Shirpur Education Society's

R. C. Patel Institute of Technology, Shirpur

(An Autonomous Institute)

Course Structure and Syllabus

Third Year B. Tech

Computer Science and Engineering (Data Science)

With effect from Year 2025-26

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

Third Year B. Tech Computer Science and Engineering (Data Science) Semester-V (w.e.f. 2025-26)

Sr	Course Category	Course Code	Course Title	Teaching Scheme			Evaluation Scheme					Total	Credit	
							Continuous Assessment (CA)							
							TA	Term Test 1 (TT1)	Term Test 2 (TT2)	Average of (TT1 & TT2)	ESE			
				L	T	P	[A]			[B]	[C]	[A+B+C]		
1	PC	RCP23DCPC501	Machine Learning-II(Deep Learning)	3			25	15	15	15	60	100	3	4
	PC	RCP23DLPC501	Machine Learning-II Laboratory			2	25				25	50	1	
2	PC	RCP23DCPC502	Design and Analysis of Algorithms	3			25	15	15	15	60	100	3	4
	PC	RCP23DLPC502	Design and Analysis of Algorithms Laboratory			2	25				25	50	1	
3	PC	RCP23DCPC503	Intelligent Systems	2			25	15	15	15	60	100	2	3
	PC	RCP23DLPC503	Intelligent Systems Laboratory			2	25					25	1	
4@	PE	RCP23DCPE511	Recommender Systems	3			25	15	15	15	60	100	3	4
		RCP23DLPE511	Recommender Systems Laboratory			2	25					25	1	
		RCP23DCPE512	Soft Computing	3			25	15	15	15	60	100	3	
		RCP23DLPE512	Soft Computing Laboratory			2	25					25	1	
		RCP23DCPE513	Social Network Analysis	3			25	15	15	15	60	100	3	
		RCP23DLPE513	Social Network Analysis Laboratory			2	25					25	1	
		RCP23DCPE514	Cloud Computing and Security	3			25	15	15	15	60	100	3	
		RCP23DLPE514	Cloud Computing and Security Laboratory			2	25					25	1	
5	MD	RCP23DCMD501	Computer Communication and Networks	3			25	15	15	15	60	100	3	4
	MD	RCP23DLMD501	Computer Communication and Networks Laboratory			2	25				25	50	1	
6#	OE	RCP23OLOE501	DevOps Laboratory			4	50					50	2	2
		RCP23OLOE502	Advanced Java Laboratory			4	50					50	2	
		RCP23OLOE503	Advanced Database Laboratory			4	50					50	2	
7	SC	RCP23IPSC501	Semester Project-III			2	25				25	50	1	1
8	HS	RCP23ICHSX07	Constitution of India	1									Audit Course	
			Total	15		16	325			75	400	800	22	

@Any 1 Programme Elective Course
#Any 1 Open Elective Laboratory

Prepared by:
Dr. P. S. Sanjekar

Checked by:
Prof. S. P. Salunkhe

Prof. Dr. U. M. Patil
BOS Chairman

Prof. S. P. Shukla
C.O.E.

Prof. Dr. P. J. Deore
Dean Academics/Dy. Director

Prof. Dr. J. B. Patil
Director

R. C. Patel Institute of Technology, Shirpur
SES
Autonomous

Program: B.Tech in Computer Science and Engineering (Data Science)	T. Y. B.Tech	Semester: V
Machine Learning-II(Deep Learning) (RCP23DCPC501)		
Machine Learning-II Laboratory (RCP23DLPC501)		

Prerequisite: Linear Algebra, Calculus, Probability, Statistics and Machine Learning Basics.

Course Objective(s):

1. To introduce students with the fundamental concepts of artificial neural network and different learning algorithms: supervised and unsupervised neural networks.
2. To expose Deep Network based methods to solve real world complex problems.
3. Develop in-depth understanding of the Transfer Learning, its key components, challenges and Applications.

Course Outcomes:

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

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Analyze different neural network architectures and their learning algorithms.	L4	Analyze
CO2	Build solution using appropriate neural network and deep network models.	L6	Create
CO3	Analyze optimization strategies and regularization methods to enhance deep learning model training.	L4	Analyze
CO4	Evaluate and implement transfer learning techniques across various applications.	L5	Evaluate

Machine Learning-II(Deep Learning) (RCP23DCPC501) Course Contents

Unit-I — 07 Hrs.

Introduction to Artificial Neural Learning:

Fundamental concepts of biological Neural Networks, NN Architectures, Important terminologies of ANN: Activation functions: (Sigmoid, Tanh, and ReLU, Leaky ReLU, GELU, Swish, ELU), weights, bias, threshold, learning rate, McCulloch Pitts Neuron: Theory and Architecture; Linear separability; Hebb Network: Theory and Algorithm.

Unit-II — 06 Hrs.

Supervised Learning Networks:

Perceptron: Representational power of Perceptron, The Perceptron Training Rule, Delta Rule; Multilayer Networks: Representational Power of Feedforward Networks; Backpropagation Algorithm: Convergence and local minima, Hypothesis space search and Inductive Bias, Generalization, Vanishing & Exploding Gradients.

Unit-III — 05 Hrs.

Optimization for Training Deep Models:

Challenges in Neural Network Optimization, Basic Algorithms, Parameter Initialization Strategies. Optimizers: Gradient Descent, Stochastic Gradient Descent, SGD with Momentum, RMSProp, Adam.

Regularization for Deep Learning: Parameter Norm Penalties, Dataset Augmentation, Noise Robustness, Early Stooping, Sparse Representation, Dropout and Batch Normalization.

Unit-IV — 06 Hrs.

Convolutional Networks:

The Convolution Operation, sparse interactions, parameter sharing, Dataset Augmentation, Pooling, Variations of Heatmaps. Variants of Basic Convolution Function, Efficient Convolution Algorithms (AlexNet, LeNet-5, VGG, InceptionNet, ResNet, MobileNet (for lightweight models)), Attention Mechanisms in CNNs (Squeeze-and-Excitation (SE) Networks, CBAM).

Unit-V — 07 Hrs.

Unsupervised Learning Networks: Kohonen Self-Organizing Feature Maps – architecture, training algorithm, Kohonen Self- Organizing Motor Map.

Autoencoders: Sparse Autoencoder, Undercomplete Autoencoders, Regularized Autoencoders, Denoising Autoencoders, Applications of Autoencoders. Variational Autoencoders (VAEs), Linear [illegible]

tor Methods such as Probabilistic PCA and Factor Analysis, Independent Component Analysis, Deep Embedded Clustering (DEC).

Self-Supervised Learning: Contrastive learning (SimCLR, CURL), Instance Discrimination Method.

Unit-VI 08 Hrs.

Transfer Learning:

Fundamental of Transfer Learning, Freezing, Fine-tuning. Transfer Learning Strategies: Inductive Transfer.

Types of Deep Transfer Learning: Domain Adaptation, Domain Confusion, One-shot Learning, Zero-shot Learning.

Types of Transferable Components: Instance transfer, Feature-representation transfer, Parameter transfer.

Transfer Learning Challenges: Negative Transfer, Transfer Bounds.

Model: CLIP, SAM (Segment Anything Model).

Applications: Transfer learning for NLP/ Audio/ Speech/ Computer Vision

Machine Learning-II Laboratory (RCP23DLPC501)

List of Laboratory Experiments

Suggested Experiments: (Any 09)

1. Implement Boolean gates using perceptron.
2. Implement backpropagation algorithm from scratch.
3. Monitoring and evaluating deep learning models using Tensorflow and Keras.
4. Evaluate and analyze Prediction performance using appropriate optimizers for deep learning models.
5. Building CNN models for image categorization. (medical image analysis).
6. Implement Graph Convolutional Networks (GCN) for Node Classification and Link Prediction.
7. Implement contrastive learning on unlabeled data.
8. Anomaly detection using Self-Organizing Network.
9. Compare the performance of PCA and Autoencoders on a given dataset.
10. Transfer Learning with Pre-trained CNN model as a Feature Extractor for Image Classification with a Data Availability Constraint.
11. Zero-shot Image Classification using CLIP & Few-shot Learning with DINO.

Any other experiment based on syllabus may be included which would help the learner to understand topic/concept.

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

Text Books:

1. Christopher M. Bishop, Hugh Bishop, "Deep Learning Foundations and concept", Springer Cham. 1st Edition, 2023.
2. S. N. Sivanandam and S. N. Deepa, "Introduction to Soft Computing", 3rd Edition, Wiley India Publications, 2018.
3. Ian Goodfellow and Yoshua Bengio and Aaron Courville, "Deep Learning", An MIT Press, 2016.
4. Simon Haykin, "Neural Networks and Learning Machines", Pearson Prentice Hall, 3rd Edition, 2010.

Reference Books:

1. François Chollet, "Deep Learning with Python", Manning Publication, 1st Edition, 2021.
2. Josh Patterson, Adam Gibson, "Deep Learning: A Practitioner's Approach", O'Reilly Publication, 2017.
3. Andrew W. Trask, Grokking, "Deep Learning", Manning Publication, 2019.
4. John D. Kelleher, "Deep Learning", MIT Press Essential Knowledge series, 2019.

Web Links:

1. Learning Rule: http://vlabs.iitb.ac.in/vlabs-dev/labs/machine_learning/labs/explist.php
2. ANN Virtual Lab: http://cse22-iiith.vlabs.ac.in/List%20of%20experiments.html
3. Deep Learning: https://vlab.spit.ac.in/ai/#/experiments
4. NPTEL Course: Deep Learning Part 1: https://onlinecourses.nptel.ac.in/noc19_cs85/preview

Program: Computer Science & Engineering (Data Science)	T. Y. B.Tech	Semester: V
Design and Analysis of Algorithms (RCP23DCPC502)		
Design and Analysis of Algorithms Laboratory (RCP23DLPC502)		

Prerequisite: Computer Programming, Data structures

Course Objective(s):

1. To provide mathematical approach for Analysis of Algorithms.
2. To introduce important algorithmic design paradigms and approaches for effective problem solving.
3. To introduce the concepts of tractable and intractable problems and the classes P, NP and NP-complete problems.

Course Outcomes:

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

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Analyze the performance of algorithms by solving recurrence relations with various methods.	L4	Analyze
CO2	Solve the problem using appropriate algorithmic design techniques.	L3	Apply
CO3	Able to prove that certain problems are NP-Complete.	L3	Apply

Design and Analysis of Algorithms (RCP23DCPC502) Course Contents

Unit-I — 06 Hrs.

Introduction:

Methods for solving recurrence relations using tree, substitution, master method Problem Solving using divide and conquer algorithm: – Binary search, Quick sort, Merge Sort, Randomized Quick Sort, Analysis of Binary search, quick sort and merge sort.

Unit-II — 06 Hrs.

Graph and Tree Algorithms:

B Tree: Properties of B Tree, Insertion, Deletion and Search Operation on B Tree, B+ Tree: Properties of B+ Tree, Insertion, Deletion and Search Operation on B+ Tree, RB Tree: Properties of RB Tree, Insertion, Deletion and Search Operation on RB Tree, Topological sorting, Applications.

Unit-III — 06 Hrs.

Greedy Method:

Introduction, control abstraction, Problem solving using - fractional knapsack problem, activity selection problem, job sequencing with deadline, Minimum Spanning trees (Kruskal's algorithm, Prim's algorithm), Single source shortest path (Dijkstra's algorithm), coin change problem.

Unit-IV — 10 Hrs.

Dynamic Programming:

Introduction, principle of optimality, Components of dynamic programming, characteristics of dynamic programming, Fibonacci problem, Coin Changing problem, 0/1 knapsack (table and set method), All pairs shortest paths (Floyd Warshall Algorithm), Single source shortest path (Bellman-Ford Algorithm), Matrix Chain Multiplication, Travelling salesperson problem, Longest Common Subsequence (LCS).

Unit-V — 06 Hrs.

Backtracking:

Introduction, Basics of backtracking, N–queen problem, Sum of subsets, Graph coloring, Hamiltonian cycles Generating permutation.

Branch-and-Bound:

Introduction, Control abstraction -LC BB, FIFO BB, LIFO BB, 15 Puzzle problem, 0/1 Knapsack problem, Job Sequencing with Deadline.

Unit-VI 05 Hrs.

Basics of Computational Complexity:

Complexity classes: The class P and NP, Polynomial reduction, NP Completeness Problem, NP-Hard Problems, NP Completeness problem using Travelling Salesman problem (TSP), Approximation algorithm using TSP.

Design and Analysis of Algorithms Laboratory (RCP23DLPC502)

List of Laboratory Experiments

Suggested Experiments:(Any 10)

1. Implementation of randomized quick sort.
2. Implementation of minimum spanning tree algorithm – Prim's and Kruskal's using greedy approach.
3. Fractional Knapsack implementation using greedy approach.
4. Implementation of Activity selection using greedy approach.
5. Implementation of job sequencing with deadline using greedy approach.
6. Implementation of Single source shortest path (Dijkstra's algorithm)
7. Implementation of Bellman Ford algorithm using Dynamic programming
8. Implementation of Longest Common Subsequence algorithm using Dynamic programming.
9. Implementation of Travelling Salesperson problem using Dynamic programming.
10. Implementation of multistage graphs/ all pair shortest path using dynamic programming.
11. Implementation of N-queen problem using Backtracking.
12. Given an integer array num of 2n integers, group these integers into n pairs (a1, b1), (a2, b2), ..., (an, bn) such that the sum of min (ai, bi) for all i is maximized. Return the maximized sum. (Using LeetCode Platform)
13. Determine if a 9 x 9 Sudoku board is valid. Only the filled cells need to be validated according to the following rules:
    1. Each row must contain the digits 1-9 without repetition.
    2. Each column must contain the digits 1-9 without repetition.
    3. Each of the nine 3 x 3 sub-boxes of the grid must contain the digits 1-9 without repetition.

14. Given an m x n grid of characters' board and a string word, return true if word exists in the grid. The word can be constructed from letters of sequentially adjacent cells, where adjacent cells are horizontally or vertically neighboring. The same letter cell may not be used more than once.

15. Given an array prices where prices[i] is the price of a given stock on the ith day. You want to maximize your profit by choosing a single day to buy one stock and choosing a different day in the future to sell that stock.Return the maximum profit you can achieve from this transaction. If you cannot achieve any profit, return 0.

16. Knuth-Morris-Pratt (KMP) String Matching

17. Implementation of Naive String Matching Algorithm string matching algorithm.

18. Implementation of Selection Sort.

19. Implementation of Bubble Sort.

20. Implement a program to merge two sorted arrays.

21. Implementation of Merge sort algorithm.

22. Implementation of quick sort algorithm.

23. Implementation of Sequential Search method.

24. Implementation of Binary Search method.

25. Multiplying two large integers

26. MIN MAX- Linear Approach

27. MIN MAX- Divide and Conquer Approach

28. Implementation of Strassen's Matrix Multiplication.

29. Implementation of Job Sequencing Problem with Deadlines.

30. Implementation of Job Scheduling.

31. Implement a program for Divide and Conquer Multiplication of two arrays.

32. Implement a program to perform Multiplication of Two Matrices.

33. Road Decoration: Australia and New Zealand have started working on preparation for the World Cup 2015. There are N important venues (like hotels and stadiums) in the city. Out of these important venues, there is one central location where the opening and closing ceremony will be held. There is an existing network of bidirectional roads connecting these venues. The organizing committee has planned to decorate some of these roads that will be used for commuting. They

have decided to choose the roads to decorate such that there is exactly one decorated path to all the venues from the central location. New Zealand is supposed to decorate these roads and Australia has taken up the responsibility of providing transportation. Only decorated roads can be used for transportation. Australia wanted to save fuel costs, and so they wanted to choose the decorated roads to minimize the total sum of distances to all venues from the central location. However, New Zealand had their own plans to minimize decoration cost by choosing the decorated roads such that the sum of the length of the chosen roads will be minimized. To prevent a fight breaking out between these two rivals before they even step on to the field, you have to help them by reporting if there is a solution in which the two rivals could choose the same set of roads while satisfying their respective constraints.

34. Fullmetal Alchemist: After completing the preliminary tests, Full Metal now faces his final exam. Captain Mustang gives him an n*m grid of letters. He defined distance between two rows of the grid as the largest absolute difference between letters in the same column. Full Metal is assigned to mark all the rows. The cost of marking the first row of his choice is zero. Thereafter the cost of marking each row is equal to the distance of the row (being marked) from any one of the previously marked rows. Help Full Metal to determine the least value of the largest cost of marking a row.

35. Implementation of Huffman Algorithm.

36. Implementation of 0/1 Knapsack problem.

37. Implementation of Optimal Binary Search Trees.

38. Implementation of Optimal Binary Search Trees: You are building a Binary Search Tree consisting of values 1,2,..N that would require the minimum number of operations. You are already provided queries given as an array F of length N - Fi stores the number of search queries asked for value i. Output the minimum number of comparisons that would be required to process all the queries.

39. Implementation of Travelling Salesperson Problem (TSP) using Dynamic Programming.

40. Implementation of Knapsack Problem using Branch and Bound.

41. Travelling Salesman Problem using Branch and Bound.

42. Overview of P, NP and NP-Complete Problems.

Any other experiment based on syllabus may be included which would help the learner to understand topic/concept.

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

Text Books:

1. Sanjoy Dasgupta, Christos Papadimitriou, Umesh Vazirani, "Algorithms", 1st Edition, Tata McGraw- Hill, 2023.
2. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein, "Introduction to Algorithms", 4th Edition, The MIT Press, 2022.
3. Ellis Horowitz, Sartaj Sahni, S. Rajsekaran, "Fundamentals of computer algorithms", 1st Edition, University Press, 2018.

Reference Books:

1. S. K. Basu, "Design Methods and Analysis of Algorithm", 2nd Edition, PHI, 2013.
2. John Kleinberg, Eva Tardos, "Algorithm Design", Pearson, 1st Edition, 2013.

Web Links:

1. NPTEL Course: https://onlinecourses.nptel.ac.in/noc19_cs47/preview
2. LeetCode: https://leetcode.com/problem-list

Program: Computer Science & Engineering (Data Science)	T. Y. B.Tech	Semester: V
Intelligent Systems (RCP23DCPC503)		
Intelligent Systems Laboratory (RCP23DLPC503)		

Prerequisite: Basic Mathematics, Data Structures

Course Objective(s):

1. Provide the basic ideas and techniques underlying the design of intelligent systems.
2. Impart the knowledge of various search techniques for problem solving.
3. Learn knowledge representation and provide the knowledge to deal with uncertain and incomplete information.
4. Impart the knowledge of Intelligent planning.

Course Outcomes:

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

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Apply appropriate search-based method for a given problem.	L3	Apply
CO2	Analyze various IS approaches to knowledge - problem solving, reasoning, and intelligent planning.	L4	Analyze
CO3	Apply the knowledge of reasoning and intelligent planning to solve a problem.	L3	Apply

Intelligent Systems (RCP23DCPC503)
Course Contents

Unit-I — 04 Hrs.

Fundamentals:

Introduction to Intelligence Systems, Evolution, Categorization of Intelligent System, Applications.

Problem solving:

Solving problem by Searching: Problem Solving Agent, Formulating Problems. State Space Search: Uninformed search, Breadth First Search (BFS), Depth First Search (DFS), Depth First Iterative Deepening (DFID).

Unit-II — 06 Hrs.

Heuristic Search and Optimization:

Best first Search, Hill Climbing, Variations of Hill Climbing, Solution Space, and Travelling Salesman Problem. Finding Optimal Paths: Branch and Bound, A*, Admissibility and monotonicity properties of A*.

Game Playing:

Game Theory, Board games and game tree, The minimax algorithm, Alpha-Beta Pruning.

Unit-III — 04 Hrs.

Knowledge and Reasoning in Logic:

Logic, Soundness and Completeness, Propositional Logic, First Order Logic, forward chaining, Backward chaining and Refutation.

Unit-IV — 06 Hrs.

Ontology:

Knowledge Modelling, Definition, and importance of ontologies in AI, Components of ontologies: classes, properties, individuals, Ontology development methodologies (e.g. Protégé), Ontology languages (e.g. OWL, RDF), Ontology reasoning and inference, Applications of ontologies in AI (e.g. semantic web, knowledge management. Ontology-based data access and integration, Rule-based reasoning with ontologies (e.g. SWRL).

Unit-V — 06 Hrs.

Planning:

Domain independent planning, Forward and Backward search, Goal Stack Planning, Plan Space Planning, Means Ends Analysis, Graphplan, algorithm AO*.

Intelligent Systems Laboratory (RCP23DLPC503)

List of Laboratory Experiments

Suggested Experiments:(Any 08)

1. Implement domain specific function for different problems.
2. Identify and analyze uninformed search Algorithm to solve the problem. Implement BFS/DFS/DFID search algorithms to reach goal state.
3. Program to implement Local Search algorithm: Hill climbing search.
4. Implement A* search algorithm to reach goal state.
5. To analyze the admissibility property of A* algorithm by comparing the results using admissible and inadmissible heuristics.
6. Implement minimax algorithm for a two-player game.
7. Implement Alpha-Beta Pruning and analyze its effectiveness in optimizing game-tree search by reducing the number of nodes evaluated.
8. Develop a knowledge base using OWL.
9. Develop a Rule based System using SWRL on Protégé software.
10. AI-Based Decision Making Using AO* Algorithm

Any other experiment based on syllabus may be included which would help the learner to understand topic/concept.

Text Books:

1. Stuart Jonathan Russell, Stuart Russell, Peter Norvig, "Artificial Intelligence: A Modern Approach", Pearson, 2020.
2. Deepak Khemani, " A First Course in Artificial Intelligence", McGraw Hill Education (India), 2013.
3. Dean Allemang, James Hendler, "Semantic Web for the Working Ontologist", 1st Edition, Elsevier 2008.

Reference Books:

1. Saroj Kaushik, "Artificial Intelligence", 1st Edition, Cengage Learning, 2011.
2. Ivan Bratko , "PROLOG Programming for Artificial Intelligence", 1th Edition, Pearson Education, 2011.

3. Crina Grosan, Ajith Abraham, "Intelligent Systems: A Modern Approach", Springer Science & Business Media, 2011.

4. Elaine Rich and Kevin Knight "Artificial Intelligence", 3rd Edition, Tata McGraw-Hill, 2008.

5. Patrick Henry Winston, "Artificial Intelligence", 3rd Edition, Addison-Wesley.

Web Links:

1. NPTEL: Computer Science and Engineering - Artificial Intelligence: Search Methods for Problem Solving

2. NPTEL Course: An Introduction to Artificial Intelligence

Program: B.Tech in Computer Science and Engineering (Data Science)	T. Y. B.Tech	Semester: V
Recommender Systems (RCP23DCPE511)		
Recommender Systems Laboratory (RCP23DLPE511)		

Prerequisite: Statistics for Data Science, and Machine Learning.

Course Objective(s): To provide students with the basic concepts of Recommender Systems, design space, trade- offs and its application in various domain.

Course Outcomes:

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

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Explain the fundamental concepts and biases in recommender systems.	L2	Understand
CO2	Apply neighborhood-based and collaborative filtering techniques for designing recommender systems.	L3	Apply
CO3	Design and evaluate advanced recommender systems using hybrid approaches, constraint-based and context-aware models.	L6	Create

Recommender Systems (RCP23DCPE511)
Course Contents

Unit-I — 07 Hrs.

Introduction to Recommender Systems:

Recommender Systems Function, Techniques, Application and Evaluation, Explanations and Persuasiveness, Conversational Systems, Visualization, Biases in Recommender Systems: Statistical, cultural and cognitive, data and algorithm bias and self-selection biases, Issues working with RSs data sets: The cold-start problem.

Recommendation System Properties: User Preference, Prediction Accuracy, Coverage, Confidence, Trust, Novelty, Serendipity, Diversity, Utility, Risk, Robustness, Privacy, Adaptivity.

Evaluation metrics: Rating prediction and accuracy, Ranking Measures: NDPM, Spearman's ρ, R-Score, MAP, NDCG, MRR, implicit/explicit. Other metrics: fairness, coverage, diversity, novelty, serendipity.

Unit-II — 05 Hrs.

Content-based Recommender System:

High level Architecture of Content-based Systems, Advantages and Drawbacks of Content-based Filtering, Item profiles, discovering features of documents, obtaining item features from tags, representing item profiles, Methods for Learning User Profiles, Similarity based retrieval, Classification algorithms, Knowledge based recommendation: Knowledge representation and reasoning, Case based recommenders.

Unit-III — 08 Hrs.

Neighbourhood-based Recommendation Methods:

Advantages of Neighborhood Approaches, Neighborhood-based Recommendation, User-based Rating Prediction, User-based Classification Regression Vs Classification, Item-based Recommendation, User-based Vs Item based Recommendation, Rating Normalization, Similarity Weight Computation, Neighborhood Selection.

Graph-based Methods: User-Item Graphs, Neighborhoods with Random Walks, Neighborhoods with the Katz Measure, Attacks on collaborative recommender systems

Unit-IV — 07 Hrs.

Neighborhood models:

Rule-Based Collaborative Filtering: Leveraging Association Rules for Collaborative Filtering, Item-Wise Models versus User-Wise Models Naive Bayes Collaborative Filtering: Handling Overfitting, Example of the Bayes Method with Binary Ratings.

Collaborative filtering-based Recommender System: Baseline predictors through least squares, Implicit feedback, Matrix factorization models: SVD, SVD++, Time-aware factor model, Comparison, echo chambers, data drift and concept drift.

Unit-V 07 Hrs.

Constraint-based Recommenders Development of Recommender Knowledge Bases: User Guidance in Recommendation Processes, Calculating Recommendations.

Context-Aware Recommender Systems: Context in Recommender Systems, Modeling Contextual Information in Recommender Systems. Paradigms for Incorporating Context in Recommender Systems: Contextual Pre- Filtering, Contextual Post-Filtering, Contextual Modeling, Combining Multiple Approaches, Additional Issues in Context-Aware Recommender Systems.

Unit-VI 05 Hrs.

Hybrid approaches:

Deep Recommender systems, Multimodal Recommenders, Monolithic hybridization design: Feature combination, Feature augmentation, Parallelized hybridization design: Weighted, Switching. Limitations of hybridization strategies.

Recommender Systems Laboratory (RCP23DLPE511)

List of Laboratory Experiments

Suggested Experiments: (Any 10)

1. Processing and analysis of public recommender systems datasets, and performance evaluation and comparison / Master spreadsheet-based tools.
2. Compare and analyze performance of Content-based recommendation engine on different datasets for Book, Movie, Song, product Recommendation.
3. Implement Recommendation System using K-Nearest Neighbors and evaluate its performance on different datasets.
4. Build project-association recommenders using association rule mining.
5. Build a Recommendation Engine with Item-Based Collaborative Filtering.
6. Implement Context-Aware Recommender Systems Trust.
7. Build Constraint-based Recommenders to provide valuable support for users searching for products and services in e-commerce environments.
8. Implement Hacker News algorithm /Subreddit User Recommendation System based on Netflix's Algorithm.

9. Implement Bayesian personalized ranking using matrix factorization algorithm
10. Implement Google PageRank algorithm for recommendation.
11. Implement unsupervised learning - Autoencoders and Restricted Boltzmann Machines.
12. Implement recommender systems in 5G wireless networks for optimizing wireless network performance and deploy designed recommender System as Hosted Interactive Web Service on AWS.

Any other experiment based on syllabus may be included which would help the learner to understand topic/concept.

Text Books:

1. Jannach D., Zanker M. and FelFering A., "Recommender Systems: An Introduction", 1st Edition, Cambridge University Press, 2011.
2. Kim Falk, "Practical Recommender Systems", 1st Edition, Manning, 2019.
3. Manouselis N., Drachsler H., Verbert K., Duval E., "Recommender Systems for Learning", 1st Edition, Springer, 2013.
4. C.C. Aggarwal, "Recommender Systems: The Textbook", 1st Edition, Springer, 2016.

Reference Books:

1. M.D. Ekstrand, J.T. Riedl, J.A. Konstan, "Collaborative filtering recommender systems", 1st Edition, Now publishers, 2011.
2. J. Leskovec, A. Rajaraman and J. Ullman, "Mining of massive datasets", Cambridge, 2nd Edition, 2012.
3. Rounak Banik, "Hands-On Recommendation Systems with Python: Start building", Ingram short title, 2018.
4. P. Pavan Kumar, S. Vairachilai, Sirisha Potluri, "Recommender Systems: Algorithms and Applications", CRC Press, 1st Edition, 2021.

Web Links:

1. Udemy course on Recommender Systems and Deep Learning in Python: https://realpython.com/build-recommendation-engine-collaborative-filtering
2. Coursera course on Recommender Systems Specialization: https://www.coursera.org/specializations/recommender-systems

Program: Computer Science & Engineering (Data Science)	T. Y. B.Tech	Semester: V
Soft Computing (RCP23DCPE512)		
Soft Computing Laboratory (RCP23DLPE512)		

Prerequisite: Mathematics, Algorithms.

Course Objective(s): To equip students with the knowledge and skills to apply fuzzy logic, genetic algorithms, evolutionary computation, and hybrid soft computing techniques for solving real-world optimization and decision-making problems.

Course Outcomes:

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

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Understand the fundamentals of soft computing.	L2	Understand
CO2	Apply fuzzy logic and evolutionary algorithms to solve real-world decision-making and optimization problems.	L3	Apply
CO3	Analyze multi-objective optimization techniques and hybrid soft computing models to handle complex problem-solving scenarios.	L4	Analyze

Soft Computing (RCP23DCPE512)
Course Contents

Unit-I — 03 Hrs.

Introduction:

Concept of computing systems, Tolerance for imprecision and uncertainty, Adaptability and learning capability, Trade-offs between computational efficiency and accuracy. "Soft" computing versus "Hard" computing Characteristics of Soft Computing, major areas of Soft Computing, applications of Soft Computing, Limitations of soft computing approaches.

Unit-II — 06 Hrs.

Fuzzy logic:

Introduction to Uncertainty Treatment, Fuzzy logic, Fuzzy sets and membership functions, Operations on Fuzzy sets. Fuzzy relations, rules, propositions, implications and inferences, Defuzzification techniques, Fuzzy logic controller design, Some applications of Fuzzy logic.

Unit-III — 07 Hrs.

Genetic Algorithms

Concept of "Genetics" and "Evolution" and its application to probabilistic search techniques, Basic GA framework and different GA architectures. GA operators: Encoding, Crossover, roulette wheel selection, tournament selection, population, binary encoding and decoding for any optimization problem, Selection, Mutation, etc. Solving single-objective optimization problems using Gas, Multi objective Gas, Concepts on Non-domination, tournament selection, crowding distance operator, ranking, Simulated annealing.

Unit-IV — 08 Hrs.

Multi-objective Optimization Problem Solving

Concept of multi-objective optimization problems (MOOPs) and issues of solving them. Multi-Objective Evolutionary Algorithm (MOEA), TOPSIS, Non-Pareto approaches to solve MOOPs Pareto-based approaches to solve MOOPs. Some applications with MOEAs.

Unit-V — 10 Hrs.

Evolutionary Computation:

Ant Colony Optimization and Artificial Bee Colony Algorithms: Biological ant colony system. Artificial ants and assumptions – Stigmergic communications, Pheromone updating - local - global - Pheromone evaporation - ant colony system ACO models. Touring ant colony system - max min ant system - Concept of elistic ants, Task partitioning in honeybees - Balancing foragers and

– Artificial bee colony (ABC) algorithms - binary ABC algorithms, ACO and ABC algorithms for solving SINX maximization problem, Particle Swarm Optimization.

Unit-VI 05 Hrs.

Rough Sets:

Basic operations, lower and upper, approximations, discernibility matrix, distinction table; Accuracy of Approximations.

Hybridization of Soft Computing tools:

Sequential Hybrid Systems, Auxiliary Hybrid Systems, Embedded Hybrid Systems, Neuro-Fuzzy Hybrid Systems, Neuro-Genetic Hybrid Systems, Fuzzy-Genetic Hybrid Systems., Rough fuzzy, Rough-Fuzzy-GA etc. boundary region. Applications

Soft Computing Laboratory (RCP23DLPE512)

List of Laboratory Experiments

Suggested Experiments:(Any 08)

1. Implement fuzzy set operations (union, intersection, complement) and visualize membership functions.
2. 1. Design and implement a Fuzzy Inference System (FIS) for temperature control.
   2. Implement different defuzzification techniques (e.g., Centroid, Bisector, MOM, SOM, LOM).
3. Genetic Algorithms (GA)
   1. Implement a simple Genetic Algorithm for function optimization.
   2. Apply GA for solving a Traveling Salesman Problem (TSP).
   3. Implement a binary encoding and decoding mechanism for GA-based optimization.
   4. Compare Roulette Wheel Selection and Tournament Selection methods in GA.
4. Multi-objective Optimization Problem Solving
   1. Implement Non-Dominated Sorting Genetic Algorithm (NSGA-II) for solving multi-objective problems.
   2. Solve a multi-objective problem using Pareto-based optimization techniques.
5. Evolutionary Computation (anyone)
   1. Implement Ant Colony Optimization (ACO) for pathfinding in a graph.
   2. Implement Artificial Bee Colony (ABC) optimization for function minimization.
   3. Solve a function maximization problem using ACO and ABC.
   4. Implement Particle Swarm Optimization (PSO) for parameter tuning in an optimization problem.
6. Implement rough set-based data analysis using lower and upper approximations.

7. Compute the discernibility matrix and generate reducts using the Rough Set approach.

8. Implement a Neuro-Fuzzy system for classification tasks.

9. Implement a hybrid Genetic Algorithm-Fuzzy Logic system for an optimization problem.

10. Implement a Rough-Fuzzy system for feature selection and classification.

Any other experiment based on syllabus may be included which would help the learner to understand topic/concept.

Text Books:

1. S. N. Sivanandam and S. N. Deepa. "Introduction to Soft Computing", 3rd Edition, Wiley India Publications, 2018.

2. Xin-She Yang, "Recent Advances in Swarm Intelligence and Evolutionary Computation, Springer International Publishing, Switzerland, 2015.

3. Kalyanmoy Deb, " Multi-Objective Optimization using Evolutionary Algorithms Paperback – Wiley India Publications, 2010.

4. Kalyanmoy Deb, "Multi-Objective Optimization using Evolutionary Algorithms, John Wiley & Sons, 2001.

Reference Books:

1. Timothy J.Rose, "Fuzzy Logic with Engineering Applications", 4th Edition, John Wiley, 2020.

2. D. E. GOLDBERG, "Genetic Algorithms: in search, optimization and machine learning, Dec 2008.

3. B. Yegnanarayana, "Artificial Neural Networks", PHI publication, 1998.

4. James FREEMAN and David Skapura, "Neural Networks: Algorithms, Applications, and Programming Techniques, 1st Edition, Pearson publication, 2002.

5. J.S.R Jang, C.T Sun and E.Mizutani, "Neuro-Fuzzy and Soft Computing", 2nd Edition, Prentice Hall of India, 2002.

Web Links:

1. Soft Computing — CS60108

2. https://nptel.ac.in/courses/103/103/103103164/

3. https://nptel.ac.in/courses/112/105/112105235/

Program: Computer Science & Engineering (Data Science)	T. Y. B.Tech	Semester: V
Social Network Analysis (RCP23DCPE513)		
Social Network Analysis Laboratory (RCP23DLPE513)		

Prerequisite: Probability and Statistics, Machine Learning.

Course Objective(s): To equip students with the knowledge and analytical skills necessary for the study of massive networks, addressing the associated computational, algorithmic, and modeling challenges, and to cultivate a research-oriented perspective on the structure, dynamics, and analysis of large-scale networks.

Course Outcomes:

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

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Analyse social networks using visualization techniques and structural measures. .	L4	Analyze
CO2	Illustrate network growth patterns and ranking methodologies in complex networks.	L3	Apply
CO3	Examine methods for detecting communities, predicting links, and modelling information flow.	L4	Analyze
CO4	Apply anomaly detection and representation learning approaches for network analysis.	L3	Apply

Social Network Analysis (RCP23DCPE513)
Course Contents

Unit-I — 08 Hrs.

Society & Network:

Introduction, Use of social networks, defining a network, types of network (link-centric, node and link centric, local view, temporal view, generalization, real-world network), levels of social network analysis, graph visualization tools.

Network Measures:

Network basics, node centrality, assortativity, transitivity and reciprocity, similarity, degeneracy.

Network Growth Models:

Overview of real-world networks and their properties, brief introduction to Erdős-Rényi Random Network Model, Watts-Strogatz Model, and Preferential Attachment Model with their key characteristics and limitations.

Unit-II — 06 Hrs.

Link Analysis:

Application of link analysis, Signed networks: Balance Theory of Undirected Signed Networks, Status Theory of Signed Networks, Triad Balance vs Status, Strong and Weak Ties: Strength of a Tie, Triadic Closure, Dunbar Number, Local Bridges and Importance of Weak Ties, PageRank, DivRank, SimRank, PathSim.

Unit-III — 06 Hrs.

Community Detection:

Application of community detection, types of communities, community detection methods, Disjoint Community Detection: Node-centric community detection, modularity and community detection, Overlapping Community Detection: Clique Dynamics, Local Community Detection.

Link Prediction:

Applications of link prediction, Evaluating Link Prediction methods

Unit-IV — 05 Hrs.

Cascade Behaviours & Network Effects:

Preliminaries and Important Terminologies, Cascade Models, Probabilistic Cascades, Epidemic Models, Independent Cascade Models, Cascade Prediction.

Unit-V 06 Hrs.

Anomaly Detection in Networks:

Outliers verses network based anomalies. Anomaly in Static Networks: Plain and attributed networks, relational learning, Anomaly in Dynamic Networks: Preliminaries, feature and decomposition-based approaches, Challenges in anomaly detection.

Unit-VI 08 Hrs.

Graphical Representation Learning:

Intuition behind representation learning, representation learning methods.

Graph Convolutional Network (GCN)

and its variations and applications in social network analysis.

Dynamic Graph Convolutional Networks (DGCN) & Continuous-Time Dynamic Graph Neural Networks (CTDGNN): Advanced models for analyzing evolving social networks.

Social Network Analysis Laboratory (RCP23DLPE513)

List of Laboratory Experiments

Suggested Experiments:(Any 08)

1. Creating and analyzing a graph using Social Network and Gephi Tool.
2. Building a network and network measures using NetworkX:
   a) Degree & Degree Distribution
   b) Clustering Coefficients
   c) Node Centrality Measure
3. Implementation of random scale-free network growth model on network science (Barabási-Albert).
4. Implementation of link analysis using the Random Walk PageRank algorithm.
5. Implementation of link prediction using a classification approach.
6. Implementation of local and global link prediction models.
7. Implement the Clique Percolation Method (CPM) for detecting overlapping communities in a given social network graph.
8. To implement and analyze epidemic models.
9. Implementation of Graph Representation Learning for Social Network Analysis Using C[illegible]
10. Mini Project

Any other experiment based on syllabus may be included which would help the learner to understand topic/concept.

Text Books:

1. Tanmoy Chakraborty, "Social Network Analysis", 1st Edition, Wiley, 2021.
2. Stephen P Borgatti, Martin G. Everett, Jeffrey C. Johnson, "Analyzing Social Networks", 2nd Edition, Sage Publications Ltd, 2018.
3. William L. Hamilton, "Graph Representation Learning", Morgan & Claypool Publishers, 2020.

Reference Books:

1. Xiaoming Fu, Jar-Der Luo, Margarete Boos, "Social Network Analysis Interdisciplinary Approaches and Case Studies', 1st Edition, CRC Press, 2020.
2. Dr. Krishna Raj P.M., Mr. Ankith Mohan, Dr. Srinivasa K.G. "Practical Social Network Analysis with Python (Computer Communications and Networks)", 1st Edition, Springer, 2019.
3. John Scott, "Social Network Analysis", 4th Edition, SAGE Publications Ltd,2017.
4. Song Yang, Franziska Barbara Keller, Lu Zheng, "Social Network Analysis : Methods and Examples", 1st Edition, SAGE Publications, 2016.

Web Links:

1. A course on Social Network Analysis:
   https://onlinecourses.nptel.ac.in/noc22_cs117/preview
2. Social Network Analysis 101: Ultimate Guide Comprehensive Introduction for Beginners:
   https://visiblenetworklabs.com/guides/social-network-analysis-101/
3. Real-world use cases of Social Network Analysis:
   https://www.latentview.com/social-media-analytics/a-guide-to-social-network-analysis-and-its-use-cases/

Program: Computer Science & Engineering (Data Science)	T. Y. B.Tech.	Semester: V
Cloud Computing and Security (RCP23DCPE514)		
Cloud Computing and Security Laboratory (RCP23DLPE514)		

Prerequisite: System Fundamentals and Basic Networking

Course Objective(s):

1. Understand the core principles of cloud computing, including parallel and distributed computing concepts, and virtualization techniques.
2. Analyze the architecture of cloud computing, covering cloud service models, types of clouds and key migration strategies.
3. Explore Virtual Private Cloud (VPC) concepts, Elastic Compute Cloud (EC2) services, and their role in cloud infrastructure design and management.
4. Learn cloud-based storage solutions, Database as a Service (DBaaS) offerings, and cloud security measures for data protection.

Course Outcomes:

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

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Demonstrate the ability to differentiate between parallel and distributed computing and understand the role of virtualization in cloud environments.	L2	Understand
CO2	Apply knowledge of cloud architecture to select appropriate cloud service models and types, and perform effective cloud migrations.	L3	Apply
CO3	Configure and manage VPCs, EC2 instances, and understand best practices for cloud networking and instance management.	L4	Analyze
CO4	Implement cloud storage solutions, leverage DBaaS, and ensure robust cloud security using industry-standard practices and AWS security services.	L6	Create

Cloud Computing and Security (RCP23DCPE514) Course Contents

Unit-I — 06 Hrs.

Introduction to Cloud Computing:

Principles of Parallel and Distributed Computing: Parallel vs. distributed computing, Elements of parallel computing and Distributed Computing.

Virtualization:

Characteristics of virtualized environments, Taxonomy of virtualization techniques: hosted, baremetal, Hypervisor and Xen Architecture, Para virtualization with Compiler Support, CPU Virtualization, Other Virtualizations: Storage, Network, Desktop and Application Server Virtualization, Virtualization and cloud computing.

Unit-II — 06 Hrs.

Cloud Computing Architecture:

The cloud reference model: SAAS, IAAS, PAAS, Types of clouds: Public, Private Hybrid, Community, Economics of the cloud, Open challenges.

Migrating Applications to the Cloud:

Key aspects, cloud migration techniques, phases during migration, cloud emulators.

Unit-III — 08 Hrs.

Virtual Private Cloud (VPC):

Introduction to VPC and its benefits, Networking concepts within a VPC (subnets, route tables, security groups) VPC peering and connectivity options , VPC design best practices and considerations.

Elastic Compute Cloud (EC2) Service:

Overview of EC2 and its role in cloud computing, EC2 instance types and families, Provisioning and launching EC2 instances, configuring security groups and key pairs, Managing EC2 instances (start, stop, terminate), Elastic IP addresses and Elastic Network Interfaces (ENIs).

Unit-IV — 06 Hrs.

Cloud-Based Storage:

Provisioning Cloud Storage, Amazon S3, Elastic Block Store (ESB), Cloud Storage Interoperability, Exploring Cloud Backup Solutions.

Database as a Service:

Key advantages of Database as a service offering, Amazon Relational Database Service (Amazon RDS), Amazon DynamoDB, Amazon Redshift, Amazon Aurora.

Unit-V 08 Hrs.

Understanding Cloud Security:

Securing the Cloud: The security boundary, Security service boundary, Security mapping, Securing Data: Brokered cloud storage access, Storage location and tenancy, Encryption, Auditing and compliance, Establishing Identity and Presence, Identity protocol standards: Windows Azure identity standards.

Data Protection:

Protect data at rest and in transit, Identify Amazon Simple Storage Service (Amazon S3) protection features, Encrypt data in Amazon S3, Differentiate between client-side encryption (CSE) and server side encryption (SSE), Identify Amazon Web Services (AWS) services that help protect your data.

Unit-VI 05 Hrs.

Administration for Clouds:

The AAA model, single sign-on for clouds, industry implementation for AAA, authentication management standards for controlling access, SAML,authorization management, accounting for resource utilization.

Cloud Computing and Security Laboratory (RCP23DLPE514)

List of Laboratory Experiments

Suggested List of Experiments: (Any 08)

1. Virtualisation: a)Hosted Virtualisation. b)Bare Metal Virtualisation.
2. Host a Static Website on cloud.
3. Create and migrate relational database on cloud.
4. Create a Virtual Private Clouds and establish connections between each other.
5. Implement user level authentication on your cloud applications.
6. Implement Load balancing on your created cloud application.
7. Automate Infrastructure Development.
8. Implement serverless architecture and configure notification services.
9. Implement Hybrid storage and Data Migration.
10. Mini Project (Capstone Project).

Any other experiment based on syllabus may be included which would help the learner to understand topic/concept.

Text Books:

1. Pravin Mishra, "Cloud Computing with AWS", Apress, 2023.
2. Rajkumar Buyya, " Mastering Cloud Computing", McGraw Hill Education (India), 2017.
3. Sk Singh, "Cloud Computing and AWS Introduction: Mastering AWS Fundamentals and Core Services",Amazon Digital Services, 2024.
4. Ray Rafaels,"Cloud Computing: From Beginning to End," CreateSpace Independent Publishing, 2015.

Reference Books:

1. Dr. Sunilkumar, S. Manvi, "Cloud Computing: Concepts and Technologies", CRC Press, 2021.
2. Temitayo Fagbola, Kamal Kant Hiran, "Cloud Computing: Master The Concepts, Architecture and Applications with Real-World Examples And Case Studies", BPB Publications, 2019.
3. Ricardo Puttini, Thomas Erl, and Zaigham Mahmood, "Cloud Computing: Concepts, Technology & Architecture," Pearson Publication, 2013
4. Michael J Kavis, "Architecting the Cloud," Wiley, 2014.
5. Thomas Erl, Zaigham Mahmood, "Cloud Computing: Concepts, Technology & Architecture", Pearson Education, 2014.

Web Links:

1. A course on Cloud Computing: `https://onlinecourses.nptel.ac.in/noc22_cs20/preview`
2. A comprehensive guide to Social Network Analysis: https://www.analyticsvidhya.com/blog/2021/04/what-is-cloud-computing/
3. AWS Cloud Services: https://docs.aws.amazon.com//?nc2=h_ql_doc_do

Program: Computer Science & Engineering (Data Science)	T. Y. B.Tech.	Semester: V
Computer Communication and Networks (RCP23DCMD501)		
Computer Communication and Networks Laboratory (RCP23DLMD501)		

Prerequisite: Computer System Fundamentals.

Course Objective(s):

1. To provide a foundational understanding of computer networks, their topologies, protocols, and network communication models.
2. To explore the working principles of network layers, including network, transport, and data link layers, along with addressing schemes and routing algorithms.
3. To introduce IoT architecture, communication protocols, and interconnectivity models, emphasizing smart applications and IPv6-based smart networks.

Course Outcomes:

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

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Understand the fundamentals of computer networks, including topologies, protocols, and network models such as OSI and TCP/IP.	L2	Understand
CO2	Apply knowledge of network addressing, subnetting, supernetting, and routing algorithms to design efficient network solutions.	L3	Apply
CO3	Analyse transport and data link layer protocols, error control, and flow control mechanisms to enhance network communication reliability.	L4	Analyze
CO4	Evaluate IoT architectures, communication protocols, and smart networking applications to propose innovative IoT-based solutions.	L5	Evaluate

Computer Communication and Networks (RCP23DCMD501) Course Contents

Unit-I — 05 Hrs.

Introduction to Computer Networks:

Basics of Computer Networks, Network Topologies and Protocols, OSI and TCP/IP Models, Network Devices and Components.

Unit-II — 08 Hrs.

Data link Layer:

Introduction, transmission medium, physical addressing, Error control (Hamming code, CRC), Flow control, Data-Link Layer Protocols: HDLC, Media Access Control: ALOHA, CSMA, Wired LANs: Ethernet, Wireless LANs.

Unit-III — 08 Hrs.

Network Layer:

Services, Packet switching, ARP, RARP, Unicast Routing Algorithms-(DVR, LSR), IPv4 Addressing (Classfull and Classless), Subnetting, Supernetting design problems, IPv4 Protocol, IPV6 protocol.

Unit-IV — 08 Hrs.

Transport & Application Layer:

Services, sockets, Transport Layer Protocols - User Datagram Protocol (UDP), Transmission Control Protocol (TCP), ARQ, Sliding Window Protocol. Application layer protocols: HTTP, SMTP, DNS.

Unit-V — 05 Hrs.

IoT Architecture and Technologies:

Introduction to the Internet of Things (IoT), IoT Architecture and Components, Communication Protocols for IoT (MQTT, CoAP, etc.).

Unit-VI — 05 Hrs.

Interconnecting Smart Objects with IP:

Architecture, IP Protocol Architecture, IPv6 for Smart Object Networks and the Internet of Things, Connectivity Models for Smart Object Networks The applications: Smart Cities and Urban Networks, Home Automation. Structural Health Monitoring

Computer Communication and Networks Laboratory (RCP23DLMD501)

List of Laboratory Experiments

Suggested Experiments:(Any 08)

1. Learn to use commands like tcpdump, netstat, ifconfig, nslookup and traceroute. Capture ping and trace route PDUs using a network protocol analyser.
2. Implementation of an error detection code using CRC.
3. Setting up and configuring routers & switches using CLI.
4. Assigning IP addresses and subnetting a network.
5. Establishing communication between different networks using static and Dynamic routes.
6. To design and configure Virtual Local Area Network and check the communication privacy among different sub networks.
7. Implement applications using TCP sockets like:
   (a) Echo client and echo server
   (b) Chat
   (c) File Transfer
8. Implement IoE based on IPv6 using packet tracer.
9. Simulate the home automation using Packet Tracer.
10. Design and Simulation of a Scalable College Network Using Cisco Packet Tracer.

Any other experiment based on syllabus may be included which would help the learner to understand topic/concept.

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

Text Books:

1. James Kurose, "Computer Networking:A Top-Down Approach", Pearson Education, 8th Edition, 2022.
2. Behrouz A. Forouzan, " TCP/IP Protocol Suite", McGraw Hill Education ,4th Edition, 2017.

Reference Books:

1. Maciej Kranz, "Building the Internet of Things", by Maciej Kranz, Wiley,1st Edition, 2017.

2. Rajkumar Buyya, Amir Vahid Dastjerdi, and Sriram Venugopal, "Internet of Things: Principles and Paradigms", Morgan Kaufmann Publishers, 2016.

3. Jean-Philippe Vasseur, "Interconnecting Smart Objects with IP The Next Internet", Morgan Kaufmann Publishers, 2010.

Web Links:

1. Routing Protocol Information: https://www.cisco.com/c/en/us/support/docs/ip/routing-information-protocol-rip/13788-3.html

2. Transmission of IPv6 Packets over IEEE 802.15.4 Networks: https://datatracker.ietf.org/doc/html/rfc4944

3. IPv6 in IoT: https://pianalytix.com/advantages-of-ipv6-in-iot/

Program: Computer Science and Engineering (Data Science)	T. Y. B.Tech	Semester: V
DevOps Laboratory (RCP23OLOE501)		

Prerequisite: Computer System Fundamentals, Web Engineering and Project Management.

Course Objective(s):

To equip students with fundamental DevOps skills in automation, CI/CD implementation, containerization, orchestration, monitoring, and MLOps integration.

Course Outcomes:

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

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Apply Virtualization, Containerization, and Infrastructure Automation.	L3	Apply
CO2	Design CI/CD Pipelines and Automated Testing	L6	Design
CO3	Develop monitoring, logging, and performance enhancement strategies	L6	Develop

DevOps Laboratory (RCP23OLOE501)
Course Contents

Unit-I — 04 Hrs.

Virtualization and Containerization with Docker

1. Install Docker on Linux or Windows.
2. Run a simple container.
3. Build a custom Docker image for a Python web application.
4. Use Docker Compose to run multi-container applications.

Unit-II — 04 Hrs.

Infrastructure as Code with Terraform

1. Install Terraform and configure it locally.
2. Write a Terraform script to provision a virtual machine.
3. Use Terraform modules to reuse infrastructure code.
4. Manage Terraform workspaces for different environments.
5. Destroy and clean up infrastructure after deployment.

Unit-III — 06 Hrs.

Configuration Management with Puppet and Ansible

1. Install Puppet and Ansible on a Linux server.
2. Write a basic Puppet manifest to install a web server.
3. Deploy a LAMP stack using Puppet modules.
4. Write an Ansible playbook to set up users and install software.
5. Use Ansible roles to manage complex configurations.

Unit-IV — 06 Hrs.

Continuous Integration with Jenkins

1. Install Jenkins and set up a basic job.
2. Implement CI/CD pipelines with Jenkins & GitHub Actions.
3. Automate build, test, and deployment processes.
4. Secure CI/CD pipelines using secrets management.
5. Set up SonarQube in a Jenkins pipeline.
6. Vulnerability detection using SonarQube.

Unit-V — 06 Hrs.

Automated Testing using Selenium

1. Install Selenium and set up WebDriver
2. Write Selenium scripts for web UI testing.
3. Automate form submission and validations.
4. Capture screenshots on test failures.
5. Run Selenium scripts on different browsers.
6. Create a Jenkins job to execute Selenium scripts automatically.

Unit-VI 06 Hrs.

DevOps Automation and Scripting

1. Write a Bash script to automate package installation.
2. Develop a Python script to monitor system logs.
3. Schedule automated tasks using cron jobs.
4. Write a script to restart services automatically.
5. Implement a simple chatbot for DevOps automation.

Unit-VII 06 Hrs.

Container Orchestration with Kubernetes

1. Install and set up a local Kubernetes cluster.
2. Deploy a simple Nginx application using Kubernetes.
3. Expose services externally using Kubernetes services.
4. Scale applications dynamically using Kubernetes auto-scaling.

Unit-VIII 04 Hrs.

Traffic Management with Kubernetes Ingress

1. Understand Kubernetes Ingress and its role in routing external traffic.
2. Configure an Ingress resource for multiple services.
3. Implement SSL/TLS termination using Kubernetes secrets.
4. Set up path-based and host-based routing.
5. Test and troubleshoot Ingress rules.

Unit-IX 04 Hrs.

Monitoring and Logging with ELK Stack

1. Install the ELK stack (Elasticsearch, Logstash, and Kibana).
2. Use Logstash to collect logs from a web server.
3. Set up Kibana dashboards to visualize logs.
4. Analyze logs for troubleshooting.

Unit-X 06 Hrs.

MLOps with PyCaret

1. Train a machine learning model using PyCaret.
2. Deploy the model as a REST API using Flask.
3. Automate model retraining using Jenkins pipelines.
4. Monitor ML model performance using the ELK stack.

Text Books:

1. Karl Matthias and Sean P. Kane, "Docker: Up and Running", 3rd Edition, O'Reilly Publication, 2022
2. John Ferguson Smart, "Jenkins, The Definitive Guide", 1st Edition, O'Reilly Publication,2011.
3. Ryan Russell-Yates, "Mastering Puppet 5: Optimize enterprise-grade environment performance with Puppet", 1st Edition, Packt Publishing, 2018
4. Jonathan McAllister, "Master Jenkins", Packt Publishing, 2015.
5. Deepak Gaikwad, Viral Thakkar, "DevOps Tools from Practitioner's Viewpoint", Wiley,2019.
6. Stephane Jourdan, Pierre Pomès ," Infrastructure as Code (IAC) Cookbook",2nd Edition, Packt Publishing, 2017.
7. Martin Alfke , Felix Frank, "Puppet 5 Essentials", 3rd Edition, O'Reilly Publication,2017
8. Yevgeniy Brikman, Terraform: Up & Running, 2nd Edition, O'Reilly, 2019

Reference Books:

1. Sanjeev Sharma and Bernie Coyne, " DevOps for Dummies", 3rd Edition, Wiley Publication,2017
2. Httermann, Michael, "DevOps for Developers", 1st Edition, APress Publication, 2012
3. Joakim Verona, "Practical DevOps", 2nd Edition Packt publication,2018
4. Martin Alfke, " Puppet Essentials - Third Edition: A fast-paced guide to automating your infrastructure", 3rd Revised Edition, Packt Publishing, 2017.

Web Links:

1. Introduction to DevOps:
   https://www.coursera.org/learn/intro-to-devops
2. Learn DevOps:
   Docker, Kubernetes, Terraform and Azure DevOps:
   https://www.udemy.com/course/devops-with-docker-kubernetes-and-azure-devops

3. MLOps for Beginners:

   https://www.udemy.com/course/mlops-for-beginners

   /?srsltid=AfmBOorNfhfo-VtBlnULsdPHYEg6NFisnhct77hRVw4LH7yv9LJUZqcz

4. Free DevOps Course Certification:

   https://intellipaat.com/academy/course/devops-free-course/

Program: Computer Science & Engineering (Data Science)	T. Y. B.Tech	Semester: V
Advanced Java Laboratory (RCP23OLOE502)		

Prerequisite: Core Java and OOP concepts.

Course Objective(s):

1. To familiarize students with advanced object-oriented concepts and design patterns in Java for creating scalable applications.
2. To enable students to optimize data handling through the Java Collections Framework, generics, and the Streams API.
3. To equip students with skills to design, build, and secure web applications using Spring and Spring Boot frameworks, with a focus on database connectivity.

Course Outcomes:

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

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Apply advanced object-oriented concepts and design patterns in Java to develop scalable and maintainable solutions for real-world problems.	L3	Apply
CO2	Optimize data processing and performance using the Java Collections Framework, Streams API,and generics.	L4	Analyze
CO3	Build secure, database-driven web applications using Spring and Spring Boot, with RESTful web services	L6	Create

Advanced Java Laboratory (RCP23OLOE502)
Course Contents

Unit-I — 04 Hrs.

Design Patterns:

Introduction to design patterns and Implementation: Singleton, Factory, Observer, Strategy

Unit-II — 04 Hrs.

SOLID Principles:

Understanding and applying SOLID principles for better design, Implementation of SOLID Principles.

Interfaces and Abstract Classes:

Demonstration of Advanced uses of interfaces and abstract classes, Default methods in interfaces.

Unit-III — 04 Hrs.

Collections:

List: ArrayList, LinkedList, Set: HashSet, Tree Set, Map: HashMap, LinkedHashMap.

Unit-IV — 04 Hrs.

Java Streams:

Introduction to Streams API, Creating streams from collections, arrays, I/O Stream operations: map, filter, reduce, collect.

Unit-V — 04Hrs.

Java Reflection API:

Understanding the Java Reflection API Accessing and manipulating class properties at runtime, Creating instances of classes dynamically Inspecting methods, fields, Annotations: Predefined, Customized.

Unit-VI — 04 Hrs.

Java Database Connectivity (JDBC):

Connecting to databases using JDBC, Executing SQL queries and managing results.

Unit-VII — 04 Hrs.

Introduction to Object-Relational Mapping (ORM):

Overview of Hibernate and JPA, Creating a simple application using Hibernate.

Unit-VIII 04 Hrs.

Microservices:

Fundamentals of Microservices, Microservices Architecture & Design Principles.

Tools for Microservices:

Spring Boot, Eureka API Gateway & load balancing between multiple instances of a microservices.

Unit-IX 04 Hrs.

Introduction to Spring:

Overview of Spring Framework features, Inversion of Control (IoC) and Dependency Injection (DI).

Unit-X 04 Hrs.

Spring Core:

Understanding Beans, Application Context, and Bean Lifecycle Configuring Spring with XML and Java annotations.

Unit-XI 04 Hrs.

Introduction to Spring Boot:

Understanding its purpose and advantages over traditional Spring.

Setting Up Spring Boot Applications:

Project structure and configuration.

Unit-XII 04 Hrs.

Building RESTful Web Services:

Creating REST APIs using Spring Boot.

Spring Data JPA:

Introduction to database interactions and repository pattern.

Unit-XIII 04 Hrs.

Securing Spring Boot Applications:

Basics of security in Spring Boot using Spring Security.

Text Books:

1. Mark Heckler, "Spring Boot: Up and Running", O'Reilly Media, 1st Edition, 2021.
2. Craig Walls, Spring in Action, Manning Publications, 6th Edition, 2022.

Reference Books:

1. Herbert Schildt, "Java: The Complete Reference", 13th Edition, McGraw Hill.

2. Dinesh Rajput, "Mastering Spring Boot 2.0", Packt Publishing, 2nd Edition, 2020.

Web Links:

1. Nptel Course: https://onlinecourses.nptel.ac.in/noc20_cs58/preview
2. Oracle links: https://docs.oracle.com/javase/tutorial/collections/; https://docs.oracle.com/javase/tutorial/jdbc/
3. Spring documentation: https://docs.spring.io/spring-boot/index.html

Program: Computer Science & Engineering (Data Science)	T. Y. B.Tech	Semester: V
Advanced Database Laboratory (RCP23OLOE503)		

Course Objective(s): To provide practical exposure to advanced database technologies, enabling learners to apply distributed, graph, and spatial databases in real-world scenarios.

Course Outcomes:

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

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Design and implement database solutions using advanced, object-oriented, and distributed database systems.	L3	Apply
CO2	Apply query optimization, security, and visualization techniques for efficient and secure data handling.	L3	Apply
CO3	Analyze emerging database technologies like vector and graph databases through practical usecases and case st.	L4	Analyze

Advanced Database Laboratory (RCP23OLOE503) Course Contents

Unit-I — 04 Hrs.

Introduction to Modern Databases:

Overview of emerging database paradigms (Document, Columnar, Graph, Objectoriented, Vector DBs). Use-case-based classification of databases.

Unit-II — 08 Hrs.

Document-Oriented Databases – MongoDB:

Overview of MongoDB as a Document-Oriented Database, Installing MongoDB, Introduction to MongoDB Compass (GUI) and Mongo Shell, Document-Oriented Data Handling, Work with JSON, XML, Query JSON/XML using inbuilt functions.

Unit-III — 04 Hrs.

Distributed DB Design:

Perform fragmentation (Range, List, Hash, Key), Simulate replication and allocation..

Unit-IV — 04 Hrs.

Document-Oriented Data Handling:

Work with JSON, XML, Query JSON/XML using inbuilt functions.

Unit-V — 04 Hrs.

Query Optimization & Processing:

View Query Execution Plan, Optimize queries using heuristics.

Unit-VI — 04 Hrs.

Object-Oriented Database with DB4O:

Store Java objects, Retrieve objects and update DB.

Unit-VII — 04 Hrs.

Graph Databases :

Install Neo4j, Create nodes and relationships. Query using Cypher.

Unit-VIII — 08 Hrs.

Vector DB :

Vector indexing, Similarity search example app, MongoDB Vector, PG Vector.

Unit-IX 04 Hrs.

Ethical & Legal Issues in Modern Databases:

Explore Real-World Data Breaches, Policy Analysis Activity, Design a Privacy-Compliant Database Schema.

Unit-X 08 Hrs.

Mini Project:

Explore an emerging databse technology such as a Graph or Vector database, Design a small use-case to demonstrate its core concept or application, Analyze its features, benefits, and limitations in comparison to traditional models.

Text Books:

1. Avi Silberschatz, Henry F. Korth, Sudarshan, "Database System Concepts", 7th Edition, Mc Graw Hill, 2021.
2. Sveta Smirnova and Alkin Tezuysal, "My SQL Cookbook" 4th Edition, O'Reilly Publication, 2022.
3. Shannon Bradshaw, Eoin Brazil, "MongoDB: The Definitive Guide - Powerful and Scalable Data Storage", 3rd Edition, O'Reilly Publication, 2020.
4. Christos Tjortjis, "Graph Databases Applications on Social Media Analytics and Smart Cities", 1st Edition, CRC Press, 2023.

Reference Books:

1. Vinicius M. Grippa and Sergey Kuzmichev, "Learning MySQL" 2nd Edition, O'Reilly Publication, 2021.
2. Tamer OEzsu, Patrick V, "Principles of Distributed Database System", Springer Publication, 2020.
3. Jeff Carpenter, Eben Hewitt, "Cassandra: The Definitive Guide - Distributed Data at Web Scale" 3rd Edition, O'Reilly Media, 2020.
4. Alex Petrov, "Database Internals: A Deep Dive into How Distributed Data Systems Work", 1st Edition, O'Reilly Media, 2019.

Web Links:

1. MongoDB Developer Center:
   Advanced Tutorials https://www.mongodb.com/developer/expertise-levels/advanced/

2. Cassandra: DataStax Academy https://www.datastax.com/dev/academy

3. Neo4j GraphAcademy:

   Advanced Courses https://graphacademy.neo4j.com/categories/advanced/

Program: Computer Science & Engineering (Data Science)	T. Y. B.Tech	Semester: V
Semester Project-III (RCP23IPSC501)		

Course Objective(s):

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

Course Outcomes:

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

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

Semester Project:

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

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

Student is expected to:

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

Assessment Criteria:

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

Prescribed project report guidelines:

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

- Introduction
- Literature Survey
- Related Theory
- Implementation details

- Project Outcomes
- Conclusion
- References

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

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

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

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

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

Table 1: Log Book Format

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

Table 2: Continuous Assessment Table

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

Table 3: Evaluation Table

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

Program: Computer Science & Engineering (Data Science)	T. Y. B.Tech	Semester: V
Constitution of India (RCP23ICHSX07)		

Prerequisite: Nil

Course Objective(s):

1. To provide basic information about Indian constitution.
2. To identify individual role and ethical responsibility towards society.
3. To understand human rights and its implications.

Course Outcomes:

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

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Have general knowledge and legal literacy and thereby to take up competitive examinations.	L2	Understand
CO2	Understand state and central policies, fundamental duties.	L2	Understand
CO3	Understand Electoral Process, special provisions.	L2	Understand
CO4	Understand powers and functions of Municipalities, Panchayats and Co-operative Societies.	L2	Understand
CO5	Understand Engineering ethics and responsibilities of Engineers.	L2	Understand
CO6	Understand Engineering Integrity & Reliability.	L2	Understand

Constitution of India (RCP23ICHSX07)
Course Contents

Unit-I — 02 Hrs.

Introduction to the Constitution of India :

The Making of the Constitution and Salient features of the Constitution. Preamble to the Indian Constitution. Fundamental Rights & its limitations.

Unit-II — 02 Hrs.

Directive Principles of State Policy:

Relevance of Directive Principles, State Policy, Fundamental Duties. Union Executives – President, Prime Minister, Parliament, Supreme Court of India.

Unit-III — 03 Hrs.

State Executives:

Governor, Chief Minister, State Legislature, High Court of State. Electoral Process in India, Amendment Procedures, 42^{nd}, 44^{th}, 74^{th}, 76^{th}, 86^{th} & 91^{st} Amendments.

Unit-IV — 02 Hrs.

Special Provisions:

For SC & ST, Special Provision for Women, Children & Backward Classes, Emergency Provisions.

Unit-V — 02 Hrs.

Human Rights:

Meaning and Definitions, Legislation Specific Themes in Human Rights, Working of National Human Rights Commission in India, Powers and functions of Municipalities, Panchayats and Co-Operative Societies.

Unit-VI — 02 Hrs.

Scope & Aims of Engineering Ethics:

Responsibility of Engineers and Impediments to Responsibility. Risks, Safety and liability of Engineers. Honesty, Integrity & Reliability in Engineering.

Text Books:

1. Durga Das Basu, "Introduction to the Constitution on India", Student Edition, Prentice-Hall EEE, 19^{th}/ 20^{th} Edition, 2001.
2. Charles E. Haries, Michael S Pritchard and Michael J. Robins, "Engineering Ethics", Thompson

Asia, 2003.

Reference Books:

1. M.V.Pylee, "An Introduction to Constitution of India", 3rd Edition, Vikas Publishing, 2002.
2. M.Govindarajan, S.Natarajan, V.S.Senthilkumar, "Engineering Ethics", Prentice – Hall of India Pvt. Ltd. New Delhi, 2013.
3. Brij Kishore Sharma, " Introduction to the Constitution of India", 7th Edition, PHI Learning Pvt. Ltd., New Delhi, 2011.
4. Latest Publications of Indian Institute of Human Rights, New Delhi.

Web Resources

1. www.nptel.ac.in
2. www.hnlu.ac.in
3. www.nspe.org
4. www.preservearticles.com