Annexure AC / 5.10

**GANGA INSTITUTE OF TECHNOLOGY AND MANAGEMENT, KABLANA (JHAJJAR)**
**An Autonomous Institute**

**'A' GRADE ACCREDITED BY NAAC**

# Evaluation Scheme and Syllabus For

# Bachelor of Technology Computer Science and Engineering-Artificial Intelligence and Machine Learning (B.Tech CSE-AIML)

# (Effective from the Session: 2026-27)

**APPROVED BY AICTE, NEW DELHI AND AFFILIATED TO MDU, ROHTAK**

## 1. DEFINITION OF CREDIT

| | | |
|---|---|---|
| 1 | 1 Lecture (L) per week | 1 Credit |
| 2 | 1 Tutorial (T) per week | 1 Credit |
| 3 | 2 Practical (P) per week | 1 Credit |
| 4 | 2 Seminar/Industrial Training per week | 1 Credit |

## 2. RANGE OF CREDIT

A range of credits from 160 to 180 is required for the award of an Undergraduate Degree in Engineering. A student will be eligible to get Under Graduate degree with Honours or additional Minor Engineering, if he/she completes an additional 18-20 credits. These could be acquired through MOOCs.

## 3. STRUCTURE OF UNDERGRADUATE ENGINEERING PROGRAM (B.TECH)

| Sr. No. | Category | Breakup of Credits |
|---|---|---|
| 1 | Professional Core Courses | 73* |
| 2 | Professional Elective Courses (Relevant to chosen specialization/branch) | 12* |
| 3 | Engineering Science Courses | 26* |
| 4 | Basic Science Courses | 21* |
| 5 | Humanities and Social Sciences including Management courses | 12* |
| 6 | Multidisciplinary Open Electives Courses | 9* |
| 7 | Project work, seminar and internship in industry or appropriate work place/academic and research institutions in India/abroad | 16* |
| 8 | Value Added Courses | 01* |
| 9 | Mandatory Courses | Non Credit |
| | **Total Credits** | 170* |

*****_Minor variation is allowed as per need of the respective disciplines_

## 4. COURSE CODE AND DEFINITIONS

| Sr. No. | Category | Course Code |
|---|---|---|
| 1 | Professional Core Courses | PCC |
| 2 | Professional Elective Courses | PEC |
| 3 | Engineering Science Courses | ESC |
| 4 | Basic Science Courses | BSC |
| 5 | Humanities and Social Sciences including Management courses | HSMC |
| 6 | Multidisciplinary Open Electives Courses | MOEC |
| 7 | Value Added Courses | VAC |
| 8 | Project | PR |
| 9 | Mandatory Courses | MC |
| 10 | Lab Courses | LC |
| 11 | Practical Training | PT |
| 12 | Internship | INT |

**General Notes:**

1. Students will be required to obtain passing marks in Mandatory Non-Credit Courses.
2. Students will be allowed to use non programmable scientific calculator. However, sharing of calculator will not be permitted in the examination.
3. Students will be permitted to opt for any elective course run by the department. However, the department shall offer those electives for which they have expertise. The choice of the students for any elective shall not be binding for the department to offer, if the department does not have expertise. To run the elective course a minimum of 1/3rd students of the class should opt for it.

# GANGA INSTITUTE OF TECHNOLOGY AND MANAGEMENT, KABLANA, JHAJJAR (HR.)

## Scheme of Studies and Examination

## B.Tech Computer Science and Engineering-Artificial Intelligence and Machine Learning (B.Tech CSE-AIML) – 5th Semester

## *w.e.f.* 2026-27

| Sr. No. | Category | Course Code | Course Title | Hours per week | | | Total Load Per Week | Credits | Examination Schedule (Marks) | | | | Exam Duration in H |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | | Assessment | End Semester Examination | | Total | |
| | | | | | | | | | | Theory | Practical | | |
| 1 | Professional Core Courses | AI-301A | Machine Learning | 3 | 1 | 0 | 4 | 4 | 40 | 60 | | 100 Marks | 3 |
| 2 | Professional Core Courses | AI-303A | Fuzzy Logic and Soft Computing | 3 | 0 | 0 | 3 | 3 | 40 | 60 | | 100 Marks | 3 |
| 3 | Professional Core Courses | AI-305A | Pattern Recognition | 3 | 0 | 0 | 3 | 3 | 40 | 60 | | 100 Marks | 3 |
| 4 | Professional Core Courses | CSE-305A | Design and Analysis of Algorithms | 3 | 0 | 0 | 3 | 3 | 40 | 60 | | 100 Marks | 3 |
| 5 | Engineering Science Courses | ECE-002A | Mobile and Wireless Communications | 3 | 0 | 0 | 3 | 3 | 40 | 60 | | 100 Marks | 3 |
| 6 | Professional Elective Courses | Refer Table-II | Professional Elective-II | 3 | 0 | 0 | 3 | 3 | 40 | 60 | | 100 Marks | 3 |
| 7 | Professional Core Courses | AI-L301A | Machine Learning Lab | 0 | 0 | 2 | 2 | 1 | 25 | | 25 | 50 | 3 |
| 8 | Professional Core Courses | AI-L303A | Fuzzy Logic and Soft Computing Lab | 0 | 0 | 2 | 2 | 1 | 25 | | 25 | 50 | 3 |
| 9 | Professional Core Courses | AI-L305A | Pattern Recognition Lab | 0 | 0 | 2 | 2 | 1 | 25 | | 25 | 50 | 3 |
| 10 | Professional Core Courses | CSE-L305A | Design and Analysis of Algorithms Lab Using C++ | 0 | 0 | 2 | 2 | 1 | 25 | | 25 | 50 | 3 |
| 11 | Practical Training | PT-301A | Practical Training-I | 0 | 0 | 2 | 0 | 0 | - | | - | - | - |
| **Total Credits** | | | | | | | | **23** | | | | **800** | |

***Note:***

I. Students must choose one course from the Professional Elective–II category (Table II). They may also opt for Massive Open Online Courses (MOOCs) offered through the SWAYAM, SWAYAM Plus, or NPTEL platforms, subject to the approval of the concerned Chairperson, Board of Studies/Head of the Department.

II. Assessment of Practical Training will be based on seminar, viva-voce, report and certificate of practical training obtained by the student from the Industry/ Institute/ Professional Organization/ Research Laboratory/ training center etc.. Students required getting passing marks otherwise, He / She will be required to repeat practical training-I.

**Table II: Professional Elective - II**

| Sr. No. | Course Code | Course Title |
|---|---|---|
| 1 | CSE-301A | Computer Networks |
| 2 | CSE-315A | Data Warehouse and Mining |
| 3 | AI-307A | DevOps Overview |
| 4 | AI-309A | AI Ethics and Responsible AI |
| 5 | ---------- | Any one of the MOOCs (offered through SWAYAM, SWAYAM Plus, or NPTEL platforms) not studied earlier and of equal credits (3)* |

# GANGA INSTITUTE OF TECHNOLOGY AND MANAGEMENT, KABLANA, JHAJJAR (HR.)

## Scheme of Studies and Examination

## B.Tech Computer Science and Engineering-Artificial Intelligence and Machine Learning (B.Tech CSE-AIML) – 6th Semester

## *w.e.f.* 2026-27

| Sr. No. | Category | Course Code | Course Title | Hours per week | | | Total Load Per Week | Credits | Examination Schedule (Marks) | | | | Exam Duration in H |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | | Assessment | End Semester Examination | | Total | |
| | | | | | | | | | | Theory | Practical | | |
| 1 | Professional Core Courses | AI-001A | Neural Networks | 3 | 1 | 0 | 4 | 4 | 40 | 60 | | 100 Marks | 3 |
| 2 | Professional Core Courses | AI-302A | Recommender Systems | 3 | 0 | 0 | 3 | 3 | 40 | 60 | | 100 Marks | 3 |
| 3 | Professional Core Courses | CSE-002A | Big Data Analytics | 3 | 0 | 0 | 3 | 3 | 40 | 60 | | 100 Marks | 3 |
| 4 | Professional Core Courses | AI-304A | Reinforcement Learning | 3 | 0 | 0 | 3 | 3 | 40 | 60 | | 100 Marks | 3 |
| 5 | Professional Elective Courses | Refer Table-III | Professional Elective-III | 3 | 0 | 0 | 3 | 3 | 40 | 60 | | 100 Marks | 3 |
| 6 | Multidisciplinary Open Elective Courses | Refer Table-IV | Multidisciplinary Open Elective-I | 3 | 0 | 0 | 3 | 3 | 40 | 60 | | 100 Marks | 3 |
| 7 | Professional Core Courses | AI-L001A | Neural Networks Lab | 0 | 0 | 2 | 2 | 1 | 25 | | 25 | 50 | 3 |
| 8 | Professional Core Courses | AI-L302A | Recommender Systems Lab | 0 | 0 | 2 | 2 | 1 | 25 | | 25 | 50 | 3 |
| 9 | Professional Core Courses | CSE-L002A | Big Data Analytics Lab | 0 | 0 | 2 | 2 | 1 | 25 | | 25 | 50 | 3 |
| 10 | Mandatory Courses (Non-Credit) | MC-301A | Constitution of India | 2 | 0 | 0 | 2 | - | 40 | 60 | | | 3 |
| **Total Credits** | | | | | | | | **22** | | | | **750** | |

***Note:***

I. MC-301A is a mandatory non –credit course in which the students will be required passing marks in theory. However these marks will not be added in the total marks.

II. Students must choose one course from the Professional Elective–III category (Table III) and one course from the Open Elective–I category (Table IV). They may also opt for Massive Open Online Courses (MOOCs) offered through the SWAYAM, SWAYAM Plus, or NPTEL platforms, subject to the approval of the concerned Chairperson, Board of Studies/Head of the Department.

III. At the end of 6th semester each student has to undergo Practical Training of 4/6 weeks in an Industry/ Institute/ Professional Organization/ Research Laboratory/ training centre etc. and submit typed report along with a certificate from the organization & its evaluation shall be carried out in the 7th Semester. Assessment of Practical Training will be based on seminar, viva-voce, report and certificate of practical training obtained by the student from the Industry/ Institute/ Professional Organization/ Research Laboratory/ training center etc.

IV. **For Working Professionals:** Students shall submit a Training/Project Report based on their work in their respective company/organization for the period of the summer/industrial training. The evaluation shall be carried out in the 7th Semester.

**Table III: Professional Elective - III**

| Sr. No. | Course Code | Course Title |
|---|---|---|
| 1 | CSE-303A | Formal Languages and Automata |
| 2 | AI-306A | Explainable AI |
| 3 | AI-308A | Swarm Intelligence |
| 4 | CSE-308A | Digital Image Processing |
| 5 | ---------- | Any one of the MOOCs (offered through SWAYAM, SWAYAM Plus, or NPTEL platforms) not studied earlier and of equal credits (3)* |

***Note:*** Students have to select any one course from the above list, provided that the course has not been studied earlier

**Table IV: Multidisciplinary Open Elective-I**

| Sr. No. | Code | Subject | Offered by | Departments Eligible to Choose the Course |
|---|---|---|---|---|
| 1 | OEC-01A | Engineering Ethics | Department of Electronics and Communication Engineering | All Engineering Departments |
| 2 | OEC-02A | Waste Management | Department of Civil Engineering | All Engineering Departments except the Department of Civil Engineering |
| 3 | OEC-03A | Internet of Things and Edge Computing | Department of Computer Science and Engineering | All Engineering Departments |
| 4 | OEC-04A | Project Management | Department of Mechanical Engineering | All Engineering Departments |
| 5 | OEC-05A | Renewable Energy Resources | Department of Electrical Engineering | All Engineering Departments |
| 6 | OEC-06A | United Nation's Sustainable Development Goals | Department of Electronics and Communication Engineering | All Engineering Departments |
| 7 | OEC-07A | Computer Aided Risk Analytics | Department of Fire Technology and Safety | All Engineering Departments |
| 8 | OEC-08A | Health, Safety and Environment | Department of Fire Technology and Safety | All Engineering Departments except the Department of Fire Technology and Safety |
| 9 | OEC-09A | Fundamentals of Additive Manufacturing | Department of Mechanical Engineering | All Engineering Departments except the Department of Mechanical Engineering |
| 10 | ---------- | MOOCs offered through SWAYAM, SWAYAM Plus, or NPTEL platforms | Online Platforms | All Engineering Departments |

| | | | | | |
|---|---|---|---|---|---|
| Course Code | **AI-301A** | | | | |
| Category | Professional Core Courses | | | | |
| Course Title | **Machine Learning** | | | | |
| Scheme and Credits | **L** | **T** | **P** | **Credits** | **Semester-V (Common for B. Tech. CSE/ CSE-AIML/CSE-DS)** |
| | **3** | **1** | **0** | **4** | |
| Course Objectives | The objectives of this course are<br>• To provide knowledge of machine learning concepts, techniques, and applications.<br>• To develop understanding of data preprocessing, feature engineering, and dimensionality reduction methods.<br>• To enable application of machine learning algorithms for prediction and pattern discovery.<br>• To develop analytical skills for evaluating and improving machine learning models. | | | | |
| Assessment | 40 Marks | | | | |
| End Semester Examination | 60 Marks | | | | |
| Total | 100 Marks | | | | |
| Duration of Exam | 03 Hours | | | | |

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

| **COs** | **Skills Demonstrated** | **RBT Level** |
|---|---|---|
| CO1 | Define machine learning concepts, learning paradigms, techniques, and applications. | Level 1: Remember |
| CO2 | Explain data preprocessing, feature representation, dimensionality reduction, and learning methodologies. | Level 2: Understand |
| CO3 | Apply machine learning algorithms to solve classification, prediction, and clustering problems. | Level 3: Apply |
| CO4 | Analyze machine learning models using appropriate performance measures and evaluation techniques. | Level 4: Analyze |

**Note:** Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (preferably 2 from each unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

**Unit-I**

**Introduction to Machine Learning:** Definition, History, Need, Features, Block diagrammatic representation of learning machines, Classification of Machine Learning: Supervised learning, Unsupervised learning, Reinforcement Learning, Machine Learning life cycle, Applications of Machine Learning.

**Unit-II**

**Dimensionality reduction**: Definition, Row vector and Column vector, how to represent a dataset, how to represent a dataset as a Matrix, Data preprocessing in Machine Learning: Feature Normalization, Mean of a data matrix, Column Standardization, Co-variance of a Data Matrix, Principal Component Analysis for Dimensionality reduction

## Unit-III

**Supervised Learning:** Definition, how it works, Types of Supervised learning algorithms k - Nearest Neighbours, Naïve Bayes, Decision Trees, Naive Bayes, Linear Regression, Logistic Regression, Support Vector Machines, Generalized Linear Models, Non-linearity and Kernel Methods

## Unit-IV

**Unsupervised Learning:** Clustering: K-means. Ensemble Methods: Boosting, Bagging, Random Forests.
**Evaluation**: Performance measurement of models in terms of accuracy, confusion matrix, precision & recall, F1-score, receiver Operating Characteristic Curve (ROC) curve and AUC, Median absolute deviation (MAD), Distribution of errors

**Suggested Readings:**


1. Introduction to machine learning by E. Alpaydin.
2. The Elements of Statistical Learning Data Mining, Inference, and Prediction by T Hastie, R Tibshirani and J Friedman, 2nd Edition, Springer, 2009.
3. Pattern Recognition and Machine Learning by C. M. Bishop, Springer, 2010.
4. Pattern Classification by R. O. Duda, P. E. Hart, and D.G. Stork, John Wiley and Sons, 2012.
5. Networks and Learning Machines by Simon O. Haykin, Neural, Pearson Education, 2016.


**Useful Video Links:**

| Unit No | Topics | Links |
|---|---|---|
| **Unit-I** | Introduction to Machine Learning | https://youtu.be/fC7V8QsPBec?si=EIpHubT-jNunHaMI |
| | Supervised Learning | https://youtu.be/OTAR0kT1swg?si=RfDSfvDNG8eWYbMS |
| | Unsupervised Learning | https://youtu.be/HTSCbxSxs-g?si=_ZIAGWXSR_0GADAU |
| | Reinforcement Learning | https://youtu.be/9vMpHk44XXo?si=mDfGQrhR3JnBraBD |
| **Unit-II** | Dimensionality Reduction: Principal Component Analysis (PCA) & kernel PCA | https://www.youtube.com/watch?v=YepECGlOl4Y |
| | Introduction to Data Preprocessing | https://www.youtube.com/watch?v=cO6lrQuepcs |
| **Unit-III** | Types of supervised learning | https://www.youtube.com/watch?v=5NSKURYzU70 |
| | Linear Regression | https://youtu.be/_M7Km1XZERU?si=NoLgPErLdkv6frY4 |
| | Logistic Regression | https://youtu.be/g__LURKuIj4?si=JtwGguSfsh_KnguR |
| **Unit-IV** | Unsupervised Learning & K-means | https://www.youtube.com/watch?v=FeVrAK77mV8 |
| | The ROC Curve | https://www.youtube.com/watch?v=6RjcFVm_k4c |

| Course Code | **AI-303A** | | | | |
|---|---|---|---|---|---|
| Category | Professional Core Courses | | | | |
| Course Title | **Fuzzy Logic & Soft Computing** | | | | |
| Scheme and Credits | **L** | **T** | **P** | **Credits** | **Semester-V** |
| | **3** | **0** | **0** | **3** | |
| Course Objectives | The objectives of this course are<br>• To recall basics of soft computing, fuzzy logic, ANN, and GA.<br>• To understand working principles of fuzzy systems, neural networks, and GA.<br>• To apply soft computing methods to real-world problems.<br>• To analyze and compare soft computing techniques for decision-making and optimization. | | | | |
| Assessment | 40 Marks | | | | |
| End Semester Examination | 60 Marks | | | | |
| Total | 100 Marks | | | | |
| Duration of Exam | 03 Hours | | | | |

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

| **COs** | **Skill Demonstrated** | **RBT Level** |
|---|---|---|
| CO1 | Recall basic concepts of soft computing, fuzzy sets, neural networks, and genetic algorithms. | Level 1: Remember |
| CO2 | Explain principles of fuzzy logic, neural networks, genetic algorithms, and their basic operations. | Level 2: Understand |
| CO3 | Apply soft computing techniques such as fuzzy logic, ANN, and genetic algorithms for solving engineering and real-world problems. | Level 3: Apply |
| CO4 | Analyze and compare different soft computing techniques including fuzzy systems, neural networks, genetic algorithms, and neuro-fuzzy systems for optimization and decision-making. | Level 4: Analyze |

**Note:** Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (2 from each unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

## Unit-I

**Introduction To Soft Computing:** Aims of Soft Computing, Foundations of Fuzzy Sets Theory, Basic Concepts and Properties of Fuzzy Sets, Elements of Fuzzy Mathematics, Fuzzy Relations, Fuzzy Logic.
**Application Of Fuzzy Sets:** Applications of Fuzzy Sets, Fuzzy Modeling, Fuzzy Decision Making, Pattern Analysis and Classification-Fuzzy Control Systems, Fuzzy Information Processing, Fuzzy Robotics.

## Unit-II

**Artificial Neural Networks:** Artificial Neural Networks, Models of Neuron-Networks, Architecture of Feed Forward Neural Networks, Recurrent Neural Networks, Learning methods-supervised and unsupervised learning, Time Delay Neural Networks, Radial Basis Function Neural Networks, Adaptive Resonance Theory (ART) Neural Networks, Associative Neural Memory Models, and Application of ANN.

## Unit-III

**Genetic Algorithms:** Main Operators- Genetic Algorithm Based Optimization, Principle of Genetic Algorithm, Genetic Algorithm with Directed Mutation, Comparison of Conventional and Genetic Search Algorithms Issues of GA in practical implementation. Introduction to Particle swarm optimization, PSO operators-GA and PSO in engineering applications.

## Unit-IV

**Neuro-Fuzzy Technology:** Fuzzy Neural Networks and their learning, Architecture of Neuro-Fuzzy Systems, Generation of Fuzzy Rules and membership functions, Fuzzification and Defuzzyfication in Neuro-Fuzzy Systems, Neuro-Fuzzy Identification, Neuro Fuzzy Control, Combination of Genetic Algorithm with Neural Networks, Combination of Genetic Algorithms and Fuzzy Logic, Neuro-Fuzzy and Genetic Approach in engineering applications.
**Programming Using MATLAB:** Using Neural Network toolbox, Using Fuzzy Logic toolbox, Using Genetic Algorithm & directed search toolbox.

**Suggested Readings:**


1. Soft Computing and Its Applications by Rafik A. Aliev and Rashad R. Aliev, World Scientific Publishing Co. Pvt. Ltd., 2001.
2. Elements of Artificial Neural Networks by Kishan Mehrotra, Chilukuri K. Mohan and Sanjay Ranka, The MIT Press, 1997.
3. Neuro fuzzy and soft computing by Juh Shing Roger Jang,Cheun Tsai Sun,Eiji Mizutani, Prentice Hall, 1997.
4. An Introduction to fuzzy logic applications in intelligent Systems by Ronald R.Yager, Lofti Zadeh, Kluwer Academic, 1992.
5. Genetic Fuzzy Systems: Evolutionary Tuning and Learning of Fuzzy Knowledge Bases by by Oscar Cordón, Francisco Herrera, Frank Hoffmann and Luis Magdalena, World Scientific Publishing Co. Pvt. Ltd., 2001.


**Useful Video links:**

| Unit No. | Topic | Link |
|---|---|---|
| **Unit-I** | Introduction to Fuzzy Sets | https://youtu.be/IZWTduVCrf8?si=LdwFv-uYpwQRZy5B |
| | Applications of Fuzzy Sets | https://youtu.be/aVsPJYxyq04?si=MHgjQyAInniTv18N |
| **Unit-II** | Introduction to Artificial Neural Network | https://youtu.be/xbYgKoG4x2g?si=bHn3rcaIYtGOhGoi |
| | Supervised Learning | https://youtu.be/OTAR0kT1swg?si=DyWLkQx945vqURM5 |
| **Unit-III** | Genetic Algorithm | https://youtu.be/THSNf9mPsmA?si=Tv8f2tYD8e3gAuWv |
| | Particle swarm optimization | https://youtu.be/8dpYjgRskgQ?si=RPTIGAGsn3Jgv63- |
| **Unit-IV** | Fuzzy Neural Networks | https://youtu.be/xwUKQcT1bKc?si=kKCAVYKpuYynuKJD |
| | Programming using MATLAB | https://youtu.be/IuEOMyGuuIg?si=9yQJfwrUxSx9qrrX |

| Course code | **AI-305A** | | | | |
|---|---|---|---|---|---|
| Category | Professional Core Courses | | | | |
| Course title | **Pattern Recognition** | | | | |
| Scheme and Credits | L | T | P | **Credits** | **Semester-V** |
| | 3 | 0 | 0 | **3** | |
| Course Objectives | The objectives of this course are<br>• To provide knowledge of pattern recognition concepts, pattern representation, and classification methods.<br>• To develop understanding of statistical classification, feature extraction, and dimensionality reduction techniques.<br>• To enable application of classification and clustering techniques to pattern recognition problems.<br>• To develop analytical abilities for evaluating pattern recognition methods and classifier performance. | | | | |
| Assessment | 40 Marks | | | | |
| End Semester Examination | 60 Marks | | | | |
| Total | 100 Marks | | | | |
| Duration of Exam | 03 Hours | | | | |

**Course Outcomes:** After studying this course, the students will be able to

| COs | Skills Demonstrated | RBT Level |
|---|---|---|
| **CO1** | Define pattern recognition concepts, feature representation methods, classification principles, and clustering techniques. | Level 1: Remember |
| **CO2** | Explain statistical classification, feature extraction, dimensionality reduction, and clustering methods. | Level 2: Understand |
| **CO3** | Apply classification, feature reduction, and clustering techniques to pattern recognition problems. | Level 3 : Apply |
| **CO4** | Analyze pattern recognition methods and classifier performance. | Level 4: Analyze |

**Note:** Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (preferably 2 from each unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

**Unit-I**

**Introduction to Pattern Recognition**: Introduction to pattern recognition, pattern recognition systems, patterns and feature vectors, feature space, pattern representation, supervised and unsupervised learning, training and testing of classifiers, pattern recognition system design cycle, applications of pattern recognition.
**Distance and similarity measures:** Euclidean distance, Manhattan distance and Mahalanobis distance. Nearest neighbour classifier and K-nearest neighbour classifier.

**Unit-II**

**Statistical Pattern Classification:** Introduction to statistical decision theory, Bayesian decision theory, Bayes classifier, discriminant functions, decision regions and decision boundaries, minimum error rate classification. Normal density and Gaussian distribution, classification using normal distributions, linear and quadratic discriminant functions, basics of maximum likelihood estimation.

## Unit-III

**Feature Selection and Dimensionality Reduction:** Introduction to features, feature extraction and feature selection, characteristics of good features, need for dimensionality reduction, curse of dimensionality. Principal Component Analysis (PCA), Linear Discriminant Analysis (LDA), Fisher's linear discriminant, feature normalization and applications of dimensionality reduction.

## Unit-IV

**Clustering and Performance Evaluation:** Introduction to clustering, similarity and distance measures in clustering, K-means clustering, hierarchical clustering, agglomerative clustering, single-linkage and complete-linkage methods.
**Classifier performance evaluation:** confusion matrix, accuracy, precision, recall and F1-score. Applications of pattern recognition in image recognition, speech recognition, handwriting recognition and biometric systems.

**Suggested Readings:**


1. Pattern Classification by Duda, R. O., Hart, P. E. and Stork, D. G., Wiley.
2. Pattern Recognition and Machine Learning by Bishop, C. M., Springer.
3. Pattern Recognition by Theodoridis, S. and Koutroumbas, K., Academic Press.
4. Fundamentals of Digital Image Processing by Jain, A. K., Prentice Hall.


**Useful Video Links**

| Unit No. | Topics | Links |
|---|---|---|
| Unit-I | Introduction to Pattern Recognition | https://youtu.be/mfePdDh9t6Q?si=diJuH1bWaf5DUE1V |
| | Pattern Recognition Systems and Applications | https://youtu.be/U5xsX2ersHQ?si=koZ0h1YYQ2uqjStW |
| | Distance and Similarity Measures | https://youtu.be/mfePdDh9t6Q?si=5iMUbc2cPJYAkkmm |
| | K-NN Classification | https://youtu.be/2ATqoglcHus?si=1z6lyIIMfJ4bXP6d |
| Unit-II | Bayesian Decision Theory and Bayes Classifier | https://youtu.be/Z66_2_VG_k8?si=uphWtWTOkpWqAlMx |
| | Discriminant Functions and Decision Boundaries | https://youtu.be/FLyEbVawmvU?si=9uVX4E6P9aZiBAm7 |
| | Maximum Likelihood Estimation | https://youtu.be/0QbjCAK4ijw?si=7BHBrTHgRqYzzcal |
| Unit-III | Feature Selection and Dimensionality Reduction | https://youtu.be/0P9gUYQ38cI?si=hsaAr7Yu9ouuEtF7 |
| | Principal Component Analysis (PCA) | https://youtu.be/0P9gUYQ38cI?si=cP6hEnfNCWXAaPZd |
| Unit-IV | Introduction to Clustering | https://youtu.be/UUu9CG4fndk?si=9hjpBlQj6Nj7I08A |
| | K-Means Clustering | https://youtu.be/sU8YC4urd-w?si=jCHmiRBGeYr5342B |

| Course Code | **CSE-305A** | | | | |
|---|---|---|---|---|---|
| Category | Professional Core Courses | | | | |
| Course Title | **Design and Analysis of Algorithms** | | | | |
| Scheme and Credits | L | T | P | **Credits** | **Semester-V (Common for B. Tech. CSE/CSE-AIML/CSE-DS)** |
| | 3 | 0 | 0 | **3** | |
| Course Objectives | The objectives of this course are<br>• To provide knowledge of algorithm design techniques and complexity analysis.<br>• To develop understanding of algorithmic paradigms and optimization methods.<br>• To enable application of algorithms for solving computational problems.<br>• To develop analytical skills for evaluating algorithm efficiency and complexity. | | | | |
| Assessment | 40 Marks | | | | |
| End Semester Examination | 60 Marks | | | | |
| Total | 100 Marks | | | | |
| Duration of Exam | 03 Hours | | | | |

**Course Outcomes:** After studying this course, the students will be able to

| **COs** | **Skills Demonstrated** | **RBT Level** |
|---|---|---|
| CO1 | Define algorithm design concepts, complexity measures, design paradigms, and computational problem classes. | Level 1: Remember |
| CO2 | Explain algorithmic strategies, optimization techniques, and complexity concepts used in problem solving. | Level 2: Understand |
| CO3 | Apply appropriate algorithm design techniques to solve computational and optimization problems. | Level 3: Apply |
| CO4 | Analyze algorithms and computational problems based on correctness, efficiency, and complexity. | Level 4: Analyze |

**Note:** Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (preferably 2 from each unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

**Unit-I**

**Introduction to Algorithms**: Algorithm, Performance Analysis (Time and Space complexity), Asymptotic Notation (Big OH, Omega and Theta)-best, average and worst-case behaviour.
**Divide and Conquer:** General method, Binary Search, Merge Sort, Quick Sort, and other sorting algorithms with divide and conquer strategy, Strassen's Matrix Multiplication algorithms.

**Unit-II**

**Greedy Method:** General method, Fractional Knapsack problem, Job Sequencing with Deadlines, Minimum Cost Spanning Trees, Single source shortest paths.
**Dynamic Programming**: General method, Optimal Binary Search Trees, 0/1 knapsack, The Travelling Salesperson problem.

## Unit-III

**Back Tracking:** General method, The 8-Queen's problem, Sum of subsets, Graph Colouring, Hamiltonian Cycles. Branch and Bound: The method, 0/1 knapsack problem, Travelling Salesperson problem, Efficiency considerations.

## Unit-IV

**NP Hard and NP Complete Problems**: Basic concepts, Cook's theorem, NP hard graph problems, NP hard scheduling problems, NP hard code generation problems, and Some simplified NP hard problems.

**Suggested Readings:**


1. Fundamental of Computer algorithms, Ellis Horowitz and Sartaj Sahni, 1978, Galgotia Publication.
2. Introduction to Algorithms, Thomas H Cormen, Charles E Leiserson and Ronald Lrivest: 1990, TMH.
3. The Design and Analysis of Computer Algorithm, Aho A.V. Hopcroft J.E ., 1974, Addison Wesley.
4. Introduction to Design and Analysis of Algorithm, Goodman, S.E. & Hedetnieni, 1997, MGH.


**Useful Video links:**

| Unit No. | Topic | Link |
|---|---|---|
| **Unit-I** | Asymptotic Notation | https://youtu.be/EL9T1ngiCqA?si=oaMBKNhfiIOODUlM |
| | Divide and Conquer Paradigm | https://youtu.be/xdD0nIWe0wA?si=P3DQs80dHBg3-aiM |
| **Unit-II** | Minimum Cost Spanning Tree | https://youtu.be/k9jemw3SZe0?si=93sq4N5-AjF-oVhy |
| | Knapsack Problem | https://youtu.be/-Cg-aL1D8CM?si=MSMQTKSaPqcNuZME |
| **Unit-III** | Sum of subsets | https://youtu.be/yDjadhjQ3eE?si=-6NQH4xIHYqemNp6 |
| | Traveling Salesman Problem | https://youtu.be/-cLsEHP0qt0?si=-asPYE1zbCTMokLK |
| **Unit-IV** | Cook's theorem | https://youtu.be/qpCvPS-WwGA?si=CswYDncPrmCi3b_W |
| | NP Complete Problems | https://youtu.be/id7k6gUkZ8Y?si=fCSY5t-XMgUKzPi1 |

| Course Code | **AI-L301A** | | | | |
|---|---|---|---|---|---|
| Category | Professional Core Courses | | | | |
| Course Title | **Machine Learning Lab** | | | | |
| Scheme and Credits | L | T | P | **Credits** | **Semester-V (Common for B. Tech. CSE/CSE-AIML/CSE-DS)** |
| | 0 | 0 | 2 | **1** | |
| Course Objectives | The objectives of this course are:<br>• To understand and implement basic machine learning algorithms for classification and prediction tasks.<br>• To apply clustering and recommendation techniques for pattern discovery and personalized suggestions.<br>• To perform dimensionality reduction and optimization using PCA and Gradient Descent techniques.<br>• To develop and evaluate advanced machine learning models using Artificial Neural Networks (ANN). | | | | |
| Assessment | 25 Marks | | | | |
| End Semester Practical Examination | 25 Marks | | | | |
| Total | 50 Marks | | | | |
| Duration of Exam | 03 Hours | | | | |

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

| **COs** | **Skills Demonstrated** | **RBT Level** |
|---|---|---|
| CO1 | Understand the fundamental concepts of machine learning, including types of learning, basic algorithms, and model building techniques. | Level 2: Understand |
| CO2 | Apply machine learning algorithms to implement solutions for classification, regression, and clustering problems using appropriate techniques. | Level 3: Apply |
| CO3 | Apply data preprocessing, feature selection, and dimensionality reduction techniques for effective data analysis and model improvement. | Level 3: Apply |
| CO4 | Analyze the performance of machine learning models using evaluation metrics and optimize models for better accuracy and efficiency. | Level 4: Analyze |

**List of Experiments:**

| **Sr. No.** | **Contents** | **COs** |
|---|---|---|
| 1 | Study the basic concepts of Machine Learning. | CO1 |
| 2 | Write a program to implement Linear Regression for predicting continuous target values based on given input features. | CO2 |
| 3 | Write a program to implement Logistic Regression for binary classification of a dataset. | CO2 |
| 4 | Write a program to implement K-Nearest Neighbors (KNN) algorithm for classification problems. | CO2 |
| 5 | Write a program to implement Decision Tree classifier for predicting outcomes based on input data. | CO3 |
| 6 | Write a program to implement Random Forest algorithm for classification and regression tasks. | CO4 |
| 7 | Write a program to implement Support Vector Machine (SVM) for classification of data points. | CO3 |
| 8 | Write a program to implement Naive Bayes classifier for text or categorical data classification. | CO3 |

| | | |
|---|---|---|
| 9 | Write a program to implement K-Means clustering algorithm for grouping similar data points. | CO3 |
| 10 | Write a program to implement Principal Component Analysis (PCA) for dimensionality reduction. | CO3 |
| 11 | Write a program to implement Gradient Descent algorithm for optimizing a machine learning model. | CO4 |
| 12 | Write a program to implement Artificial Neural Network (ANN) for classification or prediction tasks. | CO4 |
| 13 | Write a program to implement a Recommender System using collaborative filtering technique. | CO4 |

**Note:** At least 10 experiments are to be performed by the students. Faculty members can add 2-3 extra experiment if they feel useful to add.

**Useful Video Links:**

| **Experiment Name** | **Virtual Lab Link** |
|---|---|
| Implement Random Forest for Multi-Class Classification | https://www.youtube.com/watch?v=5ONlGP0Nx3Q |
| Gradient Descent | https://www.youtube.com/watch?v=JA5rIxOve20 |
| Principal Component Analysis (PCA) | https://www.youtube.com/watch?v=hkCT-6KJAK0 |
| K-Means Clustering | https://www.youtube.com/watch?v=oFr4JX75MCc |

| Course Code | **AI-L303A** | | | | |
|---|---|---|---|---|---|
| Category | Professional Core Courses | | | | |
| Course Title | **Fuzzy Logic and Soft Computing Lab** | | | | |
| Scheme and Credits | L | T | P | **Credits** | **Semester-V** |
| | 0 | 0 | 2 | **1** | |
| Course Objectives | The objectives of this course are<br>● To understand fuzzy logic concepts and neural network fundamentals.<br>● To apply MATLAB tools for fuzzy systems and neural network implementation.<br>● To analyze learning algorithms and pattern classification techniques.<br>● To evaluate the performance of fuzzy inference and neural network models. | | | | |
| Assessment | 25 Marks | | | | |
| End Semester Practical Examination | 25 Marks | | | | |
| Total | 50 Marks | | | | |
| Duration of Exam | 03 Hours | | | | |

**Course Outcomes:** After studying this course, the students will be able to

| **COs** | **Skills Demonstrated** | **RBT Level** |
|---|---|---|
| CO1 | Understand fuzzy set operations, membership functions, and basic neural network concepts using MATLAB implementations. | Level 2: Understand |
| CO2 | Apply fuzzy logic operations, FIS tools, and neural network models to solve computational problems using MATLAB. | Level 3: Apply |
| CO3 | Apply MATLAB tools and neural network techniques to design FIS editors, HebbNet models, and associative neural networks. | Level 3: Apply |
| CO4 | Analyze learning algorithms such as Hebbian learning, perceptron learning, and backpropagation for pattern storage and classification tasks.. | Level 4: Analyze |

**List of Experiments**

| **Sr. No.** | **Content** | **COs** |
|---|---|---|
| 1 | Study the basics of Fuzzy logic and Soft Computing. | CO1 |
| 2 | Write a program in MATLAB to perform Union, Intersection and Complement operations. | CO2 |
| 3 | Write a program in MATLAB to implement De-Morgan's Law. | CO2 |
| 4 | Write a program in MATLAB to plot various membership functions. | CO2 |
| 5 | Write a program to implement FIS Editor. | CO3 |
| 6 | Generate ANDNOT function using McCulloch-Pitts neural net by MATLAB program. | CO3 |
| 7 | Write a MATLAB program for Perceptron net for an AND function with bipolar inputs and targets | CO2 |

| | | |
|---|---|---|
| 8 | Write a M-file to calculate the weights for the following patterns using hetero associative neural net for mapping four input vectors to two output vectors | CO2 |
| 9 | Write an M-file to store vector [-1 -1 -1 -1] and [-1 -1 1 1] in an auto-associative net. Find weight matrix. Test the net with [1 1 1 1] as input. | CO2 |
| 10 | Find weight matrix and bias of HebbNet to classify two-dimensional input patterns. | CO3 |
| 11 | Generate XOR function using back propagation algorithm. | CO3 |

**Note:** At least 10 experiments are to be performed by the students. Faculty members can add 2-3 extra experiments under topic beyond syllabus.

**Virtual Lab Links:**

| **Experiment Name** | **Virtual Lab Link** |
|---|---|
| MATLAB Programming for Numerical Computation | https://youtu.be/IuEOMyGuuIg?si=F5_Wr1ojbsbujdsL |
| De Morgan's Laws | https://youtu.be/I8WdCozPTeQ?si=XuPBtzShDueSLvTa |
| McCulloch-Pitts neural net | https://youtu.be/UN3PqUjSoNQ?si=B-sameTHUWq3lzpz |

| Course Code | **AI-L305A** | | | | |
|---|---|---|---|---|---|
| Category | Professional Core Courses | | | | |
| Course Title | **Pattern Recognition Lab** | | | | |
| Scheme and Credits | L | T | P | **Credits** | **Semester-V** |
| | 0 | 0 | 2 | **1** | |
| Course Objectives | The objectives of this course are<br>• To develop understanding of pattern representation and distance measures.<br>• To provide practical exposure to pattern classification techniques.<br>• To develop skills in dimensionality reduction and clustering techniques.<br>• To develop analytical skills for evaluating pattern recognition methods. | | | | |
| Assessment | 25 Marks | | | | |
| End Semester Practical Examination | 25 Marks | | | | |
| Total | 50 Marks | | | | |
| Duration of Exam | 3 Hours | | | | |

**Course Outcomes:** After studying this course, the students will be able to

| COs | Skills Demonstrated | RBT Level |
|---|---|---|
| CO1 | Explain pattern representation and distance measures through computational experiments. | Level 2: Understand |
| CO2 | Apply classification techniques to pattern recognition problems. | Level 3: Apply |
| CO3 | Apply dimensionality reduction and clustering techniques to pattern datasets. | Level 3: Apply |
| CO4 | Analyze the performance of pattern recognition techniques. | Level 4: Analyze |

**List of Experiments**

| S. No. | Content | COs |
|---|---|---|
| 1. | Study the basic concepts of pattern recognition. | CO1 |
| 2. | Write a Python program to represent patterns as feature vectors and visualize a two-dimensional feature space. | CO2 |
| 3. | Write a Python program to compute Euclidean, Manhattan, and Mahalanobis distances between patterns. | CO2 |
| 4. | Implement Nearest Neighbour and K-Nearest Neighbour classifiers for pattern classification. | CO2 |
| 5. | Implement a Bayes classifier for a two-class pattern classification problem. | CO2 |
| 6. | Implement pattern classification using Gaussian distributions and discriminant functions. | CO2 |

| | | |
|---|---|---|
| 7. | Apply Principal Component Analysis (PCA) for dimensionality reduction and visualize the reduced feature space. | CO3 |
| 8. | Apply Linear Discriminant Analysis (LDA) for dimensionality reduction and classification. | CO2<br>CO3 |
| 9. | Implement K-means clustering for grouping patterns in a dataset. | CO3 |
| 10. | Implement agglomerative hierarchical clustering using single-linkage and complete-linkage methods. | CO3 |
| 11. | Compare the performance of selected classifiers using confusion matrix, accuracy, precision, recall, and F1-score. | CO4 |

**Note:** At least 10 experiments are to be performed by the students. Faculty members can add 2-3 extra experiments under topic beyond syllabus.

**Virtual Lab Links:**

| **Experiment Name** | **Virtual Lab Link** |
|---|---|
| Introduction to Pattern Recognition | https://youtu.be/mfePdDh9t6Q?si=MBIBWQ9bFUz4oUvn |
| Feature Representation | https://cse20-iiith.vlabs.ac.in/exp/feature-representation/ |
| Data Clustering: K-Means, MST-based | https://cse20-iiith.vlabs.ac.in/exp/mst-based/ |
| Generation of Random Variables | https://cse20-iiith.vlabs.ac.in/exp/generation-of-random-variables/ |

| Course Code | **CSE-L305A** | | | | |
|---|---|---|---|---|---|
| Category | Professional Core Courses | | | | |
| Course Title | **Design and Analysis of Algorithms Lab Using C++** | | | | |
| Scheme and Credits | L | T | P | **Credits** | **Semester-V (Common for B. Tech. CSE/ CSE-AIML/CSE-DS)** |
| | 0 | 0 | 2 | **1** | |
| Course Objectives | The objectives of this course are<br>• To develop understanding of algorithm design techniques and complexity analysis.<br>• To provide practical exposure to sorting and graph algorithms.<br>• To develop skills in greedy, dynamic programming, and backtracking techniques.<br>• To develop analytical skills for evaluating algorithm performance. | | | | |
| Assessment | 25 Marks | | | | |
| End Semester Practical Examination | 25 Marks | | | | |
| Total Marks | 50 Marks | | | | |
| Duration of Exam | 03 Hours | | | | |

**Course Outcomes:** After studying this course, the students will be able to

| **COs** | **Skills Demonstrated** | **RBT Level** |
|---|---|---|
| CO1 | Explain algorithm design techniques and complexity concepts. | Level 2: Understand |
| CO2 | Apply divide-and-conquer and graph algorithms to computational problems. | Level 3: Apply |
| CO3 | Apply greedy, dynamic programming, and backtracking techniques to optimization problems. | Level 3: Apply |
| CO4 | Compare the performance of selected algorithms for computational problems. | Level 4: Analyze |

**List of Experiments:**

| **Sr. No.** | **Content** | **COs** |
|---|---|---|
| **1** | Study the basic concepts of algorithm design and analysis of algorithms. | CO1 |
| **2** | Write a C++ Program to perform Quick Sort using Divide & Conquer Technique. | CO2 |
| **3** | Write a C++ program to perform Merge Sort using Divide and Conquer technique and compare its performance with Quick Sort for different input sizes. | CO2<br>CO4 |
| **4** | Write a C++ program to find all-pairs shortest paths using the Floyd–Warshall algorithm and compare its performance with Dijkstra's algorithm for suitable graphs. | CO2<br>CO4 |
| **5** | Write a C++ Program to solve the Knapsack Problem using Greedy Approach. | CO3 |
| **6** | Write a C++ Program for Shortest Path using Dijkstra's Algorithm. | CO2 |
| **7** | Write a C++ Program to find Minimum Spanning Tree using Prim's Algorithm. | CO2 |

| | | |
|---|---|---|
| **8** | Write a C++ Program for Sum of Subsets Problem using Back Tracking. | CO3 |
| **9** | Write a C++ Program to solve Travelling Sales Problem using the Dynamic Programming Approach. | CO3 |
| **10** | Write a C++ program to solve the N-Queen Problem using Backtracking and analyze the effect of increasing board size on execution time. | CO3<br>CO4 |
| **11** | Write a Program to Check whether a given graph is connected or not using DFS method. | CO2 |

**Note:** At least 10 experiments are to be performed by the students. Faculty members can add 2-3 extra experiments under topic beyond syllabus.

**Virtual Lab Links:**

| **Experiment Name** | **Virtual Lab Link** |
|---|---|
| Write a C++ Program to perform Quick Sort using Divide & Conquer Technique. | https://ds1-iiith.vlabs.ac.in/exp/quick-sort/quick-sort/index.html |
| Write a C++ Program for Shortest Path using Dijkstra's Algorithm. | https://ds2-iiith.vlabs.ac.in/exp/dijkstra-algorithm/index.html |
| Write a C++ Program to find Minimum Spanning Tree using Prim's Algorithm. | https://ds2-iiith.vlabs.ac.in/exp/min-spanning-trees/index.html |

| Course Code | **PT-301A** | | | | |
|---|---|---|---|---|---|
| Category | Practical Training | | | | |
| Course Title | **Practical Training-I*** | | | | |
| Scheme and Credits | L | T | P | **Credits** | **Semester-V (Common for B. Tech. CSE/CSE-AIML/CSE-DS)** |
| | 0 | 0 | 2 | 1 | |
| Course Objectives | The objectives of this course are to<br>• Develop practical skills using industry-standard software tools and technologies.<br>• Apply software engineering practices and technical documentation in real-world projects.<br>• Enhance professional communication, teamwork, time management, and ethical practices.<br>• Analyze and solve real-world computing problems using appropriate tools and methodologies. | | | | |
| Assessment | 50 Marks | | | | |
| Total | 50 Marks | | | | |
| Duration of Exam | 03 Hours | | | | |

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

| **COs** | **Skills Demonstrated** | **RBT Level** |
|---|---|---|
| CO1 | Explain industry practices, coding standards, and software development processes. | Level 2: Understand |
| CO2 | Apply computing knowledge and programming skills to solve practical problems. | Level 3: Apply |
| CO3 | Demonstrate effective communication, teamwork, professional ethics, and time management. | Level 3: Apply |
| CO4 | Analyze real-world computing problems and formulate appropriate solutions using collaborative and systematic approaches. | Level 4: Analyze |
| CO5 | Evaluate the application of theoretical concepts, modern technologies, and innovative methodologies to solve practical computing challenges. | Level 5: Evaluate |
| CO6 | Utilize industry-standard tools, frameworks, platforms, and development methodologies for the design, implementation, testing, and deployment of software solutions. | Level 6: Create |

**Note:**

1. Each student has to undergo practical training of 4/6 weeks during summer vacation and its evaluation shall be carried out in the V semester.
2. Assessment of Practical Training will be based on seminar, viva-voce, report and certificate of practical training obtained by the student from the Industry/ Institute/ Professional Organization/ Research Laboratory/ training center etc.

| | | | | | |
|---|---|---|---|---|---|
| Course code | **CSE-301A** | | | | |
| Category | Professional Elective Courses | | | | |
| Course title | **Computer Networks** | | | | |
| Scheme and Credits | L | T | P | **Credits** | **Semester-V (Common for B. Tech. CSE 5th Semester)** |
| | 3 | 0 | 0 | **3** | |
| Course Objectives | The objectives of this course are<br>• To provide fundamental knowledge of computer networking concepts, architectures, communication models, and transmission techniques.<br>• To develop understanding of networking protocols, addressing methods, routing mechanisms, and network services across different layers.<br>• To enable students to apply networking principles and protocols for data communication and problem solving in computer networks.<br>• To develop analytical understanding of network performance, congestion control, QoS, Networking technologies, and security mechanisms. | | | | |
| Assessment | 40 Marks | | | | |
| End Semester Examination | 60 Marks | | | | |
| Total | 100 Marks | | | | |
| Duration of Exam | 03 Hours | | | | |

**Course Outcomes:** After studying this course, the students will be able to

| COs | Skills Demonstrated | RBT Level |
|---|---|---|
| CO1 | Define the fundamental concepts, models, protocols, devices, services, techniques, and security mechanisms of computer networks. | Level 1: Remember |
| CO2 | Explain the principles, operations, functionalities, and interactions of computer networking components, protocols, architectures, and services. | Level 2: Understand |
| CO3 | Apply networking concepts, protocols, algorithms, addressing methods, and security techniques to solve computer networking problems. | Level 3 : Apply |
| CO4 | Analyze network performance, routing, QoS, congestion control, and security mechanisms. | Level 4: Analyze |

**Note:** Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (preferably 2 from each unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

**Unit-I**

**Introduction:** Data communication, Components, Computer networks and its historical development, distributed processing, network performance metrics (bandwidth, throughput, delay, jitter and packet loss), Internet Network **Models:** OSI model and TCP/IP Model.
Physical Layer: physical layer functions, Data Representation, Simplex, Half Duplex and Full Duplex Transmission, Modulation and Multiplexing, Packet and circuit switching, Transmission media, Topologies, connectionless and connection-oriented services.
**Data Link Layer:** Data link layer functions and services, MAC Addressing, Framing, flow control, error detection and correction (parity check, checksum, CRC and Hamming code), Stop and Wait, Go back – N ARQ, Selective Repeat ARQ, Sliding Window Protocol.

**Unit-II**

**Medium Access Control:** MAC layer functions, Random access, Controlled Access and channelization protocols, CSMA/CD and CSMA/CA.

**Network Layer:** Network layer functions and services, Logical addressing, IPv4 classful and classless addressing, subnetting, NAT, IPv4, ICMPv4, ARP, RARP and BOOTP, IPv6, IPv6 addressing, DHCP.
**Network Devices:** Repeater, hub, switch, router and gateway.

**Unit-III**

**Routing Algorithms:** Introduction to routing, Shortest Path Algorithm, Flooding, Hierarchical Routing, Link State and Distance Vector Routing.
**Transport Layer:** Transport layer functions and services, Process to Process Communication, User Datagram Protocol (UDP), Transmission Control Protocol (TCP), TCP connection management.
**Application Layer:** Application layer functions and services, Domain Name Space (DNS), EMAIL, File Transfer Protocol (FTP), HTTP, SNMP.

**Unit-IV**

Congestion Control, Quality of Service, QoS parameters and QoS Improving techniques.
**LAN and Wireless Networks:** Ethernet, Wireless LAN (IEEE 802.11), Wi-Fi architecture, Token Bus, Token Ring, MAN Architecture- DQDB, WAN Architectures- Frame Relay, ATM, SONET/SDH
**Network Security:** Firewalls, security goals, types of attack, Introduction to cryptography, Types of ciphers: symmetric and asymmetric key ciphers.

**Suggested Readings:**


1. Data Communication and Networking by Behrouz A. Forouzan, 4th Edition, McGraw-Hill.
2. Data and Computer Communication by William Stallings, 8th Edition, Pearson Prentice Hall India.
3. Computer Networks by Andrew S. Tanenbaum, 8th Edition, Pearson New International Edition.
4. Internetworking with TCP/IP by Douglas Comer, Volume 1, 6th Edition, Prentice Hall of India.
5. TCP/IP Illustrated by W. Richard Stevens, Volume 1, Addison-Wesley, United States of America.


**Useful Video Links**

| Unit No. | Topics | Links |
|---|---|---|
| Unit-I | Introduction to Computer Networks | https://www.youtube.com/watch?v=lnU-Zw3NEEQ |
| | OSI Model and TCP/IP Model | https://youtu.be/zzXs0EnCin0 |
| | Packet Switching and Circuit Switching | https://youtu.be/29Qdz0FmvmQ?si=Yedvul4uJzmfkDsh |
| Unit-II | Medium Access Control Protocols | https://youtu.be/sx0UPzztC5o?si=VDg2wx1B68gvenjU |
| | Network Layer Introduction | https://youtu.be/aP346youQOk?si=6DRTU5dc1t21Dk_D |
| Unit-III | Routing Algorithms | https://youtu.be/AmlOSGYkKXc?si=87eNMi6RPeTd0FkL |
| | Transport Layer – TCP and UDP | https://youtu.be/EqzDTO9tdqs?si=16VZZu9Oz3IzOeOA |
| Unit-IV | Congestion Control and QoS | https://nptel.ac.in/courses/106105081 |
| | SDH/SONET Layering, Frame Structure | https://youtu.be/f5EmFoXlYyQ?si=8ilxCANj5flH7TP4 |

| Course Code | **CSE-315A** | | | | |
|---|---|---|---|---|---|
| Category | Professional Elective Courses | | | | |
| Course Title | **Data Warehouse and Mining** | | | | |
| Scheme and Credits | L | T | P | **Credits** | **Semester-V(Common for B. Tech. CSE/ CSE-AIML/CSE-DS)** |
| | 3 | 0 | 0 | **3** | |
| Course Objectives | The objectives of this course are<br>● To introduce the fundamentals of data warehousing and data mining.<br>● To provide knowledge of data mining techniques for pattern discovery and classification.<br>● To familiarize students with clustering methods and web data mining concepts.<br>● To develop understanding of techniques and tools for knowledge discovery from large datasets. | | | | |
| Assessment | 40 Marks | | | | |
| End Semester Examination | 60 Marks | | | | |
| Total | 100 Marks | | | | |
| Duration of Exam | 03 Hours | | | | |

**Course Outcomes:** After studying this course, the students will be able to

| **COs** | **Skill Demonstrated** | **RBT Level** |
|---|---|---|
| CO1 | Define concepts and terminology related to data warehousing and data mining. | Level 1: Remember |
| CO2 | Explain data mining techniques, algorithms, and knowledge discovery processes. | Level 2: Understand |
| CO3 | Apply data warehousing and data mining methods to extract useful patterns from data. | Level 3: Apply |
| CO4 | Analyze data mining models, clustering techniques, and web mining approaches for knowledge discovery. | Level 4: Analyze |

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (2 from each unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

**Unit-I**

**Data warehousing:** Introduction, Operational data stores, ETL, Data warehouses – design guidelines for data warehouse implementation, Data warehouse metadata; OLAP – introduction, Characteristics, Multidimensional view and data cube, Data cube operations.

**Unit-II**

**Data mining:** Introduction, association rules mining, Naive algorithm, Apriori algorithm, direct hashing and pruning (DHP), Dynamic Item set counting (DIC), Mining frequent pattern without candidate generation(FP, growth), performance evaluation of algorithms.

**Unit-III**

**Classification:** Introduction, decision tree, tree induction algorithm – split algorithm based on information theory, split algorithm based on Gini index; naïve Bayes method; estimating predictive accuracy of classification method;

classification software, software for association rule mining; case study; KDD Insurance Risk Assessment.

**Unit-IV**

**Cluster analysis:** Introduction, partitional methods, hierarchical methods, and density based methods, dealing with large databases, cluster software.
**Web Data Mining:** Web Terminology and Characteristics, Locality and Hierarchy in the web, Web Content Mining, Web Usage Mining, Web Structure Mining, Web mining Software.

**Suggested Readings:**


1. Data mining concepts and techniques by Han J., Kamber M. and Pei J., Morgan Kaufmann Publishers (2011) 3rd ed.
2. Data Mining by Pudi V., Krishana P.R., Oxford University press, (2009) 1st ed.
3. Data mining by Adriaans P., Zantinge D., Pearson education press (1996), 1st ed.
4. Data Warehousing Fundamentals by Pooniah, Willey interscience Publication, (2001), 1st ed.


**Useful Video links:**

| Unit No. | Topics | Links |
|---|---|---|
| Unit-I | Operational data stores | https://youtu.be/Pd8VqYxNCf8?si=NShU4PrqvsM-Es_K |
| | OLAP | https://youtu.be/m-aKj5ovDfg?si=8A173Dujxn2OHbIL |
| Unit-II | Classification | https://youtu.be/VsYKqOokgaE?si=tNlEdtUANGMbrEuU |
| | Apriori algorithm | https://youtu.be/hEQkqpmtx-Y?si=HlMVIMDBWBhvBegT |
| Unit-IV | Cluster analysis | https://youtu.be/VcPWL9Nlozs?si=Jpshn_ax7FBsQaTH |
| | Density based methods | https://youtu.be/E_SdiZQ23xI?si=hupzFk1EjSNbge4q |

| Course code | **AI-307A** | | | | |
|---|---|---|---|---|---|
| Category | Professional Elective Courses | | | | |
| Course title | **DevOps Overview** | | | | |
| Scheme and Credits | L | T | P | **Credits** | **Semester-V** |
| | 3 | 0 | 0 | **3** | |
| Course Objectives | The objectives of this course are<br>• To introduce software development processes, Agile methodologies, and DevOps principles.<br>• To provide knowledge of continuous integration, continuous delivery, and application deployment practices.<br>• To familiarize with the CAMS framework, infrastructure automation, and application containerization.<br>• To present DevOps tools, monitoring techniques, and contemporary DevOps applications. | | | | |
| Assessment | 40 Marks | | | | |
| End Semester Examination | 60 Marks | | | | |
| Total | 100 Marks | | | | |
| Duration of Exam | 3 Hours | | | | |

**Course Outcomes:** After studying this course, the students will be able to

| COs | Skills Demonstrated | RBT Level |
|---|---|---|
| CO1 | Define software development models, Agile methodologies, DevOps concepts, and the CAMS framework. | Level 1: Remember |
| CO2 | Explain Agile practices, DevOps workflows, continuous integration, continuous delivery, and infrastructure automation. | Level 2: Understand |
| CO3 | Apply DevOps principles, automation practices, and deployment techniques to software development. | Level 3: Apply |
| CO4 | Analyze DevOps workflows, containerization, monitoring approaches, and modern software delivery practices. | Level 4: Analyze |

**Note:** Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (preferably 2 from each unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

## Unit-I

**Traditional Software development Processes:** The Advent of Software Engineering, Waterfall model and other development models, Developers vs IT Operations conflict.

## Unit-II

**AGILE Methodologies:** Agile movement in 2000, Agile Vs Waterfall Method, Iterative Agile Software Development, Individual and team interactions over processes and tools, Working software over, comprehensive documentation, Customer collaboration over contract negotiation, Responding to change over following a plan.

## Unit-III

**DevOps Overview:** Definition and Introduction to DevOps - DevOps and Agile, Purpose of Devops- Minimum Viable Product, Application Deployment, Continuous Integration, Continuous Delivery.

## Unit-IV

**CAMS (Culture, Automation, Measurement and Sharing):** Culture, Automation, Measurement, Sharing, Test-Driven Development, Configuration Management, Infrastructure Automation, Root Cause Analysis, Blamelessness, Organizational Learning, REST API, GraphQL, HTTP/2, Application Containerization, DevOps Tools, Monitoring Tools; Recent applications / Case Studies of DevOps.

**Suggested Readings:**


1. The DevOps Handbook by Gene Kim, Jez Humble, Patrick Debois, and John Willis, O'Reilly Publishers.
2. What is DevOps? by Mike Loukides, O'Reilly Media.
3. Effective DevOps: Building a Culture of Collaboration, Affinity, and Tooling at Scale by Jennifer Davis and Ryn Daniels, O'Reilly Publishers.
4. Practical DevOps by Joakim Verona, O'Reilly Publishers.
5. Building a DevOps Culture by M. Walls, O'Reilly Publications, 2013.
6. Dev Ops for Beginners: Dev Ops Software Development Method guide for software developers and IT professionals by J. Joyner, Mihails Konoplovs, 2015.


**Useful Video Links:**

| Unit No. | Topics | Links |
|---|---|---|
| Unit-I | Traditional Software development Processes | https://youtu.be/Ln_LP7c23WM?si=5sRhM-2qv78ODry2 |
| | Developer vs Operations | https://youtu.be/OJW409Dkpvg?si=DMeXWBsY47EDfVzE |
| Unit-II | Agile Development | https://youtu.be/jRs-aFETAXY?si=VeP4MjVbtLRX7WL3 |
| | Customer collaboration over contract negotiation | https://youtu.be/U0U2yS87WEA?si=sEKdug_8jsU7-SWP |
| Unit-III | Introduction to DevOps | https://youtu.be/2N-59wUIPVI?si=bDihv1hfiwHaeYSU |
| | DevOps and Agile | https://youtu.be/Hv4QGbvrEio?si=4h-O7YX1y2zphPwO |
| Unit-IV | REST API | https://youtu.be/qVTAB8Z2VmA?si=oRzqITCSxvSCfgF4 |
| | Test Driven Development | https://youtu.be/qkblc5WRn-U?si=DMJvDyt55nqERTIl |

| Course code | **AI-309A** | | | | |
|---|---|---|---|---|---|
| Category | Professional Elective Courses | | | | |
| Course title | **AI Ethics and Responsible AI** | | | | |
| Scheme and Credits | **L** | **T** | **P** | **Credits** | **Semester-V** |
| | 3 | 0 | 0 | **3** | |
| Course Objectives | The objectives of this course are<br>● To provide knowledge of ethical principles, governance frameworks, and societal impacts of AI systems.<br>● To develop understanding of fairness, transparency, privacy, accountability, and responsible AI practices.<br>● To enable application of ethical frameworks and responsible AI guidelines in AI development.<br>● To develop analytical abilities for evaluating ethical, legal, and societal implications of AI technologies. | | | | |
| Assessment | 40 Marks | | | | |
| End Semester Examination | 60 Marks | | | | |
| Total | 100 Marks | | | | |
| Duration of Exam | 03 Hours | | | | |

**Course Outcomes:** After studying this course, the students will be able to

| COs | Skills Demonstrated | RBT Level |
|---|---|---|
| CO1 | Define AI ethics concepts, responsible AI principles, governance frameworks, fairness, transparency, and accountability mechanisms. | Level 1: Remember |
| CO2 | Explain ethical challenges, societal impacts, privacy concerns, bias issues, and regulatory aspects of AI systems. | Level 2: Understand |
| CO3 | Apply responsible AI principles, ethical guidelines, and governance frameworks in AI applications. | Level 3: Apply |
| CO4 | Analyze AI systems with respect to fairness, bias, transparency, privacy, accountability, and societal impact. | Level 4: Analyze |

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (preferably 2 from each unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

**Unit-I**

**Introduction:** Ethics of AI, Benefits & risks of artificial intelligence, The singularity, Three Major Singularity Schools, Responsible and safe AI systems: The value alignment problem, Principles for creating safer AI, Algorithmic bias: From discrimination discovery to fairness-aware data mining.

**Unit-II**

**AI and State:** Data, Individuals, and Society: Individuals and society, Fairness and bias, ethics, legality, data collection and public use, Democracy Killer robots, Love Robots, Automation, Self Driving cars, Robots rights, Living with Alien minds, Self-consciousness and super intelligence, Case Study: Rethinking AI Ethics with Data Activism.

**Unit-III**

**AI and Business:** Word Embeddings, facial recognition, prediction algorithm, Disinformation, overfitting, causation vs correlation, Fairness in facial recognition, natural language processing, Case study: Algorithmic Transparency in the Public Sector, Law and Regulation of AI: Global Perspective.

**Unit-IV**

**AI and Society:** Applications, Challenges and Opportunities Understand conceptions of global governance, corporate social responsibility, decision making under risk, and market failures to investigate issues of global justice raised by AI.
**Case Study: AI and Nigeria-** Exploring Threats to Human Rights, AI Ethics in the LAC Region.
**Principles of Responsible AI:** Fairness, Reliability, Safety, Inclusiveness, Accountability, Sustainable and green AI, Responsible deployment of Generative AI and LLMs.

**Suggested Readings:**

1. Superintelligence: Paths, Dangers, Strategies by N. Bostrom, Oxford University Press, 2014.
2. Moral Machines by Wallach, W., Allen, C., Oxford University Press, 2008.
3. The ethics of artificial intelligence by N. Bostrom and E. Yudkowsky, Cambridge University Press, Cambridge, 2014.

**Useful Video Links:**

| Unit No | Topics | Links |
|---|---|---|
| **Unit-I** | Introduction to AI Ethics | https://www.youtube.com/watch?v=mmrlkO4vpts |
| | Responsible and safe AI systems: The value alignment problem | https://youtu.be/phBqlIwJxNQ?si=UJSaa0WlqBoPiAn7 |
| **Unit-II** | Principles, Governance and Regulation | https://www.youtube.com/watch?v=i8aDSaA-srQ |
| **Unit-III** | AI Bias and Fairness | https://www.youtube.com/watch?v=wmyVODy_WD8 |
| **Unit-IV** | AI and Nigeria: Exploring Threats to Human Rights | https://www.youtube.com/watch?v=iii14nWRz38 |

| | | | | | |
|---|---|---|---|---|---|
| Course code | **AI-001A** | | | | |
| Category | Professional Core Courses | | | | |
| Course title | **Neural Networks** | | | | |
| Scheme and Credits | L | T | P | **Credits** | **Semester-VI (Common for B. Tech. CSE-AIML/CSE-DS)** |
| | 3 | 1 | 0 | **4** | |
| Course Objectives | The objectives of this course are<br>● To provide knowledge of artificial neural networks, neuron models, architectures, and activation functions.<br>● To develop understanding of neural network learning mechanisms and computational models.<br>● To enable application of neural network techniques for pattern recognition and problem solving.<br>● To develop analytical abilities for evaluating neural network performance and learning behaviour. | | | | |
| Assessment | 40 Marks | | | | |
| End Semester Examination | 60 Marks | | | | |
| Total | 100 Marks | | | | |
| Duration of Exam | 03 Hours | | | | |

**Course Outcomes:** After studying this course, the students will be able to

| COs | Skills Demonstrated | RBT Level |
|---|---|---|
| CO1 | Define artificial neural network concepts, neuron models, activation functions, architectures, and learning paradigms. | Level 1: Remember |
| CO2 | Explain neural network structures, learning algorithms, associative memories, and training mechanisms. | Level 2: Understand |
| CO3 | Apply neural network models and learning techniques to solve classification, prediction, and pattern recognition problems. | Level 3: Apply |
| CO4 | Analyze neural network performance, learning behaviour, memory models, and training outcomes. | Level 4: Analyze |

**Note:** Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (preferably 2 from each unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

## Unit-I

**Overview of biological neurons**: Structure of biological neuron, neurobiological analogy, Biological neuron equivalencies to artificial neuron model, Evolution of neural network.
**Activation Functions:** Threshold functions, Signum function, Sigmoid function, Tan-hyperbolic function, Stochastic function, Ramp function, Linear function, Identity function.
**ANN Architecture:** Feed forward network, Feed backward network, single and multilayer network, fully recurrent network.

## Unit-II

**McCulloch and Pits Neural Network (MCP Model)**: Architecture, Solution of AND, OR function using MCP model.
**Hebb Model:** Architecture, training and testing, Hebb network for AND function.

**Perceptron Network:** Architecture, training, Testing, single and multi-output model, Perceptron for AND function Linear function, application of linear model, linear separability, solution of OR function using linear separability model.

**Unit-III**

**Learning**: Supervised, Unsupervised, reinforcement learning, Gradient Decent algorithm, generalized delta learning rule, Habbian learning, Competitive learning.
**Back propogation Network:** Architecture, training and testing.

**Unit-IV**

**Associative memory**: Auto associative and Hetero associative memory and their architecture, training (insertion) and testing (Retrieval) algorithm using Hebb rule and Outer Product rule. Storage capacity, Testing of associative memory for missing and mistaken data, Bidirectional memory.

**Suggested Readings:**


1. Neural Networks: A Comprehensive formulation by Simon Haykin, AW, 1998.
2. Neural Networks by Kosko, PHI, 1992.
3. Neural Network Fundamentals by N.K. Bose, P. Liang, T.M.H, 2002.
4. Neural Network by T.N.Shankar, University Science Press.
5. Neuro Fuzzy Systems by Lamba, V.K., University Science Press.


**Useful Video Links:**

| Unit No | Topics | Links |
|---|---|---|
| **Unit-I** | Introduction to Artificial Neural Networks | https://youtu.be/xbYgKoG4x2g?si=iG_Ygz7pTJuCEhIt |
| | Biological and Artificial Neural Network | https://www.youtube.com/watch?v=0aDq6ax6kGQ_ |
| **Unit-II** | Perceptron | https://youtu.be/tRG-OnnQ9g4?si=vE-g2Xx3ldWghw3R |
| | Solution of Non-Linearly Separable Problems | https://youtu.be/Fp33mf3L6AE?si=busfaI5LzLX3QZt9 |
| **Unit-III** | Learning Mechanisms Hebbian,Competitive | https://youtu.be/Zxs-f4HsTDk?si=1YbrAuv_mQaAwAOM |
| **Unit-IV** | Associative memory | https://youtu.be/Ccrw9L1DK4g?si=3KIdlhOk3jZQUmWh |

| Course code | **AI-302A** | | | | |
|---|---|---|---|---|---|
| Category | Professional Core Courses | | | | |
| Course title | **Recommender Systems** | | | | |
| Scheme and Credits | L | T | P | **Credits** | **Semester-VI (Common for B. Tech. CSE-AIML/CSE-DS)** |
| | 3 | 0 | 0 | **3** | |
| Course Objectives | The objectives of this course are<br>• To provide knowledge of recommender system concepts, architectures, similarity measures, and recommendation techniques.<br>• To develop understanding of content-based, collaborative, and trust-based recommendation methods.<br>• To enable application of recommender system techniques for personalized information retrieval.<br>• To develop analytical abilities for evaluating recommendation quality and system effectiveness. | | | | |
| Assessment | 40 Marks | | | | |
| End Semester Examination | 60 Marks | | | | |
| Total | 100 Marks | | | | |
| Duration of Exam | 3 Hours | | | | |

**Course Outcomes:** After studying this course, the students will be able to

| COs | Skills Demonstrated | RBT Level |
|---|---|---|
| CO1 | Define recommender system concepts, architectures, similarity measures, filtering techniques, and evaluation metrics. | Level 1: Remember |
| CO2 | Explain content-based, collaborative, knowledge-based, and trust-based recommendation approaches. | Level 2: Understand |
| CO3 | Apply recommendation techniques, similarity measures, and filtering algorithms to develop personalized recommendation systems. | Level 3: Apply |
| CO4 | Analyze recommender systems using evaluation strategies, trust models, dimensionality reduction techniques, and recommendation performance measures. | Level 4: Analyze |

**Note:** Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (preferably 2 from each unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

## Unit-I

**Introduction to Recommender Systems:** Introduction and basic taxonomy of recommender systems – Traditional and non-personalized Recommender Systems, Overview of data mining methods for recommender systems, similarity measures- Dimensionality reduction – Singular Value Decomposition (SVD), Applications of recommendation systems, Issues with recommender system: The cold-start problem.

## Unit-II

**Content-based Recommender System:** Architecture of Content-based Systems, Advantages and Drawbacks of Content-based Filtering, Content representation and content similarity, Item profiles, discovering features of data, obtaining item features from tags, representing item profiles, Learning User Profiles and Filtering, Similarity-based

retrieval, Classification algorithms, Knowledge base recommendation: Knowledge representation and reasoning, constraint-based recommenders, Case based recommenders.

**Unit-III**

**Collaborative filtering-based Recommender System:** Understanding ratings and rating data, User-based nearest-neighbor recommendation: Similarity Function, User-Based Algorithms Item-based nearest neighbour recommendation: Similarity Function, Item-Based Algorithms, Further model-based and preprocessing-based approaches, Comparing User-Based and Item-Based recommendations.

**Unit-IV**

**Evaluating Recommender Systems:** Introduction, General properties of evaluation research, popular evaluation designs, Evaluation on historical datasets, Alternate evaluation designs. Community-Based Web Search- The Collaborative Web Search System. Shared Web Search - The HeyStaks System, The HeyStaks Recommendation Engine. Social Tagging Recommenders Systems- Folksonomy, The Traditional Recommender Systems Paradigm, BibSonomy as Study Case, Tag Acquisition, Trust and Recommendations- Introduction, Computational Trust, Trust-Enhanced Recommender Systems

**Suggested Readings:**


1. Recommender Systems: An Introduction by Jannach D., Zanker M. and FelFering A, Cambridge University Press, 1st ed., 2011.
2. Recommender Systems Handbook by Ricci F., Rokach L., Shapira D., Kantor B.P., Springer, 1st ed., 2011.
3. Building Recommendation Engines by Suresh Kumar Gorakala, Packt Publishing, 2016.
4. Recommender Systems: The Textbook by Aggarwal, C. C., Springer, 2016.


**Useful Video Links:**

| Unit No. | Topics | Links |
|---|---|---|
| **Unit-I** | Overview of Recommender Systems | https://youtu.be/1JRrCEgiyHM?si=TI92GD7dKaLgUynP |
| | Dimensionality Reduction - Introduction | https://youtu.be/yLdOS6xyM_Q?si=IcKoxrbDJ4PVpRgy |
| **Unit-II** | Content Based Recommendations | https://youtu.be/2uxXPzm-7FY?si=5MOXAIK8XazWx5Em |
| **Unit-III** | Collaborative Filtering | https://youtu.be/h9gpufJFF-0?si=7hmFo4D9QimbfN6g |
| | Implementing Collaborative Filtering | https://youtu.be/6BTLobS7AU8?si=lUZLC1J8GfEiRG1y |
| **Unit-IV** | Evaluating Recommender Systems | https://youtu.be/VZKMyTaLI00?si=cQMi302X8yMgDLV5 |

<table>
<tr><td>Course Code</td><td colspan="5">CSE-002A</td></tr>
<tr><td>Category</td><td colspan="5">Professional Core Courses</td></tr>
<tr><td>Course Title</td><td colspan="5">Big Data Analytics</td></tr>
<tr><td rowspan="2">Scheme and Credits</td><td>L</td><td>T</td><td>P</td><td>Credits</td><td rowspan="2">Semester-VI (Common for B. Tech. CSE/ CSE-AIML/CSE-DS)</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Course Objectives</td><td colspan="5">The objectives of this course are<ul><li>To provide knowledge of big data concepts, architectures, storage models, and analytical frameworks.</li><li>To develop understanding of distributed computing, data processing, and big data technologies.</li><li>To enable application of big data tools and analytics techniques for large-scale data processing.</li><li>To develop analytical abilities for evaluating big data solutions and business insights.</li></ul></td></tr>
<tr><td>Assessment</td><td colspan="5">40 Marks</td></tr>
<tr><td>End Semester Examination</td><td colspan="5">60 Marks</td></tr>
<tr><td>Total</td><td colspan="5">100 Marks</td></tr>
<tr><td>Duration of Exam</td><td colspan="5">03 Hours</td></tr>
</table>

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

| COs | Skills Demonstrated | RBT Level |
|---|---|---|
| CO1 | Define big data concepts, architectures, storage mechanisms, distributed computing models, and analytical frameworks. | Level 1: Remember |
| CO2 | Explain big data processing techniques, distributed systems, analytical methods, and supporting technologies. | Level 2: Understand |
| CO3 | Apply big data tools, frameworks, and analytics techniques for processing and analyzing large datasets. | Level 3: Apply |
| CO4 | Analyze big data solutions, analytical outcomes, scalability issues, and performance considerations. | Level 4: Analyze |

**Note:** Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (preferably 2 from each unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

## Unit I

**Introduction to Big Data:** Big Data: Why and Where, Application and Challenges, Characteristics of Big Data and Dimensions of Scalability, The Six V, Approaches for Analysis of Big Data , Steps in the Data science process, Foundations for Big Data Systems and Programming, Distributed file systems, Role of Data analyst.

## Unit II

**Data Repositories and Big Data Platforms:** RDBMS, NoSQL, Data Marts, Data Lakes, ETL, and Data Pipelines, Introduction to Hadoop Ecosystem, HDFS, Map-Reduce Programming, Understanding Text Analytics and Big Data, Predictive analysis on Big Data, Big Data Processing Tools, Modern Data Ecosystem, Key Players, Types of Data, Understanding Different Types of File Formats, Sources of Data Using Service Bindings.

## Unit-III

**Introduction to Big Data Modeling and Management:** Data Storage, Data Quality, Data Operations, Data Ingestion, Scalability and Security Traditional DBMS and Big Data Management Systems, Real Life Applications, Data Model: Structure, Operations, Constraints, Types of Big Data Model.

## Unit-IV

**Big Data Integration and processing:** Big Data Processing, Retrieving: Data Query and retrieval, Information Integration, Big Data Processing pipelines, Analytical operations, Aggregation operation, High level Operation, Tools and Systems: Big Data workflow Management.

**Suggested Readings:**


1. Big Data Analytics by Seema Acharya, Subhasini Chellappan, Wiley, 2015
2. Intelligent Data Analysis by Michael Berthold, David J. Hand, Springer, 2007.
3. Big Data and Business Analytics by Jay Liebowitz, Auerbach Publications, CRC press.
4. Using R to Unlock the Value of Big Data: Big Data by Tom Plunkett, Mark Hornick.


**Useful Video Links:**

| Unit No. | Topics | Links |
|---|---|---|
| Unit-I | Introduction to Big Data | https://youtu.be/r5k-_RLIpuA?si=YZ1tzhVmP55jhmWb |
| | Application and Challenges, Characteristics of Big Data | https://youtu.be/uhj5oKRqY6w?si=CRZtp1M08PBjKeCp |
| | The Six V, Data Science: Getting Value out of Big Data | https://youtu.be/mI4O4bG39Wo?si=JZndMD7amRilg1Kp |
| | Distributed file systems | https://youtu.be/0QIv4kk18Kg?si=l06ISSB1CsbyLdCi |
| Unit-II | RDBMS, NoSQL, Data Marts, Data Lakes | https://youtu.be/tqD8aVpbD8o?si=7-qLiRcdvOewtMWi |
| | Modern Data Ecosystem, Key Players, Types of Data | https://youtu.be/fBK_58JUICs?si=Y28CXZDcfy-Wz8ri |
| | Sources of Data Using Service Bindings | https://youtu.be/G3OwDpYTJPE?si=73Vts0aP2LzOVewl |
| Unit- III | Data Storage, Data Quality, Data Operations, Data Ingestion | https://youtu.be/0I2QB5Q0EaE?si=TCfP4ypw9QemQbPw |
| | Scalability and Security Traditional DBMS | https://youtu.be/EUzsy3W4I0g?si=HDz2Ah5zVgBeH62O |
| | Data Model: Structure, Operations | https://youtu.be/Z2Zx2G02aI4?si=DQttlY4tIZEolUPD |
| | Types of Big Data Model. | https://youtu.be/-xxCY6WHfRY?si=bdh8TVMHm-dgE2tV |
| Unit- IV | Big Data Processing | https://youtu.be/YEMGK4BPtHc?si=_7PfT1YWyrhd3Jic |
| | Retrieving: Data Query and retrieval, Information Integration | https://youtu.be/DJOaFa8xlrs?si=DulEAUkIEoJKgvy5 |
| | Big Data Processing pipelines, Analytical operations | https://youtu.be/VtzvF17ysbc?si=mmbnnXQ7ZNAbTgvR |
| | Tools and Systems: Big Data workflow Management | https://youtu.be/Pyo4RWtxsQM?si=TXUQ-p45JnwEJTlL |

| **Course Code** | **AI-304A** | | | | |
|---|---|---|---|---|---|
| Category | Professional Core Courses | | | | |
| Course Title | **Reinforcement Learning** | | | | |
| Scheme and Credits | L | T | P | **Credits** | **Semester- VI** |
| | 3 | 0 | 0 | 3 | |
| Course Objectives | The objectives of this course are<br>● To understand the basics of Reinforcement Learning and bandit algorithms.<br>● To analyze Markov Decision Processes and value-based methods.<br>● To apply Monte Carlo, TD learning, Q-learning, and Sarsa algorithms.<br>● To evaluate advanced Reinforcement Learning methods and function approximation**.** | | | | |
| Assessment | 40 Marks | | | | |
| End Semester Examination | 60 Marks | | | | |
| Total | 100 Marks | | | | |
| Duration of Exam | 03 Hours | | | | |

**Course Outcomes:** After studying this course, the students will be able to

| **CO** | **Skill Demonstrated** | **RBT Level** |
|---|---|---|
| CO1 | Recall the basic concepts of Reinforcement Learning, stochastic bandits, Markov Decision Processes, and reward-based learning models. | Level 1: Remember |
| CO2 | Explain the principles of action-value methods, UCB, Thompson Sampling, Bellman equations, and policy evaluation methods. | Level 2: Understand |
| CO3 | Apply reinforcement learning algorithms to solve prediction, control, and decision-making problems in dynamic environments. | Level 3: Apply |
| CO4 | Analyze the convergence, efficiency, and performance of model-based and model-free reinforcement learning techniques. | Level 4: Analyze |

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (2 from each unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

**Unit-I**

**Introduction:** Elements of Reinforcement Learning, Episodic vs Continuous Tasks, The Rewards Hypothesis, Cumulative Reward, Multi-armed Bandits: A k -armed Bandit Problem, Action-value Methods, The 10-armed Testbed, Optimistic Initial Values, Gradient Bandit Algorithms. Basics of probability and linear algebra, Definition of a stochastic multi-armed bandit, Definition of regret, Achieving sublinear regret, UCB algorithm, KL-UCB, Thompson Sampling.

**Unit-II**

**Markov Decision Processes and Dynamic Programming:** Markov Decision Problem, policy, and value function, Reward models (infinite discounted, total, finite horizon, and average), Episodic & continuing tasks, Bellman's optimality operator, and Value iteration &policy iteration.

## Unit-III

**Model-Based and Model-Free Reinforcement Learning:** The Reinforcement Learning problem, prediction and control problems, Model-based algorithm, Monte Carlo methods for prediction, and Online implementation of Monte Carlo policy evaluation, Bootstrapping; TD(0) algorithm; Convergence of Monte Carlo and batch TD(0) algorithms; Model-free control: Q-learning, Sarsa, Expected Sarsa.

## Unit-IV

**Advanced Reinforcement Learning and Function Approximation:** n-step returns; TD(λ) algorithm; Need for generalization in practice; Linear function approximation and geometric view; Linear TD(λ). Tile coding; Control with function approximation; Policy search; Policy gradient methods; Experience replay; Fitted Q Iteration; Case studies**.**

**Suggested Readings:**


1. Reinforcement learning: An introduction by Sutton, Richard S., and Andrew G.Barto, MIT press 2020.
2. Statistical reinforcement learning: modern machine learning approaches by First Edition, Sugiyama, and Masashi. CRC Press 2015.
3. Bandit algorithms by First Edition, Lattimore, T. and C. Szepesvari. Cambridge University Press. 2020.
4. Reinforcement Learning Algorithms: Analysis and Applications by Boris Belousov, Hany Abdulsamad, Pascal Klink, Simone Parisi, and Jan Peters First Edition, Springer 2021.
5. Deep Reinforcement Learning in Action by Alexander Zai and Brandon Brown, First Edition, Manning Publications 2020.


**Useful Video Links:**

| Unit No | Topics | Links |
|---|---|---|
| **Unit-I** | Elements of Reinforcement Learning | https://youtu.be/lfPEJPHUllg?si=ThR6fZ2vW81F9sMw |
| | Thompson Sampling | https://youtu.be/H2OWTxdauqA?si=qzAsejOCNospMrJG |
| **Unit-II** | Markov Decision Problem | https://youtu.be/Zs9MLJnSCWU?si=VvxlSis4TQfVdx3O |
| | Bellman's optimality operator | https://youtu.be/asWQWl59Krg?si=V94m6couFxKQZVZi |
| **Unit-III** | Monte Carlo methods for prediction | https://youtu.be/U7ckRk7g5j0?si=hNqFskD2kBz-TutP |
| | Expected Sarsa | https://youtu.be/hEUOXZNSRcQ?si=jky6z5mdH0nMaHTG |
| **Unit-IV** | TD(λ) algorithm | https://youtu.be/AldBTnsk-us?si=2DDgN3OY3gwC9mbz |
| | Fitted Q Iteration | https://youtu.be/AohtWrJwvgg?si=MifE6YSttzidU1S- |

| Course Code | **AI-L001A** | | | | |
|---|---|---|---|---|---|
| Category | Professional Core Courses | | | | |
| Course Title | **Neural Networks Lab** | | | | |
| Scheme and Credits | L | T | P | **Credits** | **Semester-VI (Common for B. Tech. CSE/ CSE-AIML/CSE-DS)** |
| | 0 | 0 | 2 | **1** | |
| Course Objectives | The objectives of this course are<br>• To introduce the MATLAB environment for designing and simulating neural network models.<br>• To develop understanding of basic neuron models and learning rules such as McCulloch-Pitts and Hebbian learning.<br>• To study and implement various activation functions used in neural networks.<br>• To analyze the effect of weights, bias, and activation functions on neuron behavior.<br>• To implement and evaluate neural network models for solving linearly separable problems and pattern recognition task. | | | | |
| Assessment | 25 Marks | | | | |
| End Semester Practical Examination | 25 Marks | | | | |
| Total | 50 Marks | | | | |
| Duration of Exam | 03 Hours | | | | |

**Course Outcomes:** After studying this course, the students will be able to

| **COs** | **Skills Demonstrated** | **RBT Level** |
|---|---|---|
| CO1 | Explain the MATLAB environment and fundamental concepts of neural networks, including neuron models and activation functions. | Level 2: Understand |
| CO2 | Implement basic neural network models such as McCulloch-Pitts, Hebbian learning, and activation functions using MATLAB. | Level 3: Apply |
| CO3 | Apply neural network concepts to analyze the effect of weights, bias, and activation functions on neuron output. | Level 3: Apply |
| CO4 | Analyze and solve linearly separable problems using Perceptron and Hopfield network models. | Level 4: Analyze |

**List of Experiments:**

| **Sr. No.** | **Content** | **COs** |
|---|---|---|
| 1 | Study and explore the MATLAB environment for neural network design and simulation. | CO1 |
| 2 | Write a program to plot and analyze various activation functions such as threshold, signum, sigmoid, tanh, ramp, and identity. | CO1<br>CO2 |
| 3 | Implement the McCulloch-Pitts (MCP) neuron model with a suitable example. | CO2 |
| 4 | Implement the Hebbian learning model and demonstrate its learning process with an example. | CO2 |
| 5 | Write a program to study basic neuron models and learning algorithms using MATLAB Neural Network Toolbox | CO1<br>CO2 |
| 6 | Write a program to study the effect of weights and bias values on the output of a neuron. | CO3 |
| 7 | Write a program to analyze how different activation functions influence the output of a neuron. | CO3 |
| 8 | Implement a neural network model to solve a linearly separable problem. | CO3<br>CO4 |

| | | |
|---|---|---|
| 9 | Write a program to store a pattern (1 1 1 0). Test the network using Discrete Hopfield Net by giving the input with mistakes in First and Second position. | CO4 |
| 10 | Write a program for solving linearly separable problem using Perceptron Model. | CO3<br>CO4 |

**Note:** At least 10 experiments are to be performed by the students. Faculty members can add 2-3 extra experiments under topic beyond syllabus.

**Virtual Lab Links:**

| **Experiment Name** | **Virtual Lab Link** |
|---|---|
| Linearly separable problem using Perceptron Model. | https://cse22-iiith.vlabs.ac.in/exp/perceptron-learning/simulation.html |
| Test the network using Discrete Hopfield Net | https://cse22-iiith.vlabs.ac.in/exp/pattern-storage-task/simulation.html |
| Basic neuron models and learning algorithms using MATLAB Neural Network Toolbox. | https://cse22-iiith.vlabs.ac.in/exp/pattern-clustering/simulation.html |

| Course Code | **AI-L302A** | | | | |
|---|---|---|---|---|---|
| Category | Professional Core Courses | | | | |
| Course Title | **Recommender Systems Lab** | | | | |
| Scheme and Credits | **L** | **T** | **P** | **Credits** | **Semester-VI** |
| | 0 | 0 | 2 | **1** | |
| Course Objectives | The objectives of this course are<br>• To understand the fundamentals of recommender systems, including content-based, collaborative filtering, hybrid recommendation, user profiling, and item profiling techniques<br>• To explore Python libraries and preprocessing methods for loading, analyzing, cleaning, and visualizing datasets used in recommender systems.<br>• To develop book-based, movie-based, collaborative filtering, and SVD-based recommendation models using Python.<br>• To evaluate and improve recommendation performance using matrix factorization techniques and metrics such as RMSE, MAE, Precision, Recall, and F1-score. | | | | |
| Assessment | 25 Marks | | | | |
| End Semester Practical Examination | 25 Marks | | | | |
| Total | 50 Marks | | | | |
| Duration of Exam | 03 Hours | | | | |

**Course Outcomes:** After studying this course, the students will be able to

| **COs** | **Skills Demonstrated** | **RBT Level** |
|---|---|---|
| CO1 | Identify the concepts and techniques of recommender systems, including content-based, collaborative, hybrid recommendation, user profiling, and item profiling. | Level 2: Understand |
| CO2 | Apply Python libraries and preprocessing methods to load, explore, visualize, and prepare datasets for recommender system development. | Level 3: Apply |
| CO3 | Develop book-based, movie-based, collaborative filtering, and SVD-based recommender systems using Python. | Level 3: Apply |
| CO4 | Analyze and evaluate recommender system performance using metrics such as RMSE, MAE, Precision, Recall, and F1-score. | Level 4: Analyze |

**List of Experiments:**

| **Sr. No.** | **Content** | **COs** |
|---|---|---|
| 1 | Study the basic concepts of Recommender Systems | CO1 |
| 2 | Write a program to create a bar chart for the categories of various books along with their recommendations. | CO2 |
| 3 | Write a program to familiarize students with loading, exploring, and preprocessing datasets required for recommender systems. | CO2 |
| 4 | Write a program for content-based recommendation system in Python. | CO2 |
| 5 | Write a program to create a book-based recommender system. | CO3 |
| 6 | Write a program to create a movie-based recommender system.. | CO3 |
| 7 | Write a program for collaborative filtering using Python. | CO2 |

| | | |
|---|---|---|
| 8 | Write a program for SVD in Python for recommendation system. | CO3 |
| 9 | Write a program to design and implement Hybrid recommender system. | CO2 |
| 10 | Write a program to apply matrix factorization techniques like SVD for improving recommendation accuracy. | CO3 |
| 11 | Write a program to show item profiling and user profiling in recommender system. | CO2 |
| 12 | Write a program to calculate and interpret evaluation metrics such as RMSE, MAE, Precision, Recall and F1- score for assessing recommender system. | CO4 |

**Note:** At least 10 experiments are to be performed by the students. Faculty members can add 2-3 extra experiments under topic beyond syllabus.

**Virtual Lab Links:**

| **Experiment Name** | **Virtual Lab Link** |
|---|---|
| Basic Python Programming Concepts | https://python-iitk.vlabs.ac.in/Introduction.html |
| Collaborative filtering for recommendation systems in Python | https://youtu.be/z0dx-YckFko?si=tVfYnkM5_rRNacDA |
| Book Recommender System | https://www.youtube.com/watch?v=1YoD0fg3_EM |

| Course Code | **CSE-L002A** | | | | |
|---|---|---|---|---|---|
| Category | Professional Core Courses | | | | |
| Course Title | **Big Data Analytics Lab** | | | | |
| Scheme and Credits | L | T | P | **Credits** | **Semester-VI (Common for B. Tech. CSE/ CSE-AIML/CSE-DS)** |
| | 0 | 0 | 2 | **1** | |
| Course Objectives | The objectives of this course are<br>● To provide knowledge of the Hadoop ecosystem, distributed computing, and big data processing frameworks.<br>● To develop understanding of MapReduce, Pig, and Hive for large-scale data analysis.<br>● To enable application of big data tools and techniques for solving data-intensive problems.<br>● To develop analytical abilities for evaluating big data processing methods and outcomes. | | | | |
| Assessment | 25 Marks | | | | |
| End Semester Practical Examination | 25 Marks | | | | |
| Total | 50 Marks | | | | |
| Duration of Exam | 03 Hours | | | | |

**Course Outcomes:** After studying this course, the students will be able to

| **COs** | **Skill Demonstrated** | **RBT Level** |
|---|---|---|
| **CO1** | Explain Hadoop ecosystem components, distributed computing concepts, and big data processing frameworks. . | Level 2: Understand |
| **CO2** | Implement data processing solutions using Hadoop, MapReduce, Pig, and Hive. | Level 3: Apply |
| **CO3** | Apply big data techniques for data analysis, querying, filtering, and clustering tasks. | Level 3: Apply |
| **CO4** | Analyze big data processing algorithms and evaluate their performance for large-scale datasets. | Level 4: Analyze |

**List of Experiments:**

| **Sr. No.** | **Contents** | **COs** |
|---|---|---|
| 1 | Study and configure Hadoop. | CO1 |
| 2 | Implement Word Count using MapReduce. | CO2 |
| 3 | Perform matrix multiplication using MapReduce. | CO2 |
| 4 | Perform relational operations using Pig. | CO2 |
| 5 | Perform database operations using Hive. | CO2 |
| 6 | Implement Bloom Filter using MapReduce. | CO3 |
| 7 | Find frequent item sets using MapReduce. | CO3 |
| 8 | Implement clustering (K-Means) using MapReduce. | CO3 |
| 9 | Implement PageRank algorithm. | CO4 |

| | | |
|---|---|---|
| 10 | Use Hive to create, alter, and drop databases, tables, views, functions, and indexes. | CO4 |

**Note:** 10 experiments are to be performed by the students. Faculty members can add 2-3 extra experiments under topic beyond syllabus.

**Virtual Lab Links:**

| **Experiment Name** | **Virtual Lab Link** |
|---|---|
| Perform relational operations using pig | https://youtu.be/9_Huva3VVAY?si=w-6ETum5NmaC1tea |
| Implement Bloom Filter using MapReduce. | https://youtu.be/bD0Xw4sR8kM?si=GCdGOkJXZ1utrs-w |
| Implement clustering (K-Means) using MapReduce. | https://youtu.be/-ok7BBx_D2Y?si=xLdACQP-s4ZTSpgM |
| Implement PageRank algorithm. | https://youtu.be/rKWozgedyI4?si=yZ7cySnM1N19f9YA |

| Course code | **CSE-303A** | | | | |
|---|---|---|---|---|---|
| Category | Professional Elective Course | | | | |
| Course title | **Formal Languages and Automata** | | | | |
| Scheme and Credits | L | T | P | **Credits** | **Semester-VI (Common for B. Tech. CSE/ CSE-AIML/CSE-DS)** |
| | 3 | 0 | 0 | **3** | |
| Course Objectives | The objectives of this course are<br>• To provide knowledge of automata, formal languages, grammars, and computational models.<br>• To develop understanding of language recognition, parsing, and computational mechanisms.<br>• To enable application of automata and grammar concepts for problem solving.<br>• To develop analytical abilities related to computability, decidability, and complexity. | | | | |
| Assessment | 40 Marks | | | | |
| End Semester Examination | 60 Marks | | | | |
| Total | 100 Marks | | | | |
| Duration of Exam | 03 Hours | | | | |

**Course Outcomes:** After studying this course, the students will be able to

| **COs** | **Skills Demonstrated** | **RBT Level** |
|---|---|---|
| CO1 | Define the concepts, models, grammars, languages, and computational theories related to formal languages and automata. | Level 1: Remember |
| CO2 | Explain the principles, operations, and relationships among automata, grammars, languages, and computational models. | Level 2: Understand |
| CO3 | Apply automata, grammars, and computational models to solve language recognition and processing problems. | Level 3: Apply |
| CO4 | Analyze computational models, language classes, and decidability issues to evaluate computational problems. | Level 4: Analyze |

**Note:** Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (preferably 2 from each unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

**Unit-I**

**Finite Automata:** Introduction: Set, Power Set, Super Set, Alphabet, languages and grammars, productions and derivation, Deterministic finite automata (DFA), Nondeterministic finite automata (NDFA), Equivalence of DFA and NDFA, Conversion of NFA to DFA , minimization of finite automata, Finite automata with $\epsilon$- moves, Acceptability of a string by a finite Automata.
**Introduction to Machines**: Properties and limitations of Finite Automata, Mealy and Moore Machines, Equivalence of Mealy and Moore machines.

**Unit-II**

**Regular Expression:** State and prove Arden's Method, Regular Expressions, Recursive definition of regular expression, Regular expression conversion to Finite Automata and vice versa.
**Properties of regular languages:** Regular language, pumping lemma for regular sets/languages, Application of regular languages.

## Unit-III

**Grammars:** Chomsky hierarchy of languages, Relation between different types of grammars, Context-free grammar, Derivation tree / Parse tree, Ambiguity in regular grammar and their removal, Reduced Forms: Removal of useless symbols, null and unit productions.
**Normal Form**: Chomsky Normal form(CNF) and Greibach Normal Form(GNF), Push Down Automata: Introduction to PDA, Deterministic and Non-Deterministic PDA, Design of PDA: Transition table, Transition diagram and acceptability of strings by designed PDA, Pushdown automata (PDA) and equivalence with CFG.

## Unit-IV

**Turing machines:** The basic model for Turing machines (TM), Deterministic and NonDeterministic Turing machines and their equivalence, Design of Turing Machines: Transition table, Transition diagram and acceptability of strings by designed turing machine. Variants of Turing machines, Halting problem of Turing machine, PCP Problem of Turing Machine, Linear Bounded Automata, TMs as enumerators.
**Undecidability:** Church-Turing thesis, universal Turing machine, the universal and diagonalization languages, reduction between languages and Rice s theorem, undecidable problems about languages.

**Suggested Readings:**


1. Theory of Computer Science: Automata, Languages and Computation by K. L. P. Mishra and N. Chandrashekaran, 2nd Edition, Prentice Hall of India, India, 2003.
2. Fundamentals of the Theory of Computation: Principles and Practice by Raymond Greenlaw and H. James Hoover, Morgan Kaufmann, 1998.
3. Introduction to Languages and Automata Theory by John C. Martin, 3rd Edition, Tata McGraw-Hill, 2007.
4. Introduction to Automata Theory, Languages, and Computation by John E. Hopcroft, Rajeev Motwani, and Jeffrey D. Ullman, 3rd Edition, Pearson Education.


**Useful Video Link:**

| Unit No | Topics | Links |
|---|---|---|
| **Unit-I** | Introduction to Automata, Languages and Computation | https://www.youtube.com/watch?v=_2w9UX17m_k&list=PLbRMhDVUMngcwWkzVTm_kFH6JW4JCtAUM&index=1 |
| | Deterministic Finite Automata (DFA) | https://www.youtube.com/watch?v=CwihAY_fgRE&list=PLbRMhDVUMngcwWkzVTm_kFH6JW4JCtAUM&index=2 |
| **Unit-II** | Regular expression | https://www.youtube.com/watch?v=OA8EY3HKZoc&list=PLbRMhDVUMngcwWkzVTm_kFH6JW4JCtAUM&index=17 |
| | Pumping Lemma | https://www.youtube.com/watch?v=wQbdjmINxNU&list=PLbRMhDVUMngcwWkzVTm_kFH6JW4JCtAUM&index=28 |
| **Unit-III** | Chomsky Normal Form (CNF) | https://www.youtube.com/watch?v=AnHE1jVpgHA&list=PLbRMhDVUMngcwWkzVTm_kFH6JW4JCtAUM&index=47 |
| **Unit-IV** | Turning Machine | https://www.youtube.com/watch?v=WYncdAzKMHU&list=PLbRMhDVUMngcwWkzVTm_kFH6JW4JCtAUM&index=60 |

| Course Code | **AI-306A** | | | | |
|---|---|---|---|---|---|
| Category | Professional Elective Courses | | | | |
| Course Title | **Explainable AI** | | | | |
| Scheme and Credits | L | T | P | **Credits** | **Semester-VI (Common for B. Tech. CSE-AIML/CSE-DS)** |
| | 3 | 0 | 0 | 3 | |
| Course Objectives | The objectives of this course are<br>● To provide knowledge of explainable AI concepts, interpretability methods, and transparency mechanisms.<br>● To develop understanding of model explanation techniques and trustworthy AI practices.<br>● To enable application of explainability methods for interpreting AI models.<br>● To develop analytical abilities for evaluating transparency, fairness, and trustworthiness of AI systems. | | | | |
| Assessment | 40 Marks | | | | |
| End Semester Examination | 60 Marks | | | | |
| Total | 100 Marks | | | | |
| Duration of Exam | 03 Hours | | | | |

**Course Outcomes:** After studying this course, the students will be able to

| **COs** | **Skills Demonstrated** | **RBT Level** |
|---|---|---|
| CO1 | Define explainable AI concepts, interpretability methods, transparency principles, and trustworthy AI mechanisms. | Level 1: Remember |
| CO2 | Explain model explanation techniques, interpretability approaches, and evaluation methods used in explainable AI. | Level 2: Understand |
| CO3 | Apply explainability techniques to interpret machine learning and AI model behaviour. | Level 3: Apply |
| CO4 | Analyze AI systems for transparency, interpretability, fairness, accountability, and trustworthiness. | Level 4: Analyze |

**Note:** Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (2 from each unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

**Unit-I**

**Introduction to Explainable AI:** Science of Interpretable Machine Learning, Motivation, Challenges, and Mythos of Model Interpretability, Human Factors in Explainability, Interpreting Interpretability. Fundamentals of XAI, Categorization of XAI, Taxonomy of XAI methods for Machine Learning, Machine Learning interpretability, Causal model induction, Causality learning, XAI techniques and limitations.

**Unit-II**

**Post hoc Explanations:** Explaining the Predictions of Any Classifier, Pitfalls, Challenges, and Evaluation of Feature Attributions, LIME and SHAP, OpenXAI, The Disagreement Problem in Explainable Machine Learning, Counterfactual Explanations (or) Algorithmic Recourse, Learning Model-Agnostic Counterfactual Explanations for Tabular Data.

**Unit-III**

**Attention and Concept Based Explanations:** Quantifying Interpretability of Deep Visual Representations, Interpretability Beyond Feature Attribution, Data Attribution and Interactive Explanation, Equitable Valuation of Data, Explainable Active Learning (XAL), Theory of Explainability and Interpreting Generative Models.

**Unit-IV**

**Explainability for Fair Machine Learning:** Connections with Robustness, Privacy, Fairness, and Unlearning, Right to Explanation and the Right to be Forgotten, Fairness via Explanation Quality, Mechanistic Interpretability and Compiled Transformers, Understanding and Reasoning in Large Language Models.

**Suggested Readings:**


1. Explainable AI for Practitioners by Michael Munn, David Pitman, O'Reilly Media Inc., 2022.
2. Explainable AI with Python by Leonida Gianfagna, Antonio Di Cecco, Springer, 2021.
3. Interpretable Machine Learning, A Guide for Making Black Box Models Explainable by Christoph Molnar, Leanpub, 2023.
4. Hands-On Explainable AI (XAI) with Python: Interpret, visualize, explain, and integrate reliable AI for fair, secure, and trustworthy AI apps by Denis Rothman Packet Publishing Limited, 2020.
5. Explainable Artificial Intelligence: An Introduction to Interpretable Machine Learning by Uday Kamath and John Liu, Springer, ISBN 9783030833558.


**Useful Video Links:**

| Unit No | Topics | Links |
|---|---|---|
| **Unit-I** | Introduction to Explainable AI | https://youtu.be/McviMUYiG9s?si=p5OVqjLWD-il9fl5 |
| | Machine Learning interpretability | https://youtu.be/Rgscjp0qsmg?si=5UfNUsGA5d955l7m |
| **Unit-II** | LIME and SHAP | https://youtu.be/YZwDizPBFaM?si=TCPd-g71jKqUWe9L |
| | Counterfactual explanations | https://youtu.be/8r-1JBWBycQ?si=TmWJMCOu8BP4dA0_ |
| **Unit-III** | Quantifying Interpretability of Deep Visual Representations | https://youtu.be/Xy6RcjXMa2c?si=4x977_uUEtERZXzw |
| **Unit-IV** | Reasoning in Large Language Models | https://youtu.be/6-tv6tEprVI?si=NRTHP-FQo9Xoo0D_ |

| | | | | | |
|---|---|---|---|---|---|
| Course Code | **AI-308A** | | | | |
| Category | Professional Elective Courses | | | | |
| Course Title | **Swarm Intelligence** | | | | |
| Scheme and Credits | L | T | P | **Credits** | **Semester-VI** |
| | 3 | 0 | 0 | **3** | |
| Course Objectives | The objectives of this course are<br>● Introduce the fundamentals of swarm intelligence and metaheuristic optimization.<br>● Present the principles and variants of Ant Colony Optimization, Particle Swarm Optimization, and Artificial Bee Colony algorithms.<br>● Provide knowledge of swarm intelligence techniques for solving optimization problems.<br>● Familiarize learners with the applications of swarm intelligence in engineering and artificial intelligence. | | | | |
| Assessment | 40 Marks | | | | |
| End Semester Examination | 60 Marks | | | | |
| Total | 100 Marks | | | | |
| Duration of Exam | 03 Hours | | | | |

**Course Outcomes:** After studying this course, the students will be able to

| CO | Skills Demonstrated | RBT Level |
|---|---|---|
| **CO1** | Define the concepts and principles of swarm intelligence. | Level 1: Remember |
| **CO2** | Explain the concepts of swarm intelligence, metaheuristics, and search strategies. | Level 2: Understand |
| **CO3** | Apply swarm intelligence algorithms to solve real-world optimization problems. | Level 3: Apply |
| **CO4** | Compare the performance of swarm intelligence algorithms for different optimization tasks. | Level 4: Analyze |

**Note:** Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (2 from each unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

**Unit-I**

**Introduction to Swarm Intelligence:** Essence of an Algorithm, Algorithms and Self organization, Links between Algorithms and Self-Organization, Characteristics of Metaheuristics, Swarm Intelligence based algorithms – Ant Algorithms, Bee Algorithms, Particle Swarm Optimization and Krill Herd Algorithms, Strategies for state space search in AI, Depth First and Breadth First Search Heuristic Search, Best First Search and Hill Climbing.

**Unit-II**

**Ant Colony Optimization (ACO) -** Theoretical Considerations, Combinatorial optimization and meta heuristic, Stigmergy, Convergence Proofs, ACO Algorithm, ACO and Model Based Search, Variations Of ACO: Elitist Ant System (EAS), Minmax Ant System (MMAS) and Rank Based Ant Colony System (RANKAS), ACO Algorithm for Travelling Sales Person problem, ACO algorithm for feature selection.

**Unit-III**

**Particle Swarm Optimization:** Principles of Bird Flocking and Fish Schooling, Evolution of PSO, Operating Principles, PSO Algorithm, Neighbourhood Topologies, Convergence Criteria, Variations of PSO.

**Unit-IV**

**Artificial Bee Colony (ABC) Optimization -** Behaviour of real bees, ABC Algorithm, Variations of ABC: Abcgbest and Abcgbestdist, Case Study: Application of ABC algorithm in solving Travelling Salesman Problem, Knapsack Problem and for feature selection.

**Suggested Readings:**


1. Swarm Intelligence and Bio-Inspired Computation, Theory and Applications by Xin-She Yang, Zhihua Cui, Renbin Xiao, Amir Hossein Gandomi, Mehmet Karamanoglu, Elsevier, 2013.
2. Ant Colony Optimization by Marco Dorigo and Thomas Stutzle, MIT Press, Cambridge, England, 2004.
3. Artificial Intelligence Illuminated by Ben Coppin, Jones and Bartlett Publishers, 2004.
4. Swarm Intelligence Kennedy J and Russel C Eberhart, Morgan Kaufmann Publishers, USA, 2001.
5. A comparative study of Artificial Bee Colony Algorithm by Dervis Karaboga, Bahriye Akay, Applied Mathematics and Computation 214, Elsevier Publications, 2009.


**Useful Video Links:**

| Unit No | Topics | Links |
|---|---|---|
| **Unit-I** | Metaheuristics | https://youtu.be/FKBgCpJlX48?si=OMmSQqdMf2FKQdOD |
| | Krill Herd Algorithms | https://youtu.be/kdgDVCFBSj8?si=-UFaq80GPaMFWFWy |
| **Unit-II** | Ant Colony Optimization | https://youtu.be/xpyKmjJuqhk?si=pVliC2ZU_1YRHxXs |
| | ACO Algorithm for Travelling Sales Person problem | https://youtu.be/jNd7QJQH-kk?si=61nQmlGUdKMRTqpY |
| **Unit-III** | Particle Swarm Optimization | https://youtu.be/uwXFnzWaCY0?si=YHROI-wFBU919b6W |
| **Unit-IV** | Artificial Bee Colony Optimization | https://youtu.be/U9ah51wjvgo?si=iU_Aq0YCTZXJiZvA |

<table>
<tr><td>Course code</td><td colspan="5">CSE-308A</td></tr>
<tr><td>Category</td><td colspan="5">Professional Elective Course</td></tr>
<tr><td>Course title</td><td colspan="5">Digital Image Processing</td></tr>
<tr><td rowspan="2">Scheme and Credits</td><td>L</td><td>T</td><td>P</td><td>Credits</td><td rowspan="2">Semester-VI (Common for B. Tech. CSE/ CSE-AIML/CSE-DS)</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Course Objectives</td><td colspan="5">The objectives of this course are<ul><li>To provide knowledge of digital image processing concepts, image representation, and transformation techniques.</li><li>To develop understanding of image enhancement, restoration, segmentation, and feature extraction methods.</li><li>To enable application of image processing techniques for image analysis and interpretation.</li><li>To develop analytical abilities for evaluating image processing algorithms and outcomes.</li></ul></td></tr>
<tr><td>Assessment</td><td colspan="5">40 Marks</td></tr>
<tr><td>End Semester Examination</td><td colspan="5">60 Marks</td></tr>
<tr><td>Total Marks</td><td colspan="5">100 Marks</td></tr>
<tr><td>Duration of Exam</td><td colspan="5">03 Hours</td></tr>
</table>

**Course Outcomes:** After studying this course, the students will be able to

| COs | Skills Demonstrated | RBT Level |
|---|---|---|
| CO1 | Define digital image processing concepts, image models, transformations, enhancement techniques, and feature extraction methods. | Level 1: Remember |
| CO2 | Explain operation of image transformation, enhancement, restoration, compression, segmentation, representation techniques and analysis procedures. | Level 2: Understand |
| CO3 | Apply image processing techniques for image enhancement, segmentation, feature extraction, and analysis. | Level 3 : Apply |
| CO4 | Analyze image processing algorithms, segmentation results, feature representations, and image interpretation outcomes. | Level 4: Analyze |

**Note:** Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (preferably 2 from each unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

**Unit-I**

**Introduction to Image Processing:** Digital Image representation, Sampling & Quantization, Steps in image Processing, Image acquisition, color image representation.

**Unit-II**

**Image Transformation & Filtering:** Intensity transform functions, histogram processing, Spatial filtering, Fourier transforms and its properties, frequency domain filters, colour models, Pseudo colouring, colour transforms, Basics of Wavelet Transforms. **Image Restoration:** Image degradation and restoration process, Noise Models, Noise Filters, degradation function, Inverse Filtering, Homomorphism Filtering.

**Unit-III**

**Image Compression:** Coding redundancy, Interpixel redundancy, Psychovisual redundancy, Huffman Coding, Arithmetic coding, Lossy compression techniques, JPEG Compression.

**Unit-IV**

**Image Segmentation & Representation:** Point, Line and Edge Detection, Thresholding, Edge and Boundary linking, Hough transforms, Region Based Segmentation, Boundary representation, Boundary Descriptors.

**Suggested Readings:**


1. Digital Image Processing by Rafael C. Gonzalez, Richard E. Woods, Pearson, 3rd Edition, 2010.
2. Fundamentals of Digital Image Processing by Anil K. Jain, Pearson, 2002.
3. Digital Image Processing by Kenneth R. Castleman, Pearson, 2006.
4. Multidimensional Digital Signal Processing by D, E. Dudgeon and RM. Mersereau, Prentice Hall Professional Technical Reference, 1990.
5. Digital Image Processing by William K. Pratt, John Wiley, New York, 2002.


**Useful Video Links:**

| Unit | Topic | NPTEL Video Lecture Link |
|---|---|---|
| **Unit-I** | Introduction to Digital Image Processing | https://digimat.in/nptel/courses/video/117105135/L01.html |
| | Image Digitalization, Sampling & Quantization | https://digimat.in/nptel/courses/video/117105135/L03.html |
| | Color Fundamentals & Image Representation | https://onlinecourses.nptel.ac.in/noc19_ee55/preview |
| **Unit-II** | Histogram Processing | https://digimat.in/nptel/courses/video/117105135/L34.html |
| | Histogram Equalization & Specification | https://digimat.in/nptel/courses/video/117105135/L35.html |
| | Fourier Transform – I | https://www.youtube.com/watch?v=11b5NnpEoVE |
| | Image Transformations & Frequency Domain | https://archive.nptel.ac.in/content/storage2/courses/117104069/chapter_7/7_intro.html |
| **Unit-III** | Image Compression Fundamentals | https://archive.nptel.ac.in/content/storage2/courses/117104069/chapter_7/7_intro.html |
| | JPEG Compression | https://onlinecourses-archive.nptel.ac.in/noc18_ee40/preview |
| | Coding Redundancy & Huffman Coding | https://digimat.in/nptel/courses/video/117105135/117105135.html |
| **Unit-IV** | Edge Detection & Boundary Detection | https://digimat.in/nptel/courses/video/117105135/117105135.html |
| | Thresholding & Segmentation | https://arxiv.org/abs/1909.05084 |
| | Hough Transform & Region Based Segmentation | https://onlinecourses.nptel.ac.in/noc19_ee55/preview |
| | Boundary Representation & Descriptors | https://archive.nptel.ac.in/content/storage2/courses/117104069/chapter_1/1_intro.html |