



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

An Autonomous Institute

‘A’ GRADE ACCREDITED BY NAAC

**Scheme of Studies and Examinations For
Bachelor of Technology Computer Science and Engineering- Data Science
(B.Tech CSE-DS)**

3rd Year (A-Scheme)

Effective from the Academic 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-Data Science (B.Tech CSE-DS) – 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	DS-301A	Data Preparation and Feature Engineering	3	0	0	3	3	40	60		100	3
2	Professional Core Courses	AI-301A	Machine Learning	3	1	0	4	4	40	60		100	3
3	Professional Core Courses	DS-303A	Predictive Analytics	3	0	0	3	3	40	60		100	3
4	Professional Core Courses	CSE-305A	Design and Analysis of Algorithms	3	0	0	3	3	40	60		100	3
5	Engineering Science Courses	DS-305A	Applied Computational Statistics	3	0	0	3	3	40	60		100	3
6	Professional Elective Courses	Refer Table-II	Professional Elective-II	3	0	0	3	3	40	60		100	3
7	Professional Core Courses	DS-L301A	Data Preparation and Feature Engineering Lab	0	0	2	2	1	25		25	50	3
8	Professional Core Courses	AI-L301A	Machine Learning Lab	0	0	2	2	1	25		25	50	3
9	Professional Core Courses	CSE-L305A	Design and Analysis of Algorithms Lab using C++	0	0	2	2	1	25		25	50	3
10	Engineering Science Courses	DS-L305A	Applied Computational Statistics Lab	0	0	2	2	1	25		25	50	3
11	Practical Training	PT-301A	Practical Training-I	0	0	2	2	1	50			50	3
Total Credits								24				850	

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	DS-307A	Business Intelligence & Analytics
4	DS-309A	NoSQL Databases
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-Data Science (B.Tech CSE-DS) – 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	DS-302A	Data Visualization	3	0	0	3	3	40	60		100	3
2	Professional Core Courses	AI-001A	Neural Networks	3	1	0	4	4	40	60		100	3
3	Professional Core Courses	CSE-002A	Big Data Analytics	3	0	0	3	3	40	60		100	3
4	Professional Core Courses	DS-304A	Social Network Analysis	3	0	0	3	3	40	60		100	3
5	Professional Elective Courses	Refer Table-III	Professional Elective-III	3	0	0	3	3	40	60		100	3
6	Multidisciplinary Open Elective Courses	Refer Table-IV	Multidisciplinary Open Elective-I	3	0	0	3	3	40	60		100	3
7	Professional Core Courses	DS-L302A	Data Visualization Lab	0	0	2	2	1	25		25	50	3
8	Professional Core Courses	AI-L001A	Neural Networks 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-302A	Recommender Systems
3	AI-306A	Explainable AI
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)*

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	DS-301A				
Category	Professional Core Courses				
Course title	Data Preparation and Feature Engineering				
Scheme and Credits	L	T	P	Credits	Semester-V
	3	0	0	3	
Course Objectives	The objectives of this course are ● To introduce the role of data preparation in the data science lifecycle. ● To develop practical skills for cleaning, transforming, and preprocessing data using Python libraries. ● To enable students to handle real-world data quality issues programmatically. ● To enable students to design reproducible data preprocessing workflows using standard tools.				
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, techniques, and workflows of data preparation, cleaning, transformation, feature engineering, and integration in data science.	Level 1: Remember
CO2	Explain methods for handling data quality issues, missing values, outliers, and preparing datasets for analysis and modeling.	Level 2: Understand
CO3	Apply data preprocessing, feature engineering, encoding, scaling, and integration techniques to prepare datasets for machine learning.	Level 3 : Apply
CO4	Analyze data preprocessing strategies, evaluate workflow effectiveness, and ensure readiness of datasets for modeling and deployment.	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 Data Preparation: Role of data preparation in data science; Types of data and data sources; Data quality dimensions and common issues; Data preprocessing workflow; Introduction to Python data science environment; Overview of NumPy and Pandas; Loading, inspecting, and summarizing datasets; Introduction to feature engineering and its importance in machine learning workflows.

Unit-II

Data Cleaning and Missing Data Handling: Data cleaning process; Detection of missing values; Missing data treatment methods; Handling noisy data and outliers; Duplicate and inconsistent data handling; Data validation and integrity checks using standard techniques.

Unit-III

Data Transformation and Feature Engineering: Data transformation concepts; Normalization and standardization; Scaling techniques – Min-Max, Z-score, Robust scaling; Encoding categorical variables – label encoding and one-hot encoding; Discretization and binning; Feature construction and extraction; Logarithmic and power transformations; Introduction to feature selection methods; Creation of interaction features; Date-time feature extraction; Text-based feature generation; Feature importance and evaluation techniques.

Unit-IV

Data Integration, Feature Selection and Model Readiness: Data integration techniques; Dataset merging and joining; Data aggregation and grouping; Handling data from multiple sources; Dimensionality reduction concepts; Sampling techniques; Data reduction strategies; Advanced feature selection techniques (filter, wrapper, and embedded methods); Preparing datasets for machine learning models; Train-test split; Cross-validation readiness; Reproducible preprocessing and feature engineering workflows.

Suggested Readings:

1. Python for Data Analysis by Wes McKinney, 2nd Edition, O'Reilly Media, 2018.
2. Python Data Science Handbook by Jake VanderPlas, O'Reilly Media, 2016.
3. Python Data Science Handbook: Essential Tools for Working with Data by Jake VanderPlas, 1st Edition, O'Reilly Media, 2016.
4. Data Wrangling with Python by Jacqueline Kazil, Katharine Jarmul, 2016, O'Reilly Media.4.
5. Data Science from Scratch: First Principles with Python by Joel Grus, 2nd Edition, O'Reilly Media, 2019.
6. Feature Engineering for Machine Learning: Principles and Techniques for Data Scientists by Alice Zheng, Amanda Casari, 2018, O'Reilly Media.
7. Feature Engineering and Selection: A Practical Approach for Predictive Models by Max Kuhn and Kjell Johnson, CRC Press, 2019.
8. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow by Aurélien Géron, 3rd Edition, O'Reilly Media.

Useful Video Links:

Unit No.	Topics	Links
Unit-I	Role of data preparation in data science	https://onlinecourses.nptel.ac.in/noc22_cs32/preview
	Introduction to Python data science environment	https://www.youtube.com/watch?v=tA42nHmMEKw
	Introduction to Numpy library	https://www.youtube.com/watch?v=O0IrNk1qoUE&list=PLZ2ps_7DhBb2cXAu5PevO_mzgS3Fj3Fs&index=90
	Why Pandas	https://www.youtube.com/watch?v=HCxhHo8tV4U&list=PLZ2ps_7DhBb2cXAu5PevO_mzgS3Fj3Fs&index=91
	Introduction to Feature Engineering	https://youtu.be/BdL-cKUG4hE?si=gWMjusEkq6BKgdvE
Unit-II	Data Cleaning with Python	https://www.youtube.com/watch?v=ZX8vmcSTCrc
	Handling noisy data and outliers	https://www.youtube.com/watch?v=s8wUe49kKMU
Unit-III	Feature Engineering	https://www.youtube.com/watch?v=BdL-cKUG4hE
	Min-Max & Z-score Techniques	https://www.youtube.com/watch?v=lggqjmQzsGI
	Feature Selection Techniques	https://youtu.be/MtapFEwiiug?si=eOWLVB31_BaqCHnI
Unit-IV	Basics of Data Integrations	https://www.youtube.com/watch?v=3_12AZ0CEeo
	Nonlinear Dimensionality Reduction Techniques -I	https://www.youtube.com/watch?v=841lv79yUUQ
	Train, Test, & Validation Sets	https://www.youtube.com/watch?v=ZblqTCFnH-M
	Feature Engineering Pipeline using Scikit-Learn	https://youtu.be/C700yzE_X4Q?si=mhSMd3mzi4Y5BVhh

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 ● To provide knowledge of machine learning concepts, techniques, and applications. ● To develop understanding of data preprocessing, feature engineering, and dimensionality reduction methods. ● To enable application of machine learning algorithms for prediction and pattern discovery. ● 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, Nonlinearity 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=YepECGI0I4Y=
	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	DS-303A				
Category	Professional Core Courses				
Course Title	Predictive Analytics				
Scheme and Credits	L	T	P	Credits	Semester-V (Common for B. Tech. CSE/CSE-DS)
	3	0	0	3	
Course Objectives	The objectives of this course are • To provide knowledge of predictive analytics concepts, statistical models, and analytical frameworks. • To develop understanding of regression, classification, decision trees, and machine learning techniques. • To enable application of predictive modeling and data preprocessing methods for real-world analytics problems. • To develop analytical abilities for model evaluation, variable selection, dimensionality reduction, and performance 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	Skills Demonstrated	RBT Level
CO1	Define predictive analytics concepts, analytical frameworks, regression models, classification techniques, and machine learning fundamentals.	Level 1: Remember
CO2	Explain predictive modeling methods, data preprocessing techniques, feature selection approaches, and analytical processes.	Level 2: Understand
CO3	Apply predictive analytics techniques, statistical models, and machine learning methods to solve real-world problems.	Level 3: Apply
CO4	Analyze predictive models using evaluation measures, dimensionality reduction methods, regularization techniques, and validation strategies.	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: The Analytics Life Cycle, Introduction to Predictive Analytics, Matrix Notation, Basic Foundations, Model, Method and Feature Selection, CRISP-DM framework, and data partitioning (training/validation sets).
Regression: Covariance, Correlation and ANOVA review; Simple Linear Regression, OLS Model Diagnostics, Dummy Variables, Multivariate Regression, OLS Assumptions, Weighted Least Squares (WLS), Generalized Linear Models (GLM).

Unit II

Classification Models: Introduction, Binomial Logistic Regression, Multinomial Logistic Regression, Linear Discriminant Analysis, Quadratic Discriminant Analysis.

Decision Trees: Introduction Regression Trees, Regression Tree Issues, Classification Trees, Pruning Trees, Bootstrap Aggregation (Bagging), Random Forest Models, Support Vector Machines (SVM), and Neural Networks.

Unit-III

Data Pre-Processing: Overview, Variable Types, Introduction to Data Transformations.

Data Transformations: Categorical to Dummy Variables, Polynomials, Box-Cox Transformation, Log & Elasticity Models, Logit Transformation, Count Data Models, Centering, Standardization, Rank Transformations, Lagging Data (Causal Models), Data Reduction.

Unit-IV

Variable Selection: Dimensionality Issues, Multi-Collinearity, Variable Selection Methods, Step Methods.

Dimensionality: Regularization (Penalized or Shrinkage Models, Ridge Regression, LASSO, Dimension Reduction Models, Principal Components Regression (PCR), Partial Least Squares (PLS).

Machine Learning: Machine Learning Overview, Bias vs. Variance Trade-off, Error Measures, Cross-Validation.

Suggested Readings:

1. An Introduction to Statistical Learning: with Applications in R by James, Witten, Hastie and Tibshirani, Springer, 1st Ed., 2013.
2. The Elements of Statistical Learning-Data Mining, Inference, and Prediction by Trevor Hastie, Robert Tibshirani, Jerome Friedman, 2nd Ed., Springer Verlag, 2009.
3. Predictive & Advanced Analytics (IBM ICE Publication).

Useful Video Links:

Unit No.	Topics	Links
Unit-I	Introduction to Predictive Analytics	https://youtu.be/suIMSpBJiyM?si=wghj_qWkuUc01sS0
	Method and Feature Selection	https://youtu.be/0xFT0yvqRo4?si=BC3RJuyDRl8b8kdQ
	CRISP-DM framework, data partitioning	https://youtu.be/q_okDS2RtzY?si=L0-fXwDtLUchigXM
Unit-II	Multinomial Logistic Regression	https://youtu.be/cM4lmkq8XsU?si=Z0F0fT0CgHIBJWK7
	Linear Discriminant Analysis	https://youtu.be/LNL4G87Dpl0?si=jthNR0t1c4syCrkM
	Introduction Regression Trees	https://youtu.be/1GZDVRskXGE?si=Mlc1rNSDs_5c2zFB
	Support Vector Machines (SVM)	https://youtu.be/3ki3RKdbcPo?si=Og-G9XnbOPUw1WBf
Unit- III	Data pre-processing	https://youtu.be/L_DeunKU-FA?si=EYEVxpjckJlqeJSj
	Categorical to Dummy Variables	https://youtu.be/aMPeChbJg9A?si=7A0vzl-UDnTH3V92
	Standardization, Rank Transformations	https://youtu.be/J_rDI7dl3Y?si=y778gzeyW5gfaiRV
	Lagging Data (Causal Models)	https://youtu.be/LpRC9ds6Glc?si=MXYawUQo_WGsJiT
Unit- IV	Variable Selection Methods, Step Methods.	https://youtu.be/9h1YikP2Sno?si=hr5O_7TK9lbpLAzy
	Regularization (Penalized or Shrinkage Models, Ridge Regression, LASSO	https://youtu.be/whA8Geg4Knk?si=6Ps80ti6EE4RYbPj
	Principal Components Regression (PCR)	https://youtu.be/SWfucxnOF8c?si=4zx8fArev1W5EZZc

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 • To provide knowledge of algorithm design techniques and complexity analysis. • To develop understanding of algorithmic paradigms and optimization methods. • To enable application of algorithms for solving computational problems. • 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 Rivest: 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. & Hedetniemi, 1997, MGH.

Useful Video links:

Unit No.	Topic	Link
Unit-I	Asymptotic Notation	https://youtu.be/EL9T1ngiCqA?si=oaMBKNhfiIOODUIM
	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	DS-305A				
Category	Engineering Science Courses				
Course Title	Applied Computational Statistics				
Scheme and Credits	L	T	P	Credits	Semester-V
	3	0	0	3	
Course Objectives	The objectives of this course are To provide knowledge of statistical analysis, probability theory, estimation, and hypothesis testing. To develop understanding of inferential statistics and multivariate analytical techniques. To enable application of statistical methods for data analysis and decision making. To develop analytical abilities for evaluating stochastic processes and computational statistical models.				
Course Pre-requisite	Mathematics upto12 th Standard and Engineering Mathematics-I & II				
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 statistical concepts, probability distributions, estimation methods, hypothesis testing procedures, and stochastic processes.	Level 1: Remember
CO2	Explain inferential statistical techniques, multivariate analysis methods, classification approaches, and stochastic models.	Level 2: Understand
CO3	Apply statistical methods, multivariate techniques, and computational procedures to analyze datasets and solve data science problems.	Level 3: Apply
CO4	Analyze statistical models, multivariate relationships, stochastic processes, and data patterns for 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

Types of Data (Quantitative, Qualitative, Logical), Exploratory Data Analysis (Histogram, Scatter plots, Box plot, Fundamentals of Descriptive Statistics (moments- Measures of Central Tendency, Measure of spread, Measure Shape), Overview of Probability and Combinatorics, Inferential Statistics (Normal Distribution, Statistic Sampling, Central Limit Theorem), Estimations (Point and Intervals- Confidence intervals with means, sample proportions), Hypothesis Testing :Introduction, Confidence Intervals, Critical Value based approach, P-value base approach, Z Tests, T Tests ,the χ^2 distribution, ANOVA/ANCOV.

Unit-II

Multivariate Analysis: Multivariate distributions: multivariate normal distribution and its properties, distributions of linear and quadratic forms, tests for partial and multiple correlation coefficients and regression coefficients and their associated confidence regions. Data analytic illustrations. Wishart distribution (definition, properties),

construction of tests, union-intersection and likelihood ratio principles, inference on mean vector, Hotelling's T². MANOVA- Inference on covariance matrices.

Unit-III

Classification methods: Discriminant analysis, principal component analysis and factor analysis, Canonical Correlation analysis, Correspondence Analysis, Multidimensional Scaling, Cluster analysis. Nonparametric and robust methods of multivariate analysis. Graphical representation of multivariate data.

Unit-IV

Stochastic Process: Markov chains with stationary transition probabilities, properties of transition functions, classification of states, Stationary distribution of a Markov chain, existence and uniqueness, convergence to the stationary distribution. Methods based on Markov chains for simulation of random vectors. MCMC algorithm. Random Walks, queueing processes, branching processes. Gambler's ruin problem, transient states.

Suggested Readings:

1. An Introduction to Probability Theory and its Applications by W. Feller Vol.-II.
2. A First Course in Stochastic Processes by S. Karlin and H. M. Taylor.
3. Introduction to Stochastic Processes by P. G. Hoel, S. C. Port and C. J. Stone.
4. Introduction to Probability Models by S. Ro.
5. An Introduction to Multivariate Statistical Analysis by T. W. Anderson.
6. Introduction to Probability by Ross, 9th edition, Pearson, 2006.
7. Introduction to Probability and Statistics Using R by G. Jay Kerns, 2016.
8. An Adventure in Statistics by Andy Field SAGE Publications, 2016.
9. Head First Statistics by Dawn Griffiths, O'Reilly media Inc., 2019.
10. A step by Step Guide to Exploratory Factor Analysis with R and R Studio, by Marley W. Watkins, Tylor & Francis Group, 2021.

Useful Video links:

Unit No.	Topic	Link
Unit-I	Types of Data (Quantitative, Qualitative, Logical)	https://youtu.be/ALs6JW1wgE4?si=DY_cM3YYoTd5nl3e
	Exploratory Data Analysis	https://youtu.be/QiqZliDXCCg?si=yuZeyUOarteAHGkS
	Fundamentals of Descriptive Statistics	https://youtu.be/r-V1uZx-ndM?si=L8qSNEDAew1EnOzz
	Overview of Probability and Combinatorics	https://youtu.be/Z1zdkcwosD4?si=uRmTYfLcPMTclQvp
	Hypothesis Testing	https://youtu.be/_OjC0HZHTK4?si=9kJ5JaUcGtd0penY
Unit-II	Multivariate distributions	https://youtu.be/c6bK25xY22w?si=97wxEwL5YzrPkWhR
	Tests for partial and multiple correlation coefficients and regression	https://youtu.be/jsm226MM7JE?si=ZfPJcw6w-tjmJNGE
	Wishart distribution	https://youtu.be/RvNJOABAKqU?si=oXiSI1AAp195w0it
	MANOVA- Inference on covariance matrices	https://youtu.be/Rf94MACqfxs?si=aA4CVPWr2YzaprU
Unit-III	Discriminant analysis	https://youtu.be/vnHkTnRFdAU?si=lmNf9iI77D-tL15X
	Multidimensional Scaling	https://youtu.be/NPcwjc6Oh7k?si=A8jziP3rfxmPrEmD
	Nonparametric and robust methods of multivariate analysis	https://youtu.be/-3iGSoubUjc?si=hdGVXA0WYVMIKX20
Unit-IV	Nonparametric and robust methods of multivariate analysis	https://youtu.be/-3iGSoubUjc?si=QA0lRYWBsz2_IVjl
	MCMC algorithm	https://youtu.be/yApmR-c_hKU?si=lvCZJq2CImWtPToK
	Gambler's ruin problem, transient states	https://youtu.be/Ne2lmAZI4-I?si=UWRMN-oTOPcH7nJC

Course Code	DS-L301A				
Category	Professional Core Courses				
Course Title	Data Preparation and Feature Engineering Lab				
Scheme and Credits	L	T	P	Credits	Semester-V
	0	0	2	1	
Course Objectives	The objectives of this course are • To enable students to implement Python programs for loading and summarizing datasets using NumPy and Pandas. • To guide students in performing data cleaning by handling missing values, duplicates, inconsistencies, and outliers. • To provide hands-on practice in applying data transformation techniques such as scaling, encoding, and feature engineering. • To train students to prepare integrated and model-ready datasets using sampling and validation strategies.				
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	Implement dataset loading, inspection, and summarization using NumPy & Pandas.	Level 2: Understand
CO2	Perform data cleaning, missing value handling, and data validation.	Level 3: Apply
CO3	Apply data transformation and feature engineering techniques for preprocessing.	Level 3: Apply
CO4	Analyze and organize datasets to create model-ready data using appropriate sampling, reduction, and splitting strategies.	Level 4: Analyze

List of Experiments

Sr. No.	Contents	COs
1.	Install and explore Python data science environment (NumPy, Pandas, Matplotlib).	CO1
2.	Load datasets and perform inspection and statistical summary.	CO1
3.	Detect and handle missing values using different techniques.	CO2
4.	Identify and treat noisy data and outliers.	CO2
5.	Remove duplicate and inconsistent records.	CO2
6.	Perform normalization and standardization (Min-Max, Z-Score, Robust scaling).	CO3
7.	Encode categorical variables using Label Encoding and One-Hot Encoding.	CO3
8.	Perform discretization and binning of continuous data.	CO3
9.	Construct new features and perform feature extraction.	CO3

10.	Apply feature selection methods (filter-based techniques).	CO4
11.	Merge and join datasets from multiple sources.	CO4
12.	Perform data aggregation and grouping operations.	CO4
13.	Apply sampling techniques and dimensionality reduction.	CO4
14.	Prepare dataset for machine learning (train-test split and cross-validation readiness).	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
Load Dataset & Summary	https://colab.research.google.com/drive/1M8xTPtJVcY5UZZusL6jqqoRBamkYen?usp=sharing
Missing Value Handling	https://colab.research.google.com/drive/1M8xTPtJVcY5UZZusL6jqqoRBamkYen?usp=sharing
Encode categorical variables	https://colab.research.google.com/drive/1M8xTPtJVcY5UZZusL6jqqoRBamkYen?usp=sharing

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: • To understand and implement basic machine learning algorithms for classification and prediction tasks. • To apply clustering and recommendation techniques for pattern discovery and personalized suggestions. • To perform dimensionality reduction and optimization using PCA and Gradient Descent techniques. • 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=5ONIGP0Nx3Q
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	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 • To develop understanding of algorithm design techniques and complexity analysis. • To provide practical exposure to sorting and graph algorithms. • To develop skills in greedy, dynamic programming, and backtracking techniques. • To develop analytical skills for evaluating algorithm performance.				
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 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 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 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 CO4
11	Write a Program to Check whether a given graph is connected or not using DFS method.	CO2

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	DS-L305A				
Category	Engineering Science Courses				
Course Title	Applied Computational Statistics Lab				
Scheme and Credits	L	T	P	Credits	Semester-V
	0	0	2	1	
Course Objectives	The objectives of this course are • To provide practical knowledge of R programming and R Studio environment for statistical data analysis and visualization. • To develop skills in implementing graphical and statistical techniques using R language. • To enable students to apply statistical methods and hypothesis testing techniques for data analysis using R programming. • To develop analytical ability for interpreting multivariate statistical techniques and data-driven results using R.				
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 concepts of statistical computing, graphical representation, and data analysis techniques using R language and R Studio.	Level 2: Understand
CO2	Apply R programming techniques to implement statistical computations, graphical plots, and probability distributions.	Level 3: Apply
CO3	Apply hypothesis testing and multivariate statistical methods for analyzing datasets using R programming.	Level 3: Apply
CO4	Analyze datasets and interpret statistical and multivariate analysis results using R programming tools and techniques.	Level 4: Analyze

List of Experiments

Sr. No.	Content	COs
1	Introduction to Study of R language and R Studio.	CO1
2	Write a program to draw HISTOGRAM implementation in R Language.	CO1
3	Write a program to draw BOXPLOT implementation in R Language.	CO2
4	Write a program to draw Scatterplot implementation in R Language.	CO2
5	Write a programme to compute Mean, Median and Standard Deviation.	CO2
6	Write a programme to calculate Skewness.	CO3
7	Write a programme to find Normal Distribution.	CO3
8	Write a programme to Analyze data set using Z test.	CO3

9	Write a programme to Analyze data set using One sample T test.	CO3
10	Write a programme to find Multivariate Normal Distribution.	CO4
11	Write a programme to analyze PCA.	CO4
12	Write a programme to analyze Linear Discreminant Analysis.	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
Histogram in R	https://colab.research.google.com/drive/12ZIwxQGGEUvI7qc6AT9awAWOqQnL-nzd?usp=sharing
Mean, Median and Standard Deviation	https://colab.research.google.com/drive/12ZIwxQGGEUvI7qc6AT9awAWOqQnL-nzd?usp=sharing
Multivariate Normal Distribution	https://colab.research.google.com/drive/12ZIwxQGGEUvI7qc6AT9awAWOqQnL-nzd?usp=sharing

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 • Develop practical skills using industry-standard software tools and technologies. • Apply software engineering practices and technical documentation in real-world projects. • Enhance professional communication, teamwork, time management, and ethical practices. • 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/CSE-AIML/CSE-DS)
	3	0	0	3	
Course Objectives	The objectives of this course are • To provide fundamental knowledge of computer networking concepts, architectures, communication models, and transmission techniques. • To develop understanding of networking protocols, addressing methods, routing mechanisms, and network services across different layers. • To enable students to apply networking principles and protocols for data communication and problem solving in computer networks. • 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/EqzDT09tdqs?si=16VZZu9Oz3IzOeOA
Unit-IV	Congestion Control and QoS	https://nptel.ac.in/courses/106105081
	SDH/SONET Layering, Frame Structure	https://youtu.be/f5EmFoXIYyQ?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 ● To introduce the fundamentals of data warehousing and data mining. ● To provide knowledge of data mining techniques for pattern discovery and classification. ● To familiarize students with clustering methods and web data mining concepts. ● 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 3rd Ed, 2011.
2. Data Mining by Pudi V., Krishana P.R., Oxford University press, 1st Ed., 2009.
3. Data mining by Adriaans P., Zantinge D., Pearson education press, 1st Ed., 1996.
4. Data Warehousing Fundamentals by Pooniah, Willeyinterscience Publication, (2001), 1st ed.

Useful Video links

Unit No	Topics	Links
Unit-I	Introduction, Knowledge Discovery Process	https://www.youtubeeducation.com/watch?v=ykZ-UGcYWg
	OLAP	https://youtu.be/m-aKj5ovDfg?si=1IqwlHoN5T4VWfPK
Unit-II	Classification	https://www.youtubeeducation.com/watch?v=VsYKqOokgaE
	Apriori algorithm	https://youtu.be/hEQkqpmtx-Y?si=hMDJ-3cvDvx_Plur
Unit-III	Bayes Classifier	https://www.youtubeeducation.com/watch?v=DXnnvprUl2Y
	Decision Tree	https://www.youtubeeducation.com/watch?v=4l4BREp6ZI
Unit-IV	Cluster analysis	https://www.youtubeeducation.com/watch?v=VcPWL9Nlozs
	Density based methods	https://youtu.be/E_SdiZQ23xI?si=hupzFk1EjSNbge4q

Course Code	DS-307A				
Category	Professional Elective Courses				
Course Title	Business Intelligence & Analytics				
Scheme and Credits	L	T	P	Credits	Semester-V
	3	0	0	3	
Course Objectives	The objectives of this course are • To provide knowledge of business intelligence, analytics, data mining, and decision-support systems. • To develop understanding of predictive analytics, text mining, web analytics, and sentiment analysis techniques. • To enable application of analytical tools and models for business problem solving and decision making. • To develop analytical abilities for evaluating business intelligence solutions and emerging analytics 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

CO	Skill Demonstrated	RBT Level
CO1	Define business intelligence concepts, predictive analytics methods, data mining techniques, web analytics, and knowledge management systems.	Level 1: Remember
CO2	Explain business analytics methodologies, predictive models, sentiment analysis, web mining techniques, and decision-support mechanisms.	Level 2: Understand
CO3	Apply analytical models, data mining methods, optimization approaches, and web analytics tools to solve business problems.	Level 3: Apply
CO4	Analyze business intelligence systems, analytics outcomes, decision-support models, big data solutions, and emerging business trends.	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: Introduction to Business Intelligence, Designing Business Intelligence Application, Requirements Gathering, Establishing the Technical Architecture, Designing a Business Intelligence Solution, Designing Dimensional Models, Designing the Physical Databases.

Predictive Analytics: Data Mining Concepts- Definitions, Characteristics, and Benefits, How Data Mining Works, Data Mining Versus Statistics Data Mining Process, Data Mining Methods, Data Mining and Privacy Issues, Regression, Classification, Association Rules, clustering, Techniques for Predictive Modelling – ANN- SVM.

Unit-II

Text Analytics, Text Mining, And Sentiment Analysis: Text Analytics, Text Mining, and Sentiment Analysis, Natural Language Processing, Text Mining Process, tools, Sentiment Analysis, Overview, Process, Applications, Speech Analytics, Rule based, Multi, Layer, Hybrid Sentimental analysis, Machine Learning in Sentimental analysis.

Web Analytics and Web Mining: Web Mining Overview, Web Content and Web Structure Mining, Search Engines, Search Engine Optimization, Web Analytics Technologies, metrics, Web Analytics Maturity Model and Web Analytics Tools.

Unit-III

Prescriptive Analytics: Decision Support Systems Modeling, Mathematical Models for Decision Support, Certainty, Uncertainty, and Risk, Decision Modeling with Spreadsheets, Mathematical Programming Optimization, Decision Analysis with Decision Tables and Decision Trees, Problem-Solving Search Methods, Problem-Solving Search Methods.

Unit-IV

Knowledge Management and Big Data Analytics: Knowledge Management –Concepts, Definitions, Approaches, tools and techniques, Big Data and Analytics, Fundamentals of Big Data Analytics, Technologies, Data Scientist, Big Data and Data Warehousing, Automated Decision Systems and Expert Systems, Business Analytics: Emerging Trends and Future Impacts, Recent Trends and contemporary issues.

Suggested Readings:

1. Business Intelligence and Analytics” by Efraim Turban, Ramesh Sharda, Dursun Delen, 10th Edition, Pearson, 2015.
2. Business Analytics: Data Analysis & Decision Making by S.Christian Albright, Wayne L.Winston, 6th Edition, CENGAGE INDIA, 2017.
3. Business Analytics by Dinabandhu Bag, Routledge, 1st edition, 2016.
4. Business Intelligence Guidebook: From Data Integration to Analytics by Rick Sherman, Morgan Kaufmann, 1st edition 2014.

Useful Video Links:

Unit No	Topics	Links
Unit-I	Introduction to Business Intelligence	https://youtu.be/f1if5sqCS4U?si=2pQRFbSoLCm3gpYG
	Data Mining Concepts	https://youtu.be/ykZ-UGcYWg?si=vLCaMR8FQ4iIczN9
Unit-II	Sentiment Analysis	https://youtu.be/bbeV9YxAvqs?si=JwJa_DXEoyOlzUd6
	Natural Language Processing	https://youtu.be/G6wdZQw4d8Y?si=dCUZmaN7a6-idFWZ
Unit-III	Problem-Solving Search Methods	https://youtu.be/NCq26BvEYIg?si=nGJKmQb76UK0kO-4
	Reasoning under Uncertainty	https://youtu.be/1lKsSiEsJ18?si=iAqzM6CXfu-L0bjt
Unit-IV	Big Data and Analytics	https://youtu.be/uhj5oKRqY6w?si=y41jLEHZIqKKUnfL
	Knowledge Management	https://youtu.be/ECzT3czfqGU?si=mMau0SswidK3nhZk

Course Code	DS-309A				
Category	Professional Elective Courses				
Course Title	NoSQL Databases				
Scheme and Credits	L	T	P	Credits	Semester-V
	3	0	0	3	
Course Objectives	The objectives of this course are - To provide knowledge of NoSQL database concepts, architectures, data models, and distributed storage systems. - To develop understanding of key-value, document-oriented, columnar, and graph database technologies. - To enable application of NoSQL databases for scalable data storage, retrieval, and processing. - To develop analytical abilities for evaluating performance, consistency, scalability, and optimization techniques in NoSQL 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 NoSQL database concepts, architectures, data models, distributed storage mechanisms, and scalability principles.	Level 1: Remember
CO2	Explain NoSQL data models, database architectures, consistency mechanisms, storage strategies, and graph analytics techniques.	Level 2: Understand
CO3	Apply NoSQL database operations, querying methods, indexing techniques, and distributed processing approaches for database applications.	Level 3: Apply
CO4	Analyze scalability, consistency, performance, storage architectures, and optimization strategies in NoSQL database systems.	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 NoSQL Concepts: Database revolutions: First generation, second generation, third generation, Managing Trans-actions and Data Integrity, ACID and BASE for reliable database transactions, Speeding performance by strategic use of RAM, SSD, and disk, Achieving horizontal scalability with Database sharding, Brewers CAP theorem.

NoSQL Data Architecture Patterns: NoSQL Data model: Aggregate Models- Document Data Model- Key-Value Data Model- Columnar Data Model, Graph Based Data Model, Graph Data Model, NoSQL system ways to handle big data problems, Moving Queries to data, not data to the query, hash rings to distribute the data on clusters, replication to scale reads, Database distributed queries to Data nodes.

Unit-II

Key Value Data Stores: From array to key value databases, Essential features of key value Databases, Properties of keys, Characteristics of Values, Key-Value Database Data Modeling Terms, Key-Value Architecture and implementation Terms, Designing Structured Values, Limitations of Key-Value Databases, Design Patterns for Key-Value Databases, Case Study: Key-Value Databases for Mobile Application Configuration.

Document Oriented Database: Document, Collection, Naming, CRUD operation, querying, indexing, Replication, Sharding Consistency Implementation: Distributed consistency, Eventual Consistency, Capped Collection, Case studies: document oriented database: Mongo DB and/or Cassandra.

Unit-III

Columnar Data Model – I: Data warehousing schemas: Comparison of columnar and row-oriented storage, Column-store Architectures: C-Store and Vector-Wise, Column-store internals and, Inserts/updates/deletes, Indexing, Adaptive indexing and Database Cracking.

Columnar Data Model – II: Advanced techniques: Vectorized Processing, Compression, Write penalty, Operating Directly on Compressed Data Late Materialization Joins, Group-by, Aggregation and Arithmetic Operations, Case Studies.

Unit-IV

Data Modeling With Graph: Comparison of Relational and Graph Modeling, Property Graph Model Graph Analytics: Link analysis algorithm- Web as a graph, Page Rank- Markov chain, page rank computation, Topic specific page rank (Page Ranking Computation techniques: iterative processing, Random walk distribution Querying Graphs: Introduction to Cypher, case study: Building a Graph Database Application- community detection. Recent trends in Databases/Next Generation Databases and Contemporary Issues.

Suggested Readings:

1. NoSQL Distilled by Addison-Wesley.
2. Next Generation Databases by Apress Publication.
3. MongoDB: The Definitive Guide by O'Reilly Media.
4. Graph Databases by O'Reilly Media.
5. The Design and Implementation of Modern Column-Oriented Database Systems by Now Publishers Inc.
6. An introduction to Information Retrieval by Christopher D. Manning, Prabhakar Raghavan, Hinrich Schutze, Cambridge University Press.
7. The Design and Implementation of Modern Column-Oriented Database Systems by Daniel Abadi, Peter Boncz and Stavros Harizopoulos, Now Publishers.
8. Next Generation Database: NoSQL and big data by Guy Harrison, Apress.

Useful Video links:

Unit	Topics Covered	NPTEL / Reference Link
Unit-I	Introduction to NoSQL Concepts, ACID & BASE, CAP Theorem, NoSQL Architecture Patterns	https://onlinecourses-archive.nptel.ac.in/noc17_cs33/course
	Distributed Databases, Sharding, Replication, Query Processing	https://onlinecourses.nptel.ac.in/noc24_cs75/preview
	NoSQL Basics and Key-Value Stores	https://www.youtube.com/watch
Unit-II	Key-Value Databases, Document-Oriented Databases, MongoDB, Cassandra	https://www.youtube.com/watch

	Distributed NoSQL Systems and Big Data Storage	https://onlinecourses-archive.nptel.ac.in/noc19_cs33/preview
	CRUD Operations, Replication, Sharding in MongoDB/Cassandra	https://www.coursera.org/learn/introduction-to-nosql-databases/
Unit-III	Columnar Databases, Storage Models, Compression, Query Processing	https://onlinecourses-archive.nptel.ac.in/noc19_cs33/preview
	Indexing, Database Internals, Query Optimization	https://onlinecourses.nptel.ac.in/noc24_cs75/preview
Unit-IV	Graph Databases, Graph Modeling, Cypher Queries	https://onlinecourses-archive.nptel.ac.in/noc17_cs33/course
	Graph Analytics, PageRank, Distributed Graph Processing	https://onlinecourses-archive.nptel.ac.in/noc19_cs33/preview
	Modern NoSQL Trends and Graph-Oriented Databases	https://www.coursera.org/learn/introduction-to-nosql-databases/

Course code	DS-302A				
Category	Professional Core Courses				
Course title	Data Visualization				
Scheme and Credits	L	T	P	Credits	Semester-VI
	3	0	0	3	
Course Objectives	The objectives of this course are • To introduce students to Python-based data handling tools and structured data preparation techniques required for effective visualization. • To develop the ability to create clear, well-structured, and customizable static visualizations for exploratory and explanatory analysis. • To enable students to analyze multivariate and time-oriented data using appropriate statistical and advanced visualization techniques. • To cultivate skills in interactive visualization and data storytelling while emphasizing ethical and responsible visual communication.				
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	Recall Python libraries, data structures, plotting functions, and basic visualization concepts for exploratory data analysis.	Level 1: Remember
CO2	Explain visualization components, design principles, plot types, and techniques for effective data storytelling and communication.	Level 2: Understand
CO3	Apply Python tools to create, customize, and analyze static and interactive visualizations for datasets using Matplotlib, Seaborn, and Plotly.	Level 3 : Apply
CO4	Analyze datasets visually, compare plotting methods, detect patterns, and interpret multivariate, temporal, and interactive visual insights.	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

Data Handling Basics: Overview of Python libraries: Pandas, NumPy, Matplotlib, Seaborn, Plotly, Understanding DataFrames in Pandas (structure differences vs R), Data loading using Pandas: from CSV, Excel, JSON, URL, Basic DataFrame manipulations: indexing, slicing, merging, grouping, Introduction to tidy data in Python.

Unit-II

Basics of Visualization Analytics Problems: Key Visualization Concepts, Visualization goals, communication, perception, clarity, Plot components: figure, axes, ticks, labels, legends, themes, Creating basic plots in Matplotlib: line chart, bar chart, pie chart, Customizing plots: colors, markers, grids, annotations, Subplots and layout

management (Matplotlib gridspec, subplot2grid), Color palettes, themes, style settings, Enhanced barplots, countplots, distribution plots, PairGrid, FacetGrid concepts.

Unit-III

Statistical & Multivariate Visualization: Violin plots, Boxen plots, Jointplots & pairplots, Heatmaps for categorical & correlation data, Clustermaps.

Time & Multi-Dimensional Visualization: Multi-axis plots, Rolling window visualization, Bubble charts, spider/radar charts, Area charts, stacked charts.

Unit-IV

Plotly Interactive Visualization: Introduction to Plotly, Interactive line, bar, scatter plots, Plotly Express vs. Plotly Graph Objects, Interactive legends, hover labels, animations, 3D visualizations (surface, scatter3D, mesh plots).

Plotly Interactive Visualization: Visualization for insights vs. aesthetics, Data storytelling principles, Layout design for dashboards (Plotly Dash – conceptual only), Choosing effective chart types, Ethical visualization: misleading charts, scale distortions.

Suggested Readings:

1. Python for Data Analysis by Wes McKinney, O'Reilly Media, 2018.
2. Python Data Science Handbook by Jake VanderPlas, O'Reilly Media, 2016.
3. Python Data Visualization Essentials Guide by Kalilur Rahman, BPB Publications, 2021.
4. Data Visualization with Python and JavaScript by Kyran Dale, O'Reilly Media, 2016.
5. Mastering Matplotlib by Kirithi Raman, Packt Publishing, 2015.

Useful Video Links:

Unit No.	Topics	Links
Unit-I	Data Frames in Pandas	https://youtu.be/6DTFIKF8QIg?si=en5tm53K2XQN6Mw9
	Data loading	https://youtu.be/On6rLc1l_MU?si=tZvRvW-7ZL2PKaj7
	Numpy	https://youtu.be/rjY59WLMK2o?si=q92faGhp3hT69w_X
Unit-II	Matplotlib	https://youtu.be/eFByJkA3ti4?si=cJ0ncTkbPsvA2i2p
	Plot components: figure, axes	https://youtu.be/eFByJkA3ti4?si=gcSACHRE0sMu_yIv
Unit-III	Jointplots & pairplots	https://youtu.be/JhK2qVi5dC4?si=0mVubJza7r5s-6xp
	Spider Graph	https://youtu.be/ONtrmxxyTsw?si=xMCINbs2Wb5tjTEZ
Unit-IV	Scatter plots	https://youtu.be/eFByJkA3ti4?si=WAMwmAUPQlirmsI1

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/CSE-AIML/CSE-DS)
	3	1	0	4	
Course Objectives	The objectives of this course are • To provide knowledge of artificial neural networks, neuron models, architectures, and activation functions. • To develop understanding of neural network learning mechanisms and computational models. • To enable application of neural network techniques for pattern recognition and problem solving. • 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 propagation 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, 1998, AW.
2. Neural Networks by Kosko, 1992, PHI.
3. Neural Network Fundamentals by N.K. Bose, P. Liang, 2002, T.M.H.
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	CSE-002A				
Category	Professional Core Courses				
Course Title	Big Data Analytics				
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 ● To provide knowledge of big data concepts, architectures, storage models, and analytical frameworks. ● To develop understanding of distributed computing, data processing, and big data technologies. ● To enable application of big data tools and analytics techniques for large-scale data processing. ● To develop analytical abilities for evaluating big data solutions and business insights.				
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 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/DJOaFa8xlr?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-p45JnwEJTIL

Course Code	DS-304A				
Category	Professional Core Courses				
Course Title	Social Network Analysis				
Scheme and Credits	L	T	P	Credits	Semester-VI
	3	0	0	3	
Course Objectives	The objectives of this course are ● To provide knowledge of social networks, graph structures, network measures, and social data analysis concepts. ● To develop understanding of community detection, network evolution, influence analysis, and information diffusion. ● To enable application of social network analysis techniques for discovering patterns and relationships. ● To develop analytical abilities for evaluating social structures, interactions, and network 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 social network concepts, graph structures, network measures, social interactions, and analytical frameworks.	Level 1: Remember
CO2	Explain community structures, influence models, information diffusion processes, and network evolution mechanisms.	Level 2: Understand
CO3	Apply social network analysis techniques, graph algorithms, and analytical methods to discover patterns and relationships.	Level 3: Apply
CO4	Analyze social networks, community structures, influence propagation, and network behaviour using appropriate analytical 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

Basics of Social Network Analysis: Definition and scope of social networks, Types of networks, social, biological, technological, information networks, Real-world applications of network analysis Structure and components of a network.

Tools & Environment: Introduction to Python & Google Colab for network analysis, NetworkX, Creating graphs, Basic graph operations, Visualization basics, Degree, centrality, clustering coefficient, Network density, diameter, average path length, Degree distributions and network properties.

Unit-II

Network Growth Models: How networks evolve, Preferential attachment model, Random graph model, Small-world networks, Importance of link structure, Page Rank & related ranking algorithms, Hubs and Authorities concepts, Graph Visualization, Graph drawing tools, Layout techniques, Large network visualization challenges, Concept of communities/clusters in networks, Modularity, Popular community detection algorithms, Evaluation of communities.

Unit-III

Predictive & Behavioural Analysis in Networks: Predicting missing and future links, Similarity-based measures, Machine-learning approaches for link prediction, Spread of information and influence, Viral diffusion models, Contagion and cascading effects, Influence maximization, Outlier behavior, Fraud detection, Identifying unusual sub-graphs or nodes, Applications in security & social media.

Unit-IV

Graph Representation Learning & Applications: Basics of deep learning relevant to graph data, Challenges with graph-structured input, Node embeddings, Graph embeddings, DeepWalk, Node2Vec, LINE, GNN (Graph Neural Network) basics, Real-world applications of SNA, Social-media analytics, E-commerce networks, Web networks, Final project-style case discussions.

Suggested Readings:

1. Social Network Analysis by Tanmoy Chakraborty, Wiley India (2021).
2. Social Networks and the Semantic Web by Peter Mika, First Edition, Springer 2007.
3. Models and Methods in Social Network Analysis edited by Peter J. Carrington, John Scott & Stanley Wasserman, Cambridge University Press (2005).
4. Social Network Analysis: Methods and Applications by Stanley Wasserman & Katherine Faust, Cambridge University Press (1994).
5. Networks, Crowds, and Markets: Reasoning About a Highly Connected World by David Easley & Jon Kleinberg, Cambridge University Press (2010).
6. Network Science by Albert-László Barabási, Network-Science Book Project (open reference).

Useful Video links:

Topics	Links
Social Network Analysis	https://youtu.be/knTTWzLRlEE?si=oZFI6MLRZg3VfYUY

Course Code	DS-L302A				
Category	Professional Core Courses				
Course Title	Data Visualization Lab				
Scheme and Credits	L	T	P	Credits	Semester-VI
	0	0	2	1	
Course Objectives	The objectives of this course are - To explore Python visualization libraries (Matplotlib, Seaborn, Pandas, Plotly) to represent data effectively. - To visualize trends, distributions, and comparisons using line charts, bar/column charts, pie/donut charts, and histograms. - Analyze relationships and detect patterns through scatter plots, correlation plots, box plots, and violin plots. - To Create advanced visualizations like 3D plots, heatmaps, and stacked charts for complex datasets.				
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 and use major Python data visualization libraries (Matplotlib, Seaborn, Pandas, Plotly) for handling different types of data.	Level 2: Understand
CO2	Apply suitable visualization techniques (line, bar, pie, histogram) to represent trends, categorical data, proportions, and distributions.	Level 3: Apply
CO3	Construct advanced and interactive visualizations including scatter plots, 3D plots, heatmaps, and stacked bar charts using Seaborn and Plotly.	Level 3: Apply
CO4	Analyze multivariate datasets to interpret relationships, correlations, and statistical variations using box plots, violin plots, and correlation plots.	Level 4: Analyze

List of Experiments:

Sr. No.	Content	COs
1	To study and explore data visualization libraries in Python, including Matplotlib, Seaborn, Pandas, and Plotly.	CO1
2	Write a Python program to visualize data trends over time using line charts.	CO2
3	Write a Python program to compare categorical data using bar charts and column charts.	CO2
4	Write a Python program to represent proportions and percentages using pie charts and donut charts.	CO2
5	Write a Python program to analyze data distribution using histograms.	CO2

6	Write a Python program to identify relationships and correlations between variables using scatter plots and correlation plots.	CO3 CO4
7	Write a Python program to visualize statistical summaries and detect outliers using box plots and violin plots.	CO4
8	Write a Python program to draw 3D plots using the Plotly library.	CO3
9	Write a Python program to generate a 6×6 heatmap using random data and visualize it with Seaborn.	CO3
10	Write a Python program to plot a stacked bar chart displaying sales of multiple products across different quarters.	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
Visualize data trends over time using line charts	https://colab.research.google.com/github/ageron/handson-ml2/blob/master/tools_matplotlib.ipynb
Represent proportions and percentages using pie charts and donut charts	https://colab.research.google.com/drive/1NsncQ_M5W5F8Z03nOj713Wjf_eW8k0AQ?usp=sharing
Draw 3D plots using the Plotly library	https://colab.research.google.com/drive/1-luSy55lQQrpNhJ_W_w_rdaBgtNub0?usp=sharing

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 • To introduce the MATLAB environment for designing and simulating neural network models. • To develop understanding of basic neuron models and learning rules such as McCulloch-Pitts and Hebbian learning. • To study and implement various activation functions used in neural networks. • To analyze the effect of weights, bias, and activation functions on neuron behavior. • 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 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 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 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 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	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 • To provide knowledge of the Hadoop ecosystem, distributed computing, and big data processing frameworks. • To develop understanding of MapReduce, Pig, and Hive for large-scale data analysis. • To enable application of big data tools and techniques for solving data-intensive problems. • 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
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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 Courses					
Course title	Formal Languages & 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 • To provide knowledge of automata, formal languages, grammars, and computational models. • To develop understanding of language recognition, parsing, and computational mechanisms. • To enable application of automata and grammar concepts for problem solving. • 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 (NFA), Equivalence of DFA and NFA, Conversion of NFA to DFA, minimization of finite automata, Finite automata with ϵ - 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. Chandrashekar, 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=wQbdjmlNNU&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-302A				
Category	Professional Core Courses				
Course title	Recommender Systems				
Scheme and Credits	L	T	P	Credits	Semester-VI (Common for B. Tech. CSE-AIIML/CSE-DS)
	3	0	0	3	
Course Objectives	The objectives of this course are • To provide knowledge of recommender system concepts, architectures, similarity measures, and recommendation techniques. • To develop understanding of content-based, collaborative, and trust-based recommendation methods. • To enable application of recommender system techniques for personalized information retrieval. • 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/1JRrCEgyHM?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=IUZLC1J8GfEiRG1y
Unit-IV	Evaluating Recommender Systems	https://youtu.be/VZKMyTaLI00?si=cQMi302X8yMgDLV5

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-AIIML/CSE-DS)
	3	0	0	3	
Course Objectives	The objectives of this course are ● To provide knowledge of explainable AI concepts, interpretability methods, and transparency mechanisms. ● To develop understanding of model explanation techniques and trustworthy AI practices. ● To enable application of explainability methods for interpreting AI models. ● 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

CO	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	CSE-308A				
Category	Professional Elective Courses				
Course title	Digital Image Processing				
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 ● To provide knowledge of digital image processing concepts, image representation, and transformation techniques. ● To develop understanding of image enhancement, restoration, segmentation, and feature extraction methods. ● To enable application of image processing techniques for image analysis and interpretation. ● To develop analytical abilities for evaluating image processing algorithms and outcomes.				
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 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

Course code	OEC-03A				
Course Category	Multidisciplinary Open Elective				
Course title	Internet of Things and Edge Computing				
Scheme and Credits	L	T	P	Credits	Semester-VI
	3	0	0	3	
Course Objectives	The objectives of this course are • To introduce the fundamentals, architecture, and applications of Internet of Things (IoT) and edge computing. • To provide knowledge of IoT devices, sensors, communication protocols, and ESP32-based systems. • To familiarize with cloud connectivity, Things Board, and IoT data visualization techniques. • To present the concepts of edge computing and their integration in IoT applications.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total Marks	100				
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 fundamentals of Internet of Things and edge computing.	Level 1: Remember
CO2	Explain IoT devices, communication technologies, cloud platforms, and edge computing.	Level 2: Understand
CO3	Apply IoT hardware, cloud platforms, and edge computing to develop IoT solutions.	Level 3 : Apply
CO4	Analyze IoT architectures, communication technologies, and edge computing for engineering applications.	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 Internet of Things (IoT): Definition and significance of IoT, Evolution of IoT, Components of IoT ecosystem, IoT applications in various engineering domains. Basic Electronic components, sensors, actuators, and controllers. Development boards: Arduino Uno, ESP8266, and ESP32. Introduction to sensor and actuator Ultrasonic, PIR, LDR, IR, DHT11, RFID, MQ series sensors, Servo Motor, LED, and Relay.

Unit-II

IoT Technologies and Protocols: Understanding the Fundamentals of Industrial connectivity and Communication Protocols MQTT, CoAP, HTTP, IOT Wireless Communication Standards-Wi-Fi, Zigbee, LORA, Bluetooth, ESP32 introduction, Architecture, Pin Details, Setup with Arduino, Code uploading, Sensor interfacing with ESP32 and testing.

Unit-III

Cloud Connectivity & Introduction to Thingsboard: Architecture, components and cloud-based features, Key concepts, applications, and technologies, Introduction to Widgets and Creating customizing Dashboards, sending telemetry and attributes from devices, Building and Visualizing Dashboards, Common widgets like charts, maps,

and tables for data visualization, Setting up Real-time Data Monitoring updates and alerts. Small IOT project on Things board.

Unit-IV

Fundamentals of Edge Computing: Distributed systems and edge computing core concepts, Edge computing architectures, IoT devices and edge computing in IoT gateways, Edge computing vs cloud computing vs fog computing. Sensors & Actuators: Working with GPIO pins, analog-to-digital converters (ADC), and physical computing.

Suggested Readings:

1. Internet of Things: A Hands-On Approach by B. Ray, Springer, 2020.
2. Interconnecting Smart Objects with IP: The Next Internet by A. Dunkels, Morgan Kaufmann, 2010.
3. Internet of Things: A Hands-On Approach by Arshdeep Bahga and Vijay Madisetti, Universities Press, 2015.
4. Designing the Internet of Things by Adrian McEwen and Hakim Cassimally, Wiley, 2014.

Useful Video Links:

Unit No.	Topics	Links
Unit-I	Introduction to IOT	https://youtu.be/p7kYStiASLo?si=3HFZbofjAsy5oZCU
	IOT Sensing and Actuation	https://youtu.be/hv-aBonZMRQ?si=x40BUTJOTKy6TZfV
Unit-II	IOT Technologies	https://youtu.be/TrFaCBV7joY?si=U4HlpRE5oXYUmlFy
	IOT Protocols	https://youtu.be/u4UebEMMkJc?si=WB08KtDs9l4ARqzK
Unit-III	Overview of Cloud Computing	https://youtu.be/w2caA8ty36s?si=5WQVhV28wFCIAIFA
	Introduction to Thingsboard	https://youtu.be/80L0ubQLXsc?si=W2zjXWUM86OMoJ9R
Unit-IV	Fundamentals of Edge Computing	https://youtu.be/nPOUoJavYQc?si=pV-YVECWVD-chZtC
	Introduction to Fog Computing	https://www.youtube.com/watch?v=E19Dy_iACFI