mistakes, human considerations, interaction design process, usability engineering, prototyping basics, design rules (principles, standards, guidelines), Goal-directed design, Design Thinking (stages, frameworks, Double Diamond), User-centered design (UCD), personas, empathy mapping, mental models, affinity mapping, POV & HMW techniques, tools (Miro, Canva basics), inclusive & accessible design

Unit-III:Interface Design & Cognitive Aspects 07 Hrs.

GUI & Web UI concepts, Direct manipulation, Interface types (GUI, CLI, NUI, AR/VR), Interface metaphors, Conceptual models, Cognitive aspects (cognitive load, Miller's law, Gestalt laws, recognition vs recall), Distributed cognition, External cognition, Behavioural patterns, Interaction styles (menus, windows, controls), Case examples, Introduction to platforms like Behance..

Unit-IV:Data Collection, Prototyping & Evaluation 08 Hrs.

Data requirements, data gathering (interviews, questionnaires, observation), qualitative & quantitative analysis, ethical considerations, prototyping (Lo- Fi, Mid-Fi, Hi-Fi), tools (Figma, Adobe XD), usability testing, evaluation techniques (heuristics, A/B testing, cognitive walkthrough), UX metrics, accessibility evaluation (WCAG), experimental design, data visualization best practices.

Unit-V:Advanced HCI: AI, IoT & Smart Interfaces 06 Hrs.

Smart UI, AI-powered personalization, context-aware interfaces, IoT in HCI, HCI + AI integration, LLMs & multimodal systems, prompt engineering basics, conversational UI design, human-AI interaction, applications (healthcare, education), assistive technologies (Braille systems, ASD tools), AI tools (Canva AI, Firefly, Stable Diffusion), case studies, future trends.

Unit-VI:Design Guidelines, Communication & UX Tools 06 Hrs.

Design guidelines (Gestalt, perception, memory, color theory), communication (text, icons, multimedia, feedback), UI for web & mobile, case studies (mobile apps, assistive apps), UX tools (Figma, JustInMind, Penpot, MockFlow, Pencil), mobile ecosystem, application frameworks, types of mobile apps (native, hybrid, widgets)

Human Machine Interaction Laboratory (RCP23APE311L)
List of Laboratory Experiments (Any 10)

1. 1 To analyze and compare good and bad user interface designs by identifying usability principles, design flaws, and user experience issues in real-world applications.
2. To study and evaluate a real-world system (e.g., ATM, mobile app, website) using HCI principles, interaction models, and usability criteria.
3. To examine ergonomic factors in human-computer interaction and assess their impact on user comfort, efficiency, and productivity.
4. To apply the stages of Design Thinking (Empathize, Define, Ideate, Prototype, Test) to solve a real-world problem in a structured and user-centered manner.
5. To develop user personas and empathy maps to understand user needs, behaviors, motivations, and challenges in interface design.
6. To organize user research data using affinity mapping and formulate clear problem statements using POV and HMW techniques.
7. To design low-fidelity prototypes such as sketches and wireframes to represent initial interface ideas and user flows.
8. To create visually appealing user interface designs using Canva by applying layout, typography, and design principles.
9. To design interactive user interfaces using Figma, incorporating usability principles, consistency, and visual hierarchy.
10. To evaluate an interface based on cognitive principles such as memory load, perception, recognition vs recall, and user behavior patterns.
11. To collect user data using appropriate methods such as questionnaires and interviews for understanding user requirements.
12. To analyze collected data using qualitative and quantitative techniques and present insights through effective data visualization methods.

13. To develop interactive prototypes using tools like Figma or Adobe XD to simulate realworld user interfaces.

14. To evaluate user interfaces using usability testing methods such as heuristic evaluation, A/B testing, and cognitive walkthrough.

15. To design smart and adaptive user interfaces using AI-powered tools and techniques for personalization and automation.

16. To implement the complete HCI design lifecycle, including problem identification, user research, design, prototyping, evaluation, and presentation of an interactive system.

17. Mini Project: SDG 3: Good Health and Well-being Design a mobile application that provides accessible mental health resources (e.g., guided meditations, stress management techniques, links to support organizations) with a focus on user-centered design for diverse users, including those with disabilities or limited digital literacy. Interactive System for Promoting Healthy Habits
    SDG 4: Quality Education Accessible and Engaging E-Learning Platform for Underserved Communities: Design an e-learning platform with a focus on accessibility for learners in underserved communities, considering factors like low bandwidth, limited device capabilities, and varying levels of digital literacy.
    SDG 11: Sustainable Cities and Communities Mobile Application for Promoting Sustainable Transportation Choices: Design a mobile app that encourages users to adopt sustainable transportation options like walking, cycling, and public transport by providing real-time information, route planning, gamified challenges, and rewards.

Oral examination will be based on the entire syllabus including, the practicals performed during laboratory sessions.

Text Books:

1. When Machines Understand Us: The Human Side of Emotional AI, Taylor Royce, 2025.

2. Human-machine Interaction and Iot Applications for a Smarter World, Nishu Gupta (Editor), Srinivasa Kiran Gottapu, Rakesh Nayak, Anil Kumar Gupta, Mohammad Derawi, Jayden Khakurel, CRC, 2024.

3. Kalbande,Kanade,Iyer, "Galitz's Human Machine Interaction", 1st Edition, Wiley Publications, 2015.

4. Donald A. Normann," Design of everyday things", Basic Books; 2nd Edition, 2013

Reference Books:

1. Rogers Sharp Preece,‖Interaction Design:Beyond Human Computer Interaction‖,Wiley, 2019.

2. Guy A. Boy —The Handbook of Human Machine Interaction‖, Ashgate publishing Ltd. 2017.

3. Human-Computer Interaction: A Compact Reference for Practitioners, Alan Dix, Janet Finlay, Gregory D. Abowd, Russell Beale, Pearson College Div, 2003.

Online References:

1. NPTEL Course: https://onlinecourses.nptel.ac.in/noc25_cs38

2. https://www.coursera.org/learn/human-computer-interaction

3. https://www.edx.org/learn/human-computer-interaction

4. Human-Computer Interaction (HCI) Course for AI Systems Design

Program: Artificial Intelligence and Machine Learning	T. Y. B.Tech.	Semester: V
Advanced Data Structures and Algorithm (RCP23APE312)		
Advanced Data Structures and Algorithm Laboratory (RCP23APE312L)		

Pre-requisite: Python Programming, Data Structures, Design & Analysis of Algorithms

Course Objectives:

1. To provide conceptual and practical knowledge of Advance Data Structures and Algorithms.
2. To Cultivate algorithmic thinking and problem-solving skills through practice and exposure to diverse problem domains.
3. Develop strategies for breaking down complex problems into manageable sub problems and applying suitable algorithms and data structures.
4. Develop skills to analyze problem complexity and choose appropriate data structures and algorithms for efficient solutions.

Course Outcomes: On completion of the course, the learner will be able to:

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Explain the concept of time complexity and its importance in analyzing algorithms and to Explore the complexity analysis of popular machine learning algorithms.	L2	Understand
CO2	Explore balanced search tree data structures and spatial data structures used in geometric and spatial applications.	L2	Understand
CO3	Apply graph algorithms to solve real-world problems related to network flows, matching, and optimization.	L3	Apply
CO4	Explain the complexity classes NP, P, NP-complete, and NP-hard and their significance in algorithm classification and to explore the computational geometry algorithms.	L2	Understand

Advanced Data Structures and Algorithm (RCP23APE312)
Course Contents

Unit-I 08 Hrs.

Analysis of Algorithm Based on Time:

i. Amortized Analysis: Aggregate Method, Accounting Method, Potential Method (for Stack data structure)

ii. Probabilistic and Randomized Algorithm: Probabilistic approach to algorithm and Randomized Analysis, Indicator Random Variable (IRV), Analysis of Hiring Problem

Complexity Analysis of Machine Learning Algorithms:

i. Training Time Complexity and Testing Time Complexity

ii. Train/Test Complexity of Linear Regression

iii. Train/Test Complexity of Naïve Bayes Classifier

Self Learning : Dynamic Table, Randomized Quick Sort Analysis

Unit-II 10 Hrs.

Balanced Search Trees:

Red-Black Tree, Tango Tree,2-3 Tree, B Tree, B+ Tree, Splay Tree, Skip list, Interval Tree

Self Learning : Interval Tree Applications

Unit-III 08 Hrs.

Advanced Data Structures:

i. Spatial Data Structure: KD Tree, R Tree

ii. Probabilistic Data Structure: Bloom filter, LogLog and HyperLogLog, Count Min sketch, MinHash with Machine Learning context (Vector Representation)

iii. Functional Data Structures: Binomial Tree, Binomial Heap

Self – Learning: Binary Heap vs Binomial Heap

Unit-IV 07 Hrs.

Graph Based Algorithms:

i. Flow Network Introduction: Residual Network, Augmenting Path, Ford-Fulkerson Method, Edmonds-Karp Method, Push-Relable Algorithm

ii. Bipartite Matching: Maximum Bipartite Matching

Self Learning: Network Flow Applications

Unit-V 07 Hrs.

Classification of Algorithms:

i. Algorithm Classes: P, NP, NP Hardness and NP Completeness

ii. Np Completeness Proofs: Satisfiability (3 sat), Reducibility, Cook's Theorem, Traveling Salesman Problem

iii. Approximation Algorithms: Vertex Cover Problem, Travelling Salesman problem

Self Learning : Exact vs Approximation Algorithms for TSP

Unit-VI 02 Hrs.

Computational Algorithms – Computational Geometry:

Line Segment Properties, Convex Hull Graham's scan algorithm

Self Learning : Computational Geometry in Computer Vision

Advanced Data Structures and Algorithm Laboratory (RCP23APE312L)

List of Laboratory Experiments (Any 10)

1. Experiment on Amortized Analysis.
2. To perform and implement Hiring Problem.
3. Experiment on Randomized Algorithms (Randomized Quick Sort).
4. To implement Red Black Tree creation.
5. To implement Splay Tree.
6. To implement Interval Tree.
7. To implement Skip List.
8. To implement Skew Heap.
9. To implement Leftist Heap.
10. To To implement B+ Tree.
11. To implement KD Tree
12. To implement Ford Fulkerson Algorithm.
13. To implement Approximation Algorithms (Vertex Cover).
14. Experiment on Computational Geometry Algorithms (Graham Scan).

Oral examination will be based on the entire syllabus including, the practicals performed during laboratory sessions.

Text Books:

1. Thomas H Cormen, Charles E. Leiserson, Ronald L Rivest, Clifford Stein, "Introduction to Algorithms", 3rd Edition, 2009.
2. S. Sridhar, "Design and analysis of algorithms", 1st Edition, Oxford , 2014.
3. Horowitz, Sahani and Rajsekaran, "Fundamentals of Computer Algorithms", 2nd Edition, Galgotia, 1998.
4. Harsh Bhasin, "Algorithms Design and Analysis", 1st Edition, Oxford, 2015.
5. Giuseppe Bonaccorso, "Machine Learning Algorithms", by Packt, 2019.

Reference Books:

1. Rajeev Motwani, Prabhakar Raghavan," Randomized Algorithm", Cambridge University, 2004.
2. Vijay V. Vajirani, "Approximation Algorithms", Springer, 2003.
3. "Computational Complexity", Stanford University, 2010.
4. Jason Brownlee, "Master Machine Learning Algorithms", Machine Learning Mastery, 2020.

Web Resources Blogs and Websites::

1. Train/Test Complexity and Space Complexity of Linear Regression — by Writuparna Banerjee — Level Up Coding (gitconnected.com)
2. Computational Complexity of ML Models — by Paritosh Kumar — Analytics Vidhya — Medium
3. Importance of Understanding the Complexity of a Machine Learning Algorithm — by Baran Köseoğlu — Towards Data Science
4. Probabilistic Data Structures Decoded: Enhancing Performance in Modern Computing — by Naman Agrawal — Towards Data Science
5. ML Security Pro Tips: Understanding MinHash in a Security Context — by Melanie Beck — AI/ML at Symantec — Medium.
6. Bloom Filters and when to use them — by Janko Krstic — The Little Bit Ninja — Medium
7. The Power of Bloom Filters: A Comprehensive Guide — by Chiranjeet Baruah — Medium

8. Nptel : https://onlinecourses.nptel.ac.in/e-learning/preview/noc25_cs158

9. IIT course: https://nsm.iitm.ac.in/cse/services/adv_dsa/

10. Coursera: https://www.coursera.org/specializations/data-structures-algorithms

Program: Artificial Intelligence and Machine Learning	T. Y. B.Tech.	Semester: V
Recommendation Systems(RCP23APE313)		
Recommendation Systems Laboratory (RCP23APE313L)		

Pre-requisite: Knowledge of Machine Learning

Course Objectives:

1. To provide students with the basic concepts of Recommender Systems, design space, trade-offs and its application in various domain.
2. To have a broad understanding of the field of Recommendation Systems.

Course Outcomes: On completion of the course, the learner will be able to:

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Explain the architecture and working of Collaborative Filtering, Content based recommendation systems.	L2	Understand
CO2	Explain the architecture and basics of Knowledge based recommendation systems.	L2	Understand
CO3	Analyzing hybrid and ensembles recommendation systems.	L4	Analyze
CO4	Evaluation of recommendation systems by selecting right evaluation parameter.	L5	Evaluate

Recommendation Systems(RCP23APE313)
Course Contents

Unit-I 06 Hrs.

Introduction to Recommender Systems

Introduction to Recommendation System, Framework of recommendation systems, Eliciting Ratings and other Feedback Contributions, Implicit and Implicit Ratings, Recommender system functions. Applications of recommendation systems, Issues with recommender system.

Data for recommendation: Explicit Vs Implicit data collection Scales of measurement, Machine learning foundations for recommender system, Data preprocessing.

Unit-II 08 Hrs.

Collaborative filtering-based Recommender System Architecture of Collaborative Filtering, Collaborative filtering approaches: Memory based and model based, Memory based collaborative filtering foundations: Distance and similarity measures, User based collaborative filtering; Item based collaborative filtering. Model based collaborative filtering foundations: matrix factorization, UV decomposition, Singular value decomposition Model based collaborative filtering techniques: SVD.

Unit-III 07 Hrs.

Content-based Recommender System:

Architecture of content-based systems, Content based recommender system foundations ,Examples with text data, Feature engineering: Feature extraction, feature selection, dimensionality reduction. Decision tree for Content recommendation, KNN for Content recommendation, Naïve based for Content recommendation.

Unit-IV 07 Hrs.

Knowledge based recommendation

Knowledge representation and reasoning, Constraint based recommenders, Case based recommenders, Persistent Personalization in Knowledge-Based Systems, Conversational Recommendation. Search based recommendation, Navigation-based recommendation.

Unit-V 07 Hrs.

Ensembled- Based and Hybrid Recommendation System

Opportunities for hybridization, Monolithic hybridization design: Feature combination, Feature augmentation, Parallelized hybridization design: Weighted, Switching, Mixed, Pipelined hybridization design: Cascade Meta level, Limitations of hybridization strategies.

Unit-VI 07 Hrs.

Evaluating Recommendation System:

Evaluation Paradigms, General Goals of Evaluation Design, Design Issues in Offline Recommender Evaluation, Online Recommender evaluation techniques. Comparison between evaluation design of classification model and recommendation system, Error metrics, Decision-Support metrics, User Centered metrics. Comparative analysis between different types of recommendation systems.

Recommendation Systems Laboratory (RCP23APE313L)
List of Laboratory Experiments (Any 10)

1. Build a Recommendation Engine with Item-Based Collaborative Filtering.
2. Build a Recommendation Engine with User-Based Collaborative Filtering.
3. Build Content-based recommendation engine on different datasets.
4. Build Recommender System using association rule mining.
5. Implement Recommendation System using K-Nearest Neighbors
6. Build Context-Aware Recommender Systems.
7. Build Constraint-based Recommenders.
8. Implement knowledge-based recommender system.
9. Implement a Monolithic hybridization design.
10. Evaluate the recommendation system with evaluation matrix.
11. Compare the performance of different recommender systems.
12. Recommendation System Using Matrix Factorization:Implement SVD (Singular Value Decomposition).
13. Hybrid Recommendation System: Combine collaborative and content-based filtering.
14. Mini Project.

Oral examination will be based on the entire syllabus including, the practicals performed during laboratory sessions.

Text Books:

1. C.C. Aggarwal, "Recommender Systems: The Textbook", Springer, 1 st Edition, 2016.

2. Sachi Nandan Mohanty, Jyotir Moy Chatterjee, Sarika Jain, Ahmed A. Elngar, Priya Gupta "Recommender System with Machine Learning and Artificial Intelligence" Oreilly Publication, 2020.

3. Jannach D., Zanker M. and FelFering A., "Recommender Systems: An Introduction",Cambridge University Press, 1st Edition, 2011.

4. Ricci, F., Rokach, L., & Shapira, B.,Introduction to Recommender Systems Handbook. Springer, Boston, MA 2011.

Reference Books:

1. M.D. Ekstrand, J.T. Riedl, J.A. Konstan, "Collaborative filtering recommender systems", Now publishers, 1^{st} Edition, 2011.

2. J. Leskovec, A. Rajaraman and J. Ullman, "Mining of massive datasets", Cambridge, 2^{nd} Edition, 2012.

3. Rounak Banik, "Hands-On Recommendation Systems with Python: Start building", Ingram short title, 2018.

4. P. Pavan Kumar, S. Vairachilai, Sirisha Potluri, "Recommender Systems: Algorithms and Applications", CRC Press, 1^{st} Edition, 2021.

5. Kim Falk, "Practical Recommender Systems", Manning, 1^{st} Edition, 2019

6. Rounak Banik, "Hands-On Recommendation Systems with Python: Start building powerful and personalized, recommendation engines with Python", 2018.

Web Links:

1. Udemy course on Recommender Systems and Deep Learning in Python: https://realpython.com/build-recommendation-engine-collaborative-filtering.

2. Coursera course on Recommender Systems Specialization: https://www.coursera.org/specializations/recommender-systems

3. http://www.iem.iitkgp.ac.in/eco/Recommender_Systems/

4. https://www.coursera.org/specializations/recommender-systems

5. https://www.udemy.com/course/recommender-systems/

6. https://www.analyticsvidhya.com/blog/2021/08/developing-acourse-recommendersystem- using-python

Program: Artificial Intelligence and Machine Learning	T. Y. B.Tech.	Semester: V
Computer Network (RCP23AMD301)		

Pre-requisite: Statistics for Data Science, and Machine Learning – I.

Course Objectives:

1. To Master the principles of computer networking across all layers, from physical to application, including modern technologies like 5G.
2. Develop proficiency in network design, protocols, and problem-solving techniques for various networking scenarios.

Course Outcomes: On completion of the course, the learner will be able to:

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Explain the Demonstrate the concepts of data communication at physical layer and compare ISO - OSI model & TCP/IP model.	L2	Understand
CO2	Explain the fundamental concepts of the Data Link Layer and analyze different MAC protocols.	L2	Understand
CO3	Design IP addressing schemes and implement routing solutions.	L6	Create
CO4	Analyze various transport layer, application layer protocols.	L4	Analyze

Computer Network (RCP23AMD301)
Course Contents

Unit-I 06 Hrs.

Introduction to Networking: Introduction to computer network, network application, network software and hardware components, Network topology, design issues for the layers. Reference models: Layer details of OSI, TCP/IP models.

Unit-II 06 Hrs.

Physical Layer: Introduction to Digital Communication System: Guided Transmission Media: Twisted pair, Coaxial, Fiber optics. Unguided media: Bluetooth. Data Encoding techniques.

Unit-III 08 Hrs.

Data Link Layer: DLL Design Issues (Services, Framing, Error Control, Flow Control), Error Detection and Correction (Hamming Code, Parity, CRC, Checksum), Elementary Data Link protocols: Stop and Wait, Sliding Window (Go Back N, Selective Repeat), HDLC Medium Access Control Sublayer: Channel Allocation problem, Multiple Access Protocol (Aloha, Carrier Sense Multiple Access (CSMA/CA, CSMA/CD).

Unit-IV 10 Hrs.

Network Layer: Network Layer design issues, Communication Primitives: Unicast, Multicast, Broadcast. IPv4 Addressing (Classfull and Classless),IPv4 Protocol, Network Address Translation (NAT), IPv6.

Routing algorithms: Link state routing, Distance Vector Routing.

Routing Protocols:ARP,RARP, ICMP, IGMP, RIP, OSPF.

Congestion control algorithms: Open loop congestion control, Closed loop congestion control, Token Leaky bucket algorithms.

Unit-V 06 Hrs.

Transport Layer: The Transport Service, Port Addressing, Transport service primitives, Berkeley Sockets, Connection management (Handshake, Teardown), UDP, TCP, TCP Congestion Control: Slow Start.

Unit-VI 06 Hrs.

Application Layer: Hypertext Transfer Protocol (HTTP) , SMTP, POP3, IMAP (Internet Message Access Protocol) ,Telnet, File Transfer Protocol (FTP), DHCP, Domain Name System (DNS).

Text Books:

1. C.C. 1. A.S. Tanenbaum, Computer Networks, 6^{th} edition Pearson Education, 2020
2. 2B.A. Forouzan, Data Communications and Networking with TCP/IP Protocol Suite,6^{th}edition, TMH, 2022
3. James F. Kurose, Keith W. Ross, Computer Networking, A Top-Down Approach Featuring the Internet, 6^{th} edition, Pearson, 2017
4. David Hanes, Jerome Henry, Rob Barton, Gonzalo Salgueiro and Patrick Grossetete, IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things, 1/e, 2018

Reference Books:

1. M.D. Behrouz A. Forouzan, Firouz Mosharraf, Computer Networks: A Top-Down Approach, Mc Graw Hill, 2023
2. Dhanashree K. Toradmalle, Computer Networks and Network Design, Wiley, 2020.

Web resources:

1. https://www.netacad.com/courses/networking/networking-essentials
2. https://www.coursera.org/learn/computer-networking.
3. https://www.edx.org/course/introduction-to-networking.

Online Courses: NPTEL / Swayam:

1. https://nptel.ac.in/courses/106/105/106105081.
2. https://nptel.ac.in/courses/106105183.
3. https://onlinecourses.swayam2.ac.in/cec21$_c$s04/*preview*.

Program: Artificial Intelligence and Machine Learning	T. Y. B.Tech.	Semester: V
Programming Laboratory-III (Full Stack Development Using NextJs)(RCP23AMD302L)		

Pre-requisite: Basic knowledge of JavaScript, React.js, and fundamental database concepts

Course Objectives:

1. Understand Next.js App Router architecture and its optimizations over the traditional Pages Router.
2. Learn to build full-stack web applications utilizing React Server Components (RSC) and type-safe data handling.
3. Implement Server Actions, Route Handlers, progressive streaming, and advanced caching paradigms.
4. Integrate production-ready, type-safe authentication and role-based access control using Better Auth.
5. Seamlessly connect relational (PostgreSQL/MySQL) and NoSQL databases via modern ORMs and ODM clients.
6. Apply performance configurations using Next.js core optimization components and metadata API.
7. Deploy modern full-stack production builds with Edge middleware, secure environment variables, and modern cloud hosting engines.

Course Outcomes: On completion of the course, the learner will be able to:

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Explain Next.js App Router compilation, Server-vs-Client component trees, and hydration.	L2	Understand
CO2	Formulate full-stack architectures utilizing Server Actions for data mutations and secure backend state tracking.	L6	Create
CO3	Execute secure authorization and multi-tenant session validation via Better Auth and Next.js Proxy/Middleware layers.	L6	Create
CO4	Deploy data-driven endpoints connecting relational platforms via Prisma ORM and object databases via Mongoose.	L6	Create

Programming Laboratory-III (Full Stack Development Using NextJs)(RCP23AMD302L)
Course Contents

Unit-I 04 Hrs.

Introduction to Next.js & App Router Architecturel

Scaffold projects using modern TypeScript configurations (create-nextapp). Deep-dive into the app/ directory paradigm. File-system routing: page routes, layout inheritance, template files, nested route grouping (group), and dynamic segments [slug]. Compiling React Server Components (RSC) vs Client Components ('use client').

Unit-II 05 Hrs.

Modern UI Engineering & Layout Orchestration

Integrating Tailwind CSS for utility-first responsive web design. Component-level isolated styling using CSS Modules. Architecting persistent state, global root layouts (layout.tsx), structural route-group layouts, and shared structural UI frames across partial rendering boundaries.

Unit-III 05 Hrs.

React Server Components, Server Actions & Streaming

Transition from legacy methods (getStaticProps, getServerSideProps) to asynchronous native fetch data fetching inside Server Components. Caching architectures: Request Memoization, Data Cache (use cache, revalidateTag), and Full Route Cache. Asynchronous UI rendering using loading.tsx and explicit React ¡Suspense¿ streaming boundaries. Implementing data mutations via Server Actions and building standard REST endpoints using App Router Route Handlers (route.ts).

Unit-IV 05 Hrs.

Database Integration (Prisma ORM & Mongoose) Relational engineering: Establishing type-safe database schemas with PostgreSQL/MySQL utilizing Prisma ORM. Generating database clients and managing migrations. Performing advanced CRUD mutations inside Server Actions. Document stores: Connecting to MongoDB using Mongoose schema frameworks, creating collections, and processing document mutations securely.

Unit-V 05 Hrs.

Modern Authentication, Session Control & Security

Setting up Better Auth with a database adapter backend. Configuring multi-provider OAuth (Google and GitHub sign-in flows) and secure Email/Password handling. Multi-tenant application protection:

Session verification using Next.js Proxy layer (proxy.ts). Implementing role-based authorization rules (Admin, User, Guest) to restrict server route access.

Unit-VI 04 Hrs.

Optimization, Edge Layers & Cloud Deployment

SEO engineering: Implementation of static and dynamic SEO tracking via the Metadata API object. Asset optimizations using the next/image pipeline. Configuring modern cloud services (Vercel, Netlify). Setting up decoupled cloud databases (Supabase, PlanetScale). Managing secure deployment context via .env runtime configurations.

Programming Laboratory-III (Full Stack Development Using NextJs)(RCP23AMD302L)
List of Laboratory Experiments (Any 10)

1. Scaffold an App Router environment executing multi-page architectures with deep nested directories, specialized dynamic routes ([id]), and multi-layout route boundaries.
2. Construct a completely responsive dashboards or marketplace UI using modern Tailwind CSS configurations.
3. Build layout compositions using Next.js root layouts and localized sub-layouts to safely maintain state during client-side transitions.
4. Create standard API Route Handlers (route.ts) alongside native React Server Actions to manage data mutations (GET, POST, PUT, DELETE) without traditional API fetch boilerplates.
5. Establish a database layer using Prisma ORM with PostgreSQL/MySQL to wire relationship logic and handle full transactional operations.
6. Write operational schemas for an e-commerce catalog tracking system connecting Next.js with MongoDB through a Mongoose modeling structure.
7. Implement secure social authentication using Better Auth with Google and GitHub providers on a Next.js platform.
8. Build strict multi-role permission layers (Admin/User/Guest) by utilizing Next.js 16 proxy.ts middleware validation to block unauthorized server data access.
9. Optimize content performance scoring by writing dynamic SEO metadata objects and implementing asset-responsive next/image blocks.
10. Deploy an optimized application bundle live onto Vercel or Netlify, utilizing secure environment contexts mapping back to a remote Supabase or PlanetScale instance.

11. Edge Runtime Deployment with Geolocation-Aware Routing.
12. Containerizing Next.js via Docker for Self-Hosted Infrastructure.
13. Environment Variable Scoping: Securing Backend Keys vs. Public Client Tokens.
14. Database Connection Pooling for Serverless Functions using Supabase or Neon.

Practical and Oral examination will be based on the entire syllabus including, the practicals performed during laboratory sessions.

Text Books:

1. Michele Riva, "Real-World Next.js: Build scalable, high-performance, and modern web applications using Next.js", Packt Publishing, 2022.
2. Kartik Bhat, "Ultimate Tailwind CSS Handbook: Build sleek and modern websites", 2023

Reference Book:

1. Larson, J. (2024). Full-Stack Web Development with Next.js: Modern techniques for building type-safe applications with App Router, Prisma, and TypeScript Packt Publishing Ltd.

Web Links:

1. Next.js Official Docs (App Router Specification): https://nextjs.org/docs
2. Better Auth Core Documentation: https://better-auth.com/docs
3. Prisma Object-Relational Mapping Reference: https://www.prisma.io/docs

NPTEL and Coursera Courses:

Course Code	**Course Name**	**Institute / Instructor**	**Link**
106105182	Software Engineering	IIT Kharagpur	https://nptel.ac.in/courses/106105182
Coursera	IBM Full Stack Software Developer Professional Certificate	IBM	https://www.coursera.org/professionalcertificates/ibm-full-stack-cloud-developer
Coursera	The Complete React 19 Developer Course (incl.Next.js 16) Specialization	Packt	https://www.coursera.org/specializations/packtthe-complete-react-19-developer-course-inclnext- js-16

Program: Artificial Intelligence and Machine Learning	T. Y. B.Tech.	Semester: V
Environmental Studies (RCP23XHS331T)		

Pre-requisite: Interest in Environment and its impact on Human Calculus.

Course Objectives:

1. Familiarise students with environment related issues such as depleting resources, pollution, ecological problems and the renewable energy scenario.
2. Give overview of Green Technology options.

Course Outcomes: On completion of the course, the learner will be able to:

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Explain how human activities affect environment.	L2	Understand
CO2	Explain the various technology options that can make a difference.	L2	Understand

Environmental Studies (RCP23XHS331T)
Course Contents

Unit-I Air Pollution — 01 Hr.

Sources of Air pollution. Definition of Air Quality Index and how it is measured.

Unit-II Water Pollution — 01 Hr.

Sources of water pollution. Ground water pollution and eutrophication.

Unit-III Noise Pollution — 01 Hr.

Noise pollution and sources. Decibel limits for hospital, library, silence zone.

Unit-III Noise Pollution — 01 Hr.

Noise pollution and sources. Decibel limits for hospital, library, silence zone.

Unit-IV Biodiversity loss — 01 Hr.

Value of Biodiversity. Endangered species.

Unit-V Deforestation — 01 Hr.

Product and services provided by forests. Relationship between forests and climate change.

Unit-VI Renewable Energy sources — 01 Hr.

Our energy needs and global energy crisis. Renewable energy sources.

Unit-VII Climate change — 01 Hr.

Greenhouse gases and climate change.

Unit-VIII Green Technology — 01 Hr.

Data Center Energy Efficiency, Thin-Client and Energy Efficiency.

Environmental Studies (RCP23XHS331T)
List of Tutorials

1. Case study on Smog.
2. Presentation on Water Pollution (Industrial, Sewage) explaining any specific case.

3. List effects of noise pollution on human health. Measure decibel level in college library, canteen, classroom

4. Case study on effect of pollution on Biodiversity loss.

5. Debate for and against to promote Economic Growth Deforestation is required.

6. Presentation on different Renewable Energy Technologies.

7. Report on major impact of Global warming on Environment giving real examples.

8. Report on advantages and examples of Green Building for Sustainable development, Sustainable Software Design.

Text Books:

1. R. Rajagopalan, "Environmental Studies From Crisis to Cure", 2012.

2. Textbook for Environmental Studies For Undergraduate Courses of all Branches of Higher Education, Erach Bharucha.

3. Mohammad Dastbaz, Colin Pattinson, Babak Akhgar, Morgan and Kaufman, "Green Information Technology A Sustainable Approach", Elsevier, 2015.

Reference Books:

1. Paulina Golinska, Marek Fortsch, Jorge Marx-Gómez, "Information Technologies in Environmental Engineering: New Trends and Challenges", Springer, 2011.

Websites:

1. CITES: www.cites.org

2. Convention on Biological Diversity: www.biodiv.org

3. Kalpvriksh: www.kalpvriksh.org

4. Water pollution: http://en.wikipedia.org/wiki/Water_pollution

4. Ecosan: www.eco-solutions.org .

Program: Artificial Intelligence and Machine Learning	T. Y. B.Tech.	Semester: V
Semester Project-III (RCP23XSC301P)		

Course Objectives:

Students are expected to design, simulate/implement a project based on the knowledge acquired from current semester subjects.

Course Outcomes: On completion of the course, the learner will be able to:

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Conduct a survey of several available literatures in the preferred field of study.	L4	Analyze
CO2	Demonstrate various/alternate approaches to complete a project.	L2	Understand
CO3	Ensure a collaborative project environment by interacting and dividing project work among team members.	L3	Apply
CO4	Present their project work in the form of a technical report / paper and thereby improve the technical communication skill.	L3	Apply
CO5	Demonstrate the ability to work in teams and manage the conduct of the research study.	L2	Understand

Semester Project:

The purpose of semester project is to provide exposure to students with a variety of projects based on the knowledge acquired from the semester subjects. This activity is supposed to enrich their academic experience and bring enough maturity in student while selecting the project. Students should take this as an opportunity to develop skills in implementation, presentation and discussion of technical ideas/topics. Therefore, proper attention shall be paid to the content of semester project report which is being submitted in partial fulfillment of the requirements of the Third Year and it is imperative that a standard format be prescribed for the report.

Each student shall work on project approved by departmental committee approved by the Head of Department, a group of 03 to 05 students (max allowed: 5 students in extraordinary cases, subject to the approval of the department committee and the Head of the department) shall be allotted for each Semester Project. Each group shall submit at least 3 topics for the Semester Project. The departmental committee shall finalize one topic for every group. Semester Project Title or Theme should be based on knowledge acquired during semester. The project work shall involve sufficient work so that students get acquainted with different aspects of knowledge acquired from semester subjects.

Student is expected to:

- Select appropriate project title based on acquired knowledge from current semester subjects.
- Maintain Log Book of weekly work done(Log Book Format will be as per Table 1).
- Report weekly to the project guide along with log book.

Assessment Criteria:

- At the end of the semester, after confirmation by the project guide, each project group will submit project completion report in prescribed format for assessment to the departmental committee (including project guide).
- Assessment of the project (at the end of the semester) will be done by the departmental committee (including project guide).

Prescribed project report guidelines:

Size of report shall be of minimum 25 pages. Project Report should include appropriate content for:

- Introduction
- Literature Survey
- Related Theory
- Implementation details

- Project Outcomes
- Conclusion
- References

Assessment criteria for the departmental committee (including project guide) for Continuous Assessment:

Guide will monitor weekly progress and marks allocation will be as per Table 2.

Assessment criteria for the departmental committee (including project guide) for End Semester Exam:

Departmental committee (including project guide) will evaluate project as per Table 3.

Each group shall present/publish a paper based on the semester project in reputed/peer reviewed Conference/Journal/TechFest/Magazine before end of the semester.

Table 1: Log Book Format

Sr	Week (Start Date:End Date)	Work Done	Sign of Guide	Sign of Coordinator
1				
2				

Table 2: Continuous Assessment Table

Sr	Exam Seat No	Name of Student	Student Attendance	Log Book Maintenance	Literature Review	Depth of Understanding	Report	Total
			5	5	5	5	5	25

Table 3: Evaluation Table

Sr	Exam Seat No	Name of Student	Project Selection	Design/ Simulation/ Logic	Hardware/ Programming	Result Verification	Presentation	Total
			5	5	5	5	5	25

Program: Artificial Intelligence and Machine Learning	T. Y. B.Tech.	Semester: V
App Development with AI and Flutter (RCP23ASC301)		

Pre-requisite: Web development, OOP concepts.

Course Objectives:

1. To integrate AI-driven assistants (like Google Gemini) into the software development lifecycle to accelerate coding, debugging, and app optimization.
2. To introduce the foundational concepts of the Dart programming language and Object-Oriented Programming principles.
3. To familiarize learners with the Flutter framework and its toolchain for building cross-platform mobile applications.
4. To develop skills in designing interactive user interfaces using Flutter widgets, state management, and routing.
5. To provide hands-on experience in building, testing, and deploying a functional, multi-page application that consumes external APIs. .

Course Outcomes: On completion of the course, the learner will be able to:

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Integrate AI tools, such as Gemini, into the application development workflow to assist with code generation, debugging, and optimization.	L6	Create
CO2	Configure the Flutter development environment and apply core Object-Oriented Programming principles using the Dart programming language.	L6	Create
CO3	Design and implement interactive, cross-platform user interfaces utilizing fundamental Flutter widgets, navigation, and routing.	L6	Create
CO4	Build and structure a complete, multi-page mobile application capable of fetching and processing data from external web APIs.	L6	Create

App Development with AI and Flutter (RCP23ASC301)
Course Contents

Unit-I Gemini for Application Developers 04 Hrs.

Develop an app with Gemini assistance, Introducing Gemini for application developers, Mini Project I: an application built based on the concepts learned.

Unit-II Introduction to Flutter and Dart 03 Hrs.

Introduction to Flutter, Flutter Development Environment, Comparison of Flutter with Other Mobile Frameworks, Flutter Toolchain, SDK, and Tools, Introduction to Flutter Utilities, Basics of Dart.

Unit-III Exploring Dart Language 03 Hrs.

Internals of Dart, The Fundamentals of Dart, Variables and Types, Functions and Methods in Dart, Classes in Dart, Libraries in Dart, Command Line and Utilities.

Unit-IV Working with Flutter 05 Hrs.

Development Process of Flutter Apps, Widgets, Interaction and Forms, Navigation, Routing, Implementing Styles.

Unit-V Building a Flutter Application 05 Hrs.

Mini Project II: Build a multi-page app that fetches web API data. Utilize the common flutter widgets for layouts, images and other media.

Online Course:

1. Gemini for Application Developers - https://www.coursera.org/learn/gemini-for-application developers
2. Flutter and Dart: Developing iOS, Android, and Mobile Apps https://www.coursera.org/learn/flutter-and-dart-developing-ios-android-mobile-apps

Useful Courses:

1. Flutter & Dart Complete App Development Course Specialization - https://www.coursera.org/specializations/packt-flutter-dart-complete-app-development course
2. Apply Flutter App Development From Beginner to Advanced Specialization - https://www.coursera.org/specializations/google-flutter-app-development-beginner advanced