Annexure AC / 5.11

Annexure 4.3 (c)

GANGA INSTITUTE OF TECHNOLOGY AND MANAGEMENT, KABLANA (JHAJJAR)

An Autonomous Institute

'A' GRADE ACCREDITED BY NAAC

Evaluation Scheme and Syllabus For

Bachelor of Technology Computer Science and Engineering-Data Science

(B.Tech CSE-DS)

(Effective from the Session: 2026-27)

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

1. DEFINITION OF CREDIT

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

2. RANGE OF CREDIT

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

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

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

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

4. COURSE CODE AND DEFINITIONS

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

General Notes:

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

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

Scheme of Studies and Examination

B.Tech Computer Science and Engineering-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 Marks	3
2	Professional Core Courses	AI-301A	Machine Learning	3	1	0	4	4	40	60		100 Marks	3
3	Professional Core Courses	DS-303A	Predictive Analytics	3	0	0	3	3	40	60		100 Marks	3
4	Professional Core Courses	CSE-305A	Design and Analysis of Algorithms	3	0	0	3	3	40	60		100 Marks	3
5	Engineering Science Courses	DS-305A	Applied Computational Statistics	3	0	0	3	3	40	60		100 Marks	3
6	Professional Elective Courses	Refer Table-II	Professional Elective-II	3	0	0	3	3	40	60		100 Marks	3
7	Professional Core Courses	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	Engineering Science Courses	DS-L305A	Applied Computational Statistics Lab	0	0	2	2	1	25		25	50	3
10	Professional Core Courses	CSE-L305A	Design and Analysis of Algorithms Lab using C++	0	0	2	2	1	25		25	50	3
11	Practical Training	PT-301A	Practical Training-I	0	0	2	0	0	-		-	-	-
Total Credits								**23**				**800**	

Note:

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

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

Table II: Professional Elective - II

Sr. No.	Course Code	Course Title
1	CSE-301A	Computer Networks
2	CSE-315A	Data Warehouse and Mining
3	DS-307A	Business Intelligence & Analytics
4	DS-309A	NoSQL
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 Marks	3
2	Professional Core Courses	AI-001A	Neural Networks	3	1	0	4	4	40	60		100 Marks	3
3	Professional Core Courses	CSE-002A	Big Data Analytics	3	0	0	3	3	40	60		100 Marks	3
4	Professional Core Courses	DS-304A	Social Network Analysis	3	0	0	3	3	40	60		100 Marks	3
5	Professional Elective Courses	Refer Table-III	Professional Elective-III	3	0	0	3	3	40	60		100 Marks	3
6	Multidisciplinary Open Elective Courses	Refer Table-IV	Multidisciplinary Open Elective-I	3	0	0	3	3	40	60		100 Marks	3
7	Professional Core Courses	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=YepECGlOl4Y=
	Introduction to Data Preprocessing	https://www.youtube.com/watch?v=cO6lrQuepcs
Unit-III	Types of supervised learning	https://www.youtube.com/watch?v=5NSKURYzU70
	Linear Regression	https://youtu.be/_M7Km1XZERU?si=NoLgPErLdkv6frY4
	Logistic Regression	https://youtu.be/g__LURKuIj4?si=JtwGguSfsh_KnguR
Unit-IV	Unsupervised Learning & K-means	https://www.youtube.com/watch?v=FeVrAK77mV8
	The ROC Curve	https://www.youtube.com/watch?v=6RjcFVm_k4c

<table>
<tr><td>Course Code</td><td colspan="5">CSE-305A</td></tr>
<tr><td>Category</td><td colspan="5">Professional Core Courses</td></tr>
<tr><td>Course Title</td><td colspan="5">Design and Analysis of Algorithms</td></tr>
<tr><td rowspan="2">Scheme and Credits</td><td>L</td><td>T</td><td>P</td><td>Credits</td><td rowspan="2">Semester-V (Common for B. Tech. CSE/CSE-AIML/CSE-DS)</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Course Objectives</td><td colspan="5">The objectives of this course are
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.</td></tr>
<tr><td>Assessment</td><td colspan="5">40 Marks</td></tr>
<tr><td>End Semester Examination</td><td colspan="5">60 Marks</td></tr>
<tr><td>Total</td><td colspan="5">100 Marks</td></tr>
<tr><td>Duration of Exam</td><td colspan="5">03 Hours</td></tr>
</table>

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

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

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

Unit-I

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

Unit-II

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

Unit-III

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

Unit-IV

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

Suggested Readings:

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

Useful Video links:

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

Course Code	**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/LNL4G87DpI0?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_rDIm7dI3Y?si=y778gzeyW5gfaiRV
	Lagging Data (Causal Models)	https://youtu.be/LpRC9ds6GIc?si=MXYyawUQo_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	**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 upto12th 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 $\chi 2$ 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=_aA4CVPWr2YzapnU
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=hdGVXA0WyVMlXK20
Unit-IV	Nonparametric and robust methods of multivariate analysis	https://youtu.be/-3iGSoubUjc?si=QA0lRYWBsz2_lVjl
	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/1M8xTPtJVcY5UZTZusL6jiqooRBamkYen?usp=sharing
Missing Value Handling	https://colab.research.google.com/drive/1M8xTPtJVcY5UZTZusL6jiqooRBamkYen?usp=sharing
Encode categorical variables	https://colab.research.google.com/drive/1M8xTPtJVcY5UZTZusL6jiqooRBamkYen?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=5ONlGP0Nx3Q
Gradient Descent	https://www.youtube.com/watch?v=JA5rIxOve20
Principal Component Analysis (PCA)	https://www.youtube.com/watch?v=hkCT-6KJAK0
K-Means Clustering	https://www.youtube.com/watch?v=oFr4JX75MCc

Course Code	**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/12ZIwxGQGEUvl7qc6AT9awAWOqQnL-nzd?usp=sharing
Mean, Median and Standard Deviation	https://colab.research.google.com/drive/12ZIwxGQGEUvl7qc6AT9awAWOqQnL-nzd?usp=sharing
Multivariate Normal Distribution	https://colab.research.google.com/drive/12ZIwxGQGEUvl7qc6AT9awAWOqQnL-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/EqzDTO9tdqs?si=16VZZu9Oz3IzOeOA
Unit-IV	Congestion Control and QoS	https://nptel.ac.in/courses/106105081
	SDH/SONET Layering, Frame Structure	https://youtu.be/f5EmFoXlYyQ?si=8ilxCANj5flH7TP4

Course Code	**CSE-315A**				
Category	Professional Elective Courses				
Course Title	**Data Warehouse and Mining**				
Scheme and Credits	L	T	P	**Credits**	**Semester-V(Common for B. Tech. CSE/ CSE-AIML/CSE-DS)**
	3	0	0	**3**	
Course Objectives	The objectives of this course are ● 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_PIur
Unit-III	Bayes Classifier	https://www.youtubeeducation.com/watch?v=DXnnvprUl2Y
	Decision Tree	https://www.youtubeeducation.com/watch?v=4l4_BREP6ZI
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_DXEoyOIzUd6
	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 Database**				
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 Harizopoulas, 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 Kirthi 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/ONtrmxyxTsw?si=xMClNbs2Wb5tjTEZ
Unit-IV	Scatter plots	https://youtu.be/eFByJkA3ti4?si=WAMwmAUPQlirnsI1

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 propogation Network: Architecture, training and testing.

Unit-IV

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

Suggested Readings:

1. Neural Networks: A Comprehensive formulation by Simon Haykin, 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

<table>
<tr><td>Course Code</td><td colspan="5">CSE-002A</td></tr>
<tr><td>Category</td><td colspan="5">Professional Core Courses</td></tr>
<tr><td>Course Title</td><td colspan="5">Big Data Analytics</td></tr>
<tr><td rowspan="2">Scheme and Credits</td><td>L</td><td>T</td><td>P</td><td>Credits</td><td rowspan="2">Semester-VI (Common for B. Tech. CSE/CSE-AIML/CSE-DS)</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Course Objectives</td><td colspan="5">The objectives of this course are
● 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.</td></tr>
<tr><td>Assessment</td><td colspan="5">40 Marks</td></tr>
<tr><td>End Semester Examination</td><td colspan="5">60 Marks</td></tr>
<tr><td>Total</td><td colspan="5">100 Marks</td></tr>
<tr><td>Duration of Exam</td><td colspan="5">03 Hours</td></tr>
</table>

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

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

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

Unit I

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

Unit II

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

Unit-III

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

Unit-IV

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

Suggested Readings:

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

Useful Video Links:

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

Course Code	**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

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

Useful Video Link:

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

Course code	**AI-302A**				
Category	Professional Core Courses				
Course title	**Recommender Systems**				
Scheme and Credits	L	T	P	**Credits**	**Semester-VI (Common for B. Tech. CSE-AIML/CSE-DS)**
	3	0	0	**3**	
Course Objectives	The objectives of this course are • 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/1JRrCEgiyHM?si=TI92GD7dKaLgUynP
	Dimensionality Reduction - Introduction	https://youtu.be/yLdOS6xyM_Q?si=IcKoxrbDJ4PVpRgy
Unit-II	Content Based Recommendations	https://youtu.be/2uxXPzm-7FY?si=5MOXAIK8XazWx5Em
Unit-III	Collaborative Filtering	https://youtu.be/h9gpufJFF-0?si=7hmFo4D9QimbfN6g
	Implementing Collaborative Filtering	https://youtu.be/6BTLobS7AU8?si=lUZLC1J8GfEiRG1y
Unit-IV	Evaluating Recommender Systems	https://youtu.be/VZKMyTaLI00?si=cQMi302X8yMgDLV5

Course Code	**AI-306A**				
Category	Professional Elective Courses				
Course Title	**Explainable AI**				
Scheme and Credits	L	T	P	**Credits**	**Semester-VI (Common for B. Tech. CSE-AIML/CSE-DS)**
	3	0	0	3	
Course Objectives	The objectives of this course are ● 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_

<table>
<tr><td>Course code</td><td colspan="6">CSE-308A</td></tr>
<tr><td>Category</td><td colspan="6">Professional Elective Courses</td></tr>
<tr><td>Course title</td><td colspan="6">Digital Image Processing</td></tr>
<tr><td rowspan="2">Scheme and Credits</td><td>L</td><td>T</td><td>P</td><td>Credits</td><td colspan="2" rowspan="2">Semester-VI (Common for B. Tech. CSE/ CSE-AIML/CSE-DS)</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Course Objectives</td><td colspan="6">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.</td></tr>
<tr><td>Assessment</td><td colspan="6">40 Marks</td></tr>
<tr><td>End Semester Examination</td><td colspan="6">60 Marks</td></tr>
<tr><td>Total</td><td colspan="6">100 Marks</td></tr>
<tr><td>Duration of Exam</td><td colspan="6">03 Hours</td></tr>
</table>

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

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

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

Unit-I

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

Unit-II

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

Unit-III

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

Unit-IV

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

Suggested Readings:

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

Useful Video Links:

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

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=5WQVhV28wFCIAlFA
	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

Annexure AC / 5.13

~~Annexure AC / 4.5~~

GANGA INSTITUTE OF TECHNOLOGY AND MANAGEMENT, KABLANA (JHAJJAR)

(An Autonomous Institute)

'A' GRADE ACCREDITED BY NAAC

Scheme of Studies and Examinations

(Under NEP-2020)

B-SCHEME

Bachelor of Technology Computer Science and Engineering (CSE)

Common With

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

Bachelor of Technology Computer Science and Engineering-Data Science (CSE-DS)

2nd Year

(Effective from the Session: 2026-27)

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

1. DEFINITION OF CREDIT

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

2. RANGE OF CREDIT

A range of credits from 160 to 170 for a student to be eligible to get Under Graduate 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 Non Credit Courses – Audit Course	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) – 3rd Semester

Common with

B.Tech (CSE- Artificial Intelligence and Machine Learning) – 3rd Semester

B.Tech (CSE – Data Science) – 3rd 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	Basic Science Courses	AS-001B	Engineering Mathematics-III	3	1	0	4	4	40	60		100	3
2	Professional Core Courses	CSE-201B	Data Structures	3	0	0	3	3	30	45		75	3
3	Professional Core Courses	CSE-203B	Operating Systems	3	0	0	3	3	30	45		75	3
4	Professional Core Courses	CSE-205B	Python Programming	3	0	0	3	3	30	45		75	3
5	Humanities and Social Science including Management Courses	HSMC-01B	Fundamentals of Management and Organizational Behaviour	3	0	0	3	3	30	45		75	3
6	Engineering Science Courses	ECE-001B	Digital Electronics	3	0	0	3	3	30	45		75	3
7	Professional Core Courses	CSE-L201B	Data Structures Lab Using C	0	0	2	2	1	10		15	25	3
8	Professional Core Courses	CSE-L203B	Operating Systems Lab	0	0	2	2	1	10		15	25	3
9	Professional Core Courses	CSE-L205B	Python Programming Lab	0	0	2	2	1	10		15	25	3
10	Engineering Science Courses	ECE-L001B	Digital Electronics Lab	0	0	2	2	1	10		15	25	3
11	Mandatory Courses (Non-Credit)	MC-201B	Environmental Science	2	0	1	3	-	30	45		-	3
Total Credits								**23**				**575**	

Note: MC-201B is a mandatory non–credit course in which the students will be required passing marks in theory.

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

Scheme of Studies and Examination

B.Tech (Computer Science and Engineering) – 4th Semester

Common with

B.Tech (CSE- Artificial Intelligence and Machine Learning) 4th Semester

B.Tech (CSE – Data Science) – 4th 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	CSE-202B	Discrete Mathematics	3	1	0	4	4	40	60		100	3
2	Professional Core Courses	CSE-204B	Computer Organization and Architecture	3	0	0	3	3	30	45		75	3
3	Professional Core Courses	CSE-206B	Object Oriented Programming	3	0	0	3	3	30	45		75	3
4	Professional Core Courses	CSE-208B	Database Management Systems	3	1	0	4	4	40	60		100	3
5	Professional Core Courses	CSE-210B	Artificial Intelligence	3	0	0	3	3	30	45		75	3
6	Professional Elective Courses	Refer Professional Elective Table-1	Professional Elective-I	3	0	0	3	3	30	45		75	3
7	Professional Core Courses	CSE-L206B	Object Oriented Programming Lab using C++	0	0	2	2	1	10		15	25	3
8	Professional Core Courses	CSE-L208B	Database Management Systems Lab	0	0	2	2	1	10		15	25	3
9	Professional Core Courses	CSE-L210B	Artificial Intelligence Lab using Python	0	0	2	2	1	10		15	25	3
Total Credits								**23**				**575**	

Notes:

I. Students must choose one course from the Professional Elective–I category (Table I). 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. At the end of 4th 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 5th 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.

III. **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 5th Semester.

Table I: Professional Elective - I

Sr. No.	Course Code	Course Title
1	CSE-212B	Cloud Computing
2	CSE-214B	Nature Inspired Computing Techniques
3	CSE-216B	Human Computer Interaction
4	CSE-218B	Fundamentals of Multimedia
5	----------	Any one of the MOOCs (offered through SWAYAM, SWAYAM Plus, or NPTEL platforms) not studied earlier and of equal credits (3)

Course Code	**AS-001B**				
Category	Basic Science Courses				
Course Title	**Engineering Mathematics-III**				
Scheme and Credits	L	T	P	**Credits**	**Semester-III**
	3	1	0	**4**	
Course Objectives	The objectives of this course are ● To equip students with advanced mathematical tools—multivariable calculus, vector calculus, partial differential equations, and complex analysis—for modeling, analyzing, and solving problems in computational and engineering domains. ● To emphasise on applications in areas such as image processing, machine learning, signal processing, and system dynamics.				
Course Prerequisite	Mathematics up to 12th Standard and Engineering Mathematics-I				
Assessment	40Marks				
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	Describe key terminology of multivariable integrals, vector calculus, partial derivatives and complex analysis.	Level 2: Understand
CO2	Explain the principles and applications of multivariable integrals, vector calculus, partial derivatives and functions of complex variables.	Level 2: Understand
CO3	Solve the problems using techniques of integrals, vector calculus, partial derivatives and complex analysis.	Level 3: Apply
CO4	Analyze complex mathematical problems associated with multi-variable integrals, vector calculus, partial derivatives and complex function.	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

Multivariable Integral Calculus: Evaluation of definite and improper integrals, double integrals, Evaluation of double integrals (Cartesian and polar coordinates), Change of order of integration, Change of variables between Cartesian, cylindrical and spherical polar coordinates, Applications of double integral to find area enclosed by plane curves, Triple integrals, Applications of triple integrals, Beta and Gamma functions.

Unit-II

Vector Calculus: Differentiation of vectors, scalar and vector point functions, Gradient of a scalar point function, Directional derivative, Curl and divergence, Statement of Green's, Stoke's and Gauss divergence theorems, Verification and evaluation of vector integrals using these theorems.

Unit-III

Partial Derivatives: Definition of Partial Differential Equations, First order linear partial differential equations, Partial Differential Equations of higher order: Second-order linear partial differential equations and their classification, Solution to homogeneous and non-homogeneous linear partial differential equations of second order by complementary function and particular integral method, Initial and boundary conditions, D'Alembert's solution of the wave equation, Separation of variables method to simple problems in Cartesian coordinates, One dimensional diffusion equation and its solution by separation of variables.

Unit-IV

Functions of Complex Variable: Differentiability and Analyticity, Cauchy-Riemann equations, necessary and sufficient conditions for a function to be analytic, polar form of the Cauchy-Riemann equations, Harmonic functions, Integration of complex functions, Cauchy-integral theorem and formula (without proof), Taylor's series, Laurent's series, Zeros of analytic functions, Singularities, Residues, Cauchy Residue theorem (without proof).

Suggested Readings:

1. Higher Engineering Mathematics by B.V. Ramana, TataMcGraw-Hill Publishing Company Limited.
2. Higher Engineering Mathematics by B.S. Grewal, KhannaPublishers.
3. Advanced Engineering Mathematics by Erwin Kreyszig, John Wiley& Sons.
4. Advanced Engineering Mathematics by H.K. Dass, S.Chand.
5. A text book of Engineering Mathematics by N.P.Bali and Manish Goyal, Laxmi Publications.
6. Engineering Mathematics for first year by T. Veerarajan, Tata McGraw-Hill Publishing Company Ltd..
7. Engineering Mathematics-Calculus, Differential Equations and Linear Algebra by P. Sivaramakrishna Das, C. Vijayakumari, Pearson Education.

Useful Video links

Unit No.	Topics	Links
Unit-I	Multiple Integrals	https://youtu.be/mIeeVrv447s?si=ZxrHvWcK3RQTaOyp
	Change Order Of Integration	https://youtu.be/4rc3w1sGoNU?si=GmMACWg459ppFGyn
	Change Of Variables	https://youtu.be/wtY5fx6VMGQ?si=bSR0rySP3bql6Ngh
Unit-II	Vector Differentiation	https://youtu.be/Qj0KM9Uh7xw?si=9gLE1lLBgoYnyi8v
	Gradient of a scalar field and Directional derivative	https://youtu.be/JTJXHcLrxgM?si=kuqQlxeT4Y0N9Xeo
	Gradient, Divergence and Curl	https://youtu.be/v_sTlDeCUdU?si=yf6yzC0hazmWzYEh
	Line Integral	https://youtu.be/yCqLvRiVtng?si=iqbOrl9Bq28F9HIL
	Applications of Line integrals	https://youtu.be/mMBSb_dtkYU?si=rtFe1esglErwBr3b
	Green's Theorem	https://youtu.be/34aX-fNMS-c?si=v1hj0iSsVQ2ypsJp
	Divergence Theorem of Gauss	https://youtu.be/DtqTXJ5X3xo?si=J5KIjrjWImISylNH
	Stoke's Theorem	https://youtu.be/q-fgRrPayJY?si=MI5sFHwamcF8gApa
Unit-III	Definition of Partial Differential Equations.	https://youtu.be/Kk5SEzASkZU?feature=shared
	Homogeneous and non-homogenous linear partial differential equations of second order	https://youtu.be/Kk5SEzASkZU?feature=shared
	Initial and boundary conditions of partial differential equations of second order	https://youtu.be/Kk5SEzASkZU?feature=shared
	Separation of variables method to simple problems in Cartesian coordinates.	https://youtu.be/Kk5SEzASkZU?feature=shared
Unit-IV	Introduction to Complex Numbers	https://www.youtube.com/watch?v=gFjlBKW8aZU
	Analytic Functions Of A Complex variable	https://youtu.be/b5VUnapu-qs?si=odZ34Xpop2x-xcob https://www.youtube.com/watch?v=q01b-lV6y5Q
	Calculus Of Residues(Part I)	https://youtu.be/o77UV7YrWvw?si=9T5nTIJ3krNNYKx4
	Calculus Of Residues(Part II)	https://youtu.be/Aq6K0lmv3Qw?si=rWyCcSJMlEVpimr6

Course code	**CSE-201B**				
Category	Professional Core Courses				
Course title	**Data Structures**				
Scheme and Credits	L	T	P	**Credits**	**Semester-III**
	3	0	0	**3**	
Course Objectives	The objectives of this course are • To introduce the basics of data structures and algorithms. • To explain the concept of Stacks, Queues, Linked Lists, Trees, related operations and their implementation. • To understand sorting, hashing, and graph algorithms, including their design and complexity analysis • To develop the ability to evaluate algorithm efficiency in terms of time and space complexity.				
Assessment	30 Marks				
End Semester Examination	45 Marks				
Total	75 Marks				
Duration of Exam	03 Hours				

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

COs	**Skill Demonstrated**
CO1	Define the fundamental concepts, terminology, and operations of data structures.
CO2	Explain the principles and techniques used in data structures and algorithms.
CO3	Apply appropriate data and algorithms to solve computational problems effectively.
CO4	Analyze the performance of data structures and algorithms using complexity measures.

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 9 parts of 1 mark each from all units and remaining eight questions of 9 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: Basic Terminologies: Concept of Data Structure, Choice of right Data Structure, Algorithms, how to design and develop algorithm, Complexity of algorithm. Operations: insertion, deletion, traversal etc.; Analysis of an Algorithm, Searching: Linear Search and Binary Search Techniques and their complexity analysis. Arrays: Array Definition, Types, Operations on array and their complexity analysis.

Unit-II

Stacks and Queues: Stack and its operations: Algorithms and their complexity analysis, Applications of Stacks: Expression Conversion and evaluation -corresponding algorithms and complexity analysis. Tower of Hanoi problem. Queue, Types of Queue: Simple Queue, Circular Queue, Priority Queue; Operations on each type of Queues: Algorithms and their analysis.

Unit-III

Linked Lists: Singly linked lists: Representation in memory, Algorithms of several operations: Traversing, Searching, Insertion into, Deletion from linked list; Linked representation of Stack and Queue, Header nodes, Doubly linked list: operations on it and algorithmic analysis; Circular Linked Lists: all operations their algorithms and the complexity analysis.
Trees: Basic Tree Terminologies, Different types of Trees: Binary Tree, Threaded Binary Tree, Binary Search Tree, AVL Tree; Tree operations on each of the trees and their algorithms with complexity analysis. Path length, Huffman's algorithm, Applications of Binary Trees. B Tree, B+ Tree: definitions, algorithms and analysis.

Unit-IV

Sorting and Hashing: Objective and properties of different sorting algorithms: Selection Sort, Bubble Sort, Insertion Sort, Quick Sort, Merge Sort, Heap Sort; Performance and Comparison among all the methods, Hashing.
Graph: Basic Terminologies, Sequential representation of graphs, Adjacency matrices. Graph search and traversal algorithms and complexity analysis.

Suggested Readings:

1. Fundamentals of Data Structures, Illustrated Edition by Ellis Horowitz, SartajSahni, Computer Science Press. Programming in ANSI C by E. Balaguruswamy, Tata McGraw-Hill
2. Algorithms, Data Structures, and Problem Solving with C++, Illustrated Edition by Mark Allen Weiss, Addison-Wesley Publishing Company.
3. How to Solve it by Computer, 2nd Impression by R.G. Dromey, Pearson Education.
4. Data Structures and Algorithms Made Easy by NarasimhaKarumanchi.
5. Data Structures Using C by Aaron M.

Useful Video Links

Unit No.	Topics	Links
Unit-I	Introduction to Data Structures and Algorithms	https://www.youtube.com/watch?v=zWg7U0OEAoE&list=PLBF3763AF2E1C572F
	Linear Search Algorithm	https://www.youtube.com/watch?v=C46QfTjVCNU
	Binary Search	https://www.youtube.com/watch?v=V_T5NuccwRA
Unit-II	Stacks	https://youtu.be/g1USSZVWDsY?list=PLBF3763AF2E1C572F
	Stack and its Applications	https://www.youtube.com/watch?v=aG0HjeXBUDU
	Queues and Linked Lists	https://youtu.be/PGWZUgzDMYI?list=PLBF3763AF2E1C572F
Unit-III	Linked Lists-I	https://www.youtube.com/watch?v=K7VIKlUdo20
	Trees	https://youtu.be/tORLeHHtazM?list=PLBF3763AF2E1C572F
	Search Trees-II	https://www.youtube.com/watch?v=5jQGqaAUzOI
	AVL Trees	https://youtu.be/mRGQylRWAsI?list=PLBF3763AF2E1C572F
Unit-IV	Sorting	https://youtu.be/4OxBvBXon5w?list=PLBF3763AF2E1C572F
	Hashing	https://www.youtube.com/watch?v=2-h9193Ztqg
	Graphs	https://youtu.be/9zpSs845wf8?list=PLBF3763AF2E1C572F

Course Code	**CSE-203B**				
Category	Professional Core Courses				
Course Title	**Operating Systems**				
Scheme and Credits	L	T	P	**Credits**	**Semester-III**
	3	0	0	**3**	
Course Objectives	The objectives of this course are ● To introduce the fundamental concepts and services of operating systems. ● To provide knowledge of process, memory, and file management techniques. ● To familiarize students with synchronization, scheduling, and resource management mechanisms. ● To develop understanding of operating system design and performance issues.				
Assessment	30 Marks				
End Semester Examination	45 Marks				
Total	75 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 the fundamental concepts, terminology, and components of operating systems.	Level 1: Remember
CO2	Explain the principles, techniques, and mechanisms used in operating systems.	Level 2: Understand
CO3	Apply operating system techniques for process, memory, file, and resource management.	Level 3: Apply
CO4	Analyze operating system algorithms and mechanisms for efficient system performance.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 9 parts of 1 mark each from all units and remaining eight questions of 9 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 Operating Systems: Concept of Operating Systems, Generations of Operating systems, Types of Operating Systems, OS Architecture (Windows, Android, macOS), OS Services. Processes: Definition, Process Relationship, Different states of a Process, Process State transitions, Process Control Block (PCB), Context switching.
Thread: Definition, Various states, Benefits of threads, Types of threads, Multithreading.
Process Scheduling: Foundation and Scheduling objectives, Types of Schedulers, Scheduling criteria: CPU utilization, Throughput, Turnaround Time, Waiting Time, Response Time; Scheduling algorithms: Pre-emptive and Non-pre-emptive, FCFS, SJF, SRTF, RR Scheduling.

Unit-II

Inter-process Communication: Critical Section, Race Conditions, Mutual Exclusion, The Producer\ Consumer Problem, Semaphores, Event Counters, Monitors, Message Passing, Classical IPC Problems: Reader's & Writer Problem, Dining Philosopher Problem etc.
Deadlocks: Definition, Necessary and sufficient conditions for Deadlock, Deadlock Prevention, and Deadlock Avoidance: Banker's algorithm, Deadlock detection and Recovery.

Unit-III

Memory Management: Basic concept, Logical and Physical address map, Memory allocation: Contiguous Memory allocation – Fixed and variable partition–Internal and External fragmentation and Compaction; Paging: Principle of operation – Page allocation – Hardware support for paging, Protection and sharing, Disadvantages of paging, Memory Protection (ASLR, DEP).
Virtual Memory: Basics of Virtual Memory – Hardware and control structures – Locality of reference, Page fault, Working Set, Dirty page/Dirty bit – Demand paging, Page Replacement algorithms: First in First Out (FIFO), Optimal Page Replacement and Least Recently used (LRU).

Unit-IV

File Management: Concept of File, Access methods, File types, Modern file system (ZFS, Btrfs, APFS), File operation, Directory structure, File System structure, Allocation methods (contiguous, linked, indexed), efficiency and performance.
Disk Management: Disk structure, Disk scheduling – FCFS, SSTF, SCAN, C-SCAN, Disk reliability, Disk formatting, Boot-block, Bad blocks, Case study on UNIX and WINDOWS Operating System.

Suggested Readings:

1. Operating System Concepts by Abraham Silberschatz, Peter B. Galvin, G. Gagne, Eighth edition, Wiley Publication.
2. Modern Operating Systems by Andrew S. Tanenbaum, Second Edition, Pearson India.
3. Operating System: A Design-oriented Approach by Charles Crowley, McGraw Hill Education.
4. Design of the Unix Operating Systems by Maurice Bach, Pearson Education India.

Useful Video links

Unit No.	Topics	Links
Unit-I	Concept of Operating Systems, Generations of Operating systems, Types of Operating Systems	https://www.youtube.com/playlist?list=PLrpK1inhO61UQRHHuB8xSYulwJrAuVGPw
	Multithreading	https://www.youtube.com/watch?v=6rYOyIGfy3w&t=1440s
Unit-II	Critical Section, other Synchronization Problems	https://youtu.be/qKPCfuZAAEc
	Deadlocks, Resources, System State, Necessary and Sufficient conditions for a Deadlock.	https://www.youtube.com/watch?v=8ZS7xzWPo5A&list=PLEAYkSg4uSQ2Pach478muxnoeTNz_QeUJ&index=33
	Banker's algorithm	https://youtu.be/8ZS7xzWPo5A?list=PLyqSpQzTE6M9SYI5RqwFYtFYab94gJpWk
Unit-III	Memory Management	https://youtu.be/_pKbqFyG03s
	Virtual Memory	https://www.youtube.com/watch?v=Ev4BET3i5R0
	Page Replacement algorithms	https://www.youtube.com/watch?v=Oho3QU-7pB8
Unit-IV	File Management	https://youtu.be/EiFHM-HhsEQ
	File Access Methods	https://archive.nptel.ac.in/courses/106/105/106105214/#
	Unix and Windows	https://www.youtube.com/watch?v=6El3RW9ZOKE

Course Code	**CSE-205B**				
Category	Professional Core Courses				
Course Title	**Python Programming**				
Scheme and Credits	L	T	P	**Credits**	**Semester-III**
	3	0	0	**3**	
Course Objectives	The objectives of this course are ● To introduce the fundamentals of Python programming. ● To provide knowledge of Python programming constructs and data structures. ● To familiarize students with Python libraries for data processing and analysis. ● To develop programming skills for graphical and GUI-based applications.				
Assessment	30 Marks				
End Semester Examination	45 Marks				
Total	75 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 the fundamental concepts, terminology, and programming constructs of Python.	Level 1: Remember
CO2	Explain the functionality of Python programming constructs, data handling techniques, and graphical modules.	Level 2: Understand
CO3	Use Python programs for data processing, file handling, numerical computing, graphics, and GUI applications.	Level 3: Apply
CO4	Analyze Python programming constructs, data structures, libraries, graphics, image processing, and GUI techniques to solve real-world problems effectively.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 9 parts of 1 mark each from all units and remaining eight questions of 9 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: Installing Python; basic syntax, interactive shell, editing, saving, and running a script; data types; variables, assignments; numerical types; arithmetic operators and expressions; Loops and selection statements, Control statements String manipulations: subscript operator, indexing, slicing a string; text files: reading/writing text and numbers from/to a file; creating and reading a formatted file.

Unit-II

Lists, Tuple, dictionary and Design with functions: Basic list operators, replacing, inserting, removing an element; searching and sorting lists; Tuple: creating tuples, accessing elements, tuple immutability, operations, tuple methods, tuples vs. lists; dictionary literals, adding, and removing keys, accessing and replacing values; traversing dictionaries. Hiding redundancy, complexity; arguments and return values; Program structure and design. Recursive functions.

Unit-III

Introduction to NumPy: NumPy arrays, Array Indexing and Slicing, Array Operations, Array Manipulation, Linear Algebra with NumPy, Random Number Generation and Statistics.
Introduction to Pandas: Pandas Series, Pandas Data Frames, Data Frame Indexing and Selection, Data Cleaning and Pre-processing, Data Manipulation, Group by Operations, Merging, Joining, and Concatenating Data Frames, Input/output Operations.

Unit-IV

Simple graphics and image processing: Simple graphics, Turtle operations, Manipulating turtle screen, Drawing two dimensional shapes, examining an object attributes, Taking a random walk, Colour and RGB scheme, Image processing: Image manipulation operations, properties of images, image module, copying, blurring and reducing image.
Graphical User Interfaces using Tkinter: Terminal based and GUI based programs, Introduction to Tkinter, Simple GUI-Based Programs, Windows and Window Components, Input and Output with Entry Fields, Defining and Using Instance Variables, Other Useful GUI Resources.

Suggested Readings:

1. Fundamentals of Python: First Programs by Kenneth Lambert, Course Technology, Cengage Learning, 2012.
2. Introduction to Computer Science Using Python: A Computational Problem-Solving by Dierbach, C. Focus, John Wiley & Sons, 2012.
3. Let Us Python by, Kanetkar, A., &Kanetkar, Y., BPB Publications.
4. Python – The Complete Reference by Brown, M. C., McGraw Hill Education.
5. Core Python Programming by Rao, R. N., Dream Tech Press.
6. Python Programming: Using Problem Solving Approach byThareja, R., Oxford University Press.
7. Python Programming by Sridhar, S., Indumathi, J., &Hariharan, V. M., Pearson Education.
8. Python for Data Analysis by Wes McKinney, 3rd Edition, O'Reilly Media, 2022.
9. Python Data Science Handbook by Jake VanderPlas, O'Reilly Media.

Useful Video links

Unit No.	Topics	Links
Unit-I	Variables and Input Statement	https://youtu.be/ruQb8jzkGyQ
	Data Types, Operators and Expressions	https://youtu.be/8n4MbjuDBu4
	Introduction to for loop	https://youtu.be/lvXuQ_x7EsI
	Introduction to while loop	https://youtu.be/KTvVNN7ia8o
	String Methods	https://youtu.be/p-4HU1rcG5s
	Reading and Writing to a File	https://www.youtube.com/watch?v=rYLJaAdgLhI
	Creating and reading a formatted file	https://www.youtube.com/watch?v=NBTSDtBy5bs
Unit-II	List operators	https://youtu.be/jMShssechMI
	Searching and sorting lists	https://youtu.be/4OxBvBXon5w
	Tuples	https://youtu.be/mzx74TdGYbg
	Dictionary literals, adding, and removing elements	https://youtu.be/Aj7PwBI99A4
	Recursive functions	https://youtu.be/Uo7RyqJaaRQ
Unit-III	NumPy	https://youtu.be/rjY59WLMK2o
	Pandas	https://youtu.be/6DTFIKF8QIg?feature=shared
Unit-IV	Simple graphics	https://www.youtube.com/watch?v=pxKu2pQ7Ilo
	Graphical User Interfaces using Tkinter	https://youtu.be/-GhzpvvIXlM?si=itHn2839Kkhy89B3

Course Code	**HSMC-01B**				
Category	Humanities and Social Science including Management Courses				
Course Title	**Fundamentals of Management and Organizational Behaviour**				
Scheme and Credits	L	T	P	**Credits**	**Semester-III/IV**
	3	0	0	3	
Course Objectives	The objectives of this course are ● Introduce students to foundational management theories, functions, and organizational concepts to build a strong conceptual framework. ● Develop understanding of individual and group behavior, motivation, communication, and leadership in organizational settings. ● Equip students with practical skills to manage interpersonal processes, conflicts, and team dynamics effectively. ● Foster critical analysis of organizational structures, cultures, and change mechanisms to enhance adaptability and effectiveness in organizations.				
Assessment	30 Marks				
End Semester Examination	45 Marks				
Total	75 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 fundamental management concepts, functions, organizational processes, and organizational behavior elements.	Level 1: Remember
CO2	Explain the roles, skills, and interrelationships in management, individual behaviors, group dynamics, and communication processes within organizations.	Level 2: Understand
CO3	Apply principles of management, motivation techniques, leadership styles, and conflict management strategies to solve organizational behavior challenges.	Level 3: Apply
CO4	Analyze organizational structure, culture, change processes, and behavioral dynamics to support effective decision-making and organizational development.	Level 4: Analyse

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 9 parts of 1 mark each from all units and remaining eight questions of 9 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 of Management: Meaning, Definitions, Nature of Management; Managerial Levels, Skills and Roles in an Organization.

Functions of Management: Planning, Organizing, Staffing, Directing& Controlling, Interrelationship of Managerial Functions, Scope of Management, Importance of Management, Difference between Management and Administration.

Unit-II

Introduction of Organization: Meaning and Process of Organization, Management v/s Organization.
Fundamentals of Organizational Behavior: Concepts, Evolution, Importance and Relationship with otherFields, Contemporary Challenges and Opportunities of OB**.**
Individual Processes and Behavior: Personality, Concept, Determinants and Applications.
Perception: Concept, Process and Applications
Learning: Brief Introduction
Motivation: Concept, Techniques and Importance**.**

Unit-III

Interpersonal Processes: Teams and Groups, Definition of Group, Stages of Group Development, Types of Groups, Meaning of Team, Merits and Demerits of Team, Difference between Team and Group, Conflict- Concept, Sources, Types, Management of Conflict.
Leadership: Concept, Function, Styles, Qualities of Leadership.
Communication: Meaning, Process, Channels of Communication, Importance and Barriers of Communication.

Unit-IV

Organizational Processes: Organizational Structure, Meaning and Types of Organizational Structure and their effect on Human Behavior.
Organizational Culture: Elements, Types and Factors affecting Organizational Culture.
Organizational Change: Concept, Types and Factors affecting Organizational Change, Resistance to Change.

Suggested Readings:

1. Fundamentals of Management by Robbins, S.P. and Decenzo, Pearson Education, New Delhi.
2. Organizational Behaviour by Robbins, S.P. & Judge, T.A., Prentice Hall of India, New Delhi.
3. Management concept practice and cases by GhumanKarminder, Aswathappa K., Tata McGraw Hill, New Delhi.
4. Fundamental of Management by Chhabra T. N., Sun India Publications, New Delhi.
5. Organizational Behaviour by Stephen P Robin, Pearson Education.
6. Organizational Behaviour by McShane, Steven L, Tata McGraw Hill, New Delhi.
7. Organizational Behaviour by FC Sharma, Shree Mahavir Publications.

Useful Video Links:

Unit No.	Topics	Links
Unit-I	Nature and Scope of Management	https://nptel.ac.in/courses/110105146
Unit-II	Perception and Personality	https://nptel.ac.in/courses/110103433
Unit-III	Group Dynamics	https://archive.nptel.ac.in/courses/110/106/110106145/
Unit-IV	Organizational Change, Resistance to Change.	https://nptel.ac.in/courses/110105146

Course Code	**ECE-001B**				
Category	Engineering Science Courses				
Course Title	**Digital Electronics**				
Scheme and Credits	L	T	P	**Credits**	**Semester-III**
	3	0	0	**3**	
Course Objectives	The objectives of this course are ● To learn fundamentals of digital logic and Boolean algebra. ● To design combinational and sequential logic circuits. ● To understand ADC/DAC and memory devices. ● To study programmable logic devices like FPGA and CPLD.				
Assessment	30 Marks				
End Semester Examination	45 Marks				
Total	75 Marks				
Duration of Exam	03 Hours				

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

COs	**Skill Demonstrated**
CO1	Understand the knowledge of Boolean algebra, K-MAP and other digital design methods for simplification and optimization of digital circuits.
CO2	Design and implement combinational logic circuits using logic gates for arithmetic operations, code conversion, and control applications.
CO3	Understand and apply the concepts of latches, flip-flops, and counters in designing synchronous and asynchronous circuits for memory and storage applications.
CO4	Analyze memory types and programmable logic device architectures to interpret the functional organization.

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 9 parts of 1 mark each from all units and remaining eight questions of 9 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

Logic Simplification: Logic Simplification: Review of Boolean Algebra and De Morgan's Theorem, Digital codes, Logic gates and their operations, Realization of logic gates using universal gates, Number system, Representation of Boolean functions in sum of products (SOP) form and product of sums (POS), Addition and subtractions of a complements numbers, Minimization of Boolean functions using Karnaugh map and Quine McCuskeymethods, Error detection and correction techniques using Parity Check method and Hamming Code.

Unit-II

Combinational Logic Design: Half and Full Adders, Half and Full Subtractors, Multiplexers, Demultiplexers, Encoder, Decoder, Magnitude Comparators, Priority encoder, Parallel Adders, Adder with Look Ahead Carry, BCD Adder.

Unit-III

Sequential Logic Design: Latches, Concept of edge triggered and level triggered clock, S-R, JK and Master-Slave JK FF, D FF, T FF,Conversions of FF, Ripple and Synchronous counters, Ring and Johnson counter, UP & DOWN counter, Sequence Generator, Shift registers.

Unit-IV

A/D and D/A Converter: Sample and hold circuit, weighted resistor and R -2 R ladder D/A Converters, specifications for D/A converters. A/D converters: Quantization, parallel - comparator, successive approximation, counting type, dual-slope ADC, specifications of ADCs.
Programmable Logic Devices: ROM, PLA, PAL, SRAM, DRAM, FPGA and CPLDs.

Suggested Readings:

1. Modern digital Electronics by R.P. Jain,Tata McGraw Hill, 4th edition.
2. Switching Theory & Logic Design by A.Anand Kumar, PHI.
3. Digital Electronics Circuit and System by V K Puri, TMH.
4. Digital Circuits and Systems by D.V. Hall, Tata McGraw Hill.
5. Principle of Digital Electronics by K Meena, PHI
6. Logic & Computer Fundamentals by Morris Mano,4th Edition, Pearson Education.

Useful Video links

Unit No.	Topics	Links
Unit-I	Boolean Algebra	https://www.youtube.com/shorts/xtAYbY_Pz7I
Unit-II	Multiplexer	https://www.youtube.com/watch?v=p6yPvw88BJk
	Combinational Circuits	https://www.youtube.com/watch?v=fXrbYMDevDU
Unit-III	Sequential Circuits	https://www.youtube.com/watch?v=S0mKCNLmCh4&list=PLgwJf8NK-2e4mEQv0ttgW-am4wiqrpdcX
	Counter	https://www.youtube.com/watch?v=NTCrCYPoA5A&list=PLgwJf8NK-2e6lcDg0NxW-_yO6Bl5dPBp8
Unit-IV	Finite state machines	https://www.youtube.com/watch?v=LOZxYBOKRLg
	PLD's	https://www.youtube.com/watch?v=m6975d-U6j8

Course Code	**CSE-L201B**				
Category	Professional Core Courses				
Course Title	**Data Structures Lab Using C**				
Scheme and Credits	L	T	P	**Credits**	**Semester-III**
	0	0	2	**1**	
Course Objectives	The objectives of this course are ● To introduce C programming constructs for implementing data structures. ● To provide practical experience with linear data structures. ● To familiarize students with non-linear data structures and algorithms. ● To develop problem-solving skills using data structure implementations.				
Assessment	10 Marks				
End Semester Practical Examination	15 Marks				
Total Marks	25 Marks				
Duration of Exam	03 Hours				

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

COs	**Skill Demonstrated**	**RBT Level**
CO1	Understand the basics of C language and Turbo C Integrated Development Environment (IDE).	Level 2: Understand
CO2	Apply C programming to implement data arrays, pointers, data structures, searching, sorting, and basic data structure operations like stacks and linked lists.	Level 3: Apply
CO3	Apply C programming techniques to implement and manipulate non-linear data structures such as trees and hash tables.	Level 3: Apply
CO4	Analyze the applicability of appropriate data structures, control statements, iteration statements to implement searching and sorting.	Level 4: Analyze

List of Experiments:

Sr. No.	**Content**	**COs**
1	Study the basics of Turbo C IDE.	CO1
2	Write a Program in C programming language to insert and delete an Element in Linear Array.	CO2
3	Write a Program in C programming language to Implement Array Traversing.	CO2
4	Write a Program in C programming language to Implement Linear Search.	CO2
5	Write a Program in C programming language to Demonstrate Binary Search.	CO2
6	Write a Program in C programming language to Insert and Delete Nodes into Linked List.	CO2

7	Write a Program in C programming language to Implement PUSH and POP in Stack.	CO2
8	Write a Program in C programming language to Implement Insertion Sort.	CO4
9	Write a Program in C programming language to Implement Bubble Sort.	CO4
10	Write a Program in C programming language to Implement Merge Sort.	CO4
11	Write a Program in C programming language to Implement Quick Sort.	CO4
12	Write a Program in C programming language to Implement Heap Sort.	CO4
13	Write a program in C programming language to implement a binary tree and perform its inorder, preorder, and postorder traversals.	CO3
14	Write a Program in C programming language to Find the Height of a Binary Tree in C.	CO3
15	Write a Program in C programming language to implement a hash table with separate chaining for collision resolution.	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
Write a Program in C to implement Linear Search and binary Search.	https://ds1-iiith.vlabs.ac.in/exp/unsorted-arrays/code-assessment.html
Write a Program in C programming language to Implement Bubble Sort.	https://ds1-iiith.vlabs.ac.in/exp/bubble-sort/code-assessment.html
Write a Program in C to implement Merge Sort.	https://ds1-iiith.vlabs.ac.in/exp/merge-sort/code-assessment.html
Write a Program in C programming language to Implement Quick Sort.	https://ds1-iiith.vlabs.ac.in/exp/quick-sort/code-assessment.html
Write a program in C programming language to implement a binary tree and perform its inorder, preorder, and postorder traversals.	https://ds1-iiith.vlabs.ac.in/exp/tree-traversal/code-assessment.html
Write a Program in C to implement Linear Search and binary Search.	https://ds1-iiith.vlabs.ac.in/exp/unsorted-arrays/code-assessment.html

Course code	**CSE-L203B**				
Category	Professional Core Courses				
Course title	**Operating Systems Lab**				
Scheme and Credits	L	T	P	**Credits**	**Semester-III**
	0	0	2	1	
Course Objectives	The objectives of this course are ● To introduce operating system utilities and shell programming concepts. ● To provide practical experience with Linux and UNIX environments. ● To familiarize students with operating system algorithms and resource management techniques. ● To develop problem-solving skills using shell scripting.				
Assessment	10 Marks				
End Semester Practical Examination	15 Marks				
Total	25 Marks				
Duration of Exam	03 Hours				

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

COs	**Skill Demonstrated**	**RBT Level**
CO1	Describe the basic concepts and features of Linux, Windows, UNIX Operating System, basic UNIX commands and vi editor usage.	Level 2: Understand
CO2	Write shell scripts for system tasks like displaying user info, performing calculations, and managing files.	Level 3: Apply
CO3	Implement control structures in shell scripting to solve problems such as checking conditions and generating series.	Level 3: Apply
CO4	Analyze file allocation methods and CPU scheduling algorithms for efficient file and process management.	Level 4: Analyze

List of Experiments

Sr. No.	**Content**	**COs**
1	Explore the architecture, features, and file system of the Windows Operating System.	CO1
2	Explore the architecture, features, and file system of the Linux Operating System.	CO1
3	Study various UNIX Commands.	CO1
4	Understand the working of the VI editor and describe its modes, commands, and common file editing operations in UNIX/Linux.	CO1
5	Write a program to print the VI editor file data.	CO2
6	Write a shell program to implement a calculator.	CO2
7	Write a shell script to see current date, time, username and directory.	CO2

8	Write a program to check whether a number is odd or even using Shell Programming.	CO3
9	Write a program to find out the factorial of a number.	CO3
10	Write a program to generate Fibonacci Series.	CO3
11	Write a program to find the greatest number out of the seven numbers using a for loop.	CO3
12	Write a program to implement Do-While Loop.	CO3
13	Write a program to Implement any file allocation technique (Linked, Indexed or Contiguous)	CO4
14	Write a program to Implement any CPU scheduling technique (FCFS, SJF, SRJF, Priority and Round -Robin)	CO4

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

Course code	**CSE-L205B**				
Category	Professional Core Courses				
Course title	**Python Programming Lab**				
Scheme and Credits	L	T	P	**Credits**	**Semester-III**
	0	0	2	**1**	
Course Objectives	The objectives of this course are ● To introduce Python programming fundamentals and development tools. ● To provide practical experience with Python programming techniques. ● To familiarize students with Python libraries for data processing and analysis. ● To develop skills for graphical, image-processing, and GUI-based applications.				
Assessment	10 Marks				
End Semester Practical Examination	15 Marks				
Total	25 Marks				
Duration of Exam	03 Hours				

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

COs	**Skill Demonstrated**	**RBT Level**
CO1	Understand the installation process, basic features and programming constructs in Python.	Level 2: Understand
CO2	Apply Python programming techniques to implement algorithms for mathematical operations, searching, sorting and other real life problems.	Level 3: Apply
CO3	Apply NumPy and Pandas for data manipulation, statistical operations.	Level 3: Apply
CO4	Analyze Python's graphics, image processing, and GUI programming concepts to develop interactive applications.	Level 4: Analyze

List of Experiments

Sr. No.	**Content**	**COs**
1	Study the basic features and installation of Python.	CO1
2	Write a Python program to compute the G.C.D. of two numbers.	CO1
3	Write a Python program to find the square root of a number.	CO1
4	Write a Python program to find the power of a number.	CO1
5	Write a Python program to find the maximum in a list of numbers.	CO2
6	Write a Python program to implement linear search and binary search in a list.	CO2
7	Write a Python program to sort the element using selection sort, insertion sort and merge sort.	CO2

8	Write a Python program to compute first “n” prime numbers.	CO2
9	Write a Python program to find the most frequent word in a text file.	CO2
10	Write a Python program to create and perform operations on arrays using NumPy.	CO3
11	Write a Python program to apply Pandas for manipulating a dataset and performing grouped statistical operations.	CO3
12	Write a Program in Python for a random walk using turtle.	CO4
13	Create simple graphics using Turtle: draw shapes and take random walks.	CO4
14	Perform image processing: copy, blur, and reduce images using PIL or OpenCV	CO4
15	Design a GUI application using Tkinter with input, output, and buttons.	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**
Arithmetic Operations	https://python-iitk.vlabs.ac.in/exp/arithmetic-operations/
Built-in Functions	https://python-iitk.vlabs.ac.in/exp/built-in-functions/
Loops	https://python-iitk.vlabs.ac.in/exp/loops/
Strings	https://python-iitk.vlabs.ac.in/exp/strings/
File Handling	https://python-iitk.vlabs.ac.in/exp/file-operators/simulation.html

Course Code	**ECE-L001B**			
Category	Professional Core Courses			
Course Title	**Digital Electronics Lab**			
Scheme and Credits	T	P	**Credits**	**Semester- III**
	0	2	1	
Course Objectives	The objectives of this course are ● To learn the basics of digital electronics and use logic gates and ICs. ● To design and check different combinational and sequential logic circuits. ● To understand the working operation of adders, subtractors, multiplexers, flip-flops, and counters in digital systems. ● To learn to build and test ADC, DAC, and practical counters for various applications.			
Assessment	10 Marks			
End Semester Practical Examination	15 Marks			
Total	25 Marks			
Duration of Exam	03 Hours			

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

COs	Skills Demonstrated
CO1	Understand and apply operational principles of logic gates used in digital systems.
CO2	Analyze and verify the operation of sequential circuits used in digital systems
CO3	Verify the truth tables and behavior of combinational circuits with different states and inputs.
CO4	Perform and verify the operation of ADC and DAC circuits for digital system applications.

List of Experiments

Sr. No.	Content
1	To study the operation of logic gates and verify their truth tables.
2	To verify the operation of universal gates.
3	To design and verify the operation of Binary-to-Gray and Gray-to-Binary code converters.
4	To design Half Adder and Full Adder circuits using gates.
5	To design and verify the operation of Half Subtractor and Full Subtractor circuits.
6	To study and verify the operation of Multiplexer and De-Multiplexer circuits.
7	To study the operation of Encoder and Decoder circuits.
8	To design and verify the operation of BCD-to-Seven Segment Decoder circuits.

9	To analyze and verify the operation and characteristic behavior of S-R, J-K, T, and D flip-flops under different input conditions.
10	To design and verify the operation of Decade counter using JK flip flops.
11	To design and verify the operation of 4-bit SISO and SIPO shift registers.
12	To analyze and verify the operation and performance characteristics of ADC and DAC circuits for digital system applications.

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

Virtual Lab Links

Experiment Name	**Virtual Lab Link**
To study & design basic gates.	https://de-iitr.vlabs.ac.in/exp/truth-table-gates/
To study and realize logic functions with the help of universal gates.	https://de-iitr.vlabs.ac.in/exp/half-full-adder/
To verify the operation of Multiplexer & De-multiplexer.	https://de-iitr.vlabs.ac.in/exp/multiplexer-demultiplexer/
To perform half adder and full adder	https://de-iitr.vlabs.ac.in/exp/half-full-adder/
To perform half subtractor and full subtractor.	https://de-iitr.vlabs.ac.in/exp/half-full-subtractor/index.html
To verify the truth table of S-R, J-K, T& D Type flip flop.	https://de-iitr.vlabs.ac.in/exp/truth-tables-flip-flops/
To design & verify the operation of 3-bit synchronous counter.	https://de-iitr.vlabs.ac.in/exp/4bit-synchronous-asynchronous-counter/
To design & verify operation of Asynchronous counter.	https://de-iitr.vlabs.ac.in/exp/4bit-synchronous-asynchronous-counter/

<table>
<tr><td>Course Code</td><td colspan="5">MC-201B</td></tr>
<tr><td>Category</td><td colspan="5">Mandatory Courses</td></tr>
<tr><td>Course Title</td><td colspan="5">Environmental Science</td></tr>
<tr><td rowspan="2">Scheme and Credits</td><td>L</td><td>T</td><td>P</td><td>Credits</td><td rowspan="2">Semester- III</td></tr>
<tr><td>2</td><td>0</td><td>1</td><td>-</td></tr>
<tr><td>Course Objectives</td><td colspan="5">The objectives of this course are
Create awareness of the multidisciplinary nature and importance of environmental studies, including the sustainable management and conservation of natural resources.
Develop an understanding of ecosystem dynamics, biodiversity, pollution types, and their impacts on environmental and human health.
Foster critical thinking on social, ethical, and legislative aspects of environmental protection, emphasizing the role of individuals and society.
Engage students in practical learning through fieldwork and case studies to apply environmental concepts for sustainable development and responsible citizenship.</td></tr>
<tr><td>Practical/Field Visits</td><td colspan="5">30 Marks</td></tr>
<tr><td>End Semester Examination</td><td colspan="5">45 Marks</td></tr>
<tr><td>Total</td><td colspan="5">75 Marks</td></tr>
<tr><td>Duration of Exam</td><td colspan="5">03 Hours</td></tr>
<tr><td>Remarks</td><td colspan="5">The subject of Environmental Studies will be included as a qualifying paper in all UG Courses and the students will be required to qualify the same otherwise the final result will not be declared and degree will not be awarded. The duration of the course will be 40 lectures. The examination will be conducted along with the semester examinations.
The marks in this qualifying paper will not be included in determining the percentage of marks obtained for the award of degree. However, these marks will be shown in the detailed marks certificate of the students.</td></tr>
</table>

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

COs	**Skill Demonstrated**	**Level**
CO1	Describe key concepts of environmental studies, types of natural resources, ecosystem structures, pollution types, major environmental laws, and human-environment interactions.	Level 1: Remember
CO2	Explain the interrelationships among ecosystems, biodiversity, pollution, social issues, environmental ethics, and related legislation for sustainable development.	Level 2 : Understand
CO3	Apply principles of environmental management, pollution control, disaster preparedness, and sustainable practices in real-world and field-based environmental contexts.	Level 3: Apply
CO4	Analyze environmental problems, population growth impacts, climate change, welfare programs, and the role of information technology in promoting public health and environmental sustainability.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 9 parts of 1 mark each from all units and remaining eight questions of 9 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

The Multidisciplinary nature of environmental studies. Definition scope and importance.
Natural Resources: Renewable and non-renewable resources, Natural resources and associated problems.

a) Forest resources: Use and over-exploitation: deforestation, case studies. Timber extraction, mining dams and their effects on forests and tribal people.
b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams- benefits and problems.
c) Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies.
d) Food resources: World food problems, changes, caused by agriculture and overgrazing, effects of modern agriculture, fertilizer pesticide problems, Water logging, salinity, case studies. e) Energy resources: Growing energy needs; renewable and non- renewable energy sources, use of alternate energy sources, case studies.
f) **Land resources:** Land as are source, land degradation, man induced landslides, soil erosion and desertification. Role of an individual in conservation of natural resources, equitable use of resources for sustainable life styles

Unit-II

Ecosystems: Producers, Consumers and Decomposers, Energy flow in the ecosystem, Ecological succession, Food chains, Food web sand ecological pyramids**,** Introduction, types, characteristic features, structure and function of Forest ecosystem, Grass land ecosystem, Desert ecosystem and Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries).
Bio diversity and its conservation: Introduction, Definition, Genetic, Species and ecosystem diversity. Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values, Biodiversity at global, National and local levels, India as a mega-diversity nation, Hot-spots of biodiversity. Threats to biodiversity, habitat loss, poaching of wild life, man-wild life conflicts, Endangered and endemic species of India, In-situ and ex-situ conservation of biodiversity.

Unit-III

Environmental Pollution: Definition, Causes, Effects and Control Measures of Air Pollution, Water Pollution, Soil Pollution, Marine Pollution, Noise Pollution, Thermal Pollution, Nuclear Hazards.

Solids Waste Management: Causes, Effects and Control Measures of Urban and Industrial Wastes, Role of an Individual in Prevention of Pollution, Pollution Case Studies.

Disaster Management: Floods, Earthquake, Cyclone and Landslides.
Social issues and the Environment: From unsustainable to sustainable development, Urban problems related to energy, Water conservation, Rain Water Harvesting, Watershed Management, Resettlement and Rehabilitation of People, its problems and concerns case studies.
Environmental Ethics: Issues and possible solutions, Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case studies, Waste land reclamation, Consumerism and waste products, Environment Protection Act, Air (Prevention and Control of pollution) Act, Water (Prevention and Control of pollution) Act, Wild life Protection Act, Forest Conservation Act, Issues involved in enforcement of environmental legislation, Public awareness.

Unit-IV

Human population and the Environment: Population growth, Variation among Nations, Population explosion-Family Welfare Programme, Environment and human health, Human Rights. Value Education, HIV/AIDS, Woman and Child Welfare Role of Information Technology in Environment and human health. Case Studies.

Field Work (Field work equal to10 lecture hours)- Visit to a local area to document environmental assets-

river/forest/grassland/hill/mountain, Visit to a local polluted site-urban/Rural/Industrial/ Agricultural, Study of common plants, insects, birds, Study of simple ecosystems-pond, river, hills, slopes, etc.

Suggested Readings:

1. Environmental Biology by K.C. Agarwal, Nidi Pub. Ltd., Bikaner
2. The Biodiversity of India by Bharucha, MA Pin Publishing Pvt. Ltd., Ahmedabad.
3. Hazardous Waste Incineration by R.C. Brunner, McGraw Hill Inc., 1989
4. Environmental Chemistry by A.K. De, Wiley Eastern Ltd.
5. Global Biodiversity Assessment by V.H. Heywood & R.T. Watson, Cambridge University Press, 1995, 1140p.
6. Environmental Protection and Laws by H. Jadhav& V.M. Bhosale, Himalaya Pub. House, Delhi, 1995, 284p.
7. Matter Hazardous by A.K. Mhaskar, Techno-Science Publications.
8. Waste Water Treatment by M.N. Rao & A.K. Datta, Oxford & IBH Publ. Co. Pvt. Ltd., 1987, 345p.
9. Environmental Chemistry by B.K. Sharma, Goel Publ. House, Meerut, 2001.
10. Survey of the Environment, The Hindu.
11. Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards, Vol. I and II by R.K. Trivedi, Enviro Media.
12. Introduction to Air Pollution by R.K. Trivedi & P.K. Goel, Techno-Science Publications.
13. Environmental Management by K.D. Wagner, W.B. Saunders Co., Philadelphia, USA, 1998, 499p.
14. A Textbook of Environmental Education by Dr. J.P. Yadav, G.V.S. Publishers.

Useful Video Links:

Unit No.	Topics	Links
Unit-I	Environment Science: Introduction	https://www.youtube.com/watch?v=5QxxaVfgQ3k
	Natural Resources	https://www.youtube.com/watch?v=CXCT2R1K6Ts
	Ecosystem	https://www.youtube.com/watch?v=1dBU6HB8G6s
Unit-II	Biodiversity and its conservation	https://archive.nptel.ac.in/courses/102/104/102104068/
Unit-III	Sustainable Water Management In Urban Areas	http://digimat.in/nptel/courses/video/127106004/L29.ht
	Environmental Pollution	https://archive.nptel.ac.in/courses/123/105/123105001/
Unit-IV	Population and population growth	https://archive.nptel.ac.in/courses/102/104/102104068/
	National Family Welfare Programme	https://www.youtube.com/watch?v=X5F99L8ZEtc

Course Code	**CSE-202B**				
Category	Professional Core Courses				
Course Title	**Discrete Mathematics**				
Scheme and Credits	L	T	P	**Credits**	**Semester-IV**
	3	1	0	**4**	
Course Objectives	The objectives of this course are ● To introduce the concept of mathematical logic, concept of sets, relation and functions. ● To introduce the concept of algorithm and number theory. ● To understand the group theory and related examples. ● To apply discrete structures to areas such as algorithms, data structures, digital logic, and cryptography.				
Course Prerequisite	Mathematics up to 12thStandard and Engineering Mathematics-I &II				
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 the basic terms used in discrete mathematics and structures.	Level 1: Remember
CO2	Understand the fundamental techniques, laws, logics, relations, graphs and trees.	Level 2: Understand
CO3	Solve mathematical problems based on the concept of set theory, relations, functions and basic counting techniques.	Level 3: Apply
CO4	Classify lattices, logarithms, functions, algebraic structures, graphs and trees.	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

Sets, Relation, Function and Propositional Logic: Operations and Laws of Sets, Cartesian Products, Representation of relations, Binary Relation, Equivalence Relation, Partial Ordering Relation, POSET, Hasse Diagram, Lattices and its types, Function, Bijective functions, Inverse and Composite Function, Finite and infinite Sets, Countable and Uncountable Sets, Cantor's diagonal argument and The Power Set theorem, Schroeder-Bernstein theorem, Propositions, Logical operations, Conditional Statements, Tautologies, Contradictions, Logical Equivalence.

Unit-II

Basic Counting Techniques and Recurrence Relation: Pigeon-hole principle, Permutation andCombination, the Division algorithm: Prime Numbers, The GCD: Euclidean Algorithm, The Fundamental Theorem of Arithmetic., Linear recurrence relation with constant coefficients, Homogenous Solutions, Particular Solutions, Total Solutions, Solving recurrence relation using generating functions.

Unit-III

Algebraic Structures: Definitions and examples of Algebraic Structures with one Binary Operation: Semi Groups, Monoids, Groups; Congruence Relation and Quotient Structures, Permutation Groups, Cyclic groups, Normal Subgroups, Definitions and examples of Algebraic Structures with two Binary Operation: Rings, Integral Domain, Fields; Boolean Algebra and Boolean Ring, Identities of Boolean Algebra, Duality, Representation of Boolean Function, Disjunctive and Conjunctive Normal Form.

Unit-IV

Graphs and Trees: Graphs and their properties, Degree, Connectivity, Path, Cycle, Sub Graph, Isomorphism, Multigraph and Weighted graph, Shortest path in Weighted graphs, Eulerian paths and circuits, Hamiltonian path and circuits, Planar Graphs, Euler's formula, Graph Colouring, Trees, Binary trees and its traversals, Trees Sorting, Spanning tree, Minimal Spanning tree.

Suggested Readings:

1. Kenneth H. Rosen, Discrete Mathematics and its Applications, Tata McGraw – Hill.
2. Satinder Bal Gupta: A Text Book of Discrete Mathematics and Structures, University Science Press, Delhi.
3. C. L. Liu and D. P. Mohapatra, Elements of Discrete Mathematics: A Computer Oriented Approach, Tata McGraw – Hill.
4. J.P. Tremblay and R. Manohar, Discrete mathematical structures with applications to computer science, TMG Edition, Tata McGraw-Hill.
5. Discrete Mathematics, Babu Ram, Pearson Publication.
6. Discrete Mathematics, SemyourLipschutz and Marc Lipson, Schaum's outline.

Useful Video links

Unit No.	Topics	Links
Unit-I	Sets	https://youtu.be/s-hRgTgdVe4?si=oN4wGgPzbqYvh-pv
	Functions	https://youtu.be/ceiMP4otA28?si=00SmukP2_XlqgeKK
	Representation of relations	https://youtu.be/wGLTV8MgLlA?si=KQ3UQ6hnj8szYIvN
	Propositions Calculus	https://youtu.be/WQ40fJskFIE?si=jVpwPuZ8pUW78QWj
Unit-II	Permutation and Combination, the Division algorithm	https://youtu.be/BI84sbsOtGQ?si=ZTFN88-qrGlOwquH
	The GCD: Euclidean Algorithm	https://youtu.be/BI84sbsOtGQ?si=ZTFN88-qrGlOwquH
	Pigeon-hole principle	https://youtu.be/a-O-ioYy1rI?si=_bIKGfCet8sM8csj
	Linear recurrence relation	https://youtu.be/CsvJPEgzF18?si=lpJz5yj1X8cVuTui
	Total Solutions, Solving recurrence relation using generating functions	https://youtu.be/ZxqBgiW1VBw?si=8_5FRbpei6fKRDX1
Unit-III	Algebraic Structures: Definitions and examples of Algebraic Structures with one Binary Operation	https://youtu.be/3zOtLEeHygg?si=k9s9ejEkVLKRc1kI
	Groups; Congruence Relation and Quotient Structures	https://youtu.be/3zOtLEeHygg?si=k9s9ejEkVLKRc1kI
	Definitions and examples of Algebraic Structures with two Binary Operations	https://youtube.com/playlist?list=PLq76ktDFTJEKPnC7dWNEOYHytKvrQ4en0&si=B1K2ne130ijMGoU5
Unit-IV	Graphs and their properties	https://youtu.be/3zOtLEeHygg?si=oXeg4i1GEzZ640wx
	Eulerian paths and circuits, Hamiltonian path	https://youtu.be/3zOtLEeHygg?si=oXeg4i1GEzZ640wx
	Trees, Binary trees and its traversals	https://youtu.be/3zOtLEeHygg?si=oXeg4i1GEzZ640wx
	Trees Sorting, Spanning tree, Minimal Spanning tree	https://youtu.be/3zOtLEeHygg?si=oXeg4i1GEzZ640wx

Course Code	**CSE-204B**				
Category	Professional Core Courses				
Course Title	**Computer Organization and Architecture**				
Scheme and Credits	L	T	P	**Credits**	**Semester-IV**
	3	0	0	**3**	
Course Objectives	The objectives of this course are • To introduce the fundamentals of computer organization and architecture. • To provide knowledge of processor organization and instruction execution. • To familiarize students with memory hierarchy and input-output systems. • To develop understanding of performance enhancement techniques in computer systems.				
Assessment	30 Marks				
End Semester Examination	45 Marks				
Total	75 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 the fundamental concepts and terminology of computer organization and architecture.	Level 1: Remember
CO2	Explain the principles and techniques used in computer organization and architecture.	Level 2: Understand
CO3	Apply computer organization concepts to processor, memory, and input-output systems.	Level 3: Apply
CO4	Analyze the performance and structure of computing systems for evaluation of CPU design choices, pipeline efficiency, memory access methods, and data transfer mechanisms.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 9 parts of 1 mark each from all units and remaining eight questions of 9 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 representation: Data Types, Complements, Fixed-Point Representation, Conversion of Fractions, Floating-Point Representation, Gray codes, Decimal codes, Alphanumeric codes,
Register Transfer and Micro operations: Register Transfer Language, Register Transfer, Bus and Memory Transfers, Arithmetic Microoperations, Logic Microoperations, Shift Micro-operations, Arithmetic Logic Shift Unit.

Unit-II

Basic Computer Organization and Design: Instruction Codes, Computer Registers, Computer Instructions, Timing and Control, Instruction Cycle, Memory-Reference Instruction, Input-Output Instruction, Complete Computer Description, Design of Basic Computer, Design of Accumulator Logic.

Central Processing Unit: General Register Organization, Stack organization, Instruction Format, Addressing Modes, Data Transfer and Manipulation, Program Control, RISC, CISC.

Unit-III

Pipelining: Basic Concepts of Pipelining, Throughput and Speedup, Performance Metrics (CPI, MIPS, MFLOPS), Pipeline Hazards.
Parallel Processors: Introduction to Parallel Processors, Concurrent access to memory and cache coherency.

Unit-IV

Input-output Organization: I/O device interface, I/O Interface Standards - PCI, USB; I/O transfers - program controlled, interrupt driven and DMA, Privileged and Non-Privileged Instructions, Software Interrupts.
Memory organization: Memory Hierarchy, Main Memory, Auxiliary Memory, Associative Memory, Cache Memory, Associative Mapping, Direct Mapping, Set-Associative Mapping, Writing into Cache, Cache Initialization, Virtual Memory.

Suggested Readings:

1. Computer System Architecture, M.Morris Mano, Pearson.
2. Computer Organization and Design: The Hardware/Software Interface, David A. Patterson and John L. Hennessy, Elsevier.
3. Computer Organization and Embedded Systems, CarlHamacher, McGraw Hill Higher Education.
4. Computer Architecture and Organization, John P. Hayes, McGraw Hill Education.
5. Computer Organization and Architecture: Designing for Performance, William Stallings, Pearson Education.

Useful Video links

Unit No.	Topics	Links
Unit-I	Data Representation	https://youtu.be/Vc2KqHQKDNs
	Binary Codes	https://youtu.be/Y5yprWIPDps
	Shift Microoperations	https://youtu.be/U5aCveZ8VzE
Unit-II	Instruction Cycle	https://youtu.be/L2SLS9FgTx0
	Control Signals and Timing Sequence	https://youtu.be/LNLjGgsDjBk
	Hardwired controlled Control Unit	https://youtu.be/b5thcNYBrQc
Unit-III	Pipelining Introduction	https://youtu.be/3p8kZpT56lQ
	Pipeline Hazards	https://youtu.be/l7auULi7zls?list=PLbMVogVj5nJQmNqgs7GLBE-HhMi0GQOPW
	Cache coherence and memory consistency	https://youtu.be/QfZa8gKzFJA
Unit-IV	DMA Transfer	https://youtu.be/CSkN0wj0zZU
	Memory Hierarchy	https://youtu.be/X-XwOXdUPU4
	Cache Memory	https://youtu.be/XZF4khqXmNI

Course Code	**CSE-206B**				
Category	Professional Core Courses				
Course Title	**Object Oriented Programming**				
Scheme and Credits	L	T	P	**Credits**	**Semester-IV**
	3	0	0	**3**	
Course Objectives	The objectives of this course are ● To introduce object-oriented programming concepts and principles. ● To provide knowledge of classes, objects, inheritance, and polymorphism. ● To familiarize students with memory management and exception handling techniques. ● To develop software development skills using object-oriented programming.				
Assessment	30 Marks				
End Semester Examination	45 Marks				
Total	75 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 the fundamental concepts and terminology of object-oriented programming.	Level 1: Remember
CO2	Explain the principles and techniques used in object-oriented programming.	Level 2: Understand
CO3	Apply object-oriented programming concepts to develop software solutions.	Level 3: Apply
CO4	Analyze object-oriented programming approaches for software development.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 9 parts of 1 mark each from all units and remaining eight questions of 9 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: Comparison between procedural programming paradigm and object-oriented programming paradigm, basic concepts of object-oriented programming — concepts of an object and a class, interface and implementation of a class, operations on objects, relationship among objects, abstraction, encapsulation, data hiding, inheritance, overloading, polymorphism, messaging.
Classes and Objects: Specifying a class, creating class objects, accessing class members, access specifiers, static members, use of const keyword, friends of a class, empty classes, nested classes, local classes, abstract classes, container classes, bit fields and classes.

Unit-II

Inheritance: Introduction, defining derived classes, forms of inheritance, ambiguity in multiple and multipath inheritance, virtual base class, object slicing, overriding member functions, object composition and delegation, order of execution of constructors and destructors.
Pointers and Dynamic Memory Management: Declaring and initializing pointers, accessing data through

pointers, pointer arithmetic, pointers to objects, array of objects, pointers to object members, memory allocation (static and dynamic), dynamic memory management using new and delete operators, this pointer, pointer related problems - dangling/wild pointers, null pointer assignment, memory leak and allocation failures.

Unit-III

Constructors and Destructors: Need for constructors and destructors, copy constructor, dynamic constructors, explicit constructors, destructors, constructors and destructors with static members, initializer lists.
Operator Overloading and Type Conversion: Overloading operators, rules for overloading operators, overloading of various operators, type conversion - basic type to class type, class type to basic type, class type to another class type.
Virtual functions & Polymorphism: Concept of binding - early binding and late binding, virtual functions, pure virtual functions, abstract classes, virtual destructors.

Unit-IV

Exception Handling: Review of traditional error handling, basics of exception handling, exception handling mechanism, throwing mechanism, catching mechanism, re-throwing an exception, specifying exceptions.
Templates and Generic Programming: Template concepts, Function templates, class templates, illustrative examples. Introduction to STL, Inheritance of class template, class template containership, class template with overloaded operators.

Suggested Readings:

1. C++ Programming language by Bjrane Stroustrup,3rd edition, Pearson education Asia(1997).
2. Object oriented Programming in C++ by LaforeR.,4th Ed. Techmedia,New Delhi(2002).
3. Let us C++ by Yashwant Kenetkar,1stEd.,Oxford University Press(2006).
4. A structured approach using C++ by B.A. Forouzan and R.F. Gilberg, Cengage Learning, New Delhi.

Useful Video links

Unit No.	Topics	Links
Unit-I	Introduction to Object-Oriented Programming.	https://youtu.be/K3g4srbkUNM?feature=shared
	Classes and Objects in C++	https://youtu.be/Fvb0dPTm3fk?feature=shared
	Introduction to Paradigms of OOP	https://youtu.be/d62teoIJtOw?feature=shared
Unit-II	Inheritance - Single Inheritance	https://youtu.be/gzCOAmbR9cc?feature=shared
	Multilevel Inheritance	https://youtu.be/PaqAhlb5XVw?feature=shared
	Polymorphism	https://youtu.be/piK6my-0frA?feature=shared
Unit-III	Constructors in C++	https://youtu.be/ItkQswAvOLI?feature=shared
	Access Specifiers in C++	https://youtu.be/xKtO4yipsIY?feature=shared
	Overloading-Operator and Constructor	https://youtu.be/WUiKCKc-3v0?feature=shared
Unit-IV	Exception Handling in C++	https://youtu.be/nGFzkmUvO_I?feature=shared
	Template Class in C++	https://youtu.be/jNmyE17nRYo?feature=shared

Course Code	**CSE-208B**				
Category	Professional Core Courses				
Course Title	**Database Management System**				
Scheme and Credits	L	T	P	**Credits**	**Semester-IV**
	3	1	0	**4**	
Course Objectives	The objectives of this course are • To introduce basic concepts, architecture, and characteristics of database systems. • To understand relational algebra and SQL for querying and manipulating relational data. • To understand storage strategies, indexing methods, and transaction processing mechanisms. • To explore database security models and advanced database systems like distributed and object-oriented databases.				
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 the fundamental concepts, terminology, and components of database management systems.	Level 1: Remember
CO2	Explain the principles, models, techniques, and mechanisms used in database management systems.	Level 2: Understand
CO3	Apply database management techniques for database design, query formulation, transaction processing, and data management.	Level 3: Apply
CO4	Analyze database models, processing strategies, concurrency mechanisms, and security techniques for efficient data management.	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

Database system architecture: Data Abstraction, Data Independence, Data Definition Language (DDL), Data Manipulation Language (DML).
Data models: Entity-relationship model, network model, relational and object oriented data models, integrity constraints, data manipulation operations.

Unit-II

Relational query languages: Relational algebra, Tuple and domain relational calculus,SQL3, DDL and DML constructs, Functions - aggregate functions, Built-in functions – numeric, date, string functions, set operations, sub-

queries, correlated sub-queries, Use of group by, having, order by, join and its types, Exist, Any, All , view and its types, Procedures, Triggers.

Relational database design: Domain and data dependency, Armstrong's axioms, Normal forms, Dependency preservation, Lossless design.

Unit-III

Query processing and optimization: Evaluation of relational algebra expressions, Query equivalence, Join strategies, Query optimization algorithms.
Storage strategies: Indices, B-trees, hashing, single level indexes, Multi-level indexes.

Unit-IV

Transaction processing: Concurrency control, ACID property, Serializability of scheduling, Locking and timestamp based schedulers, Multi-version and optimistic Concurrency Control schemes, Database recovery.
Database Security: Authentication, Authorization and access control, DAC, MAC and RBAC models, Intrusion detection, SQL injection.

Suggested Readings:

1. Database System Concepts by Abraham Silberschatz, Henry F. Korth, S. Sudarshan, 6th Edition, McGraw-Hill.
2. Principles of Database and Knowledgebase Systems by J. D. Ullman, Vol 1, Computer Science Press.
3. Fundamentals of Database Systems by R. Elmasri and S. Navathe, 5th Edition, Pearson Education.
4. Foundations of Databases by Serge Abiteboul, Richard Hull, Victor Vianu, Addison-Wesley.

Useful Video links

Unit No.	Topics	Links
Unit-I	Introduction to DBMS	https://youtu.be/rbwXdTsCk2c?si=hHLikD9WqWu9cZxm
	Conceptual Modelling (E-R Model)	https://youtu.be/rbwXdTsCk2c?si=hHLikD9WqWu9cZxm
Unit-II	SQL Query-I	https://youtu.be/k-KHHN7nDI8?si=ArzMxaPeBIhlySt4
	SQL Query-II	https://youtu.be/cGQaaVlbcCQ?si=qmJxp5sUFmaoqYlx
	Integrity Constraint	https://youtu.be/8lRc-Pt_krk?si=87NfB7a3OBCtmuWg
	Functional Dependency	https://youtu.be/rbwXdTsCk2c?si=hHLikD9WqWu9cZxm
Unit-III	Storage and file structure	https://youtu.be/1IWtpmIniHQ?si=DdBI9TrgAgOXBn8K
	Indexing and Hashing	https://youtu.be/rbwXdTsCk2c?si=hHLikD9WqWu9cZxm
Unit-IV	Concurrency Control	https://youtu.be/rbwXdTsCk2c?si=hHLikD9WqWu9cZxm
	DAC - MAC and RBAC security models	https://www.youtube.com/watch?v=n8anyniHbvI

Course Code	**CSE-210B**				
Category	Professional Core Courses				
Course Title	**Artificial Intelligence**				
Scheme and Credits	L	T	P	**Credits**	**Semester-IV**
	3	0	0	**3**	
Course Objectives	The objectives of this course are ● To introduce the fundamental concepts, history, and problem-solving nature of artificial intelligence. ● To provide an understanding of core AI techniques for search, knowledge representation, reasoning, planning, and learning. ● To develop the ability to apply appropriate AI methods to solve representative computational problems. ● To familiarize students with modern AI systems, expert systems, neural networks, and emerging trends in artificial intelligence.				
Assessment	30 Marks				
End Semester Examination	45 Marks				
Total	75 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 fundamental concepts of artificial intelligence, problem characteristics, knowledge representation, learning paradigms, and current AI trends.	Level 1: Remember
CO2	Explain search strategies, knowledge representation schemes, reasoning under uncertainty, planning approaches, and learning methods used in artificial intelligence.	Level 2: Understand
CO3	Apply appropriate AI techniques such as search algorithms, logical reasoning, probabilistic methods, and learning models to solve representative AI problems.	Level 3: Apply
CO4	Analyze AI problems to select suitable problem-solving, reasoning, planning, or learning approaches and evaluate their effectiveness.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 9 parts of 1 mark each from all units and remaining eight questions of 9 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: Definition of AI, History of AI, nature of AI problems, examples of AI problems.
Problem solving by search: Uninformed Search: Depth First Search (DFS), Breadth First Search(BFS). Informed Search: Best First Search, A*. Local Search: Hill Climbing. Problem Reduction Search: AO*. Population Based Search: Ant Colony Optimization, Genetic Algorithm. Game Playing: MinMax Algorithm, Alpha-Beta Pruning.

Unit-II

Knowledge Representation: Types of Knowledge, Knowledge Representation Techniques/schemes: Propositional Logic, Predicate Logic, Semantic nets, Frames, Knowledge representation issues, Rule based systems.

Unit-III

Reasoning under Uncertainty: Basics of Probability Theory, Probabilistic Reasoning, Bayesian Reasoning, Dempster-Shafer Theory.
Planning: Introduction to Planning, Representation of Planning, Partial-order Planning.

Unit-IV

Learning: Introduction to Learning, Types of Learning: Learning by Induction, Rote Learning, Symbol Based Learning, Identification Trees, Explanation Based Learning, Transformational Analogy, Introduction to Neural Networks, Expert Systems, and Current trends in Artificial Intelligence.

Suggested Readings:

1. Artificial Intelligence: A Modern Approach, Third Edition by Stuart Russell and Peter Norvig, 2010, Pearson Education.
2. Elaine Rich, Kevin Knight, &Shivashankar B Nair, Artificial Intelligence, McGraw Hill, 3rd ed.,2009.
3. Introduction to Artificial Intelligence & Expert Systems, Dan W Patterson, PHI.,2010.
4. Artificial intelligence, Patrick Henry Winston, 1992, Addition Wesley.

Useful Video links

Unit No.	Topics	Links
Unit-I	Introduction to AI	https://youtu.be/iF1tOCEXLXY
	DFS, BFS	https://youtu.be/TMLyKcBtHuo
	Hill Climbing	https://youtu.be/ZOvRZ7UJMjk
	A* Algorithm	https://youtu.be/yMcZvZayJUA
Unit-II	Propositional Logic	https://youtu.be/5fZ_RnhvGMQ
	Semantic Nets	https://youtu.be/RTmafl2rzEw
	Rule based System	https://youtu.be/6kRYg1QVcWo
Unit-III	Bayesian Reasoning	https://youtu.be/cMN6ykIYF_U
	Probability Theory	https://nptel.ac.in/courses/117105085
	Partial-order Planning	https://www.youtube.com/watch?v=kyCibTQQQBE
Unit-IV	Introduction to Neural Networks	https://www.youtube.com/watch?v=QlhHqMnd9Wo
	Expert Systems	https://www.youtube.com/watch?v=nE5c5w4aizU

Course Code	**HSMC-02B**				
Category	Humanities and Social Science including Management Courses				
Course Title	**Economics for Engineers**				
Scheme and Credits	L	T	P	**Credits**	**Semester-III/IV**
	3	0	0	3	
Course Objectives	The objectives of this course are to ● Introduce the basic concepts of economics and their relevance to science, engineering, and national development. ● Develop a foundational understanding of microeconomic principles such as demand, supply, production, cost, and market structures. ● Equip students with tools to apply economic reasoning to real-world pricing, output, and market decisions. ● Familiarize students with macroeconomic elements like the Indian economy, banking system, privatization, and globalization.				
Assessment	30 Marks				
End Semester Examination	45 Marks				
Total	75 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	Describe economic concepts, the connection between economics with engineering and technological development, along with economic laws relevant to resource based decision making in society.	Level 1: Remember
CO2	Explain economic growth theories and illustrate the role of engineering and technology in supporting economic development.	Level 2: Understand
CO3	Apply theories of consumption and production to the design and development of engineering products.	Level 3: Apply
CO4	Analyze market conditions, evaluate cost structures and financial aspects to assess the feasibility of engineering projects.	Level 4: Analyse

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 9 parts of 1 mark each from all units and remaining eight questions of 9 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

Definition of Economics: Various Definitions, Types of Economics, Micro and Macro Economics, Nature of Economic Problem, Production Possibility Curve, Economic Laws and their Nature, Relationship between Science, Engineering, Technology and Economic Development.

Demand: Meaning of Demand, Law of Demand, Elasticity of Demand, Meaning, Factors affecting the Elasticity of Demand, Practical Application and Importance.

Unit-II

Production: Meaning of Production and Factors of production, Law of Variable Proportions, Returns to Scale, Internal and External Economies and Diseconomies of Scale, Various concepts of Cost of Production- Fixed Cost, Variable Cost, Money Cost, Real Cost, Accounting Cost, Marginal Cost, Opportunity Cost, Shape of Average Cost, Marginal Cost, Total Cost etc. in short run and long run.

Unit-III

Market: Meaning of Market, Types of Market- Perfect Competition, Monopoly, Monopolistic Competition and Oligopoly (main features).
Supply: Supply and Law of Supply, Role of Demand and Supply in Price Determination and Effect of Changes in Demand and Supply on Prices.

Unit-IV

Indian Economy: Nature and Characteristics of Indian Economy as underdeveloped, developing and mixed economy (brief and elementary introduction).
Privatization: Meaning, Merits and Demerits.
Globalization of the Indian Economy: Merits and Demerits
Banking: Concept of a Bank, Commercial Bank, Central Bank, Functions of a Bank, Difference between Commercial and Central Bank.

Suggested Readings:

1. Modern Microeconomics: Theory and Applications by H.L. Ahuja, S. Chand & Company Pvt. Ltd.
2. Indian Economy by S.K. Misra& V.K. Puri, Himalaya Publishing House
3. Indian Economy : Principles and Policies by Srirangam, SriRam, ; RohitDeo, Pearson Education
4. Managerial Economics by R. Cauvery et al., S. Chand & Company Pvt. Ltd.
5. Microeconomic Theory by Andreu; Whinston, Michael D; Green, Jerry R, Oxford University Press.
6. Principles of Economics by Case, Karl E; Fair, Ray C ; Oster, Sharon E, Pearson Education

Useful Video Links:

Unit No.	Topics	Links
Unit-I	Fundamental concepts of microeconomics, including definitions, types, and the nature of economic problems.	https://www.youtube.com/watch?v=IFtOcNbej0o&list=PLFNFJbo2hfBGRTCMuroZGykNzacwmAH2L
Unit-II	Production and Cost of production	https://www.youtube.com/watch?v=VU1zySe-8NA
Unit-III	Theory of Markets	https://www.youtube.com/watch?v=HylqSa58lqQ
Unit-IV	Nature and characteristics of the Indian economy, highlighting aspects of underdevelopment and development.	https://www.youtube.com/watch?v=ME-0GOhhZcs&list=PLFW6lRTa1g83winAoIK92HL4xTytJaW7S

Course Code	**CSE-L206B**				
Category	Professional Core Courses				
Course Title	**Object Oriented Programming Lab Using C++**				
Scheme and Credits	L	T	P	**Credits**	**Semester-IV**
	0	0	2	**1**	
Course Objectives	The objectives of this course are ● To enable students to develop C++ programs using classes, member functions, and constructors to apply object-oriented principles to real-world problems. ● To implement static members, constant members, and various constructors in C++ for designing efficient and robust class structures. ● To apply operator overloading, inheritance, polymorphism, and exception handling techniques for building maintainable and flexible C++ applications. ● To create and utilize templates and manage dynamic memory allocation and deallocation in C++ for efficient program development.				
Assessment	10 Marks				
End Semester Practical Examination	15 Marks				
Total Marks	25 Marks				
Duration of Exam	03 Hours				

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

COs	**Skill Demonstrated**	**RBT Level**
CO1	Understand object-oriented concepts for programming in C++.	Level 2: Understand
CO2	Implement classes, member functions, and constructors in C++ to solve real-world problems using object-oriented principles.	Level 3: Apply
CO3	Demonstrate the use of operator overloading, inheritance, polymorphism, and exception handling in C++ to create robust and maintainable code.	Level 3: Apply
CO4	Analyze advanced OOP features in C++ programming language for better programs.	Level 4: Analyze

List of Experiments

Sr. No.	**Contents**	**COs**
1	Study Object Oriented Programming Concepts in C++.	CO1
2	Write a program that uses a class where the member functions are defined inside a class.	CO1
3	Write a program that uses a class where the member functions are defined outside a class.	CO1
4	Write a program to demonstrate the use of static data members.	CO1
5	Write a program to demonstrate the use of const data members.	CO1

6	Write a program to demonstrate the use of zero argument and parameterized constructors.	CO2
7	Write a program to demonstrate the use of dynamic constructor	CO4
8	Write a program to demonstrate the use of explicit constructors.	CO2
9	Write a program to demonstrate the use of initializer list.	CO2
10	Write a program to demonstrate the overloading of increment and decrement operators.	CO2
11	Write a program to demonstrate the overloading of binary arithmetic operators.	CO2
12	Write a program to demonstrate the overloading of memory management operators.	CO4
13	Write a program to demonstrate the multilevel inheritance.	CO3
14	Write a program to demonstrate the virtual derivation of a class.	CO3
15	Write a program to demonstrate the runtime polymorphism.	CO4
16	Write a program to demonstrate the exception handling.	CO4
17	Write a program to demonstrate the use of function templates.	CO4
18	Write a program to demonstrate the use of class templates.	CO4
19	Write a program to find the mean of two numbers of different classes using the Friend function.	CO3
20	Write a program to swap two numbers of the same class using the Friend function.	CO3

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

Virtual Lab Links

Experiment Name	Virtual Lab Link
Write a program that uses a class where the member functions are defined inside a class.	https://www.youtube.com/watch?v=c9vSNQtQVaA&list=PLduM7bkxBdOekXfkEqIBAivzG99V2LrAS&index=3
Write a program to demonstrate the use of zero argument and parameterized constructors	https://www.youtube.com/watch?v=gL7GBhvbvIo&list=PLduM7bkxBdOekXfkEqIBAivzG99V2LrAS&index=7
Write a program to demonstrate the use of const data members	https://www.youtube.com/watch?v=8HQHZVLbVUg&list=PLduM7bkxBdOekXfkEqIBAivzG99V2LrAS&index=17
Write a program to demonstrate the overloading of increment and decrement operators.	https://www.youtube.com/watch?v=Lvl6xi0JAkA&list=PLduM7bkxBdOekXfkEqIBAivzG99V2LrAS&index=24

Course Code	**CSE-L208B**				
Category	Professional Core Courses				
Course Title	**Database Management System Lab**				
Scheme and Credits	L	T	P	**Credits**	**Semester-IV**
	0	0	2	**1**	
Course Objectives	The objectives of this course are ● To introduce basic concepts, architecture and characteristics of database system ● To introduce relational model concepts and PL/SQL programming ● To introduce relational database design and Normal forms based on functional dependencies.				
Assessment	10 Marks				
End Semester Practical Examination	15 Marks				
Total Marks	25 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 the basics of SQL, PL/SQL Block and Procedures.	Level 2: Understand
CO2	Write the SQL Queries, PL/SQL Block to satisfy some conditions and exception.	Level 3: Apply
CO3	Apply the concepts of relationships in relational databases.	Level 3: Apply
CO4	Analyze the use of views, sequences, indexes, constraints, and relationships to ensure data integrity and performance.	Level 4: Analyze

List of Experiments

Sr. No.	**Contents**	**COs**
1	Study the basic features, syntax and components of SQL.	CO1
2	Create a database and write SQL queries to retrieve information from the database.	CO2
3	Perform Insertion, Deletion, Modifying, Altering, Updating and Viewing records based on conditions.	CO2
4	Use Aggregate Functions- COUNT, SUM, AVG, MIN, MAX with GROUP BY and HAVING Clause.	CO2
5	Create Views, Synonyms, Sequence, Indexes, Save point.	CO4
6	Create an Employee database to set various constraints.	CO4
7	Create relationships between the databases.	CO4
8	Study the PL/SQL blocks.	CO1
9	Write a PL/SQL block to satisfy some conditions by accepting input from the user.	CO3

10	Write a PL/SQL block that handles all types of exceptions.	CO3
11	Create Procedures.	CO3
12	Create and implement database triggers and functions.	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	**Link**
Using Aggregate Functions-COUNT, SUM, AVG, MIN, MAX with GROUP BY and HAVING Clause	https://youtu.be/muwEdPsx534?si=6Ys2whV9ekMGng93
Creation of Views, Synonyms, Sequence, Indexes, Save point.	https://www.youtube.com/watch?v=tdRihGrzOg4
PL/SQL block code that handles all types of exceptions.	https://www.youtube.com/watch?v=0fzTqyk3dmQ
Creation of database triggers and functions	https://www.youtube.com/watch?v=hTRr-tVVfZ4

Course code	**CSE-L210B**				
Category	Professional Core Courses				
Course title	**Artificial Intelligence Lab using Python**				
Scheme and Credits	L	T	P	**Credits**	**Semester-IV**
	0	0	2	**1**	
Course Objectives	The objectives of this course are ● To introduce the foundational concepts of Artificial Intelligence and familiarize students with classical AI techniques for problem solving. ● To equip students with the ability to model real-world problems using AI representations such as state-space, search trees, and logic-based systems. ● To provide hands-on experience in implementing AI algorithms using Python for solving puzzles, games, and optimization problems.				
Assessment	10 Marks				
End Semester Practical Examination	15 Marks				
Total Marks	25 Marks				
Duration of Exam	03 Hours				

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

COs	**Skill Demonstrated**	**RBT Level**
CO1	Understand the fundamental concepts and working principles of classical AI search algorithms such as BFS, DFS.	Level 2: Understand
CO2	Apply search algorithms to solve standard AI problems such as Tic-Tac-Toe, and Water Jug problem using Python.	Level 3: Apply
CO3	Implement heuristic-based and problem-specific algorithms like A and AO* for solving real-world path finding and decision problems.	Level 3: Apply
CO4	Analyze various AI techniques in context to their suitability for solving complex problems such as Monkey-Banana, Missionaries-Cannibals, and 8-Queens.	Level 4: Analyze

List of Experiments

Sr. No.	**Contents**	**COs**
1	Study and explain the logic and flow of BFS and DFS search algorithms.	CO1
2	Write a Program to implement Breadth First Search using Python.	CO1, CO2
3	Write a Program to implement Depth First Search using Python.	CO1, CO2
4	Write a Program to implement A* algorithm using Python.	CO3
5	Write a Program to implement AO* algorithm using Python.	CO3
6	Write a Program to implement Tic-Tac-Toe game using Python.	CO2

7	Write a Program to implement 8-Puzzle problem using Python.	CO3
8	Write a Program to implement Water-Jug problem using Python.	CO2
9	Write a Program to implement Travelling Salesman Problem using Python.	CO3
10	Write a Program to implement Tower of Hanoi using Python.	CO2
11	Write a Program to implement Monkey Banana Problem using Python.	CO4
12	Write a Program to implement Missionaries-Cannibals Problems using Python.	CO4
13	Write a Program to implement 8-Queens Problem using Python.	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.

Course Code	**CSE-212B**				
Category	Professional Elective Courses				
Course Title	**Cloud Computing**				
Scheme and Credits	L	T	P	**Credits**	**Semester-IV**
	3	0	0	**3**	
Course Objectives	The objectives of this course are ● To introduce the fundamental concepts, characteristics, and service models of cloud computing. ● To explain key cloud technologies such as virtualization, web services (SOAP and REST), and cloud platforms. ● To develop skills in managing cloud data systems. ● To analyze cloud security principles, quality of service (QoS) issues, and intercloud challenges, preparing students to design secure and efficient cloud solutions.				
Assessment	30 Marks				
End Semester Examination	45 Marks				
Total	75 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 the fundamental concepts and terminology of cloud computing.	Level 1: Remember
CO2	Explain the principles, architectures, and technologies of cloud computing.	Level 2: Understand
CO3	Apply cloud computing concepts, technologies and tools, to deploy and manage cloud-based applications and services effectively.	Level 3: Apply
CO4	Analyze cloud computing solutions with respect to performance, security, and reliability.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 9 parts of 1 mark each from all units and remaining eight questions of 9 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 Cloud Computing, Definition, Characteristics, Components, Cloud provider, SAAS, PAAS, IAAS and Others, Organizational scenarios of clouds, Administering & Monitoring cloud services, benefits and limitations, Comparison among SAAS, PAAS, IAAS, Cloud computing platforms: Infrastructure as service: Amazon EC2,Platform as Service: Google App Engine, Microsoft Azure.

Unit-II

Introduction to Cloud Technologies, Study of Hypervisors, SOAP, REST, Comparison of SOAP and REST, Web services, mashups-Web services, Mashups: user interface services, Virtual machine technology, virtualization applications in enterprises, Pitfalls of virtualization, Multi-entity support, Multi-schema approach, Multi-tenancy using cloud data stores.

Unit-III

Data in the cloud: Relational databases, Cloud file systems: GFS and HDFS, Big Table, HBase and Dynamo, Map-Reduce and extensions: Parallel computing, The map-Reduce model. MICEF Computing (Mist, IOT, Cloud, Edge and FOG Computing): Concept and Application.

Unit-IV

Cloud security fundamentals, Vulnerability assessment tool for cloud, Privacy and Security in cloud, Cloud computing security architecture, Issues in cloud computing, Issues in Intercloud environments, QoS Issues in Cloud, Streaming in Cloud. Quality of Service (QoS) monitoring in a Cloud computing environment, Inter Cloud issues, load balancing, resource optimization.

Suggested Readings:

1. Cloud Computing Bible by Sosinsky Barrie, Wiley India, 2011.
2. Cloud computing: Principles and paradigms by Buyya, Rajkumar, James Broberg, and Andrzej M. Goscinski, eds., Vol. 87, John Wiley & Sons, 2010.
3. Cloud Computing Black Book by Jayaswal, Kailash, John Wiley & Sons, 2014.
4. Cloud Computing: A Practical Approach by Velte, Anthony T., Toby J. Velte, and Robert Elsenpeter, McGraw-Hill, Inc. 2019.
5. Cloud Computing : A Complete Guide by Gerardus Blokdyk, Starcooks, 2019.

Useful Video links

Unit No.	Topics	Links
Unit-I	Cloud Computing	https://youtu.be/NzZXz3fJf6o?list=PLShJJCRzJWxhz7SfG4hpaBD5bKOloWx9J
	SAAS, PAAS, IAAS	https://youtu.be/lOh2x-UACaU?list=PLShJJCRzJWxhz7SfG4hpaBD5bKOloWx9J
Unit-II	Cloud Computing Web Services	https://youtu.be/GtJGB1WxRW8?list=PLShJJCRzJWxhz7SfG4hpaBD5bKOloWx9J
Unit-III	Cloud file system, GFS	https://youtu.be/Dr6MSqRFaZQ?list=PLShJJCRzJWxhz7SfG4hpaBD5bKOloWx9J
	Map reduce	https://youtu.be/XWNEhv-b2PM?list=PLShJJCRzJWxhz7SfG4hpaBD5bKOloWx9J
Unit-IV	Cloud Security	https://youtu.be/LcAPj95KeSA?list=PL-FqPEn1dZJDg-6LHNYnappA6DcXz3ieZ

Course Code	**CSE-214B**				
Category	Professional Elective Courses				
Course Title	**Nature Inspired Computing Techniques**				
Scheme and Credits	L	T	P	**Credits**	**Semester-IV**
	3	0	0	**3**	
Course Objectives	The objectives of this course are ● To introduce the fundamental concepts and biological motivations behind nature-inspired computing. ● To explore various algorithms derived from evolutionary, swarm-based, immune, and DNA models. ● To develop the ability to apply nature-inspired techniques to solve real-world computational problems. ● To cultivate analytical skills for evaluating the behavior and effectiveness of bio-inspired algorithms.				
Assessment	30 Marks				
End Semester Examination	45 Marks				
Total	75 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 key concepts and terminology of nature-inspired computing techniques.	Level 1: Remember
CO2	Explain the working principles of biologically inspired algorithms and models.	Level 2: Understand
CO3	Apply nature-inspired algorithms to computational and optimization problems.	Level 3: Apply
CO4	Analyze the performance and behavior of nature-inspired approaches in varied scenarios.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 9 parts of 1 mark each from all units and remaining eight questions of 9 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, Overview of Philosophy, Nature to Nature Computing, A Brief Overview of Three Branches, Individuals, Entities and agents, Parallelism and Distributivity Interactivity, Adaptation- Feedback, SelfOrganization, Complexity, Emergence, Bottom-up Vs Top-Down Approach, Determination, Chaos and Fractals.

Unit-II

Evolutionary Computing, Hill Climbing, Simulated Annealing, Genetics Principles, Standard Evolutionary Algorithm, Genetic Algorithms, Reproduction, Crossover Mutation, Evolutionary Programming, Genetic Programming.

Unit-III

Swarm Intelligence – Introduction, Ant Colony Optimization, Ant Foraging Behavior, Ant Colony Optimization, SACO algorithm, Ant Colony Algorithm (ACA), Scope of ACO algorithms, Swarm Robotics, Social Adaptation of Knowledge, Particle Swarm Optimization. Immune System-Introduction to Immune System, Physiology and main components, Pattern Recognition and Binding, Immune Network Theory, Danger Theory, Immune Algorithms, Genetic algorithms, Bone Marrow Models, Forest's Algorithm, Artificial Immune Networks.

Unit-IV

DNA Computing, DNA Molecule, Adleman's experiment, PAM Model, Splicing Systems, From Classical to DNA Computing, Universal DNA Computers, Scope of DNA Computing, Lipton's Solution to SAT Problem, Recent Trends and real world applications.

Suggested Readings:

1. Fundamentals of Natural Computing, Basic Concepts, Algorithms And Applications by Leandro Nunesde Castro, Chapman & Hall/CRC, Taylor and Francis Group, 2007.
2. Bio- Inspired Artificial Intelligence: Theories, Methods and Technologies by Floreano D. and Mattiussi C., MIT Press, Cambridge, 2008.
3. Handbook of Nature-Inspired and Innovative Computing by Albert Y. Zomaya, Springer, 2006.
4. Ant Colony Optimization by Marco Dorrigo, Thomas Stutzle, PHI, 2005.

Useful Video links

Unit No.	Topics	Links
Unit-I	Nature to Nature Computing	https://youtu.be/LBGninIdu1k?feature=shared
	Chaos and Fractals	https://www.youtube.com/watch?v=INXuVxhJfc4
Unit-II	Hill Climbing	https://youtu.be/ZOvRZ7UJMjk
	Simulated Annealing	https://youtu.be/TC9WNwM2noM
	Genetic algorithms	https://www.youtube.com/watch?v=WueuYdDqUt0
	Evolutionary Programming	https://www.youtube.com/watch?v=Yma8Y-W0SYE
Unit-III	Ant Colony Optimization	https://www.youtube.com/watch?v=u7bQomllcJw
	Particle Swarm Optimization.	https://www.youtube.com/watch?v=HmDjfL3R39M
	Immune Network Theory	https://www.youtube.com/watch?v=b5LojEVC97M
	The Danger Theory	https://www.youtube.com/watch?v=urd4uWJ2rH4
Unit-IV	DNA Computing	https://www.youtube.com/watch?v=vefBhhjodpE
	Adleman's experiment	https://www.youtube.com/watch?v=C_f7ky0mBsk
	PAM Model	https://www.youtube.com/watch?v=c0751ITCi5g
	DNA Computing	https://www.youtube.com/watch?v=vefBhhjodpE

Course Code	**CSE-216B**				
Category	Professional Elective Courses				
Course Title	**Human Computer Interaction**				
Scheme and Credits	L	T	P	**Credits**	**Semester-IV**
	3	0	0	**3**	
Course Objectives	The objectives of this course are • To introduce the fundamental concepts of human-computer interaction. • To provide knowledge of interface design principles and interaction techniques. • To familiarize students with usability and evaluation methods. • To develop user-centered design skills.				
Assessment	30 Marks				
End Semester Examination	45 Marks				
Total	75 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 the fundamental concepts and terminology of human-computer interaction.	Level 1: Remember
CO2	Explain the principles and techniques used in human-computer interaction.	Level 2: Understand
CO3	Apply standard design rules, usability principles, and interface patterns to create user-friendly screen layouts and interactive interfaces.	Level 3: Apply
CO4	Analyze various evaluation techniques to assess and improve the usability of human-computer interfaces.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 9 parts of 1 mark each from all units and remaining eight questions of 9 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: Definition and scope of HCI, Importance and applications of HCI, Importance of user Interface – definition, importance of good design, Benefits of good design, A brief history of Screen design, The graphical user interface – popularity of graphics, the concept of direct manipulation, graphical system, Characteristics, Web user – Interface popularity, characteristics- Principles of user interface.

Unit-II

Design process: Human interaction with computers, importance of human characteristics human consideration, Human interaction speeds, and understanding business junctions. Screen Designing: Design goals – Screen planning and purpose, organizing screen elements, ordering of screen data and content – screen navigation and flow – Visually pleasing composition – amount of information – focus and emphasis – presentation information simply and meaningfully – information retrieval on web – statistical graphics – Technological consideration in interface design.

Unit-III

Windows: New and Navigation schemes selection of window, selection of devices based and screen-based controls. Components – text and messages, Icons and increases – Multimedia, colors, uses problems, choosing colours, Voice-based interaction (Alexa, Siri, and Google Assistant), Augmented Reality (AR) and Virtual Reality (VR) interfaces.

Unit-IV

HCI in the software process: the software life cycle Usability engineering Iterative design and prototyping Design Focus: Prototyping in practice Design rationale Design rules Principles to support usability Standards Golden rules and heuristics HCI patterns Evaluation techniques, Goals of evaluation, Evaluation through expert analysis, Evaluation through user participation, Choosing an evaluation method. Universal design, Universal design principles Multi-modal interaction.

Suggested Readings

1. The essential guide to user interface design by Wilbert O Galitz, Wiley Dream Tech.
2. Human – Computer Interaction by Alan Dix, Janet Fincay, GreGoryd, Abowd, Russell Bealg, Pearson Education
3. Designing the user interface by Ben Shneidermann, 3rd Edition, Pearson Education Asia.
4. Interaction Design Prece by Rogers, Sharps, Wiley Dreamtech.
5. User Interface Design by Soren Lauesen, Pearson Education.

Unit No.	Topics	Links
Unit-I	Definition and scope of HCI	https://www.youtube.com/watch?v=sAShrCXzgC8
	Graphical User Interface	https://youtu.be/aaGPJzO9FIk?feature=shared
Unit-II	Design process-Human interaction with computers	https://youtu.be/uFYuHHglC6U?feature=shared
	Screen Designing	https://www.youtube.com/watch?v=lpIBwp7txhY
Unit-III	Multimedia	https://www.youtube.com/watch?v=fAJzLuce_ms&t=106s
	Virtual Reality (VR) interfaces	https://youtu.be/aNC5YMUTcQ4?feature=shared
Unit-IV	Software life cycle	https://www.youtube.com/watch?v=c1QR6EapK4k
	Evaluation techniques	https://www.youtube.com/watch?v=PMr3wWfAH0c

Course Code	**CSE-218B**				
Category	Professional Elective Courses				
Course Title	**Fundamentals of Multimedia**				
Scheme and Credits	L	T	P	**Credits**	**Semester-IV**
	3	0	0	**3**	
Course Objectives	The objectives of this course are ● To introduce the fundamental concepts, components, and applications of multimedia systems. ● To provide knowledge of multimedia data representation and compression techniques. ● To familiarize students with audio, video, animation, and multimedia processing technologies. ● To develop understanding of multimedia networking, synchronization, and emerging multimedia applications.				
Assessment	30 Marks				
End Semester Examination	45 Marks				
Total	75 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 the fundamental concepts, terminology, components, and technologies of multimedia systems.	Level 1: Remember
CO2	Explain the principles, techniques, and standards used in multimedia data processing and communication.	Level 2: Understand
CO3	Apply multimedia technologies, compression methods, and processing techniques in multimedia applications.	Level 3: Apply
CO4	Analyze multimedia systems, communication mechanisms, and application frameworks for diverse domains.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 9 parts of 1 mark each from all units and remaining eight questions of 9 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 Multimedia: Introduction to Multimedia and its characteristics, Elements of Multimedia: Text, Graphics, Audio, Video, Animation, Multimedia hardware and software components, Multimedia data representation, Multimedia applications and challenges, Multimedia authoring tools.

Unit-II

Multimedia Data Compression: Need for compression, Lossless and Lossy compression techniques, Run Length Encoding (RLE), Huffman Coding, Lempel-Ziv-Welch (LZW) compression, JPEG image compression standards, MPEG video compression standards.

Unit-III

Audio and Video Processing: Digital audio concepts and formats, Audio compression techniques, MIDI and speech processing, Digital video fundamentals, Video formats and standards, Video compression and streaming techniques, Animation principles and techniques.

Unit-IV

Multimedia Networking and Applications: Multimedia communication systems, Quality of Service (QoS) requirements, Multimedia databases, Multimedia synchronization, Hypermedia and web-based multimedia, Virtual Reality and Augmented Reality concepts, Multimedia applications in education, entertainment, healthcare, and e-commerce.

Suggested Readings:

1. Multimedia Systems by Ralf Steinmetz and KlaraNahrstedt, Springer, 2004.
2. Fundamentals of Multimedia by Ze-Nian Li and Mark S. Drew, Springer Nature, 2014.
3. Multimedia: Making It Work by Tay Vaughan, McGraw-Hill Osborne Media, 2014.
4. Multimedia Communications by Fred Halsall, Addison Wesley, 2000.

Useful Video links

Unit No.	Topics	Links
Unit-I	Introduction to Multimedia and its characteristics	https://youtu.be/s2EKGMa4-zM?si=oLEX79QlmZHpYA3H
	Multimedia authoring tools	https://youtu.be/ak1YOwsVzpE?si=RnkC44KhgYa2vSOX
Unit-II	Lossless and Lossy compression techniques	https://youtu.be/91WdRMWrJGU?si=Tl7iYxD9GsjN5Q4N
	JPEG image compression standards, MPEG video compression standards	https://youtu.be/42dWHkYh5Wo?si=n1Ls-d5oU4ecOwD3
Unit-III	Digital audio concepts and formats, Audio compression techniques	https://youtu.be/rC16fhvXZOo?si=Mfxm4R4uRXUSVRM0
	Animation principles and techniques.	https://youtu.be/NsJUKwvKRdw?si=3eUqWxprfopZQLHb
Unit-IV	Quality of Service (QoS) requirements	https://youtu.be/FqTvwttoTJ4?si=3ohurlLGUhXoU0YN
	Virtual Reality and Augmented Reality concepts	https://youtu.be/Uy1-mVplKVI?si=Kp0MClMgfUqlTAZM

Annexure AC / 5.14

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

'A' GRADE ACCREDITED BY NAAC

Scheme of Studies and Examinations

For

Minor Degree/Honors (Hons.)/Specialization

in

Cyber Security

Department of Computer Science and Engineering

(Effective from the Session: 2026-27)

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

Minor Degree/Honors (Hons.)/Specialization
in
Cyber Security
Offered by the Department of Computer Science and Engineering

Cyber Security is an interdisciplinary field that combines computer science, information technology, and network engineering to protect digital systems, networks, and data from cyber threats. With the rapid expansion of digital infrastructure across industries, government services, and daily life, ensuring information security has become a critical priority. Recognizing its growing importance, the government is actively promoting education, research, and innovation in cyber security. Therefore, universities and institutions are encouraged to integrate cyber security into their academic programs.

In view of this, the **Department of Computer Science Engineering** has introduced a **Minor Degree/Honors (Hons.)/Specialization in "Cyber Security"** from the academic session **2026–27**. This program aims to enhance students' employability by providing specialized knowledge and practical skills in areas such as network security, ethical hacking, data protection, and cyber risk management—fields that are often not extensively covered in the regular undergraduate curriculum. The program will enable students to develop expertise in cyber security and prepare them for diverse career opportunities in this rapidly evolving domain.

This Minor Degree/Honors (Hons.)/Specialization will require earning 20 credits. It will be an addition to the regular undergraduate program, implying that passing or failing it will not affect the results of the regular undergraduate program being pursued by the student. Upon successful completion of the course, a Minor Degree/Honors (Hons.)/Specialization shall be awarded to the candidate. Students enrolled in B.Tech programs shall be eligible to pursue a Minor Degree/Honors (Hons.)/Specialization as outlined below:

Name of the Minor/Honors (Hons.)/Specialization Degree	**B.Tech Program whose students are eligible to opt for Minor Degree**	**B.Tech Program whose students are eligible to opt for Honors (Hons.)/Specialization**
Cyber Security	All Branches except Computer Science and Engineering, CSE-Artificial Intelligence and Machine Learning and CSE-Data Science	Computer Science and Engineering, CSE-Artificial Intelligence and Machine Learning and CSE-Data Science

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

Scheme of Studies and Examination

Minor Degree/Honors (Hons.)/Specialization in Cyber Security

(Effective from the Session: 2026-27)

Sr. No	Semester	Course Code	Course Title	Hours per week			Total Load Per Week	Credits	Examination Scheme (Marks)				Exam Duration in H
				Lecture (L)	Tutorial (T)	Practical (P)			Assessment	End Semester Examination		Total	
										Theory	Practical		
1	III	MCS-001	Information Security Fundamentals	3	0	0	3	3	30	45		75	3
2	IV	MCS-002	Cryptography and Secure Communication	3	1	0	4	4	40	60		100	3
3	V	MCS-003	Ethical Hacking and Penetration Testing	3	0	0	3	3	30	45		75	3
4	V	MCS-L003	Ethical Hacking and Penetration Testing Lab	0	0	2	2	1	10		15	25	
5	VI	MCS-004	Network Security	3	0	0	3	3	30	45		75	3
6	VI	MCS-L004	Network Security Lab	0	0	2	2	1	10		15	25	
7	VII	MCS-005	Cyber Laws and Ethics	3	0	0	3	3	30	45		75	3
8	VIII	MPCS-006	Project	0	0	4	4	2	20		30	50	
Total Credits								20				500	

Note: To earn the required credits for the award of B. Tech Minor Degree/Honors (Hons.)/Specialization, students may choose either:

(i) To enroll in courses offered through NPTEL/MOOCs that must be equivalent to the prescribed courses in the approved scheme, subject to availability in any semester.

OR

(ii) To complete the prescribed courses in the same semester as offered by the department under the approved scheme and curriculum structure.

Course code	**MCS-001**				
Course title	**Information Security Fundamentals**				
Scheme and Credits	L	T	P	**Credits**	**Semester-III**
	3	0	0	**3**	
Course Objectives	The objectives of this course are • To introduce fundamental concepts of information theory that underpin secure communication and cyber security systems. • To develop conceptual understanding of secrecy, authentication, privacy, and cryptographic security principles used in cyber environments. • To enable learners to reason about security mechanisms, attacks, and defences using information-theoretic and cryptographic models. • To provide analytical perspective on emerging cyber security challenges, including threats, forensic considerations, and security guarantees.				
Assessment	30 Marks				
End Semester Examination	45 Marks				
Total	75 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 key concepts of information theory and secure communication relevant to cyber security.	Level 1: Remember
CO2	Explain theoretical principles underlying secrecy, authentication, privacy, and cryptographic security.	Level 2: Understand
CO3	Apply information-theoretic and cryptographic models to reason about security mechanisms and attacks.	Level 3 : Apply
CO4	Analyze cyber security scenarios by evaluating threats, security guarantees, and investigative approaches.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 9 parts of 1 mark each from all units and remaining eight questions of 9 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

Shannon's foundation of Information theory, Random variables, Probability distribution factors, Uncertainty/entropy information measures, Leakage, Quantifying Leakage and Partitions, Lower bounds on key size for secrecy, authentication, and secret sharing, provable security, computational security, motivation for symmetric cipher systems, role of entropy in key generation and randomness.

Unit-II

Secrecy, Authentication, Secret sharing, Optimistic results on perfect secrecy, Secret key agreement, Unconditional Security, Quantum Cryptography, Randomized Ciphers, Types of codes- block codes, Hamming and Lee metrics, description of linear block codes, parity check Codes, cyclic code, Masking techniques.

Unit-III

Information-theoretic security and cryptography, basic introduction to Diffie-Hellman, AES, and side channel attacks. Secrecy metrics- strong, weak, semantic security, partial secrecy, Secure source coding, rate-distortion theory for secrecy systems, side information at receivers, Distributed channel synthesis.

Unit-IV

Cyber warfare: definition, evolution and objectives, cyberspace as a domain of warfare, cyber warfare vs cyber crime vs cyber terrorism, types of cyber warfare attacks including cyber espionage, sabotage, information warfare and DDoS attacks, nation-state cyber-attacks and cyber weapons.

Digital Forensics: introduction to digital and network forensics, digital forensic investigation process, types of digital evidence and sources, chain of custody and legal admissibility of digital evidence, role of digital forensics in incident response, connection of information theory concepts to modern cryptographic and forensic systems.

Suggested Readings:

1. Information Theory and Coding by Muralidhar Kulkarni and K. S. Shivaprakasha, John Wiley & Sons, 1st Edition.
2. Communication Systems: Analog and Digital by Singh and Sapre, Tata McGraw-Hill.
3. Fundamentals in Information Theory and Coding by Monica Borda, Springer, 1st Edition, 2011.
4. Information Theory, Coding and Cryptography by R. Bose, McGraw-Hill Education, 3rd Edition, 2008.
5. Information Security & Cyber Laws by Gupta & Gupta, Khanna Publishing House, 1st Edition, 2019.
6. "Multimedia System Design" by Prabhat K. Andleigh and Kiran Thakrar, Prentice Hall, 1st Edition, 1995.

Useful Video Links:

Unit No.	Topics	Links	Sources
Unit-I	Random Variable	https://youtu.be/snt3FVAVqHg?si=VPerGmbHCnbddfHv	NPTEL (IIT Delhi)
	Uncertainty/entropy information measures, Leakage	https://youtu.be/TT5Wm9jDR2A	NPTEL (IIT Bombay)
Unit-II	Secret Key Exchange (Diffie-Hellman)	https://youtu.be/2kfAga111ls?si=BCCh4CwcgUOdmV34	NPTEL (IIT Kharagpur)
	Quantum Cryptography	https://www.youtube.com/watch?v=BQhZpcg0sc4&list=PLyqSpQzTE6M8Pp2Z8kOAVyoSbw1UOPWQY	NPTEL (IIT Madras)
	Cyclic Codes	https://youtu.be/a_-vfzdvCFg?si=qeoPjw5h-GjT6ZpC	NPTEL (IIT Delhi)
Unit-III	AES	https://youtu.be/fMJl01wbmWE?si=Usn2dUJE9e_ZSwYd	NPTEL (IIT Kharagpur)
	Differential privacy	https://youtu.be/_wMBrZSBBow?si=2AsoeS0sl2RfQU1s	NPTEL (IIT Madras)
Unit-IV	Cyber Warfare	https://onlinecourses.nptel.ac.in/noc26_lw01/preview	Swayam (NALSAR University of Law)
	Digital Forensics	https://youtu.be/jEJYXu59ecQ?si=S2GjKBCqkwulGanI	YouTube (Mossé Cyber Security Institute)

Course code	**MCS-002**				
Course title	**Cryptography and Secure Communication**				
Scheme and Credits	L	T	P	**Credits**	**Semester-IV**
	3	1	0	**4**	
Course Objectives	The objectives of this course are • To introduce the mathematical and algorithmic foundations of modern cryptography. • To explain formal security goals, definitions, and threat models used in cryptographic systems. • To familiarize students with symmetric-key primitives, block ciphers, and their provably secure constructions. • To develop an understanding of semantic, computational, and provable security concepts. • To enable students to analyze and reason rigorously about cryptographic security guarantees in secure communication systems.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total	75 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 fundamental cryptographic primitives, security goals, and formal security models used in secure communication.	Level 1: Remember
CO2	Explain semantic and computational security, pseudorandom generators, and block cipher modes of operation.	Level 2: Understand
CO3	Apply provably secure constructions of cryptographic primitives such as PRGs, PRFs, and CPA-secure encryption schemes.	Level 3 : Apply
CO4	Analyze cryptographic definitions, reductions, and security proofs to evaluate the strength of secure communication mechanisms.	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 and Symmetric Key Foundations: Overview of cryptography and secure communication, historical ciphers and motivation for modern cryptography. Security goals: confidentiality, integrity, and authenticity. Symmetric-key encryption: syntax and threat models. Perfect secrecy and Shannon's theorem, limitations of perfect secrecy. Computational security and adversarial models. Formal definition of semantic security. Introduction to pseudorandom generators (PRGs) and their basic properties.

Unit-II

Pseudorandom Functions and Stream Ciphers: Provable security definitions for pseudorandom generators. Practical constructions and instantiations of secure PRGs. Stream ciphers: design principles, security requirements, and real-world examples. Pseudorandom functions (PRFs): definitions, constructions, and examples. Relationship between PRGs and PRFs and their role in secure communication protocols.

Unit-III

Block Ciphers and Modes of Operation: Block cipher fundamentals: definitions and security intuition. Construction of CPA-secure encryption schemes using PRFs. Standard block cipher modes of operation: ECB, CBC, and CTR modes. Security analysis and limitations of various modes. Principles of secure mode design. Provable security constructions based on block ciphers.

Unit-IV

Provable Security and Advanced Constructions: Introduction to provable security methodology. Game-based definitions and reduction-based proof techniques. Security of composition of cryptographic primitives. Advanced encryption notions: CCA security and authenticated encryption. Practical considerations in secure communication systems. Overview of real-world cryptographic standards and best practices.

Suggested Readings:

1. Foundations of Cryptography by Oded Goldreich, Volumes 1 & 2, Cambridge University Press.
2. Introduction to Modern Cryptography by Jonathan Katz & Yehuda Lindell, CRC Press.
3. Foundations of Cryptography Lecture Notes by Mihir Bellare & Phillip Rogaway.
4. A Graduate Course in Applied Cryptography by Dan Boneh & Victor Shoup, (freely available online).

Useful Video Links:

Course Name	Tutor	NPTEL Link
Foundations of Cryptography	Prof. Ashish Choudhury, IIT Madras	https://nptel.ac.in/courses/106106221

Course code	**MCS-003**				
Course title	**Ethical Hacking and Penetration Testing**				
Scheme and Credits	L	T	P	**Credits**	**Semester-V**
	3	0	0	**3**	
Course Objectives	The objectives of this course are • To introduce ethical hacking principles, penetration testing methodologies, and legal–ethical frameworks. • To explain reconnaissance, system exploitation, malware, and network-based attacks from an attacker's perspective. • To enable understanding of web, wireless, and cryptographic attack surfaces and basic defensive measures. • To familiarize students with digital forensics fundamentals, incident response, and emerging hacking trends.				
Assessment	30 Marks				
End Semester Examination	45 Marks				
Total	75 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 ethical hacking concepts, penetration testing processes, and legal–ethical considerations.	Level 1: Remember
CO2	Explain reconnaissance, system hacking techniques, malware behavior, and network attack mechanisms.	Level 2: Understand
CO3	Apply ethical hacking concepts to analyze web, wireless, and cryptographic security weaknesses.	Level 3 : Apply
CO4	Analyze forensic evidence, incident response processes, and emerging security challenges.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 9 parts of 1 mark each from all units and remaining eight questions of 9 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

Foundations of Ethical Hacking and Reconnaissance: Ethical hacking: definition, scope, objectives, ethical vs unethical hacking, roles of ethical hackers, legal and regulatory framework in India. Penetration testing concepts, penetration testing vs vulnerability assessment, penetration testing life cycle, threat modeling, red teaming and blue teaming.

Reconnaissance and footprinting: passive and active reconnaissance, WHOIS and DNS interrogation, search engine hacking, OSINT, basic network scanning and enumeration.

Unit-II

System Hacking and Malware: System hacking techniques: authentication weaknesses, password attacks, privilege escalation, maintaining access, backdoors. Malware fundamentals: viruses, worms, Trojans, ransomware, botnets – characteristics and propagation. Malware analysis overview: static vs dynamic analysis, indicators of compromise.
Sniffing and spoofing attacks: packet sniffing concepts, ARP poisoning, DNS spoofing, session hijacking. Basic countermeasures: system hardening, endpoint security, intrusion detection overview.

Unit-III

Network, Web, and Wireless Attacks: Network attacks: DoS and DDoS concepts, man-in-the-middle attacks, routing and protocol abuse, Web application attacks: web attack surface, OWASP Top 10 vulnerabilities, SQL injection, XSS, CSRF, authentication and session flaws, Wireless attacks: wireless security standards (WEP, WPA, WPA2, WPA3), rogue access points, evil twin attacks, Bluetooth threats, Overview of defensive mechanisms: firewalls, web application firewalls, intrusion prevention systems.

Unit-IV

Cryptographic Attacks, Forensics, and Emerging Trends: Cryptography from an attacker's view: weak encryption usage, password storage flaws, brute force and rainbow table attacks, PKI overview: digital certificates, trust models, common PKI and SSL/TLS misconfigurations. Digital forensics fundamentals: investigation process, evidence acquisition, chain of custody, log and memory analysis. Incident response basics and cyber law overview in India, Emerging trends: cloud misconfigurations, IoT hacking basics, mobile security threats, social engineering.

Suggested Readings:

1. CEH Certified Ethical Hacker Study Guide by Ric Messier, 4th Edition, Wiley, 2019.
2. The Web Application Hacker's Handbook by Dafydd Stuttard and Marcus Pinto, 2nd Edition, Wiley, 2011.
3. Hacking: The Art of Exploitation by Jon Erickson, 2nd Edition, No Starch Press, 2008.
4. Computer Security: Principles and Practice by William Stallings and Lawrie Brown, 4th Edition, Pearson, 2018.

Useful Video Links:

Course Name	Tutor	NPTEL Link
Ethical Hacking	Prof. Indranil Sengupta, IIT Kharagpur	https://onlinecourses.nptel.ac.in/noc23_cs44/preview

Course Code	**MCS-L003**				
Course Title	**Ethical Hacking and Penetration Testing Lab**				
Scheme and Credits	L	T	P	**Credits**	**Semester-V**
	0	0	2	**1**	
Course Objectives	The objectives of this course are ● To provide hands-on exposure to ethical hacking tools, techniques, and methodologies. ● To practice reconnaissance, scanning, exploitation, and basic post-exploitation activities in controlled environments. ● To analyze common system, network, web, and wireless vulnerabilities through laboratory experiments. ● To understand attacker techniques alongside basic defensive and forensic countermeasures. ● To develop ethical awareness, legal compliance, and responsible hacking practices.				
Assessment	10 Marks				
End Semester Practical Examination	15 Marks				
Total	25 Marks				
Duration of Exam	03 Hours				

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

COs	**Skills Demonstrated**	**RBT Level**
CO1	Understand ethical hacking concepts, penetration testing methodology, and legal frameworks through practical demonstrations.	Level 2: Understand
CO2	Apply reconnaissance, scanning, and enumeration techniques using standard ethical hacking tools.	Level 3: Apply
CO3	Perform controlled exploitation of system, network, web, and wireless vulnerabilities.	Level 3: Apply
CO4	Analyze attacks, malware behavior, logs, and incident evidence to propose countermeasures.	Level 4: Analyze

List of Experiments:

Sr. No.	**Content**	**COs**
1.	Install and configure an ethical hacking lab environment (Kali Linux/Parrot OS, Metasploitable, DVWA) and study ethical hacking laws and guidelines in India.	CO1
2.	Perform passive and active reconnaissance using WHOIS, DNS lookup, Google dorking, and OSINT tools.	CO2
3.	Network scanning and enumeration using Nmap: port scanning, service detection, OS fingerprinting.	CO2
4.	Perform vulnerability scanning using tools such as OpenVAS/Nessus; analyze scan reports.	CO2

5.	Demonstrate password attacks: dictionary and brute-force attacks on test systems using ethical tools.	CO3
6.	Perform privilege escalation and maintain access in a controlled lab environment.	CO3
7.	Study malware behavior using static and dynamic analysis tools; identify indicators of compromise.	CO2
8.	Demonstrate sniffing and spoofing attacks: packet capture, ARP poisoning, DNS spoofing in a sandbox.	CO3
9.	Exploit web application vulnerabilities (SQL Injection, XSS, CSRF) using OWASP DVWA / Juice Shop.	CO3
10.	Perform wireless security assessment: WEP/WPA attacks, evil twin simulation, Bluetooth scanning.	CO3
11.	Analyze cryptographic weaknesses: password hashing flaws, brute force and rainbow table attacks.	CO4
12.	Perform basic digital forensics: log analysis, memory dump inspection, evidence handling and chain of custody.	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**	**Source**
Network scanning using Nmaps	https://labex.io/labs/nmap-how-to-scan-multiple-ip-addresses-simultaneously-using-nmap-in-cybersecurity-414798	Labex
Cryptographic attacks	https://overthewire.org/wargames/bandit/	overthewire.org
SQL injection	https://portswigger.net/web-security/sql-injection	portswigger.net

Course code	**MCS-004**				
Course title	**Network Security**				
Scheme and Credits	L	T	P	**Credits**	**Semester-VI**
	3	0	0	**3**	
Course Objectives	The objectives of this course are • To introduce secure network architectures, communication models, and fundamental principles of network security. • To explain transport, IP, wireless, email, and web security protocols with emphasis on secure design and vulnerability mitigation. • To familiarize students with network defense mechanisms, traffic monitoring, and incident response processes. • To enable analysis of emerging network security challenges in cloud, IoT, mobile, and zero-trust environments.				
Assessment	30 Marks				
End Semester Examination	45 Marks				
Total	75 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 network security concepts, secure architectures, threat models, and communication principles.	Level 1: Remember
CO2	Explain secure communication protocols, certificate infrastructures, and protocol-level vulnerabilities.	Level 2: Understand
CO3	Apply network defense mechanisms, monitoring tools, and mitigation strategies to protect communication systems.	Level 3 : Apply
CO4	Analyze advanced network security challenges, incident response scenarios, and emerging secure network architectures.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 9 parts of 1 mark each from all units and remaining eight questions of 9 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

Network security fundamentals: CIA triad in network communication, Authentication–Authorization–Accounting (AAA), threat models and attack surfaces, secure network design principles: defense-in-depth, segmentation, DMZ, trusted vs. untrusted zones, conceptual analysis of DNS hijacking, man-in-the-middle attacks, and distributed denial-of-service (DDoS) attacks (case-study based).

Unit-II

Secure communication protocols: SSL/TLS architecture, handshake and record protocols, digital certificates and PKI, certificate pinning and HSTS, analysis of TLS vulnerabilities (BEAST, POODLE, Heartbleed) and mitigation strategies, IPSec architecture, AH and ESP headers, transport and tunnel modes, Internet Key Exchange (IKE), Virtual Private Networks (VPNs): site-to-site and remote-access VPNs.

Unit-III

Network defense and monitoring mechanisms: firewalls (packet filtering, stateful inspection, proxy and next-generation firewalls), Network Address Translation (NAT), Intrusion Detection Systems (IDS) and Intrusion Prevention Systems (IPS), signature-based and anomaly-based detection, Security Information and Event Management (SIEM) fundamentals, log collection and correlation, network traffic monitoring, anomaly detection, network-level incident response and forensic readiness.

Unit-IV

Advanced network security and emerging trends: wireless, email, and web security (secure configuration and protection), wireless security standards (WEP, WPA, WPA2, WPA3) and KRACK vulnerability analysis, email security (PGP, S/MIME), web security mechanisms (HTTPS, secure cookies, DNSSEC), cloud network security (VPCs, cloud firewalls, Web Application Firewalls, zero-trust models), IoT network security fundamentals, Zero Trust Network Architecture (ZTNA), Secure Access Service Edge (SASE), AI/ML-based network anomaly detection, post-quantum cryptography impact on network protocols.

Suggested Readings:

1. Network Security Essentials: Applications and Standards by William Stallings, 6th Edition, Pearson.
2. Cryptography and Network Security: Principles and Practice by William Stallings, 8th Edition, Pearson.
3. Computer Security: Principles and Practice by William Stallings & Lawrie Brown, Pearson.
4. Network Security Bible by Eric Cole, Wiley.
5. Applied Cryptography by Bruce Schneier, Wiley.
6. Network Security: Private Communication in a Public World by Kaufman, Perlman & Speciner, Prentice Hall.
7. Encyclopedia of Cryptography and Security by Henk C.A. van Tilborg (Ed.), Springer.

Useful Video Links:

Course Name	Tutor	NPTEL Link
Network Security	Prof. Gaurav S. Kasbekar, IIT Bombay	https://nptel.ac.in/courses/108101585?

Course Code	**MCS-L004**				
Course Title	**Network Security Lab**				
Scheme and Credits	L	T	P	**Credits**	**Semester-VI**
	0	0	2	**1**	
Course Objectives	The objectives of this course are ● To understand network security fundamentals, threats, and cryptographic mechanisms through hands-on experiments. ● To apply transport, IP-layer, wireless, email, and web security protocols in practical network environments. ● To configure and analyze network defense mechanisms including firewalls, IDS/IPS, and monitoring tools. ● To investigate network attacks, perform forensics, and study emerging trends such as cloud, IoT, and zero-trust security.				
Assessment	10 Marks				
End Semester Practical Examination	15 Marks				
Total	25 Marks				
Duration of Exam	03 Hours				

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

COs	**Skills Demonstrated**	**RBT Level**
CO1	Understand network security principles, threats, cryptographic foundations, and secure network architectures.	Level 2: Understand
CO2	Apply security protocols and mechanisms at transport, IP, wireless, email, and web layers.	Level 3: Apply
CO3	Implement and configure firewalls, IDS/IPS, traffic monitoring, and secure network services.	Level 3: Apply
CO4	Analyze network attacks, security incidents, forensics evidence, and effectiveness of modern defense strategies.	Level 4: Analyze

List of Experiments:

Sr. No.	**Content**	**COs**
1	Install and configure Linux networking tools; study CIA triad, AAA, and basic cryptographic primitives.	CO1
2	Perform packet sniffing and traffic analysis using Wireshark; study plaintext credential leakage.	CO2
3	Implement and analyze spoofing attacks (ARP poisoning, MAC spoofing) in a controlled lab setup.	CO2
4	Perform scanning and reconnaissance using Nmap; analyze attack surface exposure.	CO2
5	Configure SSL/TLS; analyze handshake, certificates, PKI, HSTS, and certificate pinning.	CO2

6	Study TLS vulnerabilities Heartbleed, POODLE, BEAST) using simulations and test environments.	CO3, CO4
7	Configure IPSec in transport and tunnel modes; implement site-to-site and remote-access VPNs.	CO3
8	Implement wireless security: WEP/WPA/WPA2/WPA3 configuration; analyze 4-way handshake and KRACK.	CO3
9	Configure firewall rules (packet filtering, stateful, NAT, DMZ); analyze traffic behavior.	CO3
10	Deploy IDS/IPS (Snort/Suricata); analyze alerts and intrusion patterns.	CO4
11	Simulate DDoS attacks (SYN flood, UDP flood); study mitigation strategies and logging.	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	Source
TCP SYN Flood attack	https://ns-amrt.vlabs.ac.in/exp/tcp-syn-flood/	Virtual Labs
To simulate the Secure Socket Layer (SSL) transmission between a user and a server	https://ns-amrt.vlabs.ac.in/exp/ssl-simulation/	Virtual Labs
Intrusion Detection Systems (IDS)	https://ns-amrt.vlabs.ac.in/exp/intrusion-detection/	Virtual Labs
Intrusion prevention system using firewalls	https://ns-amrt.vlabs.ac.in/exp/firewall/	Virtual Labs

Course code	**MCS-005**				
Course title	**Cyber Laws and Ethics**				
Scheme and Credits	L	T	P	**Credits**	**Semester-VII**
	3	0	0	**3**	
Course Objectives	The objectives of this course are • To introduce the foundations of cyber law, cyberspace, and cyber jurisprudence. • To familiarize learners with the Information Technology Act, cyber-crimes, and electronic governance. • To outline cyber law in relation to intellectual property, allied laws, and dispute resolution. • To highlight cyber ethics, cyber regulations, and ethical issues in artificial intelligence.				
Assessment	30 Marks				
End Semester Examination	45 Marks				
Total	75 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 fundamental terms and concepts related to cyber law, cyberspace governance, cyber-crimes and cyber ethics.	Level 1: Remember
CO2	Explain the legal, regulatory and ethical frameworks governing activities and interactions in cyberspace, including emerging digital technologies.	Level 2: Understand
CO3	Apply cyber law principles and statutory provisions to address practical issues and case scenarios arising in digital environments.	Level 3: Apply
CO4	Analyze the broader implications of cyberspace technologies by evaluating legal compliance, ethical challenges and responsible use in contemporary society.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 9 parts of 1 mark each from all units and remaining eight questions of 9 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 Cyber Law: Evolution of computer technology, emergence of cyber space, cyber jurisprudence, jurisprudence and law, doctrinal approach, consensual approach, real approach, cyber ethics, cyber jurisdiction, hierarchy of courts, civil and criminal jurisdictions, cyberspace web-space, web hosting and web development agreement, legal and technological significance of domain names, Internet as a tool for global access.

Unit-II

Information Technology Act: Overview of IT Act 2000, amendments and limitations of IT Act, digital signatures, cryptography, electronic governance, legal recognition of electronic records, legal recognition of digital signature, certifying authorities, cyber crime and offences, Network Service Providers Liability, Cyber Regulations Appellate Tribunal, Penalties and Adjudication.

Unit-III

Cyber Law and Related Legislation: Patent Law, Trademark Law, Copyright, Software Copyright or Patented, Domain Names and Copyright disputes, Electronic Data Base and its Protection, IT Act and Civil Procedure Code, IT Act and Criminal Procedural Code, Relevant Sections of Indian Evidence Act, Relevant Sections of Bankers Book Evidence Act, Relevant Sections of Indian Penal Code, Relevant Sections of Reserve Bank of India Act, Law Relating To Employees And Internet, Alternative Dispute Resolution, Online Dispute Resolution (ODR).

Unit-IV

Cyber Ethics: Introduction to Cyber ethics, Significance of cyber Ethics, Need for Cyber regulations and Ethics. Ethics in Information society, Introduction to Artificial Intelligence Ethics: Ethical Issues in AI and core Principles.

Suggested Readings:

1. Textbook on Cyber Law by Pavan Duggal, Deccan Law House, 2007.
2. Cyber Law Simplified by Vivek Sood, Tata McGraw-Hill Publishing Company, 2001.
3. Cyber Laws, Information Technology and Artificial Intelligence by Jyoti Rattan, Eastern Book Company (EBC), 2023.
4. Introduction to Computer Security by Matt Bishop, Pearson Education, 2003.
5. Cyber Law and Cyber Crimes by Dr. Santosh Kumar and Dr. Gagandeep Kaur, Eastern Book Company (EBC), 2020.

Useful Video Links:

Unit No.	Topics	Links	Sources
Unit-I	Introduction to Cyber Laws	https://onlinecourses.swayam2.ac.in/cec24_cs14/preview	NPTEL (Punjabi University, Patiala)
	Cyber Security and Privacy	https://onlinecourses.nptel.ac.in/noc23_cs127/preview	NPTEL (IIT Madras)
Unit-II	Cryptography	https://youtu.be/B-Xe7_mf2CY?si=KuOwiHqLmyZXTzxH	NPTEL (IIT Kharagpur)
	Sections 11, 12, and 13 of Information Technology Act, 2000	https://www.youtube.com/watch?v=0BbBRRVX_l4	YouTube (Asian School of Cyber Laws)
Unit-III	Patent Law, Trademark Law, Copyright	https://youtu.be/xeAtjYoMa1A?si=53PJ532fA0NW2c2t	YouTube (Dhaval Chandarana)
	Indian patent act, 1970	https://youtu.be/8VGW5Y81SxU?si=-tjk0r-Nl02jIXVl	YouTube (Lawlecture by TarunaSharma)
Unit-IV	Introduction of Cyber Ethics	https://youtu.be/xeDZalBaLkQ?si=L0cCFKcxLJmOWXKF	YouTube (Dhaval Chandarana)
	Ethics in information society	https://onlinecourses.nptel.ac.in/noc23_hs47/preview	YouTube (IIT Bangalore)

<table>
<tr><td>Course code</td><td colspan="5">MPCS-006</td></tr>
<tr><td>Course title</td><td colspan="5">Project</td></tr>
<tr><td rowspan="2">Scheme and Credits</td><td>L</td><td>T</td><td>P</td><td>Credits</td><td rowspan="2">Semester-VIII</td></tr>
<tr><td>0</td><td>0</td><td>4</td><td>2</td></tr>
<tr><td>Course Objectives</td><td colspan="5">The objectives of this course are
• To identify an engineering problem through literature review and clearly define project objectives.
• To learn fundamental engineering principles to propose a feasible solution methodology.
• To inculcate skills in project planning, preliminary design, and use of appropriate engineering tools.
• To enhance teamwork, technical documentation, and presentation skills.</td></tr>
<tr><td>Assessment</td><td colspan="5">20 Marks</td></tr>
<tr><td>End Semester Practical Examination</td><td colspan="5">30 Marks</td></tr>
<tr><td>Total</td><td colspan="5">50 Marks</td></tr>
<tr><td>Duration of Exam</td><td colspan="5">03 Hours</td></tr>
</table>

The students expected to take up a project under the guidance of teacher from the college. The Project must be based on **Cyber Security** problems, which can be extended up to the full semester. The students may be asked to work individually or in a group normally not more than three students in a group (if any large/ big projects occur then strength of students' can be increased as per guide supervision). Viva-voce must be based on the preliminary reports submitted by the students related to the project.

Annexure AC / 5.15

~~ANNEXURE 4.6(b)~~

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

'A' GRADE ACCREDITED BY NAAC

Scheme of Studies and Examinations

For

Minor Degree

in

Data Science

Department of Computer Science and Engineering

(Effective from the Session: 2026-27)

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

Minor Degree
in
Data Science
Offered by the Department of Computer Science and Engineering

Data Science is an interdisciplinary field that integrates computer science, statistics, and mathematics to extract meaningful insights from large and complex datasets. With the rapid growth of digital technologies and data-driven decision-making across industries, government services, and research domains, the demand for skilled data science professionals has increased significantly. Recognizing its importance, the government is actively promoting education, research, and innovation in data science and related technologies. Therefore, universities and institutions are encouraged to incorporate data science into their academic programs.

In view of this, the **Department of Computer Science and Engineering** has introduced a **Minor Degree in "Data Science"** from the academic session **2026–27**. This program aims to enhance students' employability by providing specialized knowledge and practical skills in areas such as data analytics, machine learning, data visualization, and big data technologies fields that are often not extensively covered in the regular undergraduate curriculum. The program will enable students to develop expertise in data science and prepare them for diverse career opportunities in this rapidly evolving domain.

This Minor Degree will require earning 20 credits. It will be an addition to the regular undergraduate program, implying that passing or failing it will not affect the results of the regular undergraduate program being pursued by the student. Upon successful completion of the course, a Minor Degree shall be awarded to the candidate. Students enrolled in B.Tech programs shall be eligible to pursue a Minor Degree, as outlined below:

Name of the Minor	B.Tech Program whose students are eligible to opt for Minor Degree
Data Science	All Branches except Computer Science and Engineering, CSE-Artificial Intelligence and Machine Learning and CSE-Data Science

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

Scheme of Studies and Examination

Minor Degree in Data Science

(Effective from the Session: 2026-27)

Sr. No.	Semester	Course Code	Course Title	Hours per week			Total Load Per Week	Credits	Examination Scheme (Marks)				Exam Duration in H
				Lecture (L)	Tutorial (T)	Practical (P)			Assessment	End Semester Examination		Total	
										Theory	Practical		
1	III	MDS-001	Mathematics for DS	3	1	0	4	4	40	60		100	3
2	IV	MDS-002	Fundamentals of DS	3	0	0	3	3	30	45		75	3
3	V	MDS-003	Data Preparation and Preprocessing	3	0	0	3	3	30	45		75	3
4	V	MDS-L003	Data Preparation and Preprocessing Lab	0	0	2	2	1	10		15	25	
5	VI	MDS-004	Data Handling and Visualization	3	0	0	3	3	30	45		75	3
6	VI	MDS-L004	Data Handling and Visualization Lab	0	0	2	2	1	10		15	25	
7	VII	MDS-005	Big Data Analytics	3	0	0	3	3	30	45		75	3
8	VIII	MPDS-006	Project	0	0	4	4	2	20		30	50	
Total Credits								20				500	

Note: To earn the required credits for the award of B. Tech Minor Degree, students may choose either:

(i) To enroll in courses offered through NPTEL/MOOCs that must be equivalent to the prescribed courses in the approved scheme, subject to availability in any semester.

OR

(ii) To complete the prescribed courses in the same semester as offered by the department under the approved scheme and curriculum structure.

Course code	**MDS-001**				
Course title	**Mathematics for DS**				
Scheme and Credits	L	T	P	**Credits**	**Semester-III**
	3	1	0	**4**	
Course Objectives	The objectives of this course are • To introduce the fundamentals of probability theory and random variables for modeling uncertainty in data science. • To develop understanding of discrete and continuous probability distributions and statistical measures for data analysis. • To enable application of estimation methods and descriptive statistics for parameter inference. • To cultivate skills in hypothesis testing and statistical decision-making for data-driven conclusions.				
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 fundamental concepts of probability, random variables, probability distributions, and statistical inference.	Level 1: Remember
CO2	Explain properties of discrete and continuous distributions, estimation methods, and hypothesis testing principles.	Level 2: Understand
CO3	Apply probability models, estimation techniques, and statistical tests to solve data-driven problems.	Level 3 : Apply
CO4	Analyze statistical data using distribution theory, correlation measures, and hypothesis testing frameworks to draw meaningful conclusions.	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

Foundations of Probability Theory: Random experiments and events, Definitions of probability and basic properties of probability functions. Conditional probability, independence of events. Problems on probability. Definition of random variables, probability distribution of a random variable, discrete and continuous distributions. Special discrete distributions: Bernoulli, Binomial, Geometric, Poisson. Introduction to discrete processes: Poisson process.

Unit-II

Continuous Distributions: Special continuous distributions – Exponential, Gamma, Beta, Uniform and related families; Normal distribution and applications. Joint distributions (discrete and continuous), independence, product moments, correlation, bivariate normal distribution, additive properties of distributions. Distribution of order statistics.

Unit-III

Descriptive Statistics: Measures of central tendency, dispersion, quantiles, moments, measures of skewness and kurtosis.
Estimation Theory: Concepts of unbiasedness, consistency, method of moments estimation (MME), maximum likelihood estimation (MLE).

Unit-IV

Hypothesis Testing: Basic definitions of hypothesis testing, types of errors. Tests for normal mean and variance, large-sample tests for variance, two-sample problems, paired t-test, testing equality of proportions. Sampling distributions – Chi-square, t-distribution and F-distribution.

Suggested Readings:

1. An Introduction to Probability and Statistics by V. K. Rohatgi and A. K. Md. E. Saleh, 3rd Edition, Wiley Series in Probability and Statistics, 2015.
2. Probability and Statistical Inference by R. V. Hogg, E. A. Tanis, and J. M. Rao, 7th Edition, Pearson Education, New Delhi, 2009.
3. John E. Freund's Mathematical Statistics with Applications" by Irwin Miller and Marylees Miller, 7th Edition, Pearson Education, Asia, 2006.
4. Fundamentals of Statistics, Vol. I by A. M. Goon, M. K. Gupta, and B. Dasgupta, 8th Edition, The World Press, Kolkata, 2002.
5. An Introduction to the Theory of Statistics by G. U. Yule and M. G. Kendall, 14th Edition, Universal Book Stall, Delhi, 1994.

Useful Video Links:

Unit No.	Topics	Links	Source
Unit-I	Random experiments, sample space, events	https://youtu.be/r1sLCDA-kNY?si=YjBpSNfFcBNXuixd	NPTEL (IIT Kharagpur)
	Conditional probability & independence	https://youtu.be/o1qL2Eb87Ew?si=ZT6TZex4bKfUGklD	NPTE (IIT Guwahati)
	Special discrete distributions: Bernoulli, Binomial, Geometric, Poisson	https://youtu.be/dByGT1N8JAw?si=HKeIgCFrGXyg4yTl	NPTEL (IISC Bengaluru)
Unit-II	Normal distribution	https://youtu.be/GMcfFrsfBQU	NPTEL (IIT Kharagpur)
	Joint distribution	https://youtu.be/S_Zx-g8FU0w?si=ECEKIcSgAt4ICPq3	NPTEL (IIT Kharagpur)
	Order Statistics	https://youtu.be/E_sJQML1PMg?si=UFtbHnBcDhgT6ZrA	NPTEL (IIT Guwahati)
Unit-III	Moments	https://youtu.be/rlFR9Co8UgY?si=mrx7EcVotJtbxzAF	NPTEL (IIT Delhi)
	Maximum Likelihood Estimation	https://youtu.be/iXyMDeYqwaQ?si=og7R9e-rw_wvvBtF	NPTEL (IIT Guwahati)
Unit-IV	Hypothesis testing	https://youtu.be/6zslEdMGGiQ?si=v7L3lsCWuLR5W6TE	NPTEL (IIT Kharagpur)
	The Chi-Square Test	https://youtu.be/qUQ-alqJQag?si=lP3JMaggYy9lqv7q	NPTEL(IISER Kolkata)
	t and F Distribution	https://youtu.be/ZJHXVVjl1ns?si=XxJRVa06VOvjx4GY	NPTEL (IIT Kanpur)

Course code	**MDS-002**				
Course title	**Fundamentals of DS**				
Scheme and Credits	L	T	P	**Credits**	**Semester-IV**
	3	0	0	**3**	
Course Objectives	The objectives of this course are • To understand the fundamentals and evolution of Data Science, including Big Data, Little Data, Machine Learning, Artificial Intelligence, and Data Analytics. • To learn the types of data, challenges in data science, and the role of a data scientist in handling and processing data effectively. • To acquire skills in statistical modeling, Python programming, and data handling techniques to analyze datasets and solve practical problems. • To develop the ability to analyze real-world datasets and design simple recommendation systems using statistical reasoning, Python tools, and utility matrices.				
Assessment	30 Marks				
End Semester Examination	45 Marks				
Total Marks	75 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 and define the basic terminology, concepts, and scope of Data Science.	Level 1: Remember
CO2	Explain the data science process, types of data, and statistical foundations used in data analysis and decision-making..	Level 2: Understand
CO3	Apply statistical techniques and Python programming constructs to perform basic data analysis, file handling, and exception handling tasks.	Level 3 : Apply
CO4	Analyze real-world data problems and recommendation systems using statistical reasoning, Python-based approaches, and utility matrix concepts.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 9 parts of 1 mark each from all units and remaining eight questions of 9 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: Evolution and scope of Data Science, Big Data vs Little Data, Data Science vs. Data Analytics vs. ML vs. AI, Types of data (structured, semi-structured, unstructured), Data Science life cycle / process, Challenges in data science, Data science process & role of a data scientist, Applications of Data Science in real-world domains (business, healthcare, social media).

Unit-II

Statistical Modeling for Data Science: Descriptive statistics (mean, median, mode, variance, standard deviation), Probability distributions (normal, binomial, Poisson), Sampling methods (Simple random sampling, Stratified sampling, Systematic sampling), Hypothesis testing, null and alternative hypotheses, Type-I and Type-II errors, Basics of confidence intervals.

Unit-III

Python for Data Science: Introduction to Python and its role in Data Science, Python basics, control structures, Data structures (lists, dictionaries), Files and exception handling, Python Libraries for Data Science (Introductory): NumPy (arrays and numerical operations), Pandas (Series, Data Frames, basic data manipulation), Matplotlib and Seaborn (basic data visualization).

Unit-IV

Recommendation systems: Introduction to recommendation systems, Types of recommendation systems (overview): Content-based, Collaborative filtering**,** Utility matrix and long tail concept, Applications and populating the utility matrix, Applications of recommendation systems.

Suggested Readings:

1. Python for Data Analysis, Second Edition – Wes McKinney, 2017, O'Reilly Media.
2. Elaine Rich, Kevin Knight, & Shivashankar B Nair, Artificial Intelligence, McGraw Hill, 3rd ed., 2009.
3. Introduction to Artificial Intelligence & Expert Systems, Dan W Patterson, PHI, 2010.
4. Artificial intelligence, Patrick Henry Winston, 1992, Addition Wesley.

Useful Video Links:

Unit No.	Topics	Links	Source
Unit-I	Evolution & scope, Big vs Little Data	https://www.youtube.com/watch?v=tA42nHmmEKw	NPTEL (IIT Madras)
	AI vs ML vs Data Science	https://www.youtube.com/watch?v=tA42nHmmEKw	NPTEL (IIT Madras)
	Types of data, challenges	https://www.youtube.com/watch?v=tA42nHmmEKw	NPTEL (IIT Madras)
Unit-II	Descriptive statistics	https://www.youtube.com/playlist?list=PLyqSpQzTE6M_JcleDbrVyPnE0PixKs2JE	NPTEL (IIT Madras)
	Mean/median/mode	https://www.youtube.com/playlist?list=PLyqSpQzTE6M_JcleDbrVyPnE0PixKs2JE	NPTEL (IIT Madras)
	Sampling	https://www.youtube.com/playlist?list=PLyqSpQzTE6M_JcleDbrVyPnE0PixKs2JE	NPTEL (IIT Madras)
Unit-III	Python basics	https://www.youtube.com/playlist?list=PLyqSpQzTE6M_fFg1zZmeGIkenMDgXKGYi	NPTEL (IIT Madras)
	File & exception handling	https://www.youtube.com/playlist?list=PLyqSpQzTE6M_fFg1zZmeGIkenMDgXKGYi	NPTEL (IIT Madras)
Unit-IV	Utility matrix	https://www.youtube.com/playlist?list=PLOAciEalMV3Hqaau-IJo_cR9k2k76ErJl	NPTEL (IIT Madras)
	Long-tail concept	https://www.youtube.com/playlist?list=PLOAciEalMV3Hqaau-IJo_cR9k2k76ErJl	NPTEL (IIT Madras)

Course code	**MDS-003**				
Course title	**Data Preparation and Preprocessing**				
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	30 Marks				
End Semester Examination	45 Marks				
Total	75 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 9 parts of 1 mark each from all units and remaining eight questions of 9 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.

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.

Unit-IV

Data Integration 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; Preparing datasets for machine learning models; Train-test split; Cross-validation readiness; Reproducible preprocessing workflows.

Suggested Readings:

1. Python for Data Analysis by Wes McKinney, 2nd Edition, O'Reilly Media, 2018.
2. Python Data Science Handbook – Jake VanderPlas, 2016, O'Reilly Media
3. Python for Data Analysis by Wes McKinney, 3rd Edition, O'Reilly Media, 2022.
4. Python Data Science Handbook: Essential Tools for Working with Data by Jake VanderPlas, 1st Edition, O'Reilly Media, 2016.
5. Data Wrangling with Python – Jacqueline Kazil, Katharine Jarmul, 2016, O'Reilly Media.4.
6. Practical Statistics for Data Scientists, Second Edition – Peter Bruce, Andrew Bruce, 2020, O'Reilly Media.
7. Data Science from Scratch: First Principles with Python by Joel Grus, 2nd Edition, O'Reilly Media, 2019.
8. Feature Engineering for Machine Learning: Principles and Techniques for Data Scientists – Alice Zheng, Amanda Casari, 2018, O'Reilly Media.

Useful Video Links:

Unit No.	Topics	Links	Source
Unit-I	Role of data preparation in data science	https://onlinecourses.nptel.ac.in/noc22_cs32/preview	NPTEL (IIT Madras)
	Introduction to Python data science environment	https://www.youtube.com/watch?v=tA42nHmmEKw	NPTEL (IIT Madras)
	Introduction to Numpy library	https://www.youtube.com/watch?v=O0IrNk1qoUE&list=PLZ2ps__7DhBb2cXAu5PevO_mzgS3Fj3Fs&index=90	NPTEL (IIT Madras)
	Why Pandas	https://www.youtube.com/watch?v=HCxhHo8tV4U&list=PLZ2ps__7DhBb2cXAu5PevO_mzgS3Fj3Fs&index=91	NPTEL (IIT Madras)
Unit-II	Data Cleaning with Python	https://www.youtube.com/watch?v=ZX8vmcSTCrc	YouTube (Tech Classes)
	Handling noisy data and outliers	https://www.youtube.com/watch?v=s8wUe49kKMU	NPTEL (IIT Bombay)
Unit-III	Feature Engineering	https://www.youtube.com/watch?v=BdL-cKUG4hE	YouTube (Intellipaat)
	Min-Max & Z-score Techniques	https://www.youtube.com/watch?v=lggqjmQzsGI	YouTube (Gate Smashers)
Unit-IV	Basics of Data Integrations	https://www.youtube.com/watch?v=3_12AZ0CEeo	YouTube (365 Data Science)
	Nonlinear Dimensionality Reduction Techniques -I	https://www.youtube.com/watch?v=841lv79yUUQ	NPTEL(IISc Bengaluru)
	Train, Test, & Validation Sets	https://www.youtube.com/watch?v=ZblqTCFnH-M	YouTube (Greg Hogg)

Course Code	**MDS-L003**				
Course Title	**Data Preparation and Preprocessing 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	10 Marks				
End Semester Practical Examination	15 Marks				
Total	25 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.	**Content**	**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**	**Source**
Load Dataset & Summary	https://colab.research.google.com/drive/1M8xTPtJVcY5UZTZusL6jiqooRBamkYen?usp=sharing	Google Colab
Missing Value Handling	https://colab.research.google.com/drive/1M8xTPtJVcY5UZTZusL6jiqooRBamkYen?usp=sharing	Google Colab
Encode categorical variables	https://colab.research.google.com/drive/1M8xTPtJVcY5UZTZusL6jiqooRBamkYen?usp=sharing	Google Colab

Course code	**MDS-004**				
Course title	**Data Handling and 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	30 Marks				
End Semester Examination	45 Marks				
Total	75 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 9 parts of 1 mark each from all units and remaining eight questions of 9 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 Kirthi Raman, Packt Publishing, 2015.

Useful Video Links:

Unit No.	Topics	Links	Sources
Unit-I	Data Frames in Pandas	https://youtu.be/6DTFIKF8QIg?si=en5tm53K2XQN6Mw9	NPTEL (IIT Madras)
	Data loading	https://youtu.be/On6rLc1l_MU?si=tZvRvW-7ZL2PKaj7	NPTEL (IIT Madras)
	Numpy	https://youtu.be/rjY59WLMK2o?si=q92faGhp3hT69w_X	NPTEL (IIT Madras)
Unit-II	Matplotlib	https://youtu.be/eFByJkA3ti4?si=cJ0ncTkbPsvA2i2p	NPTEL (IIT Madras)
	Plot components: figure, axes	https://youtu.be/eFByJkA3ti4?si=gcSAChRE0sMu_yIv	NPTEL (IIT Madras)
Unit-III	Jointplots & pairplots	https://youtu.be/JhK2qVi5dC4?si=0mVubJza7r5s-6xp	NPTEL (IIT Madras)
	Spider Graph	https://youtu.be/ONtrmxyxTsw?si=xMClNbs2Wb5tjTEZ	NPTEL (IIT Madras)
Unit-IV	Scatter plots	https://youtu.be/eFByJkA3ti4?si=WAMwmAUPQlirnsI1	NPTEL (IIT Madras)

Course Code	**MDS-L004**				
Course Title	**Data Handling and 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	10 Marks				
End Semester Practical Examination	15 Marks				
Total Marks	25 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**	**Source**
Visualize data trends over time using line charts	https://colab.research.google.com/github/ageron/handson-ml2/blob/master/tools_matplotlib.ipynb	Google Colab
Represent proportions and percentages using pie charts and donut charts	https://colab.research.google.com/drive/1NsncQ_M5W5F8Z03nOj713Wjf_eW8k0AQ?usp=sharing	Google Colab
Draw 3D plots using the Plotly library	https://colab.research.google.com/drive/1-luSy55lQQrpNhJ_-W_w__rdaBgtNub0?usp=sharing	Google Colab

Course code	**MDS-005**				
Course title	**Big Data Analytics**				
Scheme and Credits	L	T	P	**Credits**	**Semester-VII**
	3	0	0	**3**	
Course Objectives	The objectives of this course are • To introduce the fundamentals of Big Data, its characteristics, challenges, and the data science process. • To familiarize students with Big Data platforms, data repositories, data ecosystems, and data formats. • To develop the ability to apply Big Data modeling, storage, ingestion, and management techniques for scalable systems. • To enable students to analyze Big Data integration and processing pipelines using appropriate tools and workflow management systems.				
Assessment	30 Marks				
End Semester Examination	45 Marks				
Total	75 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 fundamental concepts of Big Data, its characteristics (Six V), data science process, and foundations of Big Data systems.	Level 1: Remember
CO2	Explain Big Data platforms, data repositories, data types, file formats, and modern data ecosystem components.	Level 2: Understand
CO3	Apply appropriate Big Data models, data storage techniques, data ingestion methods, and processing tools for scalable data management.	Level 3 : Apply
CO4	Analyze Big Data integration and processing pipelines, including data querying, aggregation, analytical operations, and workflow management tools.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 9 parts of 1 mark each from all units and remaining eight questions of 9 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, Data Science: Getting Value out of Big Data, Steps in the Data science process, Foundations for Big Data Systems and Programming, Distributed file systems.

Unit-II

Data Repositories and Big Data Platforms: RDBMS, NoSQL, Data Marts, Data Lakes, ETL, and Data Pipelines, Foundations of 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 and Subhasini Chellappan, 2015, Wiley.
2. Intelligent Data Analysis by Michael Berthold and David J. Hand, 2007, Springer.
3. Big Data and Business Analytics by Jay Liebowitz, 2013, Auerbach Publications (CRC Press).
4. Using R to Unlock the Value of Big Data: Big Data Analytics with Oracle R Enterprise and Oracle R Connector for Hadoop by Tom Plunkett and Mark Hornick, 2013, McGraw-Hill/Osborne Media (Oracle Press).
5. Mining of Massive Datasets by Anand Rajaraman and Jeffrey David Ullman, 2012, Cambridge University Press.
6. Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics by Bill Franks, 2012, John Wiley & Sons.
7. Making Sense of Data by Glenn J. Myatt, 2007, John Wiley & Sons.
8. Big Data Glossary by Pete Warden, 2011, O'Reilly Media.
9. Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses by Michael Minelli, Michele Chambers, and Ambiga Dhiraj, 2013, Wiley Publications.
10. Big Data Analytics: Disruptive Technologies for Changing the Game by Arvind Sathi, 2012, MC Press.
11. Harness the Power of Big Data: The IBM Big Data Platform by Paul Zikopoulos, Dirk DeRoos, Krishnan Parasuraman, Thomas Deutsch, James Giles, and David Corrigan, 2012, Tata McGraw-Hill Publications.

Useful Video Links:

Unit No.	Topics	Links	Source
Unit-I	Introduction to Big Data	https://youtu.be/rvJgArru8dI?si=WKCCX-VosNczfSzj	NPTEL (IIT Kanpur)
	Hadoop Distributed File System	https://youtu.be/0QIv4kk18Kg?si=FxQeaoBlepztA0XK	NPTEL (IIT Kanpur)
Unit-II	NoSQL	https://youtu.be/-s29jUAkg70?si=um-_zk8Xq6wipHEd	NPTEL (IIT Kanpur)
	Data Lakes	https://youtu.be/LxcH6z8TFpI?si=nDW2KBeKh9vGW_FE	YouTube (IBM Technology)
Unit-III	Introduction to Spark (Data operations and scalability)	https://youtu.be/-5yf4vCUsbQ?si=KET1yMZZxsdnCA2f	NPTEL (IIT Kanpur)
	Data Modeling	https://youtu.be/WSNqcYqByFk?si=2JWVZDxJN5jzIPAO	NPTEL (IIT Bombay)
Unit-IV	Big Data Pipeline	https://youtu.be/eDGa095uSyk?si=xYjXNotbYEf0YUgR	YouTube (StudyIQ IAS)
	Big Data Workflow Management System: OOZIE	https://youtu.be/cPLi8l_sehY?si=1lXn6RpHRrgdE7ub	YouTube (CEC)

<table>
<tr><td>Course code</td><td colspan="5">MPDS-006</td></tr>
<tr><td>Course title</td><td colspan="5">Project</td></tr>
<tr><td rowspan="2">Scheme and Credits</td><td>L</td><td>T</td><td>P</td><td>Credits</td><td rowspan="2">Semester-VIII</td></tr>
<tr><td>0</td><td>0</td><td>4</td><td>2</td></tr>
<tr><td>Course Objectives</td><td colspan="5">The objectives of this course are
• To identify an engineering problem through literature review and clearly define project objectives.
• To learn fundamental engineering principles to propose a feasible solution methodology.
• To inculcate skills in project planning, preliminary design, and use of appropriate engineering tools.
• To enhance teamwork, technical documentation, and presentation skills.</td></tr>
<tr><td>Assessment</td><td colspan="5">20 Marks</td></tr>
<tr><td>End Semester Practical Examination</td><td colspan="5">30 Marks</td></tr>
<tr><td>Total Marks</td><td colspan="5">50 Marks</td></tr>
<tr><td>Duration of Exam</td><td colspan="5">03 Hours</td></tr>
</table>

The students expected to take up a project under the guidance of teacher from the college. The Project must be based on **Data Science** problems, which can be extended up to the full semester. The students may be asked to work individually or in a group normally not more than three students in a group (if any large/ big projects occur then strength of students' can be increased as per guide supervision). Viva-voce must be based on the preliminary reports submitted by the students related to the project.

Annexure AC / 5.16

ANNEXURE 4.6(c)

GANGA INSTITUTE OF TECHNOLOGY AND MANAGEMENT, KABLANA (JHAJJAR)

An Autonomous Institute
'A' GRADE ACCREDITED BY NAAC

Scheme of Studies and Examination

For

Minor Degree

in

Artificial Intelligence and Machine Learning

Department of Computer Science and Engineering

(Effective from the Session: 2026-27)

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

Minor Degree
in
Artificial Intelligence and Machine Learning
Offered by the Department of Computer Science and Engineering

Artificial Intelligence and Machine Learning is interdisciplinary fields that integrate computer science, mathematics, statistics, and data analysis to develop intelligent systems capable of learning from data and making decisions with minimal human intervention. With the rapid advancement of digital technologies and the increasing adoption of automation, smart systems, and data-driven solutions across industries, government services, healthcare, finance, and research sectors, the demand for skilled professionals in Artificial Intelligence and Machine Learning has grown significantly. Recognizing their strategic importance in technological advancement and economic development, the government is actively promoting education, research, and innovation in AI and ML technologies. Therefore, universities and higher educational institutions are encouraged to incorporate Artificial Intelligence and Machine Learning into their academic programs.

In view of this, the Department of Computer Science and Engineering has introduced a Minor Degree in "**Artificial Intelligence and Machine Learning**" from the academic session **2026–27**. This program aims to enhance students' employability by providing specialized knowledge and practical skills in areas such as intelligent systems, machine learning algorithms, deep learning, natural language processing, and computer vision—domains that are often not extensively covered in the regular undergraduate curriculum. The program will enable students to develop strong expertise in Artificial Intelligence and Machine Learning and prepare them for diverse career opportunities in this rapidly evolving technological landscape.

This Minor Degree will require earning 20 credits. It will be an addition to the regular undergraduate program, implying that passing or failing it will not affect the results of the regular undergraduate program being pursued by the student. Upon successful completion of the course, a Minor Degree shall be awarded to the candidate. Students enrolled in B.Tech programs shall be eligible to pursue a Minor Degree, as outlined below:

Name of the Minor	B.Tech Program whose students are eligible to opt for Minor Degree
Artificial Intelligence and Machine Learning	All Branches except Computer Science and Engineering, CSE-Artificial Intelligence and Machine Learning and CSE-Data Science

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

Scheme of Studies and Examination

B.Tech Minor Degree in Artificial Intelligence and Machine Learning

w.e.f. 2026-27

Sr. No.	Sem	Course Code	Course Title	Hours per week			Total Load Per Week	Credits	Examination Scheme (Marks)				Exam Duration in H
				Lecture (L)	Tutorial (T)	Lecture (L)			Assessment	End Semester Examination		Total	
										Theory	Practical		
1	III	MAI-001	Mathematics for AI	3	1	0	4	4	40	60		100	3
2	IV	CSE-210B	Artificial Intelligence	3	0	0	3	3	30	45		75	3
3	V	MAI-003	Python for AI	3	0	0	3	3	30	45		75	3
4	V	MAI-L003	Python for AI Lab	0	0	2	2	1	10		15	25	
5	VI	MAI-004	Machine Learning	3	0	0	3	3	30	45		75	3
6	VI	MAI-L004	Machine Learning Lab	0	0	2	2	1	10		15	25	
7	VII	MAI-005	Applied Artificial Intelligence	3	0	0	3	3	30	45		75	3
8	VIII	MP-006	Project	0	0	4	4	2	20		30	50	
Total Credits								**20**				**500**	

Note: To earn the required credits for the award of B. Tech Minor Degree students may choose either:

(i) To enroll in courses offered through NPTEL/MOOCs that must be equivalent to the prescribed courses in the approved scheme, subject to availability in any semester.

OR

(ii) To complete the prescribed courses in the same semester as offered by the department under the approved scheme and curriculum structure.

Course code	**MAI-001**				
Course title	**Mathematics for AI**				
Scheme and Credits	L	T	P	**Credits**	**Semester-III**
	3	1	0	**4**	
Course Objectives	The objectives of this course are • To introduce fundamental probability and statistical concepts required to model uncertainty in Artificial Intelligence. • To explain multivariate probability and statistical inference techniques used in data-driven AI systems. • To present information theory and optimization methods that underpin machine learning and deep learning algorithms. • To enable application of advanced mathematical tools to design, train, and evaluate Artificial Intelligence models.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total	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 fundamental concepts of probability, random variables, statistical measures, and information theory used in Artificial Intelligence.	Level 1: Remember
CO2	Explain multivariate probability, statistical inference, and optimization principles relevant to AI and machine learning models.	Level 2: Understand
CO3	Apply probability distributions, estimation methods, and optimization techniques to solve AI-related computational problems.	Level 3 : Apply
CO4	Analyze AI models using information-theoretic measures, regularization techniques, and statistical evaluation to improve performance and generalization.	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

Probability Theory for Artificial Intelligence: Fundamentals of probability- sample space and events, axioms of probability, conditional probability, Bayes' theorem. Random variables- discrete and continuous cases, probability mass function, probability density function, and cumulative distribution function. Mathematical expectation concepts- mean, variance, standard deviation, moments, covariance, and correlation. Study of standard probability distributions- Bernoulli, Binomial, Poisson, Uniform, and Gaussian distributions, and their relevance in AI systems.

Unit–II

Multivariate Probability and Statistical Inference: Multivariate probability concepts- joint distributions, marginal, conditional distributions, and multivariate Gaussian distribution, Statistical inference fundamentals, sampling

techniques, estimation theory, and the bias–variance tradeoff. Parameter estimation methods- point estimation, Maximum Likelihood Estimation (MLE), Maximum A Posteriori (MAP) estimation, Hypothesis testing concepts- null and alternative hypotheses, confidence intervals, Type I and Type II errors.

Unit–III

Information Theory and Optimization Techniques for AI: Core information theory concepts: information content, entropy, joint and conditional entropy, cross entropy, and Kullback–Leibler (KL) divergence. Optimization fundamentals: formulation of optimization problems, convex sets, convex functions, and their properties. Unconstrained optimization techniques- gradient descent, batch, stochastic, and mini-batch gradient descent, momentum-based methods. Constrained optimization using Lagrange multipliers and Karush–Kuhn–Tucker (KKT) conditions, and regularization techniques including L1 (Lasso), L2 (Ridge), and Elastic Net.

Unit–IV

Advanced Mathematics and Applications in AI: Numerical optimization concepts including numerical stability, condition number, approximation errors, Graph theory fundamentals covering graphs and their types, adjacency matrix, degree matrix, graph Laplacian, Geometry in high-dimensional spaces- metrics, curse of dimensionality, manifold hypothesis, Mathematical foundations of deep learning-Universal Approximation Theorem, loss landscapes, over-parameterization, Applications of probability, statistics, optimization, information theory in AI- Bayesian inference, Naïve Bayes classifier, probabilistic models, training machine learning models, model evaluation, regularization, and avoiding overfitting.

Suggested Readings:

1. Mathematics for Machine Learning by Marc Peter Deisenroth, A. Aldo Faisal, and Cheng Soon Ong, 2019, Cambridge University Press.
2. Deep Learning by Ian Goodfellow, Yoshua Bengio, and Aaron Courville, 2016, MIT Press.
3. Linear Algebra and Its Applications by Gilbert Strang, 2016, Cengage Learning.
4. Probability, Random Variables and Stochastic Processes by Athanasios Papoulis and S. Unnikrishna Pillai, 2002, McGraw-Hill Education.
5. Convex Optimization by Stephen Boyd and Lieven Vandenberghe, 2004, Cambridge University Press.

Useful Video Links:

Unit No.	Topics	Links	Source
Unit-I	Sample space, events, axioms	https://youtu.be/POv_YgCqAv8?si=c5bqoYWFCuU2c7mx	NPEL(IIT Kanpur)
	Random variables, PMF, PDF, CDF	https://www.youtube.com/playlist?list=PLyqSpQzTE6M_JcleDbrVyPnE0PixKs2JE	NPTEL(IIT Tirupati)
	Moments	https://youtu.be/vNNLvowQqoU?si=46OGZxJWxSUYu392	NPTEL(IIT Kharagpur)
Unit-II	Multivariate Gaussian	https://youtu.be/XbA9CmYAfVk?si=d4bNUD3Xuy1eve5q	NPTEL(IIT Madras)
	Bias–variance tradeoff	https://youtu.be/1_8zmpy_Q7w?si=jmOB5OfbujSkvch_	NPTEL(IIT Madras)
	Type I & II errors	https://youtu.be/qqVWgxWn2d4?si=bG4Nq_BVclYT1d8e	NPTEL(IIT Madras)
Unit-III	Convex sets & functions	https://youtu.be/KZPq0bGbqDY?si=ve6tOWLZZmJsHTp2	NPTEL(IIT Bombay)
	Elastic Net, L1	https://youtu.be/sdoSkZRrBZI?si=hf46X2Kj-zb1zilf	NPTEL(IISC Bengaluru)
Unit-IV	Numerical stability, condition number	https://youtu.be/TWAN_T66Cps?si=hLJFP0ZhYR_9djlv	NPTEL (IIT Roorkee)
	Graph Theory	https://youtube.com/playlist?list=PLEAYkSg4uSQ2fXcfrTGZdPuTmv98bnFY5&si=F0ujo6ibJCzlCQYf	NPTEL (IISER Pune)
	Bayesian inference, Naïve Bayes	https://youtu.be/1B_lrrEo5ds?si=vOBgekF_1RikDYwu	NPTEL(IIT Madras)

Course code	**CSE-210B**				
Course title	**Artificial Intelligence**				
Scheme and Credits	L	T	P	**Credits**	**Semester-IV (Common with B. Tech. CSE/AI&ML/DS 4th Semester)**
	3	0	0	**3**	
Course Objectives	The objectives of this course are • To introduce the fundamental concepts, history, and problem-solving nature of artificial intelligence. • To provide an understanding of core AI techniques for search, knowledge representation, reasoning, planning, and learning. • To develop the ability to apply appropriate AI methods to solve representative computational problems. • To familiarize students with modern AI systems, expert systems, neural networks, and emerging trends in artificial intelligence.				
Assessment	30 Marks				
End Semester Examination	45 Marks				
Total	75 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 fundamental concepts of artificial intelligence, problem characteristics, knowledge representation, learning paradigms, and current AI trends.	Level 1: Remember
CO2	Explain search strategies, knowledge representation schemes, reasoning under uncertainty, planning approaches, and learning methods used in artificial intelligence.	Level 2: Understand
CO3	Apply appropriate AI techniques such as search algorithms, logical reasoning, probabilistic methods, and learning models to solve representative AI problems.	Level 3 : Apply
CO4	Analyze AI problems to select suitable problem-solving, reasoning, planning, or learning approaches and evaluate their effectiveness.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 9 parts of 1 mark each from all units and remaining eight questions of 9 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: Definition of AI, History of AI, nature of AI problems, examples of AI problems. **Problem solving by search:** Uninformed Search: Depth First Search (DFS), Breadth First Search(BFS). Informed Search: Best First Search, A*. Local Search: Hill Climbing. Problem Reduction Search: AO*. Population Based Search: Ant Colony Optimization, Genetic Algorithm. Game Playing: MinMax Algorithm, Alpha-Beta Pruning.

Unit-II

Knowledge Representation: Types of Knowledge, Knowledge Representation Techniques/schemes: Propositional Logic, Predicate Logic, Semantic nets, Frames, Knowledge representation issues, Rule based systems.

Unit-III

Reasoning under Uncertainty: Basics of Probability Theory, Probabilistic Reasoning, Bayesian Reasoning, Dempster-Shafer Theory.
Planning: Introduction to Planning, Representation of Planning, Partial-order Planning.

Unit-IV

Learning: Introduction to Learning, Types of Learning: Learning by Induction, Rote Learning, Symbol Based Learning, Identification Trees, Explanation Based Learning, Transformational Analogy, Introduction to Neural Networks, Expert Systems, and Current trends in Artificial Intelligence.

Suggested Readings:

1. Artificial Intelligence: A Modern Approach, Third Edition by Stuart Russell and Peter Norvig, 2010, Pearson Education.
2. Elaine Rich, Kevin Knight, & Shivashankar B Nair, Artificial Intelligence, McGraw Hill, 3rd ed.,2009.
3. Introduction to Artificial Intelligence & Expert Systems, Dan W Patterson, PHI., 2010.
4. Artificial intelligence, Patrick Henry Winston, 1992, Addition Wesley.

Useful Video Links:

Unit No.	Topics	Links
Unit-I	Introduction to AI	https://youtu.be/iF1tOCEXLXY
	DFS, BFS	https://youtu.be/TMLyKcBtHuo
	Hill Climbing	https://youtu.be/ZOvRZ7UJMjk
	A* Algorithm	https://youtu.be/yMcZvZayJUA
Unit-II	Propositional Logic	https://youtu.be/5fZ_RnhvGMQ
	Semantic Nets	https://youtu.be/RTmafl2rzEw
	Rule based System	https://youtu.be/6kRYg1QVcWo
Unit-III	Bayesian Reasoning	https://youtu.be/cMN6ykIYF_U
	Probability Theory	https://nptel.ac.in/courses/117105085
	Partial-order Planning	https://www.youtube.com/watch?v=kyCibTQQQBE
Unit-IV	Introduction to Neural Networks	https://www.youtube.com/watch?v=QlhHqMnd9Wo
	Expert Systems	https://www.youtube.com/watch?v=nE5c5w4aizU

Course code	**MAI-003**				
Course title	**Python for AI**				
Scheme and Credits	L	T	P	**Credits**	**Semester-V**
	3	0	0	**3**	
Course Objectives	The objectives of this course are • To introduce the fundamentals of Python programming, including syntax, data types, control structures, and file handling. • To develop structured programming skills using Python data structures, functions, and recursion. • To familiarize students with numerical and data manipulation libraries such as NumPy and Pandas for handling real-world data. • To enable students to visualize and interpret data effectively using Matplotlib for exploratory and analytical purposes.				
Assessment	30 Marks				
End Semester Examination	45 Marks				
Total	75 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 core Python programming concepts, data structures, and library functionalities.	Level 1: Remember
CO2	Explain the working principles of Python programs, NumPy arrays, Pandas data structures, and visualization components.	Level 2: Understand
CO3	Apply Python, NumPy, Pandas, and Matplotlib to perform data processing, analysis, and visualization tasks.	Level 3 : Apply
CO4	Analyze datasets by selecting appropriate data manipulation techniques and visualization methods to derive 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

Introduction: Installing Python; basic syntax, interactive shell, editing, saving, and running a script; data types; variables, assignments; numerical types; arithmetic operators and expressions; Loops and selection statements, Control statements String manipulations: subscript operator, indexing, slicing a string; text files: reading/writing text and numbers from/to a file; creating and reading a formatted file.

Unit-II

Lists, Tuple, dictionary and Design with functions: Basic list operators, replacing, inserting, removing an element; searching and sorting lists; Tuple: creating tuples, accessing elements, tuple immutability, operations, tuple methods,

tuples vs. lists; dictionary literals, adding, and removing keys, accessing and replacing values; traversing dictionaries. Hiding redundancy, complexity; arguments and return values; Program structure and design. Recursive functions.

Unit-III

Introduction to NumPy: NumPy arrays, Array Indexing and Slicing, Array Operations, Array Manipulation, Linear Algebra with NumPy, Random Number Generation and Statistics.
Introduction to Pandas: Pandas Series, Pandas Data Frames, Data Frame Indexing and Selection, Data Cleaning and Pre-processing, Data Manipulation, Group by Operations, Merging, Joining, and Concatenating Data Frames, Input/output Operations.

Unit-IV

Matplotlib: Overview of Data Visualization in Python, What is Matplotlib? Features and Advantages, Matplotlib Architecture, Installation and Setup, Importing Matplotlib, Basic plotting concepts, Statistical & Categorical Plots (Bar Charts (Vertical and Horizontal, Histograms, Pie Charts, Scatter Plots, Error Bars), Advanced Plot Customization, Plotting with NumPy arrays, Plotting with Pandas DataFrames, Time series visualization, Handling large datasets, 3D Plotting, Applications of Matplotlib.

Suggested Readings:

1. Fundamentals of Python: First Programs by Kenneth Lambert, Course Technology, Cengage Learning, 2012.
2. Introduction to Computer Science using Python: A Computational Problem-Solving by Dierbach, C. Focus, John Wiley & Sons, 2012.
3. Python – The Complete Reference by Brown, M. C., McGraw Hill Education.
4. Core Python Programming by Rao, R. N., Dream Tech Press.
5. Python Programming: Using Problem Solving Approach by Thareja, R., Oxford University Press.
6. Python Programming by Sridhar, S., Indumathi, J., & Hariharan, V. M., Pearson Education.
7. Python for Data Analysis by Wes McKinney, 3rd Edition, O'Reilly Media, 2022.
8. Python Data Science Handbook by Jake VanderPlas, O'Reilly Media.

Useful Video Links:

Unit No.	Topics	Links	Source
Unit-I	Variables and Input Statement	https://youtu.be/ruQb8jzkGyQ	NPTEL(IIT Madras)
	Data Types, Operators and Expressions	https://youtu.be/8n4MbjuDBu4	NPTEL(IIT Madras)
	Introduction to for loop	https://youtu.be/lvXuQ_x7EsI	NPTEL(IIT Madras)
	Introduction to while loop	https://youtu.be/KTvVNN7ia8o	NPTEL(IIT Madras)
	Reading and Writing to a File	https://www.youtube.com/watch?v=rYLJaAdgLhI	NPTEL(IIT Madras)
	Creating and reading a formatted file	https://www.youtube.com/watch?v=NBTSDtBy5bs	NPTEL(IIT Roorkee)
Unit-II	List operators	https://youtu.be/jMShssechMI	NPTEL(IIT Madras)
	Searching and sorting lists	https://youtu.be/4OxBvBXon5w	NPTEL(IIT Delhi)
	Tuples	https://youtu.be/mzx74TdGYbg	NPTEL(IIT Madras)
	Dictionary literals, adding and removing elements	https://youtu.be/Aj7PwBI99A4	NPTEL(IIT Ropar)
	Recursive functions	https://youtu.be/Uo7RyqJaaRQ	NPTEL(IIT Ropar)
Unit-III	NumPy	https://youtu.be/pEyizxN3K84?si=mMhOKJ5eI-sEwuSG	NPTEL(IIT Madras)
	Pandas	https://youtu.be/V-PozDJ7c1A?si=4o2rCAP_hJuUugE8	NPTEL(IIT Madras)
Unit-IV	Matplotlib	https://youtu.be/eFByJkA3ti4?si=sm1gY8G0rCRF6c6k	NPTEL(IIT Madras)
	Advanced Plot Customization	https://youtu.be/YxchP5MziC4?si=VqvKBbar-gT9EZxR	YouTube (Geo-Python)
	3D Plotting	https://youtu.be/7e3BGIXwQvo?si=5HK1zkvL5XwwR-bi	You Tube (Finxter AI Nuggets)

Course Code	**MAI-L003**				
Course Title	**Python for AI 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 using core language constructs and file handling. ● To develop the ability to apply data structures and modular programming for problem solving. ● To provide hands-on experience with NumPy and Pandas for data manipulation and analysis. ● To train students in visualizing data effectively using Matplotlib for analytical insights.				
Assessment	10 Marks				
End Semester Practical Examination	15 Marks				
Total Marks	25 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 syntax, control structures, string operations, and file handling mechanisms of Python through guided laboratory exercises.	Level 2: Understand
CO2	Develop Python programs using lists, tuples, dictionaries, and functions (including recursion) to solve structured computational problems.	Level 3: Apply
CO3	Apply NumPy and Pandas libraries to perform array-based computation, data cleaning, manipulation, and basic statistical analysis on real-world datasets.	Level 3: Apply
CO4	Analyze datasets and interpret results by designing appropriate 2D/3D visualizations using Matplotlib with customized and optimized plots.	Level 4: Analyze

List of Experiments

Sr. No.	**Content**	**COs**
1	Study the basic features and installation of Python.	CO1
2	Write a Python program to compute the G.C.D. of two numbers.	CO1
3	Write a Python program to find the square root of a number.	CO1
4	Write a Python program to find the power of a number.	CO1
5	Write a Python program to find the maximum in a list of numbers.	CO2
6	Write a Python program to implement linear search and binary search in a list.	CO2

7	Write a Python program to sort the element using selection sort, insertion sort and merge sort	CO2
8	Write a Python program to compute first “n” prime numbers	CO2
9	Write a Python program to find the most frequent word in a text file.	CO2
10	Write a Python program to create and perform operations on arrays using NumPy	CO3
11	Write a Python program to apply Pandas for manipulating a dataset and performing grouped statistical operations.	CO3
12	Write a program in Python to create bar charts, histograms, pie charts, and scatter plots.	CO4
13	Write a program in Python to plot data using NumPy arrays.	CO4
14	Write a program in Python to visualize data using Pandas DataFrame.	CO4
15	Write a program in Python to create a 3D plot using Matplotlib.	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	Source
Loops in Python	https://python-iitk.vlabs.ac.in/exp/loops/	Virtual Labs
File Handling in Python	https://python-iitk.vlabs.ac.in/exp/file-operators/index.html	Virtual Labs
List, Dictionary in Python	http://python-iiith.vlabs.ac.in/exp/complex-datatypes/index.html	Virtual Labs

Course code	**MAI-004**				
Course title	**Machine Learning**				
Scheme and Credits	L	T	P	**Credits**	**Semester-VI**
	3	0	0	**3**	
Course Objectives	The objectives of this course are • To introduce the fundamental concepts, terminology, and evolution of Machine Learning along with its need and applications. • To familiarize students with the Machine Learning life cycle, data representation methods, and preprocessing techniques. • To develop an understanding of supervised and unsupervised learning paradigms and commonly used Machine Learning algorithms. • To enable students to analyze learning outcomes using appropriate performance evaluation metrics and error measures.				
Assessment	30 Marks				
End Semester Examination	45 Marks				
Total	75 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 fundamental concepts, terminology, and classifications of Machine Learning.	Level 1: Remember
CO2	Explain the Machine Learning life cycle, data representation methods, and working principles of learning algorithms.	Level 2: Understand
CO3	Apply suitable preprocessing techniques and Machine Learning algorithms to basic real-world datasets.	Level 3 : Apply
CO4	Analyze Machine Learning models by comparing algorithms and interpreting performance metrics.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 9 parts of 1 mark each from all units and remaining eight questions of 9 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 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 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 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.

Unit-IV

Unsupervised Learning 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 Ethem Alpaydin, Prentice Hall of India, 2006.
2. The Elements of Statistical Learning: Data Mining, Inference, and Prediction (2nd Edition) by Trevor Hastie, Robert Tibshirani, and Jerome Friedman, Springer, 2009.
3. Pattern Recognition and Machine Learning by Christopher M. Bishop, Springer, 2010.
4. Pattern Classification by Richard O. Duda, Peter E. Hart, and David G. Stork, John Wiley & Sons, 2012.
5. Neural Networks and Learning Machines by Simon O. Haykin, Pearson Education, 2016.

Useful Video Links:

Unit No.	Topics	Links	Source
Unit-I	Definition, History, Features of ML	https://youtu.be/oX0sfqHsGMI?si=HmvFRlnXHS2mxsdt	NPTEL (IIIT-Delhi)
	Types of ML	https://youtu.be/fC7V8QsPBec?si=C6SFLiFetMmzjhv1	NPTEL (IIT-Madras)
Unit-II	Principal Component Analysis	https://youtu.be/hkCT-6KJAK0?si=REHs_XXvLh4NS4OJ	NPTEL(IIT Kharagpur)
	Dimensionality Reduction	https://youtu.be/0P9gUYQ38cI?si=gKuCjKu7iIUUJjZB	NPTEL(IISc Bangalore
Unit-III	Supervised Learning	https://youtu.be/OTAR0kT1swg?si=-uIrst7xSFi_0Gk-	NPTEL (IIT-Madras)
	Support Vector Machines	https://youtu.be/JUR6m7-jXaY?si=mnqq8YOO_k79zU9G	NPTEL (IIT-Madras)
Unit-IV	Bagging	https://youtu.be/enD2BvWSukI?si=5XRVXWkqHcMUqOkr	NPTEL (IIT-Madras)
	Boosting	https://youtu.be/i4OvvmRIz4A?si=-LiawZoaMyH5rZry	NPTEL (IIT-Madras)

<table>
<tr><td>Course Code</td><td colspan="5">MAI-L004</td></tr>
<tr><td>Course Title</td><td colspan="5">Machine Learning Lab</td></tr>
<tr><td rowspan="2">Scheme and Credits</td><td>L</td><td>T</td><td>P</td><td>Credits</td><td rowspan="2">Semester-VI</td></tr>
<tr><td>0</td><td>0</td><td>2</td><td>1</td></tr>
<tr><td>Course Objectives</td><td colspan="5">The objectives of this course are
To provide hands-on exposure to fundamental concepts and workflow of Machine Learning.
To enable students to preprocess, represent, and transform datasets suitable for Machine Learning tasks.
To develop the ability to implement supervised and unsupervised Machine Learning algorithms using Python.
To train students in comparing, and analyzing Machine Learning models using appropriate performance metrics.</td></tr>
<tr><td>Assessment</td><td colspan="5">10 Marks</td></tr>
<tr><td>End Semester Practical Examination</td><td colspan="5">15 Marks</td></tr>
<tr><td>Total</td><td colspan="5">25 Marks</td></tr>
<tr><td>Duration of Exam</td><td colspan="5">03 Hours</td></tr>
</table>

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

COs	Skills Demonstrated	RBT Level
CO1	Explain the basic concepts, workflow, and types of Machine Learning through guided laboratory demonstrations and experiments.	Level 2: Understand
CO2	Implement data preprocessing techniques and dimensionality reduction methods such as PCA for Machine Learning tasks.	Level 3: Apply
CO3	Apply supervised learning algorithms to build predictive models using Python-based Machine Learning libraries.	Level 3: Apply
CO4	Analyze and evaluate Machine Learning models using appropriate performance metrics and error distribution techniques.	Level 4: Analyze

List of Experiments

Sr. No.	Content	COs
1	Study the basic concepts, applications, and life cycle of Machine Learning using Python libraries.	CO1
2	Write a Python program to represent a dataset using row vectors, column vectors, and matrix representation.	CO2
3	Write a Python program to perform feature normalization and column standardization on a dataset.	CO2
4	Write a Python program to compute mean, covariance matrix, and visualize data variance.	CO2

5	Write a Python program to implement Principal Component Analysis (PCA) for dimensionality reduction.	CO2
6	Write a Python program to implement k-Nearest Neighbours (k-NN) classification algorithm.	CO3
7	Write a Python program to implement Naïve Bayes classifier for a given dataset.	CO3
8	Write a Python program to implement Decision Tree classification and visualize the tree.	CO3
9	Write a Python program to implement Linear Regression and Logistic Regression models.	CO3
10	Write a Python program to implement Support Vector Machine (SVM) for classification.	CO3
11	Write a Python program to implement K-Means clustering and visualize clusters.	CO3
12	Write a Python program to implement ensemble techniques such as Bagging, Boosting, and Random Forests.	CO3
13	Write a Python program to evaluate classification models using confusion matrix, accuracy, precision, recall, and F1-score.	CO4
14	Write a Python program to plot ROC curve and compute AUC for a classification model.	CO4
15	Write a Python program to analyze model errors using MAD and error distribution plots.	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	Source
Dataset Representation using rows and columns	https://colab.research.google.com/drive/186nx47CNlqGDEkpshA04dwT6lq9gQ9Q5?usp=sharing	Google Colab
Decion Tree Classification	https://colab.research.google.com/drive/1wJBt5QZFRx3cjXtyywvvwDuyZzs1xj9k?usp=sharing	Google Colab
K-Means clustering.ipynb	https://colab.research.google.com/drive/1Yb1fMvzu1trKUeXVAf9XV00geS-yLyUO?usp=sharing	Google Colab

Course code	**MAI-005**				
Course title	**Applied Artificial Intelligence**				
Scheme and Credits	L	T	P	**Credits**	**Semester-VII**
	3	0	0	**3**	
Course Objectives	The objectives of this course are • To introduce core concepts and applications of Applied Artificial Intelligence. • To explain methods for processing text, images, temporal data, and user preferences. • To apply AI models for real-world problem solving. • To analyze the effectiveness and challenges of AI techniques.				
Assessment	30 Marks				
End Semester Examination	45 Marks				
Total	75 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 fundamental concepts and challenges in Applied Artificial Intelligence.	Level 1: Remember
CO2	Explain the principles and techniques used in NLP, Computer Vision, Time Series, and Recommendation Systems.	Level 2: Understand
CO3	Apply suitable AI models to text, image, forecasting, and recommendation problems.	Level 3 : Apply
CO4	Analyze AI solutions based on performance, suitability, and limitations.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 9 parts of 1 mark each from all units and remaining eight questions of 9 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 NLP: Overview, scope, and evolution of Natural Language Processing, NLP in Artificial Intelligence, Challenges in NLP.
Linguistic Foundations for NLP: Lexical Analysis, Morphological Analysis, Syntactic Analysis (Parsing), Semantic Analysis, Discourse Analysis, Pragmatic Analysis, Text Processing and Normalization, Introduction to NLP Tools and Libraries.

Unit-II

Introduction to Computer Vision: Overview of Computer Vision and Image Processing, Applications of Computer Vision.
Image Representation: Digital image representation, Image types and formats, Color models (RGB, Grayscale, HSV), Image Preprocessing and Enhancement, Feature Extraction and Detection, Image Classification and Recognition.

Unit-III

Introduction to Time Series: Definition and characteristics of time series data, Applications of time series analysis, Components of Time Series, Time Series Visualization and Preprocessing.
Classical Time Series Models: Auto-Regressive (AR) models, Moving Average (MA) models, ARIMA models, Seasonal ARIMA (SARIMA).
Forecasting Technique: Model selection, Forecast accuracy measures, Applications of time series forecasting.

Unit-IV

Recommendation Systems: Introduction to Recommendation Systems, Need and importance of recommendation systems, Real-world motivation and examples.
Types of Recommendation Systems: Content-Based Recommendation Systems, Collaborative Filtering, Knowledge-Based Systems .
Recommendation Techniques: User-based and Item-based Collaborative Filtering, Matrix Factorization techniques, Hybrid Recommendation Systems, Evaluation and Challenges.

Suggested Readings:

1. Computer Vision: Algorithms and Applications by Richard Szeliski, 2011.
2. Natural Language Understanding by James Allen, 1994.
3. Introduction to Time Series and Forecasting by Peter J. Brockwell & Richard A. Davis, 2016.
4. Forecasting: Principles and Practice by Rob J. Hyndman & George Athanasopoulos, 2021.
5. Recommender Systems Handbook by Francesco Ricci, Lior Rokach & Bracha Shapira, 2022.
6. Recommender Systems: An Introduction by Dietmar Jannach et al., 2011.
7. Introduction to Natural Language Processing by Jacob Eisenstein, 2019.

Useful Video Links

Unit No.	Topics	Links	Source
Unit-I	Introduction to NLP	https://youtu.be/XRpJMxLaLeA?si=DCvumrsBSVhGEViG	NPTEL (IIT Bengaluru)
	Text Processing	https://youtu.be/7ok49o24SDw?si=QU0TmC5422oiz6us	NPTEL (IIT Kharagpur)
Unit-II	Image Representation	https://youtu.be/a4yd0Au8QLg?si=R4mqSUssVHgNG6Mz	NPTEL (IIT Delhi)
	Colour Image Processing	https://www.youtube.com/watch?v=svgZodJgKaU	NPTEL (IIT Kharagpur)
Unit-III	Introduction to Time Series	https://youtu.be/bc_7XnEt7TU?si=viOrGSvAS5kAZKNR	NPTEL (IIT Madras)
	ARIMA Models	https://www.youtube.com/watch?v=dXND1OEBABI	YouTube (Aric LaBarr)
Unit-IV	Collaborative Filtering	https://youtu.be/h9gpufJFF-0?si=wo_FnVDL19wSqSVA	Stanford University
	Introduction to Recommendation Systems	https://youtu.be/1JRrCEgiyHM?si=WPTsJajCQDm_qgye	Stanford University

<table>
<tr><td>Course code</td><td colspan="5">MP-006</td></tr>
<tr><td>Course title</td><td colspan="5">Project</td></tr>
<tr><td rowspan="2">Scheme and Credits</td><td>L</td><td>T</td><td>P</td><td>Credits</td><td rowspan="2">Semester-VIII</td></tr>
<tr><td>0</td><td>0</td><td>4</td><td>2</td></tr>
<tr><td>Course Objectives</td><td colspan="5">The objectives of this course are
To identify an engineering problem through literature review and clearly define project objectives.
To learn fundamental engineering principles to propose a feasible solution methodology.
To inculcate skills in project planning, preliminary design, and use of appropriate engineering tools.
To enhance teamwork, technical documentation, and presentation skills.</td></tr>
<tr><td>Assessment</td><td colspan="5">20 Marks</td></tr>
<tr><td>End Semester Practical Examination</td><td colspan="5">30 Marks</td></tr>
<tr><td>Total</td><td colspan="5">50 Marks</td></tr>
<tr><td>Duration of Exam</td><td colspan="5">03 Hours</td></tr>
</table>

The students expected to take up a project under the guidance of teacher from the college. The Project must be based on **Artificial Intelligence and Machine Learning** problems, which can be extended up to the full semester. The students may be asked to work individually or in a group normally not more than three students in a group (if any large/ big projects occur then strength of students' can be increased as per guide supervision). Viva-voce must be based on the preliminary reports submitted by the students related to the project.