Shri Vile Parle Kelavani Mandal's

Dwarkadas J. Sanghvi College of Engineering

(Autonomous College Affiliated to the University of Mumbai)

Scheme and Detailed syllabus (DJS23)

Third Year B.Tech

in

Computer Science and Engineering (Data Science)

(Semester V)

Shri Vile Parle Kelavani Mandal's
DWARKADAS J. SANGHVI COLLEGE OF ENGINEERING
(Autonomous College Affiliated to the University of Mumbai)
NAAC Accredited with "A" Grade (CGPA : 3.18)

Scheme of Semester - V for Department of Computer Science and Engineering (Data Science)
Academic Year (2025 - 2026)

Sr. No.	Course Code	Course	Teaching Scheme (hrs.)				Semester End Examination(A)						Continuous Assessment (B)						Aggregate (A+B)	Total Credits	
			Theory (hrs)	Practical (hrs)	Tut (hrs)	Credits	Duration (hrs)	Theory/ Cb	Oral	Pract	Oral & Pract	Total SEE (A)	Term Test 1 (TT1)	Term Test 2 (TT2)	Term Test 3 (TT3)	Total (TT1,TT2,TT3)	Term Work Total	TotalCA(A)			
1	DJ823DCPC501	Machine Learning-II(Deep Learning)	3	--	--	3	2	60	--	--	--	60	15	15	10	40		40	100	3	
	DJ823DLPC501	Machine Learning-II Laboratory	--	2	--	1	2	--	--	--	25	25					25	25	50	1	4
2	DJ823DCPC502	Design and Analysis of Algorithms	3	--	--	3	2	60	--	--	--	60	15	15	10	40		40	100	3	
	DJ823DLPC502	Design and Analysis of Algorithms Laboratory	--	2	--	1	2	--	--	--	25	25					25	25	50	1	4
3	DJ823DCPC503	Intelligent Systems	2	--	--	2	2	60	--	--	--	60	15	15	10	40		40	100	2	
	DJ823DLPC503	Intelligent Systems Laboratory	--	2	--	1	--	--	--	--	--	--					25	25	25	1	3
4@	DJ823DCPE511	Recommender Systems	3	--	--	3	2	60	--	--	--	60	15	15	10	40		40	100	3	
	DJ823DLPE511	Recommender Systems Laboratory	--	2	--	1	--	--	--	--	--	--					25	25	25	1	4
	DJ823DCPE512	Soft Computing	3	--	--	3	2	60	--	--	--	60	15	15	10	40		40	100	3	
	DJ823DLPE512	Soft Computing Laboratory	--	2	--	1	--	--	--	--	--	--					25	25	25	1	4
	DJ823DCPE513	Social Network Analysis	3	--	--	3	2	60	--	--	--	60	15	15	10	40		40	100	3	
	DJ823DLPE513	Social Network Analysis Laboratory	--	2	--	1	--	--	--	--	--	--					25	25	25	1	4
	DJ823DCPE514	Cloud Computing and Security	3	--	--	3	2	60	--	--	--	60	15	15	10	40		40	100	3	
	DJ823DLPE514	Cloud Computing and Security Laboratory	--	2	--	1	--	--	--	--	--	--					25	25	25	1	4
5	DJ823DCMD501	Computer Communication and Networks	3	--	--	3	2	60	--	--	--	60	15	15	10	40		40	100	3	
	DJ823DLMD501	ComputerCommunication and Networks Laboratory	--	2	--	1	2	--	--	--	25	25					25	25	50	1	4
6#	DJ823OLOE501	DevOps Laboratory	--	4	--	2	--	--	--	--	--	--					50	50	50	2	2
	DJ823OLOE502	Advanced Java Laboratory																			
	DJ823OLOE503	Advanced Database Laboratory																			
7	DJ823IPSCX03	Innovative Product Development III	--	2	--	1	2	--	--	--	25	25					25	25	50	1	1
8	DJ823ICHSX09	Constitution of India	1	--	--	--	--	--	--	--	--	--				--		--	--	--	--
		Total	**15**	**16**	**0**	**22**	**18**	**300**	**0**	**0**	**100**	**400**	**75**	**75**	**50**	**200**	**200**	**400**	**800**	**22**	**22**

Continuous Assessment (A):

Course	Assessment Tools	Marks	Time (hrs.)
Theory	a. Term Test 1 (based on 40 % syllabus)	15	45
	b. Term Test 2 (on next 40 % syllabus)	15	45
	c. Assignment / course project / group discussion / presentation / quiz/ any other.	10	--
	Total marks (a + b + c)	40	--
Audit course	Performance in the assignments / quiz / power point presentation / poster presentation / group project / any other tool.	--	As applicable
Laboratory	Performance in the laboratory and documentation.	25	
Tutorial	Performance in each tutorial & / assignment.	25	
Laboratory &Tutorial	Performance in the laboratory and tutorial.	50	

The final certification and acceptance of term work will be subject to satisfactory performance upon fulfilling minimum passing criteria in the term work / completion of audit course.

Semester End Assessment (B):

Course	Assessment Tools	Marks	Time (hrs.)
Theory / * Computer based	Written paper based on the entire syllabus.	60	2
	* Computer based assessment in the college premises.		
Oral	Questions based on the entire syllabus.	25	As applicable
Practical	Performance of the practical assigned during the examination and the output / results obtained.	25	2
Oral & Practical	Project based courses - Performance of the practical assigned during the examination and the output / results obtained. Based on the practical performed during the examination and on the entire syllabus.	As per the scheme	2

Prepared by Checked by Head of the Department Principal

PROGRAMME CORE COURSE

Program: B.Tech in Computer Science and Engineering (Data Science) **Semester: V**

Course: Machine Learning - II (Deep Learning) (DJS23DCPC501)

Machine Learning - II Laboratory (DJS23DLPC501)

Pre-requisite: Linear Algebra, Calculus, Probability, Statistics and Machine Learning Basics.

Course Objectives:

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, learner will be able to:

1. Analyze different neural network architectures and their learning algorithms.
2. Build solution using appropriate neural network and deep network models.
3. Analyze optimization strategies and regularization methods to enhance deep learning model training.
4. Evaluate and implement transfer learning techniques across various applications.

Machine Learning - II (Deep Learning) (DJS23DCPC501)		
Unit	**Description**	**Duration**
1	**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.	**07**
2	**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.	**06**
3	**Optimization for Training Deep Models:** Challenges in Neural Network Optimization, Basic Algorithms, Parameter Initialization Strategies. Optimizers: Gradient Descent, Stochastic Gradient Descent, SGD with Momentum, SGD with Momentum, RMSProp, Adam. **Regularization for Deep Learning:** Parameter Norm Penalties, Dataset Augmentation, Noise Robustness, Early Stooping, Sparse Representation, Dropout and Batch Normalization.	**05**
4	**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	**06**

	(Squeeze-and-Excitation (SE) Networks, CBAM).	
5	**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 Factor 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.	**07**
6	**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	**08**
	Total	**39**

Machine Learning - II Laboratory (DJS23DLPC501)	
Exp.	**Suggested Experiments**
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

* The Term Work will be calculated based on Laboratory Performance (15m) and Assignment/Quizzes (10m).

Books Recommended:

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”, Wiley India Publications, 3rd Edition, 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, 2nd 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: B.Tech in Computer Science and Engineering (Data Science) **Semester: V**

Course: Design and Analysis of Algorithms (DJS23DCPC502)

Design and Analysis of Algorithms Laboratory (DJS23DLPC502)

Pre-requisite: Computer Programming, Data structures.

Course Objectives:

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, learner will be able to:

1. Analyze the performance of algorithms by solving recurrence relations with various methods.
2. Solve the problem using appropriate algorithmic design techniques.
3. Able to prove that certain problems are NP-Complete.

Design and Analysis of Algorithms (DJS23DCPC502)		
Unit	**Description**	**Duration**
1	**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.	**06**
2	**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.	**06**
3	**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.	**06**
4	**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).	**10**
5	**Backtracking:** Introduction, Basics of backtracking, N–queen problem, Sum of subsets, Graph coloring, Hamiltonian cycles Generating permutation. **Branch-and-Bound:**	**06**

	Introduction, Control abstraction -LC BB, FIFO BB, LIFO BB, 15 Puzzle problem, 0/1 Knapsack problem, Job Sequencing with Deadline.	
6	**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.	**05**
	Total	**39**

Design and Analysis of Algorithms Laboratory (DJS23DLPC502)	
Exp.	**Suggested Experiments**
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 Kruskal's/ Prim's algorithm using greedy approach.
6	Implementation of job sequencing with deadline using greedy approach.
7	Implementation of Single source shortest path (Dijkstra's algorithm)
8	Implementation of Bellman Ford algorithm using Dynamic programming
9	Implementation of Longest Common Subsequence algorithm using Dynamic programming.
10	Implementation of Travelling Salesperson problem using Dynamic programming.
11	Implementation of multistage graphs/ all pair shortest path using dynamic programming.
12	Implementation of N-queen problem using Backtracking.
13	Given an integer array num of 2n integers, group these integers into n pairs (a_1, b_1), (a_2, b_2), ..., (a_n, b_n) such that the sum of min (a_i, b_i) for all i is maximized. Return the maximized sum. (Using LeetCode Platform)
14	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.
15	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.
16	Given an array prices where prices[i] is the price of a given stock on the i^{th} 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.

Minimum 10 experiments from the above-suggested list or any other experiment or mini project based on syllabus will be included, which would help the learner to apply the concept learnt.

*The Term Work will be calculated based on Laboratory Performance (15m) and Assignments/Quizzes (10m).

Books Recommended:

Textbooks:

1. Sanjoy Dasgupta, Christos Papadimitriou, Umesh Vazirani, 'Algorithms', Tata McGraw- Hill, 1st Edition, 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", University Press, 1st Edition, 2018.

Reference Books:

1. S. K. Basu, 'Design Methods and Analysis of Algorithm', PHI, 2nd Edition, 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: B.Tech in Computer Science and Engineering (Data Science) **Semester: V**

Course: Intelligent Systems (DJS23DCPC503)

Intelligent Systems Laboratory (DJS23DLPC503)

Pre-requisite: Basic Mathematics**,** Data Structures

Course Objectives:

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, learner will be able to:

1. Apply appropriate search-based method for a given problem.
2. Analyze various IS approaches to knowledge - problem solving, reasoning, and intelligent planning.
3. Apply the knowledge of reasoning and intelligent planning to solve a problem.

Intelligent Systems (DJS23DCPC503)		
Unit	**Description**	**Duration**
1	**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, Depth First Iterative Deepening (DFID).	**04**
2	**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.	**06**
3	**Knowledge and Reasoning in Logic:** Logic, Soundness and Completeness, Propositional Logic, First Order Logic, forward chaining, Backward chaining and Refutation.	**04**
4	**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).	**06**

5	**Planning:** Domain independent planning, Forward and Backward search, Goal Stack Planning, Plan Space Planning, Means Ends Analysis, Graphplan, algorithm AO*.	**06**
	Total	**26**

Intelligent Systems Laboratory ((DJS23DLPC503)	
Exp.	**Suggested Experiments**
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

* The Term Work will be calculated based on Laboratory Performance (15m) and Assignment/Quizzes (10m).

Books Recommended:

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", Elsevier 1st Edition, 2008.

Reference Books:

1. Saroj Kaushik "Artificial Intelligence", First Edition, Cengage Learning, 2011.
2. Ivan Bratko "PROLOG Programming for Artificial Intelligence", Fourth 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" Third Edition, Tata McGraw-Hill, 2008.
5. Patrick Henry Winston, "Artificial Intelligence", Addison-Wesley, Third Edition.

Web Links:

1. NPTEL: Computer Science and Engineering - Artificial Intelligence: Search Methods for Problem Solving
2. NPTEL Course: An Introduction to Artificial Intelligence

PROGRAMME ELECTIVE COURSE

Program: B.Tech in Computer Science and Engineering (Data Science) **Semester: V**

Course: Recommender Systems (DJS23DCPE511)

Recommender Systems Laboratory (DJS23DLPE511)

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

Course Objectives: 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:

1. Explain the fundamental concepts and biases in recommender systems.
2. Apply neighborhood-based and collaborative filtering techniques for designing recommender systems.
3. Design and evaluate advanced recommender systems using hybrid approaches, constraint-based and context-aware models.

Recommender Systems (DJS23DCPE511)		
Unit	**Description**	**Duration**
1	**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.	**07**
2	**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.	**05**
3	**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,	**08**

	Neighborhood Selection. **Graph-based Methods:** User-Item Graphs, Neighborhoods with Random Walks, Neighborhoods with the Katz Measure, Attacks on collaborative recommender systems	
4	**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.	**07**
5	**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.	**07**
6	**Hybrid approaches:** Deep Recommender systems, Multimodal Recommenders, Monolithic hybridization design: Feature combination, Feature augmentation, Parallelized hybridization design: Weighted, Switching. Limitations of hybridization strategies.	**05**
	Total	**39**

Recommender Systems Laboratory (DJS23DLPE511)	
Exp.	**Suggested Experiments**
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.

Minimum 10 experiments from the above-suggested list or any other experiment or mini project based on syllabus will be included, which would help the learner to apply the concept learnt.
*The Term Work will be calculated based on Laboratory Performance (15m) and Assignments/Quizzes (10m).

Books Recommended:

Textbooks:

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

Reference Books:

1. 1. M.D. Ekstrand, J.T. Riedl, J.A. Konstan, "Collaborative filtering recommender systems", Now publishers, 1st Edition, 2011.
2. 2. J. Leskovec, A. Rajaraman and J. Ullman, "Mining of massive datasets", Cambridge, 2nd Edition, 2012.
3. 3. Rounak Banik, "Hands-On Recommendation Systems with Python: Start building", Ingram short title, 2018
4. 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: B.Tech in Computer Science and Engineering (Data Science) **Semester: V**

Course: Soft Computing (DJS23DCPE512)

Soft Computing Laboratory ((DJS23DLPE512)

Pre-requisite: Mathematics, Algorithms.

Course Objectives: 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, learner will be able to:

1. Understand the fundamentals of soft computing.
2. Apply fuzzy logic and evolutionary algorithms to solve real-world decision-making and optimization problems.
3. Analyze multi-objective optimization techniques and hybrid soft computing models to handle complex problem-solving scenarios.

Soft Computing (DJS23DCPE512)		
Unit	**Description**	**Duration**
1	**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.	**03**
2	**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.	**06**
3	**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.	**07**
4	**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.	**08**

5	**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 receivers – Artificial bee colony (ABC) algorithms - binary ABC algorithms, ACO and ABC algorithms for solving SINX maximization problem, Particle Swarm Optimization.	**10**
6	**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	**05**
	Total	**39**

Soft Computing Laboratory ((DJS23DLPE512)	
Exp.	**Suggested Experiments**
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.

* The Term Work will be calculated based on Laboratory Performance (15m) and Assignment/Quizzes (10m).

Books Recommended:

Textbooks:

1. S. N. Sivanandam and S. N. Deepa, "Introduction to Soft Computing", Wiley India Publications, 3rd Edition, 2018.
2. Recent Advances in Swarm Intelligence and Evolutionary Computation, Xin-She Yang, Springer International Publishing, Switzerland, 2015.
3. Kalyanmoy Deb, Multi-Objective Optimization using Evolutionary Algorithms Paperback – Wiley India Publications, 2010.
4. Multi-Objective Optimization using Evolutionary Algorithms, Kalyanmoy Deb, John Wiley & Sons, 2001.

Reference Books:

1. Timothy J.Rose, "Fuzzy Logic with Engineering Applications", Fourth Edition, John Wiley, 2020.
2. GENETIC ALGORITHMS: in search, optimization and machine learning, D. E. GOLDBERG, Dec 2008.
3. Artificial Neural Networks, B. Yegnanarayana, PHI publication, 1998.
4. Neural Networks: Algorithms, Applications, and Programming Techniques, James FREEMAN and David Skapura, Pearson publication, 1st edition – 2002.
5. J.S.R Jang,C.T Sun and E.Mizutani, "Neuro-Fuzzy and Soft Computing", Second 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/

Prepared by Checked by Head of the Department Principal

Program: B.Tech in Computer Science and Engineering (Data Science) **Semester: V**

Course: Social Network Analysis (DJS23DCPE513)

Social Network Analysis Laboratory (DJS23DLPE513)

Pre-requisite: Probability and Statistics, Machine Learning.

Course Objectives: 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:

1. Analyse social networks using visualization techniques and structural measures.
2. Illustrate network growth patterns and ranking methodologies in complex networks.
3. Examine methods for detecting communities, predicting links, and modelling information flow.
4. Apply anomaly detection and representation learning approaches for network analysis.

Social Network Analysis (DJS23DCPE513)		
Unit	**Description**	**Duration**
1	**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.	**08**
2	**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.	**06**
3	**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	**06**

4	**Cascade Behaviours & Network Effects:** Preliminaries and Important Terminologies, Cascade Models, Probabilistic Cascades, Epidemic Models, Independent Cascade Models, Cascade Prediction.	**05**
5	**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.	**06**
6	**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.	**08**
	Total	**39**

Social Network Analysis Laboratory ((DJS23DLPE513)	
Exp.	**Suggested Experiments**
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 GCN.
10	Mini Project

* The Term Work will be calculated based on Laboratory Performance (15m) and Assignment (10m).

Books Recommended:

Textbooks:

1. Tanmoy Chakraborty, "Social Network Analysis", First Edition, Wiley, 2021.
2. Stephen P Borgatti, Martin G. Everett, Jeffrey C. Johnson, "Analyzing Social Networks",
3. Sage Publications Ltd, 2nd Edition, 2018.
4. 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)", First Edition, Springer, 2019.
3. John Scott, "Social Network Analysis", Fourth Edition, SAGE Publications Ltd,2017.
4. Song Yang, Franziska Barbara Keller, Lu Zheng,"Social Network Analysis : Methods and Examples", First 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: B.Tech in Computer Science and Engineering (Data Science) **Semester: V**

Course: Cloud Computing and Security (DJS23DCPE514)

Cloud Computing and Security Laboratory (DJS23DLPE514)

Pre-requisite: System Fundamentals and Basic Networking.

Course Objectives:

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 students will able to

1. Demonstrate the ability to differentiate between parallel and distributed computing and understand the role of virtualization in cloud environments.
2. Apply knowledge of cloud architecture to select appropriate cloud service models and types, and perform effective cloud migrations.
3. Configure and manage VPCs, EC2 instances, and understand best practices for cloud networking and instance management.
4. Implement cloud storage solutions, leverage DBaaS, and ensure robust cloud security using industry-standard practices and AWS security services.

Cloud Computing and Security (DJS23DCPE514)		
Unit	**Description**	**Duration**
1	**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, bare-metal, Hypervisor and Xen Architecture, Para virtualization with Compiler Support, CPU Virtualization, Other Virtualizations: Storage, Network, Desktop and Application Server Virtualization, Virtualization and cloud computing.	**06**
2	**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.	**06**

3	**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).	**08**
4	**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.	**06**
5	**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.	**08**
6	**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.	**05**
	Total	**39**

Cloud Computing and Security Laboratory (DJS23DLPE514)	
Exp.	**Suggested Experiments**
1	Virtualisation: • Hosted Virtualisation • 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).

*The Term Work will be calculated based on Laboratory Performance (15m) and Assignment/Quizzes (10m).

Books Recommended:

Text Books:

1. Pravin Mishra, "Cloud Computing with AWS", Apress, 2023.
2. Rajkumar Buyya,"Mastering Cloud Computing", McGraw Hill Education, 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

Shri Vile Parle Kelavani Mandal's
DWARKADAS J. SANGHVI COLLEGE OF ENGINEERING
(Autonomous College Affiliated to the University of Mumbai)
NAAC Accredited with "A" Grade (CGPA : 3.18)

MULTIDISCIPLINARY MINOR

Program: B.Tech in Computer Science and Engineering (Data Science) **Semester: V**

Course: Computer Communication and Networks (DJS23DCMD501)

Computer Communication and Networks Laboratory (DJS23DLMD501)

Pre-requisite: Computer System Fundamentals.

Course Objectives:

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:

1. Understand the fundamentals of computer networks, including topologies, protocols, and network models such as OSI and TCP/IP.
2. Apply knowledge of network addressing, subnetting, supernetting, and routing algorithms to design efficient network solutions.
3. Analyse transport and data link layer protocols, error control, and flow control mechanisms to enhance network communication reliability.
4. Evaluate IoT architectures, communication protocols, and smart networking applications to propose innovative IoT-based solutions.

Computer Communication and Networks (DJS23DCMD501)		
Unit	**Description**	**Duration**
1	**Introduction to Computer Networks:** Basics of Computer Networks, Network Topologies and Protocols, OSI and TCP/IP Models, Network Devices and Components.	**05**
2	**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.	**08**
3	**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.	**08**
4	**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.	**08**

5	**IoT Architecture and Technologies:** Introduction to the Internet of Things (IoT), IoT Architecture and Components, Communication Protocols for IoT (MQTT, CoAP, etc.).	**05**
6	**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	**05**
	Total	**39**

Computer Communication and Networks Laboratory (DJS23DLMD501)	
Exp.	**Suggested Experiments**
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.

Minimum eight experiments from the above suggested list or any other experiment or mini project based on syllabus will be included, which would help the learner to apply the concept learnt.

***** The Term Work will be calculated based on Laboratory Performance (15m) and Assignment/Quizzes (10m).

Books Recommended:

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, 2016.
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/

OPEN ELECTIVE

Program: B.Tech in Computer Science and Engineering (Data Science) **Semester: V**

Course: DevOps Laboratory (DJS23OLOE501)

Pre-requisite: Computer System Fundamentals, Web Engineering and Project Management.

Course Objectives:
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 students will able to
1. Apply Virtualization, Containerization, and Infrastructure Automation.
2. Design CI/CD Pipelines and Automated Testing.
3. Develop monitoring, logging, and performance enhancement strategies.

DevOps Laboratory (DJS23OLOE501)		
Unit	**Description**	**Duration**
1	**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.	**04**
2	**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.	**04**
3	**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.	**06**
4	**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.	**06**
5	**Automated Testing using Selenium** 1. Install Selenium and set up WebDriver.	**06**

	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.	
6	**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.	**06**
7	**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.	**06**
8	**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.	**04**
9	**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.	**04**
10	**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.	**06**
	Total	**52**

* The Term Work will be calculated based on Laboratory Performance (15m), Mini Project (10m) and Computer Based Assessment (25m).

Books Recommended:

Text Books:

1. Karl Matthias & 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”, 2 nd Edition Packt publication,2018. 4. Martin Alfke, “ Puppet Essentials - Third Edition: A fast-paced guide to automating your infrastructure”, 3 rd 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: B.Tech in Computer Science and Engineering (Data Science) **Semester: V**

Course: Advanced Java Laboratory (DJS23OLOE502)

Pre-requisite: Core Java and OOP concepts.

Course Objectives:

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:

1. Apply advanced object-oriented concepts and design patterns in Java to develop scalable and maintainable solutions for real-world problems.
2. Optimize data processing and performance using the Java Collections Framework, Streams API, and generics.
3. Build secure, database-driven web applications using Spring and Spring Boot, with RESTful web services.

Advanced Java Laboratory (DJS23OLOE502)		
Unit	**Description**	**Duration**
1	**Design Patterns:** Introduction to design patterns and Implementation: Singleton, Factory, Observer, Strategy.	**04**
2	**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.	**04**
3	**Collections:** List: ArrayList, LinkedList, Set: HashSet, Tree Set, Map: HashMap, LinkedHashMap.	**04**
4	**Java Streams**: Introduction to Streams API, Creating streams from collections, arrays, I/O Stream operations: map, filter, reduce, collect.	**04**
5	**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.	**04**

6	**Java Database Connectivity (JDBC):** Connecting to databases using JDBC, Executing SQL queries and managing results.	**04**
7	**Introduction to Object-Relational Mapping (ORM):** Overview of Hibernate and JPA, Creating a simple application using Hibernate.	**04**
8	**Microservices:** Fundamentals of Microservices, Microservices Architecture & Design Principles. **Tools for Microservices:** Spring Boot, Eureka API Gateway & load balancing between multiple instances of a microservices.	**04**
9	**Introduction to Spring:** Overview of Spring Framework features, Inversion of Control (IoC) and Dependency Injection (DI).	**04**
10	**Spring Core:** Understanding Beans, Application Context, and Bean Lifecycle Configuring Spring with XML and Java annotations.	**04**
11	**Introduction to Spring Boot**: Understanding its purpose and advantages over traditional Spring. **Setting Up Spring Boot Applications:** Project structure and configuration.	**04**
12	**Building RESTful Web Services:** Creating REST APIs using Spring Boot. **Spring Data JPA:** Introduction to database interactions and repository pattern.	**04**
13	**Securing Spring Boot Applications:** Basics of security in Spring Boot using Spring Security.	**04**
	Total	**52**

* The Term Work will be calculated based on Laboratory Performance (15m), Mini Project (10m) and Computer Based Assessment (25m).

Books Recommended:

Textbooks:

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

Prepared by Checked by Head of the Department Principal

Program: B.Tech in Computer Science and Engineering (Data Science) **Semester: V**

Course: Advanced Database Laboratory (DJS23OLOE503)

Course Objectives:
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:

1. Design and implement database solutions using advanced, object-oriented, and distributed database systems.
2. Apply query optimization, security, and visualization techniques for efficient and secure data handling.
3. Analyze emerging database technologies like vector and graph databases through practical use-cases and case studies.

Advanced Database Laboratory (DJS23OLOE503)		
Unit	**Description**	**Duration**
1	**Introduction to Modern Databases:** • Overview of emerging database paradigms (Document, Columnar, Graph, Object-oriented, Vector DBs). • Use-case-based classification of databases.	**04**
2	**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.	**08**
3	**Distributed DB Design:** • Perform fragmentation (Range, List, Hash, Key). • Simulate replication and allocation.	**04**
4	**Document-Oriented Data Handling:** • Work with JSON, XML. • Query JSON/XML using inbuilt functions.	**04**
5	**Query Optimization & Processing:** • View Query Execution Plan. • Optimize queries using heuristics.	**04**
6	**Object-Oriented Database with DB4O** • Store Java objects. • Retrieve objects and update DB.	**04**
7	**Graph Databases** • Install Neo4j.	**04**

	• Create nodes and relationships. • Query using Cypher.	
8	**Vector DB** • Vector indexing. • Similarity search example app. • MongoDB Vector • PG Vector	**08**
9	**Ethical & Legal Issues in Modern Databases** • Explore Real-World Data Breaches. • Policy Analysis Activity. • Design a Privacy-Compliant Database Schema..	**04**
10	**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.	**08**
	Total	**52**

*The Term Work will be calculated based on Laboratory Performance (15m), Mini Project (10m) and Computer Based Assessment (25m).

Books Recommended:

Textbooks:

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", Third 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/tutorials/
2. Cassandra: DataStax Academy https://www.datastax.com/dev/academy
3. Neo4j GraphAcademy: Advanced Courses https://graphacademy.neo4j.com/categories/advanced/

VOCATIONAL AND SKILL ENHANCEMENT COURSE

Program: B.Tech in Computer Science and Engineering (Data Science) **Semester: V**

Course: Innovative Product Development III (DJS23IPSCX03)

Objectives:

1. To acquaint the students with the process of identifying the need (considering a societal requirement) and ensuring that a solution is found out to address the same by designing and developing an innovative product.
2. To familiarize the students with the process of designing and developing a product, while they work as part of a team.
3. To acquaint the students with the process of applying basic engineering fundamentals, so as to attempt at the design and development of a successful value-added product.
4. To inculcate the basic concepts of entrepreneurship and the process of self-learning and research required to conceptualize and create a successful product.

Outcome: Learner will be able to:

1. Identify the requirement for a product based on societal/research needs.
2. Apply knowledge and skills required to solve a societal need by conceptualizing a product, especially while working in a team.
3. Use standard norms of engineering concepts/practices in the design and development of an innovative product.
4. Draw proper inferences through theoretical/ experimental/simulations and analyze the impact of the proposed method of design and development of the product.
5. Develop interpersonal skills, while working as a member of the team or as the leader.
6. Demonstrate capabilities of self-learning as part of the team, leading to life-long learning, which could eventually prepare themselves to be successful entrepreneurs.
7. Demonstrate product/project management principles during the design and development work and also excel in written (Technical paper preparation) as well as oral communication.

Guidelines for the proposed product design and development:

1. Students shall form a team of 3 to 4 students (max allowed: 5-6 in extraordinary cases, subject to the approval of the department review committee and the Head of the department).
2. Students should carry out a survey and identify the need, which shall be converted into conceptualization of a product, in consultation with the faculty supervisor/head of department/internal committee of faculty members.
3. Students in the team shall understand the effective need for product development and accordingly select the best possible design in consultation with the faculty supervisor.
4. Students shall convert the best design solution into a working model, using various components drawn from their domain as well as related interdisciplinary areas.
5. Faculty supervisor may provide inputs to students during the entire span of the activity, spread over 2 semesters, wherein the main focus shall be on self-learning.
6. A record in the form of an activity log-book is to be prepared by each team, wherein the team can record weekly progress of work. The guide/supervisor should verify the recorded notes/comments and approve the same on a weekly basis.

7. The design solution is to be validated with proper justification and the report is to be compiled in a standard format and submitted to the department. Efforts are to be made by the students to try and publish a technical paper, either in the institute journal, "Techno Focus: Journal for Budding Engineers" or at a suitable publication, approved by the department research committee/ Head of the department.
8. The focus should be on self-learning, capability to design and innovate new products as well as on developing the ability to address societal problems. Advancement of entrepreneurial capabilities and quality development of the students through the year long course should ensure that the design and development of a product of appropriate level and quality is carried out, spread over 4 semesters, i.e. during the semesters III to VI.

Guidelines for Assessment of the work:

1. The review/ progress monitoring committee shall be constituted by the Head of the Department. The progress of design and development of the product is to be evaluated on a continuous basis, holding a minimum of two reviews in each semester.
2. In the continuous assessment, focus shall also be on each individual student's contribution to the team activity, their understanding and involvement as well as responses to the questions being raised at all points in time.
3. Distribution of marks individually for the both reviews as well as for the first review during the subsequent semester shall be as given below:

A.	Marks awarded by the supervisor based on log-book	20
B.	Marks awarded by review committee	20
C.	Quality of the write-up	10

Review/progress monitoring committee may consider the following points during the assessment.

In the semester V, the entire design proposal shall be ready, including components/system selection as well as the cost analysis. Two reviews will be conducted based on the presentation given by the student's team.

- First shall be for finalization of the product selected.
- Second shall be on finalization of the proposed design of the product.

The overall work done by the team shall be assessed based on the following criteria;

1. Quality of survey/ need identification of the product.
2. Clarity of Problem definition (design and development) based on need.
3. Innovativeness in the proposed design.
4. Feasibility of the proposed design and selection of the best solution.
5. Cost effectiveness of the product.
6. Societal impact of the product.
7. Functioning of the working model as per stated requirements.
8. Effective use of standard engineering norms.
9. Contribution of each individual as a member or the team leader.
10. Clarity on the write-up and the technical paper prepared.

The semester V reviews may be based on relevant points listed above, as applicable.

Guidelines for Assessment of Semester Reviews:

- The write-up should be prepared as per the guidelines given by the department.

The design and the development of the product shall be assessed through a presentation and demonstration of the working model by the student team to a panel of Internal and External Examiners, preferably from industry or any research organizations having an experience of more than five years, approved by the Head of the Institution. The presence of the external examiner is desirable only for the 2nd presentation in semester VI. Students are compulsorily required to present the outline of the technical paper prepared by them during the final review in semester VI.

Shri Vile Parle Kelavani Mandal's
DWARKADAS J. SANGHVI COLLEGE OF ENGINEERING
(Autonomous College Affiliated to the University of Mumbai)
NAAC Accredited with "A" Grade (CGPA : 3.18)

VALUE EDUCATION COURSE

Program: B.Tech in Computer Science and Engineering (Data Science) **Semester: V**

Course: Constitution of India (DJS23ICHSX09)

Course Objectives:

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:

1. Have general knowledge and legal literacy and thereby to take up competitive examinations.
2. Understand state and central policies, fundamental duties.
3. Understand Electoral Process, special provisions.
4. Understand powers and functions of Municipalities, Panchayats and Co-operative Societies.
5. Understand Engineering ethics and responsibilities of Engineers.
6. Understand Engineering Integrity & Reliability.

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration**
1	**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.	**02**
2	**Directive Principles of State Policy:** Relevance of Directive Principles, State Policy, Fundamental Duties. Union Executives – President, Prime Minister, Parliament, Supreme Court of India.	**02**
3	**State Executives:** Governor, Chief Minister, State Legislature, High Court of State. Electoral Process in India, Amendment Procedures, 42nd, 44th, 74th, 76th, 86th & 91st Amendments.	**03**
4	**Special Provisions:** For SC & ST, Special Provision for Women, Children & Backward Classes, Emergency Provisions.	**02**
5	**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.	**02**
6	**Scope & Aims of Engineering Ethics**: Responsibility of Engineers and Impediments to Responsibility. Risks, Safety and liability of Engineers. Honesty, Integrity & Reliability in Engineering.	**02**
	Total	**13**

Books Recommended:

Text books:

1. Durga Das Basu, *"Introduction to the Constitution on India",* (Students Edition) Prentice Hall EEE, 19th / 20th 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",* Vikas Publishing, 3rd Edition, 2003.
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",* PHI Learning Pvt. Ltd., New Delhi, 7th Edition 2015.
4. Latest Publications of *Indian Institute of Human Rights*, New Delhi

Website Resources:

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