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 2024-25

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. 2024-25)														
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	22PCCS5010T	Machine Learning-II(Deep Learning)	3			25	10	10	10	65	100	3	4
	PC	22PCCS5010L	Machine Learning-II(Deep Learning)Laboratory			2	25				25	50	1	
2	PC	22PCCS5020T	Intelligent Systems	3			25	10	10	10	65	100	3	4
	PC	22PCCS5020L	Intelligent Systems Laboratory			2	25					25	1	
3	PC	22PCCS5030T	Image Processing and Computer Vision - I	3			25	10	10	10	65	100	3	4
	PC	22PCCS5030L	Image Processing and Computer Vision - I Laboratory			2	25				25	50	1	
4	PC	22PCCS5040L	Big Data Engineering Laboratory	2		2	50				50	100	3	3
5@	PE	22PECS5051T	Distributed Computing	3			25	10	10	10	65	100	3	4
		22PECS5051L	Distributed Computing Laboratory			2	25					25	1	
		22PECS5052T	Time Series Analysis	3			25	10	10	10	65	100	3	
		22PECS5052L	Time Series Analysis Laboratory			2	25					25	1	
		22PECS5053T	Digital System Design	3			25	10	10	10	65	100	3	
		22PECS5053L	Digital System Design Laboratory			2	25					25	1	
		22PECS5054T	Probabilistic Graph Models	3			25	10	10	10	65	100	3	
		22PECS5054L	Probabilistic Graph Models Laboratory			2	25					25	1	
6	HM	22HMCS5060T	Professional and Business Communication Tutorial		2		25					25	2	2
7	PJ	22PJCS5070L	Semester Project-III			2	25				25	50	1	1
8	HM	22HMCS5080L	Employability Skill Development Program-II			2	50					50	1	1
			Total	14	2	14	350			40	385	775	23	

@Any 1 Elective Course

Prepared by:
Dr. P. S. Sanjekar

Checked by:
Ms. S. P. Salunkhe

Prof. Dr. U. M. Patil
BOS Chairman

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

K. K. Patel Institute of Technology

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

Prof. Dr. J. B. Patil
Director

Third Year B. Tech Computer Science and Engineering (Data Science) Semester-VI (w.e.f. 2024-25)

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	22PCCS6010T	Machine Learning - III (Reinforcement Learning)	3			25	10	10	10	65	100	3	4
	PC	22PCCS6010L	Machine Learning - III Laboratory			2	25					25	1	
2	PC	22PCCS6020T	Natural Language Text Processing	3			25	10	10	10	65	100	3	4
	PC	22PCCS6020L	Natural Language Text Processing Laboratory			2	25				25	50	1	
3	PC	22PCCS6030T	Image Processing and Computer Vision - II	3			25	10	10	10	65	100	3	4
	PC	22PCCS6030L	Image Processing and Computer Vision - II Laboratory			2	25				25	50	1	
4	PC	22PCCS6040L	Programming Laboratory	2		2	50				50	100	3	3
5@	PE	22PECS6051T	Cloud Computing	3			25	10	10	10	65	100	3	4
		22PECS6051L	Cloud Computing Laboratory			2	25					25	1	
		22PECS6052T	Recommender System	3			25	10	10	10	65	100	3	
		22PECS6052L	Recommender System Laboratory			2	25					25	1	
		22PECS6053T	Embedded System & RTOS	3			25	10	10	10	65	100	3	
		22PECS6053L	Embedded System & RTOS Laboratory			2	25					25	1	
		22PECS6054T	Computational Neuroscience	3			25	10	10	10	65	100	3	
		22PECS6054L	Computational Neuroscience Laboratory			2	25					25	1	
6	PJ	22PJCS6060L	Project Stage-I			4	25				25	50	2	2
			Total	14		14	275			40	385	700	21	

@Any 1 Elective Course

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Director

Machine Learning -II (Deep Learning) (22PCCS5010T)

Teaching Scheme
Lectures : 03 Hrs./week
Credits : 03

Examination Scheme
Term Test : 10 Marks
Teacher Assessment : 25 Marks
End Sem Exam : 65 Marks
Total Marks : 100 Marks

Prerequisite: 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. Develop in-depth understanding of the key techniques in designing Deep Network and Transfer Learning.
3. To expose Deep Network based methods to solve real world complex problems.

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Analyze different neural network architectures and their learning algorithms.	L4	Analyze
CO2	Implement deep network training and design concepts.	L5	Evaluate
CO3	Build solution using appropriate neural network models.	L3, L6	Apply, Create
CO4	Illustrate performance of deep learning models using different techniques.	L2	Understand

Course Contents

Unit-I — 05 Hrs.

Introduction to Artificial Neural Learning:

Fundamental concepts of biological Neural Networks, NN Architectures, Important terminologies of ANN: Activation functions(sigmoid, ReLu, Leaky ReLu, Tanh, Softmax), weights, bias, threshold, learning rate, McCulloch Pitts Neuron: Theory and Architecture.

Unit-II — 08 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, overfitting and stopping criteria.

Optimization for Training Deep Models:

Challenges in Neural Network Optimization, Basic Algorithms, Parameter Initialization Strategies. Optimizers: Gradient Descent (Stochastic, Mini-Batch, Batch), SGD with Momentum, Nesterov Accelerated GD, Adagrad, Adadelta, RMSProp, Adam, Regularization for Deep Learning: Parameter Norm Penalties, Dataset Augmentation, Noise Robustness, Early Stopping, Sparse Representation, Dropout

Unit-III — 06 Hrs.

Convolutional Networks:

The Convolution Operation, sparse interactions, parameter sharing, Pooling, Convolution and Pooling as an Infinity Strong Prior, Variants of Basic Convolution Function, Efficient Convolution Algorithms (AlexNet, LeNet-5, VGG, DenseNet, InceptionNet, ResNet).

Unit-IV — 06 Hrs.

Sequence Modelling:

Recurrent Neural Networks (RNN), Bidirectional RNNs, Deep recurrent Networks, Recursive Neural Networks, The challenges of Long-Term Dependencies, Echo State Networks, Leaky Units, The Long Short-Term Memory (LSTM).

Unit-V — 08 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. Linear Factor Methods such as Probabilistic PCA and Factor Analysis, Independent Component Analysis.

Unit-VI 07 Hrs.

Transfer Learning:

Fundamental of Transfer Learning, Pre-trained Model Approach, Freezing, Fine-tuning. Transfer Learning Strategies: Inductive Learning, Inductive Transfer, Transductive Transfer Learning, Unsupervised Transfer Learning; Types of Deep Transfer Learning: Domain Adaptation, Domain Confusion, One-shot Learning, Zero-shot Learning, Multitask Learning; Types of Transferable Components: Instance transfer, Feature- representation transfer, Parameter transfer, Relational-knowledge transfer; Transfer Learning Challenges: Negative Transfer, Transfer Bounds; Applications: Transfer learning for NLP/ Audio/ Speech/ Computer Vision.

Text Books:

1. Simon Haykin, "Neural Networks and Learning Machines", Pearson Prentice Hall, 3rd Edition, 2010.
2. S. N. Sivanandam and S. N. Deepa, "Introduction to Soft Computing", 3rd Edition, Wiley India Publications, 2018.

Reference Books:

1. François Chollet, "Deep Learning with Python", Manning Publication, 2017.
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_cs[illegible] preview

Evaluation Scheme:

Theory :

Continuous Assessment (A):

Subject teacher will declare Teacher Assessment criteria at the start of semester.

Continuous Assessment (B):

1. Two term tests of 10 marks each will be conducted during the semester.
2. Average of the marks scored in both the tests will be considered for final grading.

End Semester Examination (C):

1. Question paper based on the entire syllabus, summing up to 65 marks.
2. Total duration allotted for writing the paper is 2 hrs.

Machine Learning -II(Deep Learning)Laboratory (22PCCS5010L)

Practical Scheme
Practical : 02 Hrs./week
Credit : 01

Examination Scheme
Teacher Assessment : 25 Marks
End Sem Exam : 25 Marks
Total : 50 Marks

Course Objectives:

1. Monitor and evaluate the deep learning models using different techniques.
2. Building SNN, RNN and explainable AI with real world data.

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Build solution using appropriate neural network models.	L4	Analyze
CO2	To expose Deep Network based methods to solve real world complex problems.	L5	Evaluate
CO3	Illustrate performance of deep learning models using different techniques.	L2	Understand

List of Laboratory Experiments

Suggested List of 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. Implement Sentiment analysis on text dataset to evaluate customer reviews.
6. Building CNN models for image categorization.
7. Document classification using RNN models.
8. Outlier detection in time series dataset using RNN.
9. Anomaly detection using Self-Organizing Network.
10. Compare the performance of PCA and Autoencoders on a given dataset.
11. Transfer Learning with Pre-trained CNN model as a Feature Extractor for Image Classification with a Data Availability Constraint.

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

Evaluation Scheme:

Laboratory:

Continuous Assessment (A):

Laboratory work will be based on 22PCCS5010T with at least 10 experiments from the above list to be incorporated. The distribution of marks for term work shall be as follows:

1. Performance in Experiments: 05 Marks
2. Journal Submission: 05 Marks
3. Viva-voce: 05 Marks
4. Subject Specific Lab Assignment/Case Study: 10 Marks

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

End Semester Examination (C):

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

Intelligent Systems (22PCCS5020T)

Teaching Scheme
Lectures : 03 Hrs./week
Credits : 03

Examination Scheme
Term Test : 10 Marks
Teacher Assessment : 25 Marks
End Sem Exam : 65 Marks
Total Marks : 100 Marks

Prerequisite: : Basic Mathematics and 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.

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– intensive problem solving, reasoning and intelligent planning.	L4	Analyze
CO3	Apply the knowledge of reasoning and intelligent planning to solve a problem.	L3	Apply

Course Contents

Unit-I — 08 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, Depth First Iterative Deepening (DFID). Heuristic Search: Best first Search, Hill Climbing, Variations of Hill Climbing, Solution Space, and Travelling Salesman Problem

Unit-II — 09 Hrs.

Optimizations:

Population Based Methods: Simulated annealing, Local beam search, Genetic algorithm. 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 — 06 Hrs.

Knowledge and Reasoning in Logic:

Logic, Soundness and Completeness, Propositional Logic, First Order Logic, forward chaining, Backward chaining and Refutation. Uncertain Knowledge and Reasoning: Fuzzy sets, Fuzzy Logic, Fuzzy Logic Controller.

Unit-IV — 05 Hrs.

Logic Foundation for Ontologies:

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.

Unit-V — 06 Hrs.

Ontology Modelling:

Advanced ontology modelling constructs (e.g. restrictions, class axioms), Ontology alignment, merging and versioning, Ontology-based data access and integration, Probabilistic and fuzzy ontologies, Rule-based reasoning with ontologies (e.g. SWRL), Scalable ontology reasoning techniques, Real-world ontology case studies and industry applications.

Unit-VI 05 Hrs.

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

Text Books:

1. Deepak Khemani, "A First Course in Artificial Intelligence", McGraw Hill Education, (India), 2013.
2. Dean Allemang, James Hendler, "Semantic Web for the Working Ontologist", Elsevier 1st Edition, 2008.

Reference Books:

1. Saroj Kaushik, "Artificial Intelligence", 1st Edition, Cengage Learning, 2011.
2. Ivan Bratko, "PROLOG Programming for Artificial Intelligence",4th Edition, Pearson Education, 2011.
3. Elaine Rich and Kevin Knight, "Artificial Intelligence", 3rd Edition, Tata McGraw-Hill, 2008.
4. Davis E.Goldberg, "Genetic Algorithms: Search, Optimization and Machine Learning", Addison Wesley, N.Y.
5. Patrick Henry Winston, "Artificial Intelligence", 3rd Edition, Addison-Wesley.
6. N.P.Padhy, "Artificial Intelligence and Intelligent Systems", Oxford University Press, 2005.
7. John Yen and Reza Langari, "Fuzzy Logic: Intelligence, Control, and Information", Pearson, 2002.

Evaluation Scheme:

Theory :

Continuous Assessment (A):

Subject teacher will declare Teacher Assessment criteria at the start of semester.

Continuous Assessment (B):

1. Two term tests of 10 marks each will be conducted during the semester.
2. Average of the marks scored in both the tests will be considered for final grading.

End Semester Examination (C):

1. Question paper based on the entire syllabus, summing up to 65 marks.
2. Total duration allotted for writing the paper is 2 hrs.

Intelligent Systems Laboratory (22PCCS5020L)

Practical Scheme	Examination Scheme
Practical : 02 Hrs./week	Teacher Assessment : 25 Marks
Credit : 01	Total : 25 Marks

Course Objectives:

1. Provide understanding of various techniques and algorithms of AI used in problem solving, optimization problems and game programming.
2. Familiarize with fuzzy operations for a given problem.

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Identify and apply searching algorithms to solve problems.	L3	Apply
CO2	Build knowledge base for a problem.	L3	Apply
CO3	Apply fuzzy operations for a given input.	L3	Apply

List of Laboratory Experiments

Suggested List of 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. Program on any natures inspired algorithm to solve a optimization problem in AI.
5. Implement A* search algorithm to reach goal state.
6. Implement minimax algorithm for a two-player game.
7. Implement Fuzzy operations for given input values.
8. Design a fuzzy logic controller for a given problem.
9. Develop a knowledge base using OWL.
10. Develop a Rule based System using SWRL on Protégé software.

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

Evaluation Scheme:

Laboratory:

Continuous Assessment (A):

Laboratory work will be based on 22PCCS5020T with minimum 10 experiments to be incorporated. The distribution of marks for term work shall be as follows:

1. Performance in Experiments: 05 Marks
2. Journal Submission: 05 Marks
3. Viva-voce: 05 Marks
4. Subject Specific Lab Assignment/Case Study: 10 Marks

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

Image Processing and Computer Vision - I (22PCCS5030T)

Teaching Scheme
Lectures : 03 Hrs./week
Credits : 03

Examination Scheme
Term Test : 10 Marks
Teacher Assessment : 25 Marks
End Sem Exam : 65 Marks
Total Marks : 100 Marks

Prerequisite: Basic co-ordinate geometry, matrix algebra, linear algebra and random process.

Course Objectives:

To teach various feature engineering and preprocessing techniques on image and video data types.

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Identify the need of different image and video pre-processing.	L1	Remember
CO2	Apply different image and video corrections.	L3	Apply
CO3	Compare different image and video processing methods.	L4	Analyze

Course Contents

Unit-I — 04 Hrs.

Digital Image Fundamentals: Steps in Digital Image Processing, Components, Image Sampling and Quantization, Neighborhood of pixels.

Unit-II — 11 Hrs.

Image Enhancement (point processing): Image Negative, Thresholding, Gray-level slicing with and without background, power law and log transform, Contrast Stretching, Histogram equalization

Image Enhancement in Spatial Domain (Neighbourhood processing): Low Pass and High Pass filtering for image enhancement, High boost filtering, Basics of Spatial Filtering, Generating Spatial Filter Masks–Smoothing and Sharpening Spatial Filtering

Image Transforms: 1-D DFT, 2-D Discrete Fourier Transform and Its Inverse, Some Properties of 2D DFT, Walsh -Hadamard, Discrete Cosine Transform, Haar Transform, Slant Transform

Image Enhancement in Frequency Domain: The Basics of Filtering in the Frequency Domain, Smoothing and Sharpening frequency domain filters

Unit-III — 08 Hrs.

Morphology: Erosion and Dilation, Opening and Closing, The Hit or-Miss Transformation. Restoration: Noise models – Mean Filters – Order Statistics – Adaptive filters- Adaptive mean filter, adptive guassian filter. .

Corner and Interest Point detection: The Harris Interest Point Operator: Corner Signals and shifts for various geometric configuration, Performance with crossing point and Junctions, Different forms of Harris Operator, Local Invariant Feature Detectors and Descriptors: Harris scale and Affine-Invariant Detectors and Descriptors.

Unit-IV — 08 Hrs.

Point, Line, and Edge Detection: Detection of Isolated Points, Line detection, edge models, basic and advance edge detection (Kirsch Compass Kernels) , Edge linking and boundary detection, Canny's edge detection algorithm

Thresholding: Foundation, Role of illumination, Basic Global thresholding, Otsu's method Region Based segmentation: Region Growing, Region Splitting and merging, Relationships between pixels, Hough transform

Region Identification: Chain code, simple geometric border representation (Topological and region based descriptor), Fourier Transform of boundaries, Boundary description using segment sequences

Unit-V — 08 Hrs.

Motion: Optical Flow, Interpretation of Optical Fields, Using focus of expansion to avoid collision, Time to adjacency analysis, Basic difficulties with optical flow models, Stero from Motion

Text Books:

1. Rafel C. Gonzalez and Richard E. Woods, "Digital Image Processing", 4th Edition, Pearson Education Asia, 2018.
2. Sanjit Mitra, "Digital Signal Processing: A Computer Based Approach", 4th Edition, Tata McGraw Hill, 2013.

Reference Books:

1. S. Salivahanan, A. Vallavaraj, C. Gnanapriya, "Digital Signal Processing", 4th Edition, Tata McGraw Hill Publication, 2019.
2. E. R. Davies, "Computer and Machine Vision: Theory, Algorithms", 4th Edition, Academic Press, 2012.
3. S. Jayaraman, E. Esakkirajan and T. Veerkumar, "Digital Image Processing", 1st Edition, Tata McGraw Hill Education Private Ltd, 2017.
4. Anil K. Jain, "Fundamentals and Digital Image Processing", 1st Edition, Pearson Education, 2015.
5. John G. Proakis, Dimitris and G. Manolakis, "Digital Signal Processing: Principles, Algorithms, and Applications", 4th Edition, Pearson Education, 2014.
6. A. Anand Kumar, "Digital Signal Processing", 2nd Edition, Prentice Hall, 2015.
7. S. Sridhar, "Digital Image Processing", 2nd Edition, Oxford University Press, 2016.

Web Links:

1. NPTEL Digital Image Processing, By Prof. Prabir Kumar Biswas, IIT Kharagpur: https://nptel.ac.in/courses/117/105/117105135/

Evaluation Scheme:

Theory :

Continuous Assessment (A):

Subject teacher will declare Teacher Assessment criteria at the start of semester.

Continuous Assessment (B):

1. Two term tests of 10 marks each will be conducted during the semester.
2. Average of the marks scored in both the tests will be considered for final grading.

End Semester Examination (C):

1. Question paper based on the entire syllabus, summing up to 65 marks.

2. Total duration allotted for writing the paper is 2 hrs.

Image Processing and Computer Vision - I Laboratory (22PCCS5030L)

Practical Scheme
Practical : 02 Hrs./week
Credit : 01

Examination Scheme
Teacher Assessment : 25 Marks
End Sem Exam : 25 Marks
Total : 50 Marks

Course Objectives:

1. To become familiar with image processing, geometric, arithmetic and logical operations on images.
2. To introduce Image Enhancement using different teciniques.
3. To introduce segmentation, equalization, image restoration background subtraction and motion analysis.

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Implement basic operations applied on image and Image Enhancement using different techniques.	L3	Apply
CO2	Demonstrate histogram equalization and application of Haar transform.	L4	Analyze
CO3	Implement region-based segmentation, morphological operations and edge detection techniques.	L3	Apply
CO4	Construct Image restoration, background subtraction and motion analysis in a video.	L3	Apply

List of Laboratory Experiments

Suggested List of Experiments:

1. To perform basic Image Processing, Geometric, Arithmetic and Logical operations on Images.
2. To perform Spatial Domain Image Enhancement using different Point Processing Techniques like Image Negative Transformation, Thresholding, Gray Level Slicing with without background.
3. To perform Spatial Domain Image Enhancement using different Neighborhood Processing Techniques.
4. To perform Histogram equalization.
5. To perform frequency domain Image Enhancement techniques.
6. To perform region-based segmentation.
7. To perform morphological operations on Image.
8. To perform edge detection using basic and advanced techniques.
9. To perform Image restoration using various filters.
10. To extract the key frames from a video.
11. To perform background subtraction in a video.
12. To perform motion analysis using Lucas-Kanade optical flow estimation Algorithm.

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

Evaluation Scheme:

Laboratory:

Continuous Assessment (A):

Laboratory work will be based on 22PCCS5030T with at least 10 experiments from the above list to be incorporated. The distribution of marks for term work shall be as follows:

1. Performance in Experiments: 05 Marks
2. Journal Submission: 05 Marks
3. Viva-voce: 05 Marks
4. Subject Specific Lab Assignment/Case Study: 10 Marks

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

End Semester Examination (C):

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

Big Data Engineering Laboratory (22PCCS5040L)

Teaching Scheme	Examination Scheme
Lectures : 02 Hrs./week	Teacher Assessment : 50 Marks
Practical : 02 Hrs./week	End Sem Exam : 50 Marks
Credits : 03	Total: 100 Marks

Prerequisite: Foundations of Data Analysis, Database Management System, Python Laboratory, Java and Scala Laboratory.

Course Objectives:

The objective of this lab is to provide the basic framework of handling and processing big data.

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Relate to the need of different types of data preprocessing tools/methods.	L4	Analyze
CO2	Use appropriate tool/method for a specific Data Engineering task.	L3	Apply

Detail of the Experiment

Hadoop Ecosystem — 04 Hrs.

1. Understanding inputs and outputs of Map Reduce Concept of Hadoop.
2. The Map Tasks, Grouping by Key, The Reduce Tasks, Combiners, Details of Map Reduce Execution.
3. HDFS file system - Command line.
4. Overview of resource managem ent - YARN.

Infrastructure Implementation — 04 Hrs.

1. Introduction to Kubernetes and Docker.
2. Setting up applications on Kubernetes and Docker.
3. Creating Docker images and deploying them.

Messaging Service — 02 Hrs.

1. Differentiate between different types of connections: Point-to-point, Broadcast/Multicast and Multi point.
2. Real time messaging using AMPS
3. Pub / Sub models
4. Allows subscribers to apply filters on server level

Messaging Service — 02 Hrs.

1. Need of scalability and concurrency in the messaging services.
2. Real time messaging, ensuring scalability and concurrency using Kafka.
3. Pub / Sub models
4. Allows subscribers to apply filters on client side.

Data Processing — 08 Hrs.

1. Need of advance methods for data processing of Big Data.
2. Introduce SPARK
3. Real time and Batch processing of high volume of data.
4. Write scripts using Java/ Python/Scala.

5. Processing high volume records in-memory.

6. Integration with Hive, HDFS, Kafka, event hub and other messaging and storage system.

Data Warehouse — 02 Hrs.

1. Need of advance methods for data warehousing for storing Big data.

2. Introduce HIVE

3. Storage of data on HDFS for high volume data.

4. Perform Analytical queries using Map Reduce.

No SQL Data Store — 02 Hrs.

1. Difference between SQL and NoSQL data stores

2. Types of NoSQL Data stores

3. Introduce HBase

4. Demonstration of Dynamic Scaling

No SQL Data Store — 04 Hrs.

1. NoSQL Databases for different use cases.

2. DynamoDB - Serverless AWS service for storing data in bytes.

3. MongoDB - Data Storage as documents (Binary JSON -BSon).

4. Pipeline, query aggregation, complex querying, transaction.

ETL Task — 04 Hrs.

1. Introduce AWS Glue for ETL.

2. Data Integration service from multiple sources.

3. Keeping track of schema in form of catalogue.

4. Data query via Amazon Athena, Amazon EMR, and Amazon Redshift Spectrum.

Data Retrieval — 04 Hrs.

1. Introduction to Open-Source Indexing Engine Elastic Search for transactional data.

2. Data querying, aggregation, visualization, log extraction and analytics.

Cold Data Retrieval AWS S3, Athena and Redshift — 04 Hrs.

1. Introduction of AWS S3, Athena and RedShift.

2. Storing / Extracting data in S3 in different forms (csv, parquet, text).

3. Querying the data via Athena / Redshift.

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

Text Books:

1. Joe Reis and Matt Housley, "Fundamentals of Data Engineering: Plan and Build Robust Data Systems", 1st Edition, O'Reilley, 2022.

2. Stevan N Brunton and J Nathan Kutz, "Data-Driven Science and Engineering: Machine Learning, Dynamical Systems, and Control", 1st Edition, Cambridge University Press, 2019.

3. Tom White, "Hadoop: The Definitive Guide", O'Reilley, 3rd Edition, 2012.

4. Eric Sammer, "Hadoop Operations", 1st Edition, Reilly, 2012.

5. Pramod J Sadalge and Martin Fowler, "NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence", 1st Edition, Addison-Wesley Professional publications 2012.

Reference Books:

1. Paul Zikopoulos, Chris Eaton, Dirk DeRoos, Tom Deutsch, George Lapis, "Understanding Big Data: Analytics for Enterprise Class Hadoop and streaming Data", 1st Edition, The McGraw-Hill Companies, 2017.

2. Gaurav Vaish, "Getting Started with NoSQL", 1st Edition, Packt Publishing, 2013.

3. Manoj Kukreja, "Data Engineering with Apache Spark, Delta Lake, and Lakehouse", 1st Edition, Packt Publishing, 2021.

4. Scott Haines, "Modern Data Engineering with Apache Spark: A Hands-On Guide for Building Mission-Critical Streaming Applications", 1st Edition, Apress Publications, 2022.

Web Links:

1. Real-time Bigdata Messaging Services: Built for realtime: Big data messaging with Apache Kafka, Part 1 | InfoWorld

2. Understanding Big data Processing: Understanding Big Data Processing: 2022's Ultimate Guide - Learn | Hevo (hevodata.com)

3. Serverless Databases: What Is Serverless? An Overview | Knowledge Base | Dashbird

4. Kubernet Vs Docker: Kubernetes vs. Docker: Why Not Both? | IBM

Evaluation Scheme:

Laboratory:

Continuous Assessment (A) 50 Marks:

Laboratory work will be based on 22PCCS5040L with minimum 10 experiments to be incorporated. The distribution of marks for term work shall be as follows:

1. Performance in Experiments: 10 Marks
2. Journal Submission: 10 Marks
3. Viva-voce: 10 Marks
4. Subject Specific Lab Assignment/Case Study: 20 Marks

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

End Semester Examination (C) 50 Marks:

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

Distributed Computing (22PECS5051T)

Teaching Scheme
Lectures : 03 Hrs./week
Credits : 03

Examination Scheme
Term Test : 10 Marks
Teacher Assessment : 25 Marks
End Sem Exam : 65 Marks
Total Marks : 100 Marks

Prerequisite: Operating Systems.

Course Objectives: The objective of this course is to introduce the fundamentals of distributed computing that includes system architecture, programming model, design, and implementation and performance analysis of these systems.

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Demonstrate Interprocess Communication and Synchronization in a Distributed System.	L2, L3	Understand, Apply
CO2	Apply appropriate Resource, Process management, File and Memory technique in a given Distributed Environment for efficient processing.	L3	Apply
CO3	Apply suitable methods to improve data availability in a system.	L3	Apply

Course Contents

Unit-I Introduction — 04 Hrs.

Distributed Computing Models, Issues in Designing Distributed Systems, Network communication: LAN and WAN technologies, Protocols for Network Systems, Asynchronous Transfer Mode.

Unit-II Communication — 07 Hrs.

Interprocess Communication: Message Passing, Group Communication, API for Internet Protocols; Remote Communication: Middleware, Remote Procedural Call (RPC) Basics, RPC Implementation, RPC Communication, Exception Handling and Security, RPC in Heterogeneous environment, Failure Handling, RPC Optimization.

Unit-III Synchronization — 06 Hrs.

Clock Synchronization, Logical Clocks, Global State, Mutual Exclusion: Centralized, Decentralized, Distributed and Token Ring Algorithms, Election Algorithms: Ring and Bully election algorithms, Deadlocks in Distributed Systems.

Unit-IV Resource and Process Management — 06 Hrs.

Desirable features of a global scheduling algorithm, Task Assignment Approach, Load Balancing Approach, Load Sharing Approach, Functions of Distributed Process Management, Desirable features of a process migration mechanism, Process migrations and Threads.

Unit-V Consistency, Replication and Fault Tolerance — 08 Hrs.

Introduction to Replication and Consistency, Data-Centric (Continuous Consistency, Consistent Ordering of Operation) and Client-Centric (Eventual Consistency, Monotonic Read, Monotonic Write, Read your Writes, Writes follow Reads); Consistency Models, Replica Management; Fault Tolerance: Introduction, Process resilience, Reliable client-server and group communication, Recovery.

Unit-VI Distributed Shared Memory (DSM) and Distributed File System (DFS) — 08 Hrs.

Architecture, Types of DSM, Advantages of DSM, Design Issues in DSM systems, Issues in Implementing DSM systems; Introduction to DFS, DFS Designs, DFS Implementation, File Caching and Replication in DFS.

Text Books:

1. Andrew S. Tanenbaum and Maarten Van Steen, "Distributed Systems: Principles and Paradigms", 2nd Edition, Pearson Education, 2017.

2. Sunita Mahajan and Seema Shah, "Distributed Computing", Oxford University Press, 2013.

Reference Books:

1. S. Tanenbaum and M. V. Steen, "Distributed Systems: Principles and Paradigms", 2nd Edition, Prentice Hall, 2006.

2. M. L. Liu, "Distributed Computing Principles and Applications", Pearson Addison Wesley, 2019.

3. George Coulouris, Jean Dollimore, Tim Kindberg, "Distributed Systems: Concepts and Design", 5th Edition, Pearson Education, 2011.

Web Links:

1. NPTEL Course: Distributed Computing Systems: https://nptel.ac.in/courses/106106107

2. NPTEL Course: Distributed Systems: https://nptel.ac.in/courses/106106168

Evaluation Scheme:

Theory :

Continuous Assessment (A):

Subject teacher will declare Teacher Assessment criteria at the start of semester.

Continuous Assessment (B):

1. Two term tests of 10 marks each will be conducted during the semester.

2. Average of the marks scored in both the tests will be considered for final grading.

End Semester Examination (C):

1. Question paper based on the entire syllabus, summing up to 65 marks.

2. Total duration allotted for writing the paper is 2 hrs.

Distributed Computing Laboratory (22PECS5051L)

Practical Scheme	Examination Scheme
Practical : 02 Hrs./week	Teacher Assessment : 25 Marks
Credit : 01	Total : 25 Marks

Course Objectives:

1. Implement multithread application and client/server using RPC/RMI.
2. Discriminate Inter-process communication and group communication.
3. Implement various algorithms like load balancing algorithm, election algorithm, clock synchronization and mutual exclusion algorithm.
4. Construct distributed file system and deadlock management in distributed systems.

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Implement multithread application and client/server using RPC/RMI.	L3	Apply
CO2	Demonstrate Inter-process communication and group communication.	L4	Analyze
CO3	Implement various algorithms like load balancing algorithm, election algorithm, clock synchronization and mutual exclusion algorithm.	L3	Apply
CO4	Construct distributed file system and deadlock management in distributed systems.	L3	Apply

List of Laboratory Experiments

Suggested List of Experiments:

1. Implement Client/server using RPC/RMI.
2. Implementation of multithread application.
3. Implement Inter-process communication.
4. Implement Group Communication.
5. Implement Load Balancing Algorithm.
6. Implement Election Algorithm.
7. Implement Clock Synchronization algorithms.
8. Implement Mutual Exclusion Algorithm.
9. Implement Deadlock management in Distributed systems.
10. Implement Distributed File System.

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

Evaluation Scheme:

Laboratory:

Continuous Assessment (A):

Laboratory work will be based on 22PECS5051T with minimum 10 experiments to be incorporated. The distribution of marks for term work shall be as follows:

1. Performance in Experiments: 05 Marks
2. Journal Submission: 05 Marks
3. Viva-voce: 05 Marks
4. Subject Specific Lab Assignment/Case Study: 10 Marks

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

Time Series Analysis (22PECS5052T)

Teaching Scheme
Lectures : 03 Hrs./week
Credits : 03

Examination Scheme
Term Test : 10 Marks
Teacher Assessment : 25 Marks
End Sem Exam : 65 Marks
Total Marks : 100 Marks

Prerequisite: Probability, Statistics and Linear Models.

Course Objectives: Learn basic analysis of time series data; concepts in time series regression; auto-regressive and model averaging models; learn basic concepts of spectral analysis and space-time models.

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Interpret a correlogram and a sample spectrum.	L4	Analyze
CO2	Apply appropriate model for a time series dataset.	L3, L5	Apply, Evaluate
CO3	Compute forecasts for a variety of linear and non-linear methods and models.	L2,L3 and L4	Understand, Apply and Analyze

Course Contents

Unit-I — 08 Hrs.

Introduction: Formal definition of a time series, Interpolation vs Extrapolation, Components of time series, Models of Time Series Analysis, Types of forecasting methods, Types of Time Series, Types of time series patterns, different types of data, simple descriptive techniques, Trends in time series (Parametric trends, differencing, non-parametric methods, noise), measurement of trends, seasonality, seasonal indices, stochastic processes, correlogram.

Stationary Time Series: The sample mean and its standard error, Stationary processes (weak and strict), statistical inference of time series.

Unit-II — 08 Hrs.

Linear Time Series: Motivation, Autocorrelation function (ACF) and Partial Autocorrelation function (PACF) plot, Linear time series and MA models, theoretical properties of time series with a MA (1) and MA (2) model, The AR model, simulating from an autoregressive process, The ARMA model, The ARIMA model, Unit roots with $|\Phi|$, backshift and lag operator, integrated and non-invertible processes, SARIMA model, Box – Jenkins Model Selection.

Unit-III — 06 Hrs.

Prediction: Using prediction in estimating, forecasting for autoregressive processes (1), forecasting for AR(p), forecasting for general time series using infinite past, forecasting for ARIMA model, Ψ-weight representation of ARIMA model, One-step ahead predictors based on the finite past: Levinson -Durbin algorithm, Kalman filter.

Unit-IV — 06 Hrs.

Models with Trend: Removing trend, Unit Root (Augmented Dickey Fuller Test) and Regression Residuals, The Monte Carlo Method.

Multiequation Time Series Models: Intervention Analysis, Estimating the Intervention Effect, ADLs and Transfer Functions, Introduction to VAR Analysis.

Unit-V — 06 Hrs.

Multivariate Time Series: Background: Sequences and Functions, Convolution using Fourier transform, Methods for Estimating the Spectral Density, Smoothing Method (Nonparametric Estimation of the Spectral Density); Multivariate time series regression: Conditional independence, Partial correlation and coherency between time series.

Unit-VI — 05 Hrs.

Non Linear Time series: The ARCH model: Feature of an ARCH, interpretation of ARCH model, The GARCH model: Existence of stationary solution of a GARCH(1,1) and Bilinear models.

Text Books:

1. Walter Enders, "Applied Econometric Time Series", 4^{th} Edition, Wiley, 2014.
2. B. V. Vishwas and Ashish Patel, "Hands-on Time Series Analysis with Python", 1^{st} Edition, Apress, 2020

Reference Books:

1. Chris Chatfield, "Time- Series Forecasting", 1^{st} Edition, Chapman & Hall/CRC, 2001.
2. Douglas C. Montgomery, Cheryl L. Jennings and Nurat Kulahci, "Introduction to Time Series Analysis and Forecasting", 2^{nd} Edition, Wiley, 2015.
3. Aileen Nielsen, "Practical Time Series Analysis", O'Reilly, 2019.
4. James D Hamilton, "Time Series Analysis", Princeton University Press, 1994.
5. Robert H. Shumway and David S. Stoffer, "Time Series Analysis and Its Applications", Springer, 2000.

Web Links:

1. A course on Time Series Analysis. https://web.stat.tamu.edu/suhasini/teaching673/time_series.pdf
2. A comprehensive guide to Time Series Analysis. https://www.analyticsvidhya.com/blog/2021/10/acomprehensive-guide-to-time-series-analysis/
3. The Complete Guide to Time Series Analysis and Forecasting. https://towardsdatascience.com/the-completeguide- to-time-series-analysis-and-forecasting-70d476bfe775

Evaluation Scheme:

Theory :

Continuous Assessment (A):

Subject teacher will declare Teacher Assessment criteria at the start of semester.

Continuous Assessment (B):

1. Two term tests of 10 marks each will be conducted during the semester.
2. Average of the marks scored in both the tests will be considered for final grading.

End Semester Examination (C):

1. Question paper based on the entire syllabus, summing up to 65 marks.
2. Total duration allotted for writing the paper is 2 hrs.

Time Series Analysis Laboratory (22PECS5052L)

Practical Scheme	Examination Scheme
Practical : 02 Hrs./week	Teacher Assessment : 25 Marks
Credit : 01	Total : 25 Marks

Course Objectives:

1. To Introduce students to Time series characteristics and Detecting its Trends.
2. To become familiar with seasonality, Data wrangling and preparation of time series data.
3. To become familiar with AR Model, Moving average model,ARMA model, ARIMA model, SARIMA Model.

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Understand and Detecting trends in Time series Data.	L2	Understand
CO2	Analysing Seasonality in the time series Dataset.	L4	Analyze
CO3	Apply Data Wrangling and prepare for time series Data.	L3	Apply
CO4	Build various model for time Series.	L3, L6	Apply, Create

List of Laboratory Experiments

Suggested List of Experiments:

1. Trends:
   (a) Detecting trends using Hodrick -Prescott Filter.
   (b) Detrending a Time Series (Pandas, SciPy Signal, HP filter).
2. Seasonality:
   (a) Multiple Box Plots.
   (b) Autocorrelation Plot.
   (c) Deseasoning of Time-Series Data.
   (d) Seasonal Decomposition(Additive and Multiplicative)..
   (e) Detecting Cyclic Variations.
3. Data Wrangling and Preparation for Time Series Data
4. Smoothing Methods: Simple exponential, Double exponential and Triple exponential.
5. Making Data Stationary using Augmented Dicky Fuller Test.
6. Autoregressive Moving Average Model.
7. ARIMA Model
8. VAR Model.
9. ARCH and GARCH Models.
10. Mini Project.

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

Evaluation Scheme:

Laboratory:

Continuous Assessment (A):

Laboratory work will be based on 22PECS5052T with minimum 10 experiments to be incorporated. The distribution of marks for term work shall be as follows:

1. Performance in Experiments: 05 Marks
2. Journal Submission: 05 Marks

3. Viva-voce: 05 Marks

4. Subject Specific Lab Assignment/Case Study: 10 Marks

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

Digital System Design (22PECS5053T)

Teaching Scheme
Lectures : 03 Hrs./week
Credits : 03

Examination Scheme
Term Test : 10 Marks
Teacher Assessment : 25 Marks
End Sem Exam : 65 Marks
Total Marks : 100 Marks

Prerequisite: Basic Electrical & Electronics Engineering.

Course Objectives:

1. To introduce different digital codes and their conversions.
2. To introduce methods for minimizing logical expressions.
3. To outline the formal procedure to design combinational logic circuits.
4. To introduce flip flops and outline the formal procedure to sequential circuits.
5. To illustrate concept of programmable devices.

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Explain different digital codes and their conversions.	L2	Understand
CO2	Minimize logic expressions using various reduction techniques.	L6	Create
CO3	Analyze and design combinational logic circuits.	L4	Analyze
CO4	Design flip-flops using logic gates and use them to realize different sequential circuits.	L6	Create
CO5	Classify different programmable logic devices.	L4	Analyze

Course Contents

Unit-I — 12 Hrs.

Digital codes and binary arithmetic: Signed Binary number representation: Sign Magnitude, 1's complement, 2's complement representation and binary arithmetic's. Codes: Binary, BCD, XS-3, Gray code, ASCII, EBCDIC, Parity, Hamming, conversions.

Unit-II — 08 Hrs.

Minimization techniques and Logic gates: Logic Gates: AND, OR, NOT, NAND, NOR, Exclusive–OR and Exclusive–NOR, Implementations of Logic Functions using universal gates. Boolean postulates and laws – De-Morgan's Theorem, Boolean expression -Minterm – Maxterm - Sum of Products (SOP) – Product of Sums (POS), Minimization of Boolean expressions — Karnaugh map Minimization – Quine - Mc Cluskey method of minimization, don't care conditions.

Unit-III — 04 Hrs.

Design of Combinational Logic: Introduction to combinational logic, Code converter: BCD, Excess-3, Gray code, Binary Code, Half- Adder, Full Adder, Half Subtractor, Full Subtractor, Binary Adder, BCD adder, Look ahead carry generator, Multiplexers- MUX tree, Encoder, De-multiplexer & Decoders, Implementation of SOP and POS using Multiplexer & De-multiplexer/Decoder

Unit-IV — 09 Hrs.

Sequential Logic Design: Introduction to sequential logic, Flip- flop: SR, JK, D, T; Preset & Clear, Truth Tables and Excitation tables, Conversion, Shift Registers: SISO, SIPO, PISO, PIPO, Bi-directional, Counters: Asynchronous counter, Synchronous counter, ring counters, Johnson Counter, Modulus of the counter. State Machines: Basic design steps- State diagram, State table, State reduction, State assignment, Mealy and Moore machines representation, Sequence detector

Unit-V — 06 Hrs.

Programmable Logic Devices: Programmable logic devices: Architecture of PROM, PAL, PLA, designing combinational circuits using PLDs. General Architecture of FPGA and CPLD, Introduction to Hardware Description Language.

Text Books:

1. John F. Wakerly, "Digital Design Principles and Practices", 5th Edition, Pearson Education, 2018.
2. R. P. Jain, "Modern Digital Electronics", 4th Edition, Tata McGraw Hill, 2010.
3. M. Morris Mano, "Digital Logic and computer Design", 4th Edition, PHI, 2010.

Reference Books:

1. Thomas L. Floyd, "Digital Fundamentals", 11^{th} Edition, Pearson Prentice Hall, 2015.
2. Mandal, "Digital Electronics Principles and Applications", 1^{st} Edition, McGraw Hill Education, 2010.
3. Ronald J. Tocci, Neal Widmer, "Digital Systems Principles and Applications", 12^{th} Edition, PHI, 2017.
4. Donald P Leach, Albert Paul Malvino, "Digital Principles and Applications", 8^{th} Edition, Tata McGraw Hill, 2015.
5. Balabanian, Carlson, "Digital Logic Design Principles", 3^{rd} Edition, Wiley Publication, 2000.
6. Holdsworth and R. C. Woods, "Digital Logic Design", 4^{th} Edition, Newnes, 2002.
7. William I. Fletcher, "An Engineering Approach to Digital Design", 10^{th} Edition, PHI, 2015.

Web Links:

1. Digital Electronic Circuits Lab: http://vlabs.iitkgp.ac.in/dec/#
2. Virtual Lab: https://cse15-iiith.vlabs.ac.in/List%20of%20experiments.html
3. NPTEL Course: Digital System Design: https://nptel.ac.in/courses/108106177

Evaluation Scheme:

Theory :

Continuous Assessment (A):

Subject teacher will declare Teacher Assessment criteria at the start of semester.

Continuous Assessment (B):

1. Two term tests of 10 marks each will be conducted during the semester.
2. Average of the marks scored in both the tests will be considered for final grading.

End Semester Examination (C):

1. Question paper based on the entire syllabus, summing up to 65 marks.
2. Total duration allotted for writing the paper is 2 hrs.

Digital System Design Laboratory (22PECS5053L)

Practical Scheme	Examination Scheme
Practical : 02 Hrs./week	Teacher Assessment : 25 Marks
Credit : 01	Total : 25 Marks

Course Objectives:

1. To learn the fundamental concepts and methods for design of digital circuits.
2. To provide basic knowledge of simplifying Boolean expressions using logic gates.
3. To learn the concept of constructing logic gates using universal gates.

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Simplify Boolean expressions using logic gates.	L4	Analyze
CO2	Construct basic gates using universal gates.	L3	Apply
CO3	Construct binary to gray code and gray to binary code converter.	L3	Apply
CO4	Design and implement adder and subtractor circuit.	L6	Create
CO5	Realization of comparator circuit.	L6	Create
CO6	Realization of counters and flip flop.	L6	Create
CO7	Implementation of basic gates, multiplexer, demultiplexer, counters etc. using VHDL.	L6	Create

List of Laboratory Experiments

Suggested List of Experiments:

1. Implement 8:3 octal to binary code converter using encoder IC 74148.
2. Verify different logic gates (introduce logic families CMOS and TTL and electrical and switching parameters).
3. Simplification of Boolean functions.
4. Verify Universal gates NAND and NOR and design EXOR and EXNOR gates using Universal gates.
5. Implement Half adder, Full adder, Half subtractor and Full subtractor circuits.
6. To study and implement 4-bit magnitude comparator using IC 7485 and verify its truth table.
7. Implement BCD adder using 4-bit binary adder IC-7483.
8. Flip flops conversion JK to D, JK to T and D to T FF.
9. Implement logic equations using Multiplexer.
10. Design synchronous MOD N counter using IC-7490.
11. Verify encoder and decoder operations.
12. Implement 1:8 De-multiplexer using IC 74138.
13. Implement the functions using 8:1 Multiplexer with the help of IC 74151.
14. Implement digital circuits to perform binary to gray and gray to binary operations.
15. Verify different counter operations.
16. Verify the functions of Universal Shift Register IC 74194: Parallel loading, Right shift, Left shift.
17. Implement any two above experiments using HDL.

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

Evaluation Scheme:

Laboratory:

Continuous Assessment (A):

Laboratory work will be based on 22PECS5053T with at least 10 experiments from the above list to be incorporated. The distribution of marks for term work shall be as follows:

1. Performance in Experiments: 05 Marks
2. Journal Submission: 05 Marks
3. Viva-voce: 05 Marks
4. Subject Specific Lab Assignment/Case Study: 10 Marks

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

Probabilistic Graph Models(22PECS5054T)

Teaching Scheme
Lectures : 03 Hrs./week
Credits : 03

Examination Scheme
Term Test : 10 Marks
Teacher Assessment : 25 Marks
End Sem Exam : 65 Marks
Total Marks : 100 Marks

Prerequisite: Machine learning, Probability.

Course Objectives:

The objective of this course intends to model problems using graphical models; design inference algorithms; and learn the structure of the graphical model from data.

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Explain the basic fundamentals of probabilistic graph theory.	L2	Understand
CO2	Illustrate various principles of representation methods, learning and inference algorithms.	L2	Understand
CO3	Integrate core theoretical knowledge of graphical models to solve problems.	L3	Apply

Course Contents

Unit-I — 05 Hrs.

Fundamentals: Overview and Motivation of Probabilistic Graphical Models, Structured Probabilistic Models, Marginal and Joint Distributions, Independence and Conditional Independence, Factors.
Bayesian networks (Representation): Semantics and Factorization, Reasoning Patterns, Flow of Probabilistic Influence, Conditional Independence, Independence in Bayesian Networks, Naïve Bayes, Applications .

Unit-II — 07 Hrs.

Temporal Models of Bayesian Network (Representation): Overview of Temporal Models, Dynamic Bayesian Networks (DBN), Hidden Markov Model (HMM), Plate Models.
Structured CPDs (Representation): Overview of Structured CPDs, Tree- Structured CPDs, Independence of Casual Influence, Continuous Variable, Applications.

Unit-III — 06 Hrs.

Markov networks (Representation): Pairwise Markov Networks, General Gibbs Distribution, Conditional Random Fields, Independencies in Markov Networks, I- maps and perfect maps.

Unit-IV — 06 Hrs.

Exact inference (Inference): Conditional Probability Queries, MAP Inference, Analysis of Complexity, Sum- and Max-product algorithms, Variable elimination, Belief propagation (message passing) on trees, Clique tree.

Unit-V — 06 Hrs.

Inference and sampling methods (Inference): Simple Sampling, MCMC method, Gibbs sampling Algorithm, Importance sampling, Particle filtering.

Unit-VI — 09 Hrs.

Parameter Estimation (Learning): Learning Overview, Maximum Likelihood Estimation for Bayesian Networks, Bayesian Estimation, Bayesian Prediction, Bayesian Estimation for Bayesian Networks, Maximum Likelihood for Log-Linear Models, Maximum Likelihood for MRFs and CRFs.
Structure Learning: Overview, Likelihood Scores, BIC and Asymptotic Consistency, Bayesian Scores, Learning Tree Structured Networks, Learning General Graphs: Heuristic Search.

Text Books:

1. Koller, D. and Friedman, N., "Probabilistic Graphical Models: Principles and Techniques", MIT Press, 2009.

Reference Books:

1. Jensen, F. V. and Nielsen, T. D. "Bayesian Networks and Decision Graphs. Information Science and Statistics", 2nd Edition, Springer, 2002.
2. Marloes Maathuis, Mathias Drton, Steffen Lauritzen, Martin Wainwright, "Handbook of Graphical Models", Routledge Taylor and Francis group, 2020.
3. Kevin P. Murphy, "Machine Learning: A Probabilistic Perspective", 4th Printing. MIT Press, 2013.
4. Barber, D. "Bayesian Reasoning and Machine Learning",1st Edition. Cambridge University Press, 2011.
5. Bishop, C. M. "Pattern Recognition and Machine Learning (Information Science and Statistics)", 2nd printing, Springer, 2011.
6. Wainwright, M. and Jordan, M. "Graphical Models, Exponential Families, and Variational Inference", Foundations and Trends in Machine Learning, 2008.

Evaluation Scheme:

Theory :

Continuous Assessment (A):

Subject teacher will declare Teacher Assessment criteria at the start of semester.

Continuous Assessment (B):

1. Two term tests of 10 marks each will be conducted during the semester.
2. Average of the marks scored in both the tests will be considered for final grading.

End Semester Examination (C):

1. Question paper based on the entire syllabus, summing up to 65 marks.
2. Total duration allotted for writing the paper is 2 hrs.

Probabilistic Graph Models Laboratory (22PECS5054L)

Practical Scheme	Examination Scheme
Practical : 02 Hrs./week	Teacher Assessment : 25 Marks
Credit : 01	Total : 25 Marks

Course Objectives:

1. To introduce students implementation of graph models.
2. To become familiar with various principles of graph theory and algorithms.

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Implement Discrete and Alarm Bayesian Networks.	L3	Apply
CO2	Build Implementation of Linear Gaussian Bayesian Networks (GBNs).	L3	Apply
CO3	Implementation of Causal Inference.	L3	Apply

List of Laboratory Experiments

Suggested List of Experiments:

1. Implement Discrete Bayesian Networks.
2. Implementation of Alarm Bayesian Network.
3. Implementation of Linear Gaussian Bayesian Networks (GBNs).
4. Implementation of Monty Hall Problem using Bayesian Network.
5. Implementation of Exact inference in Bayesian Networks.
6. Implementation of Inference in Discrete Bayesian Network.
7. Implementation of Causal Inference.
8. Implement Approximate Inference using MCMC.
9. Implementation of Parameter Learning in Discrete Bayesian Networks.
10. Mini Project.

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

Evaluation Scheme:

Laboratory:

Continuous Assessment (A):

Laboratory work will be based on 22PECS5054T with at least 10 experiments from the above list to be incorporated. The distribution of marks for term work shall be as follows:

1. Performance in Experiments: 05 Marks
2. Journal Submission: 05 Marks
3. Viva-voce: 05 Marks
4. Subject Specific Lab Assignment/Case Study: 10 Marks

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

Professional and Business Communication Tutorial (22HMCS5060T)

Teaching Scheme	Examination Scheme
Tutorials : 02 Hrs./week	Teacher Assessment : 25 Marks
Credits : 02	Total Marks : 25 Marks

Prerequisite: Basic course in Effective Communication Skills.

Course Objectives:

1. To inculcate professional and ethical attitude at the workplace.
2. To enhance communication and interpersonal skills.
3. To develop effective employability skills.
4. To hone written skills for technical documentation.

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Prepare technical documents using appropriate style, format, and language.	L3	Apply
CO2	Use employability skills to optimize career opportunities.	L3	Apply
CO3	Employ storytelling techniques in corporate situations.	L3	Apply
CO4	Conduct effective meetings and document the process.	L3	Apply
CO5	Demonstrate interpersonal skills in professional and personal situations.	L3	Apply
CO6	Describe cultural differences, etiquettes, and the concept of professional ethics.	L2	Understand

Course Contents

Unit-I Technical Writing — 06 Hrs.

Report Writing : Types of report, Basic structure of a report, collection of data through questionnaires and survey analysis, language and style in reports.

Business Proposal Writing : Types of business proposals, format of proposal, language and style, presentation of proposal.

Plagiarism : Types of plagiarism, consequences of plagiarism.

Unit-II Employment Skills — 08 Hrs.

Group Discussion: Purpose of a GD, types of GD, criteria for evaluating a GD, Dos and Don'ts of a GD.

Resume Writing: Types of resume, structure, content and formatting of resume.

Interview Skills: Types and modes of interview, Preparation for interview, Dos and Don'ts of interview, frequently asked questions during interview.

Presentation Skills: Presentation strategies, overcoming stage fear, techniques to prepare effective PowerPoint presentation.

Unit-III Corporate Story Telling — 03 Hrs.

Basics of storytelling: Setting, characters, plot, crisis, climax, resolution, Benefits of storytelling.

Types of stories: Elevator pitch, product stories, event stories, stories in presentations, storytelling in SOP's and interviews, storytelling to manage conflict or to motivate.

Storytelling techniques: Narration using verbal and non-verbal communication, Analysis of storytelling strategies of corporate master storytellers.

Unit-IV Meetings and Documentation — 02 Hrs.

Planning and preparation for meetings: Planning layout of meetings, arranging logistics, defining roles and responsibilities.

Strategies for conducting effective meetings: Follow the agenda, record discussion, observe meeting decorum.

Documentation: Draft notice, agenda and minutes of meeting.

Business meeting etiquettes: Verbal and non-verbal aspects of etiquettes.

Unit-V Introduction to Interpersonal Skills — 05 Hrs.

Emotional Intelligence: Definition, difference between IQ and EQ, how to develop EQ.

Leadership: Types of leadership, leadership styles, case studies.

Team Building: Difference between group and team, importance of teamwork, strategies to be a

good team player.

Time Management: Importance of time management, cultural views of time, 80/20 rule, time wasters, setting priorities and goals.

Conflict Management: Types of conflicts, strategies to manage conflict, case studies.

Unit-VI Cross-cultural communication and Professional ethics 05 Hrs.

Communication across cultures: Understanding cultures and developing sensitivity towards cultural differences.

Corporate etiquettes: Telephone, dining, cubicle etiquette, etc.

Professional ethics: Effective work habits, accountability, integrity and excellence.

Reference Books:

1. Fred Luthans, "Organizational Behavior", McGraw Hill, edition.
2. Lesiker and Petit, "Report Writing for Business", McGraw Hill, edition.
3. Huckin and Olsen, "Technical Writing and Professional Communication", McGraw Hill.
4. Wallace and Masters, "Personal Development for Life and Work", 12th Edition, Thomson Learning.
5. Heta Murphy, "Effective Business Communication", Mc Graw Hill, edition.
6. Sharma R.C. and Krishna Mohan, "Business Correspondence and Report Writing", Tata McGraw-Hill Education.
7. Ghosh, B. N., "Managing Soft Skills for Personality Development", Tata McGraw Hill.
8. Bell, Smith, "Management Communication" Wiley India Edition, 3rd edition.
9. Dr. Alex, K., "Soft Skills", S Chand and Company.
10. Subramaniam, R., "Professional Ethics" Oxford University Press.
11. Sandeep Das, "How Business Story Telling Works: Increase Your Influence and Impact", Penguin Random House India Pvt. Ltd.

Evaluation Scheme:

Continuous Assessment (A):

The term work will be calculated based on Tutorials (10m), Business Proposal (10m) and Group Discussion (05m).

The distribution of marks will be as follows:

1. Tutorials: 10 Marks

2. Business Proposal : 10 Marks

3. Group Discussion : 05 Marks

Total : 25 Marks

The final certification and acceptance of journal/manual/report will be subject to satisfactory performance of Continuous Assessment and upon fulfilling minimum passing criteria in the CA.

Semester Project-III (22PJCS5070L)

Practical Scheme
Practical : 02 Hrs./week
Credit : 01

Examination Scheme
Teacher Assessment : 25 Marks
End Sem Exam : 25 Marks
Total : 50 Marks

Course Objectives:

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

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

Employability Skill Development Program-II (22HMCS5080L)

Practical Scheme
Practical : 02 Hrs./week
Credit : 01

Examination Scheme
Teacher Assessment : 50 Marks
Total : 50 Marks

Prerequisite: Basic Mathematics, Basic knowledge of C programming.

Course Objectives:

1. To enhance the problem solving skills with real life examples.
2. To enable the students to express their thoughts and knowledge on various platforms.
3. Able to describe the basic database management system.
4. Able to implement basic programming project using python.

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Analyze and solve the logical problem based on words, venn diagram etc.	L4	Analyze
CO2	Understand and solve the English comprehension, Sentence completion, Sentence Correction problems.	L2 and L4	Understand, Analyze
CO3	Understand and illustrate the concept of Exception Handling, Garbage collection.	L2 and L3	Understand, Apply
CO4	Understand and describe the fundamental of DBMS, NoSql, MongoDB.	L2	Understand

Course Contents

Unit-I 10Hrs

Reasoning : Data sufficiency, Logical Deductions, Logical Sequence of Words, Logical Venn Diagrams, Statement and Arguments, Statement and Assumptions, Statement and Conclusions Syllogism.
English: Reading Comprehension, Para Jumbles, Cloze Test, Tenses/ Voice/ Speech, Prepositions/ SVA/ Articles, Vocab /Verbal Analogy, Sentence completion, Sentence Correction.

Unit-II 10Hrs

Modules: Modules Introduction, Importance of Modularity programming, Import keyword, User defined modules creation, Function based modules, Classes based modules, Connecting modules, 'from' keyword.
Files Handling: Reading file char by character, Reading file line by line, Modes of files, Writing into file, Append data to a file, Reading CSV file, Pickling and Un pickling.
Garbage collection: Introduction, Importance of manual GC, Self-referenced objects, 'gc' module, Collect() method, Threshold function.

Unit-III 8Hrs

Collections Framework: Introduction to collection of data types, Importance of Data processing, DS algorithms introduction.
List: Create a list, Adding elements, Deleting elements, Pre-defined functionality of List, Nested List, Immutability and Mutability of List.
Set: The functionality of Set object, Frozen set, Dictionaries, Create a dictionary, Adding elements.
Dict: Pre-defined functions of Dict class, Programs using Collection types.

Unit-IV 8Hrs

Tkinter – GUI: Types of Layouts, Create Labels and Display images, Create Buttons, Create Events, StringVar class, Calculator program using GUI
Basic ML AI including Projects: Iterators, Nested functions, Generators, Closures, Decorators, Basic ML and AI, PIP, Visualization etc...
Project Domain(Per domain 1 or 2 project)

1. ML/AI Based Projects
2. Data Analysis Based projects
3. Test Summarization based projects
4. web scrapping and crawling

Unit-V 10Hrs

DBMS Using Python: Introduction to Mysql, Mysql – Python connectivity, DDL, DRL, DML, Transaction management examples (rollback and commit), GUI –Database connectivity.

NoSql Using Python: Installation and Configuration, MongoDB Tools, Collection and Documents, CRUD and the MongoDB Shell, Introduction to CRUD, Introduction to the MongoDB API, Creating a Database, Collection and Documents.

Data Modelling and Schema Design: MongoDB Database References Model Tree Structures, MongoDB Analysing Queries, Atomic Operations, Map Reduce, Text Search, Regular Expression, Capped Collections.

Administration: MongoDB Deployment and Cluster setup, MongoDB GridFS, Trident Spout, Working with Replica Sets, MongoDB Sharding.

Reference Books:

1. Dr. R S Aggarwal, "Quantitative Aptitude for Competitive Examinations", S. Chand Publication.
2. M. G. Venkateshmurthy, "Programming Techniques through C", Pearson Publication.
3. Behrouz Forouzan, "A Computer Science Structure Programming Approaches using C", Cengage Learning.
4. YashwantKanetkar, "Let Us C", BPB Publication.

Evaluation Scheme:

Teacher Assessment(TA):

Teacher's Assessment (TA) will carry weightage of 50 marks. The components of TA are

1. MCQ Test based on Aptitude: 20 Marks
2. MCQ Test based on Programming skills: 30 Marks
3. Total Marks: 50 Marks

Any other component recommended by BOS and approved by Dean Academics.

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

Machine Learning – III (Reinforcement Learning) (22PCCS6010T)

Teaching Scheme
Lectures : 03 Hrs./week
Credits : 03

Examination Scheme
Term Test : 10 Marks
Teacher Assessment : 25 Marks
End Sem Exam : 65 Marks
Total Marks : 100 Marks

Prerequisite: Machine Learning-I, Machine Learning-II and Artificial Intelligence.

Course Objectives:

To make students learn to build programs that act in a stochastic environment, based on past experience using various Reinforcement Learning methods.

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Explain basic and advanced Reinforcement Learning techniques.	L2	Understand
CO2	Identify suitable learning tasks to which Reinforcement learning and Deep Reinforcement Learning techniques can be applied.	L3,L4	Apply, Analyze
CO3	Apply appropriate Reinforcement Learning method to solve a given problem.	L3	Apply

Course Contents

Unit-I — 04 Hrs.

Introduction:

Reinforcement Learning (RL), Elements of Reinforcement Learning, Reinforcement Learning Vs Supervised Learning, Approaches of solving Reinforcement Learning: Value based, policy based, model based, Exploration - Exploitation dilemma, Evolutionary methods, Immediate Reinforcement Learning.

Unit-II — 06 Hrs.

Immediate Reinforcement Learning:

Bandit Problems: Bandit problems, Value-action based methods (sample average), Greedy method, ϵ-greedy method, Incremental Implementation, Non-stationary problem, Optimistic Initial values, UCB algorithm, Thompson Sampling.

Policy Gradient Approaches: Linear reward Penalty Algorithm, Parameterized policy representation(Θ), Evaluation of policy((Θ)), REINFORCE algorithm.

Unit-III — 08 Hrs.

Full Reinforcement Learning:

Difference between Immediate and Full Reinforcement Learning, Agents and Environment, Goals, Rewards, Returns, Policy in Full Reinforcement Learning, Episodic and Continuing Tasks.

Markov Decision Process (MDP):

Markov Property, Finite Markov Decision Process, Value functions, Bellman's equations, optimal value functions, Definition of MDP in Reinforcement Learning, Solution of the Recycling Robot problem.

Unit-IV — 08 Hrs.

Dynamic Programing:

Policy evaluation, policy improvement, policy iteration, value iteration, Asynchronous Dynamic Programing, bootstrap, full back up.

Monte Carlo Method:

Advantages of Monte Carlo over Dynamic Programing, Monte Carlo Control, on-policy, off- policy, Incremental Monte Carlo, Issues/Assumptions in Monte Carlo Methods, Solution of Blackjack using Monte Carlo Method.

Unit-V — 06 Hrs.

Temporal Difference Learning:

What is Temporal Difference learning, Advantages of Temporal Difference methods over Monte Carlo and Dynamic Programming methods, TD (0), On-policy vs off-policy, SARSA, Q learning.

Eligibility traces:

N-step Temporal Difference methods, On-line vs Off-line updation, TD(λ): forward view, backward view, Traces: Accumulating trace, Dutch trace, Replacing trace, Equivalence of forward and backward view, SARSA(λ).

Unit-VI 07 Hrs.

Deep Reinforcement Learning:

Function Approximation:

Drawbacks of tabular implementation, Function Approximation, Gradient Descent Methods, Linear parameterization, Policy gradient with function approximation.

Deep Reinforcement Learning:

Intro of Deep Learning in Reinforcement Learning, Deep learning training workflow, Categories of Deep learning, Deep Q-Network, Ways of improving Deep Q-Network, REINFORCE in Full Reinforcement Learning, Actor-Critic Algorithm, A2C, A3C, DDPG.

Text Books:

1. Richard S. Sutton and Andrew G. Barto, "Reinforcement Learning: An Introduction", MIT Press, 2nd Edition, 2018.
2. Laura Graesser Wah Loon Keng, "Foundations of Deep Reinforcement Learning", Pearson Education, 1st Edition, 2020.

Reference Books:

1. Phil Winder, "Reinforcement Learning Industrial Applications of Intelligent Agents", O'Reilly, 1st Edition, 2020.
2. Csaba Szepesvari, "Algorithms for Reinforcement Learning," Morgan & Claypool Publishers, 1st Edition, 2019.
3. Enes Bilgin, "Mastering Reinforcement Learning with Python", Packt publication, 1st Edition, 2020.
4. Brandon Brown, Alexander Zai, "Deep Reinforcement Learning in Action", Manning Publications, 1st Edition, 2020.
5. Micheal Lanham, "Hands-On Reinforcement Learning for Games," Packt Publishing, 1st Edition, 2020
6. Abhishek Nandy, Manisha Biswas, "Reinforcement Learning: With Open AI, TensorFlow and Keras using Python," Apress, 1st Edition, 2018.

Weblinks:

1. NPTEL Course in Reinforcement Learning: https://onlinecourses.nptel.ac.in/noc22_cs75/preview
2. Reinforcement Learning Course (Stanford University): https://www.youtube.com/watch?v=FgzM3zpZ55o
3. AI Games with Deep Reinforcement Learning: https://towardsdatascience.com/how-to-teach-an-ai- to-play-games-deep-reinforcement-learning-28f9b920440a
4. Deep Reinforcement Learning: https://www.v7labs.com/blog/deep-reinforcement-learning-guide

Evaluation Scheme:

Theory :

Continuous Assessment (A):

Subject teacher will declare Teacher Assessment criteria at the start of semester.

Continuous Assessment (B):

1. Two term tests of 10 marks each will be conducted during the semester.
2. Average of the marks scored in both the tests will be considered for final grading.

End Semester Examination (C):

1. Question paper based on the entire syllabus, summing up to 65 marks.
2. Total duration allotted for writing the paper is 2 hrs.

Machine Learning – III Laboratory (22PCCS6010L)

Practical Scheme	Examination Scheme
Practical : 02 Hrs./week	Teacher Assessment : 25 Marks
Credit : 01	Total : 25 Marks

Course Objectives:

1. Learn to apply reinforcement learning methods.
2. Compare and Analyze various algorithms used in reinforcement and deep reinforcement learning.

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Construct basic types of algorithms and apply in reinforcement learning algorithms.	L3	Apply
CO2	Analyzing different types of deep reinforcement learning techniques.	L4	Analyze
CO3	Compare techniques used in Reinforcement and Deep Reinforcement learning.	L4	Evaluate

List of Laboratory Experiments

Suggested List of Experiments:

1. Bandit Problem:
    - Implement Greedy and Epsilon greedy methods.
    - Comparison between Greedy and Epsilon Greedy Policy.
    - UCB: Upper Confidence Bound.
2. Policy Gradient (Convergence)
    - Implement REINFORCE algorithm on a CartPole/ Lunar Lander.
3. Dynamic Programming and Monte Carlo Methods.
    - Implementation of GridWorld using Dynamic Programming.
    - Jack's Car Rental using Dynamic Programming.
    - Gamblers Problem using Dynamic Programming.
    - BlackJack using Monte Carlo.
    - Race Track Problem.
4. Temporal Difference.
    - Implement Frozen Lake using SARSA.
    - Implement Grid world using Q learning.
5. Deep Reinforcement Learning.
    - Compare the performance of Reinforcement Learning and Deep Reinforcement Learning on a Cart pole. problem.
    - Implementation of Deep Q-Network algorithm.
    - Actor Critic: Find the optimal policy using the Actor Critic method.

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.

Evaluation Scheme:

Laboratory:

Continuous Assessment (A):

Laboratory work will be based on 22PCCS6010T with at least 10 experiments from the above list to be incorporated. The distribution of marks for term work shall be as follows:

1. Performance in Experiments: 05 Marks
2. Journal Submission: 05 Marks
3. Viva-voce: 05 Marks
4. Subject Specific Lab Assignment/Case Study: 10 Marks

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

Natural Language Text Processing (22PCCS6020T)

Teaching Scheme
Lectures : 03 Hrs./week
Credits : 03

Examination Scheme
Term Test : 10 Marks
Teacher Assessment : 25 Marks
End Sem Exam : 65 Marks
Total Marks : 100 Marks

Prerequisite: Machine Learning-I, Machine Learning-II, Foundations of Data Analysis, Statistics for Data Science

Course Objectives:

To introduce basics of language computation fundamental through morphological computation, syntax, semantic and discourse analysis. Apply these concepts to develop Computational Models for Real World Applications

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Understand the pre-processing required for linguistic data types.	L2	Understand
CO2	Apply appropriate pre-processing technique on linguistic data.	L3	Apply
CO3	Analyze different Machine Learning and deep learning algorithms to develop applications based on natural language processing.	L4	Analyze

Course Contents

Unit-I — 05 Hrs.

Introduction:

Generic Natural Language Processing (NLP) system, levels of NLP, Knowledge in language processing, Ambiguity in Natural language, stages in NLP, challenges of NLP, Applications of NLP Machine Translation, Sentiment Analysis etc.

Text Processing:

Word Tokenization and Segmentation, Lemmatization, Bag of words, N-gram language model, N-gram for spelling correction. Edit distance - Dynamic Programming Approach, Weighted Edit Distance, Finding Dictionary Entries with Small Edit Distances, Noisy Channel Model, Non-word errors Real-word errors. Evaluation of Language Models, Basic Smoothing, Advanced Smoothing Models. Advanced: Perplexity's Relation to Entropy.

Unit-II — 05 Hrs.

Text Classification:

Text classification definition and datasets, Generative text classifiers (naive Bayes) Discriminative text classifiers (logistic regression), Bag-of-words Generative Classifier, BOW Discriminative Model , Multi-class Classification: Softmax, Gradient Descent, Statistical significance testing, Dataset understanding and creation.

Unit-III — 06 Hrs.

Recurrent Neural Networks:

Recurrent Neural Network ,RNNs as Language, RNNs for Sequence Classification, Stacked Recurrent Neural network, Bidirectional RNNs, Managing Context in RNNs:Long Short Term Memory (LSTMs) and gated Recurrent Unit(GRUs).

Unit-IV — 07 Hrs.

Computational Semantics and Semantic Parsing:

Vector Semantics:

Words and Vectors, Term Frequency-Inverse Document Frequency (TFIDF), Word2vec, Continuous Bag of Words, ELMO, Vector Visualizing Embedding's, Semantic properties of embedding's, Bias and Embedding's Evaluating Vector Models, Cosine for measuring similarity, Pointwise Mutual Information (PMI), PPMI vector models. **Lexical Semantics:** Word Senses -Relations Between Senses, WordNet: A Database of Lexical Relations, Word Sense Disambiguation Alternate WSD algorithms and Tasks.

Unit-V 12 Hrs.

Computational Morphology and Syntax Analysis:

Computational Morphology:

Morphological Processes, Morphological Analysis- Inflectional morphology Derivational morphology, Regular expression, Finite State Automata, Finite State Transducer, Morphological parsing with FST, Lexicon free FST Porter stemmer, Two - level Morphology.

Syntax Analysis:

Introduction to POS Tagging, Probabilistic Tagging, Markov Models, Hidden Markov Models (HMM) for POS Tagging, Conditional Random Fields (CRF), Named Entities and Named Entity Tagging, Context-Free Grammars-Derivation, Constituency Parsing, Dependency Parsing.

Unit-VI 04 Hrs.

Discourse Coherence:

Coherence Relation, Discourse Structure Parsing, Centring and Entity-Based Coherence, Global Coherence.

Text Books:

1. Jurafsky and Martin, "Speech and Language Processing", Prentice Hall, 3rd Edition, 2020.
2. Uday Kamath, "Deep Learning for NLP and Speech Recognition", 1st Edition, 2019.

Reference Books:

1. Jelinek, F., "Statistical Methods for Speech Recognition", The MIT Press, 2022.
2. Yuli Vasiliev, "Natural Language Processing with Python and spaCy - A Practical Introduction", No Starch Press, 2022.
3. Sowmya Vajjala, Bodhisattwa Majumder, Anuj Gupta, Harshit Surana, "Practical Natural Language Processing: A Comprehensive Guide to Building Real-World NLP Systems", O'Reilly, 1st Edition, 2020.

Weblinks:

1. Virtual Lab: -https://nlp-iiith.vlabs.ac.in/
2. Virtual Lab:- http://vlabs.iitb.ac.in/vlabs dev/vlab_bootcamp/bootcamp/The_Big_Bang_Nerds/index.html
3. Nptel Course: - https://nptel.ac.in/courses/106105158

Evaluation Scheme:

Theory :

Continuous Assessment (A):

Subject teacher will declare Teacher Assessment criteria at the start of semester.

Continuous Assessment (B):

1. Two term tests of 10 marks each will be conducted during the semester.

2. Average of the marks scored in both the tests will be considered for final grading.

End Semester Examination (C):

1. Question paper based on the entire syllabus, summing up to 65 marks.

2. Total duration allotted for writing the paper is 2 hrs.

Natural Language Text Processing Laboratory (22PCCS6020L)

Practical Scheme
Practical : 02 Hrs./week
Credit : 01

Examination Scheme
Teacher Assessment : 25 Marks
End Sem Exam : 25 Marks
Total : 50 Marks

Course Objectives:

1. To understand Preprocessing steps in NLP like Tokenization, stop word Removal, Lemmatization, stemming.
2. To provide the knowledge of operations involved in Natural Language Processing.
3. Implement complex applications like Information Retrieval System, Spelling Check, Spelling Correction, Auto complete, Text Summarization and Question Answering System.

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Use Natural Language Processing to solve language related tasks.	L3	Apply
CO2	Develop various applications based on natural language processing.	L6	Create

List of Laboratory Experiments

Suggested List of Experiments:

1. Perform Pre-processing steps in Natural language Processing (Tokenization, Stop Word detection, Stemming and Lemmatization.
2. Implement Parts of Speech tagging using HMM
3. Implement word-embedding and TF-IDF vectors in Natural language Processing
4. Implement language model using Ngram language model
5. Generate recursive set of sentences using Context Free Grammar. Identify the word senses using "synset" in NLTK
6. Implement Spelling Check, Spelling Correction and Auto complete using Language models or CFG.
7. Implement a Spam classifier in Natural Language Processing
8. Implement Fake News Classifier Using LSTM-Deep Learning in NLP
9. Implement a Sentiment Analysis in Natural Language Processing
10. Implement NLP application on Regional Language
11. Implement Question Answering in NLP
12. Implement Chatbot in NLP
13. Implement Information Retrieval for extracting Text from Webpages and Images
14. Mini Project

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.

Evaluation Scheme:

Laboratory:

Continuous Assessment (A):

Laboratory work will be based on 22PCCS6020T with at least 10 experiments from the above list to be incorporated. The distribution of marks for term work shall be as follows:

1. Performance in Experiments: 05 Marks
2. Journal Submission: 05 Marks

3. Viva-voce: 05 Marks

4. Subject Specific Lab Assignment/Case Study: 10 Marks

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

End Semester Examination (C):

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

Image Processing and Computer Vision – II (22PCCS6030T)

Teaching Scheme
Lectures : 03 Hrs./week
Credits : 03

Examination Scheme
Term Test : 10 Marks
Teacher Assessment : 25 Marks
End Sem Exam : 65 Marks
Total Marks : 100 Marks

Prerequisite: Mathematics for Intelligent System, Machine Learning -I and II, IPCV -I

Course Objectives:

To introduce theory and computation related to imaging geometry, and scene understanding. Also, to provide exposure to clustering, classification and deep learning techniques applied in computer vision.

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Understand various data capturing methods.	L2	Understand
CO2	Apply appropriate object detection and object segmentation methods.	L3	Apply
CO3	Apply suitable method to analyze complex vision data.	L3	Apply
CO4	Develop suitable vision model for prediction.	L6	Create

Course Contents

Unit-I — 06 Hrs.

Camera Geometry Model:

Basics of Real Aperture Camera, Lens as LSI System, Geometric Projective, 2D Transformations, 3D Transformations, Homography Computation, planar homography, Camera geometry, Stereo geometry, Linear Filtering, Correlation, Convolution, Hierarchy of Transformations, Rotational Representation, Weak perspective projection and orthographic projection, coordinate system, camera parameters and camera calibration Algorithm.

Unit-II — 08 Hrs.

Object Detection:

Two Stage/Proposal: Convolutional Neural Networks for Detection: R-CNN, Fast R-CNN, Faster R-CNN, RFCN and Mask RCN; Architecture and Issues in each algorithm. visualization of Kernels; Backprop-to-image/Deconvolution Methods

One Stage/Proposal Free:

YOLO, SSD, evaluation metrics (IoU, AP), Non-max suppression YOLO Loss function, Variants of YOLO.

Unit-III — 06 Hrs.

Face Recognition and Verification:

Zero-shot, One-shot, Few-shot Learning; Siamese Networks, Triplet Loss, Contrastive Loss, Ranking Loss; Attention Models in Vision, Spatio-temporal Models, Action/Activity Recognition, Region-based convolutional neural network, Semantic segmentation

Unit-IV — 06 Hrs.

Generative Models:

Types of generative models: Implicit and Explicit density; Generative Adversarial Network; Vanilla GAN, Mode Collapse in GAN, Conditional GAN, DC GAN, GAN objective functions, JSD Divergence, EM Distance Least Squares.

Unit-V — 07 Hrs.

Object Segmentation:

Semantic segmentation, Scene Parsing, semantic flow, Bilinear Interpolation, Symmetry in Segmentation, Featured image pyramid, pixel-wise softmax, PSPNet, FPN, UNet, clustering method for segmentation, Distance metrics(Euclidean, Cosine, Hamming, Manhattan, Minkowski, Chebyshev, Jaccard, Haversine, Sorensen-Dice), Linkage Types (Single, Average, Complete, Centroid).

Unit-VI 06 Hrs.

Motion Analysis and action recognition:

Introduction to motion analysis, Horn and Shunck method, Lucas-Kanade algorithm for optical flow, Deep learning in optical flow estimation. Motion models. Introduction to action recognition, Action classification, Action localization. Spatio-Temporal Analysis, Dynamic Stereo; Motion parameter estimation. Visual object tracking methods and its examples, multiple objects tracking methods, Tomasi and Kanade Motion factorization algorithm, Applications of feature point tracking: mosaicing, video stabilization, structure from motion.

Text Books:

1. Richard Szeliski, "Computer Vision: Algorithms and Applications", 2nd Edition, Springer, 2022.
2. Ian Goodfellow, Yoshua Bengio, Aaron Courville, "Deep Learning", MIT Press, 2019.
3. Benjamin Planche, Eliot Andres, "Hands-On Computer Vision with TensorFlow 2", Packt Publishing, 2019.
4. Gonzalez, Rafael C., and Woods, Richard E., "Digital Image Processing", 4th Edition Pearson, 2018.
5. Mark Nixon, "Feature Extraction and Image Processing for Computer Vision", 3rd Edition, Academic Press, 2019.
6. Scott Krig, "Computer Vision Metrics: Survey, Taxonomy, and Analysis", 2nd Edition, Apress, 2019.

Reference Books:

1. Adrian Kaehler, Gary Bradski, "Learning OpenCV 4: Computer Vision with Python", O'Reilly Media, 2019.
2. Richard Hartley, Andrew Zisserman, "Multiple View Geometry in Computer Vision," 2nd Edition, Cambridge University Press, 2020.
3. E. R. Davies, "Computer Vision: Principles, Algorithms, Applications, Learning", 5th Edition Academic Press (Elsevier), 2017.
4. Mohamed Elgendy, "Deep Learning for Vision Systems", Manning Publications, 2020.
5. Yeshwanth Reddy, Kishore Ayyadevara, "Modern Computer Vision with PyTorch", Packt Publishing, 2020.

Weblinks:

1. Virtual Lab on Vision and deep learning Lab, https://www.ee.iitb.ac.in/ viplab/
2. Virtual Lab on Computer Vision Laboratory https://www.iitk.ac.in/ee/computer-vision-lab
3. Course on Modern Computer Vision
   https://www.youtube.com/playlist?list=PLzWRmD0Vi2KVsrCqA4VnztE4t71KnTnP5
4. Coursera course on Advanced Computer Vision with TensorFlow
   https://www.coursera.org/learn/advanced-computer-vision-with-tensorflow
5. Udemy course on Deep Learning and Computer Vision A-Z™: OpenCV, SSD & GANs — Udemy
6. Vision Lab: Computeer Vision http://cse.iitm.ac.in/lab_details.php?arg=NQ
7. Funded Projects on Computer Vision at NAVER LABS Europe
   https://europe.naverlabs.com/research/computer-vision/

Evaluation Scheme:

Theory :

Continuous Assessment (A):

Subject teacher will declare Teacher Assessment criteria at the start of semester.

Continuous Assessment (B):

1. Two term tests of 10 marks each will be conducted during the semester.
2. Average of the marks scored in both the tests will be considered for final grading.

End Semester Examination (C):

1. Question paper based on the entire syllabus, summing up to 65 marks.
2. Total duration allotted for writing the paper is 2 hrs.

Image Processing and Computer Vision - II Laboratory (22PCCS6030L)

Practical Scheme
Practical : 02 Hrs./week
Credit : 01

Examination Scheme
Teacher Assessment : 25 Marks
End Sem Exam : 25 Marks
Total : 50 Marks

Course Objectives:

To become familiar with CNN, YOLO, GAN, Transfer Learning and U-Net associated with image processing.

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Implement basic object detection using YOLO and different CNN models on image dataset.	L3	Apply
CO2	Demonstrate face recognition by hybrid image formation for Identification of facial expression classification and detection.	L4	Analyze
CO3	Implement image color conversion and deep fake detection using GAN.	L3	Apply
CO4	Construct transfer learning and U-Net by applying Image classification and Segmentation.	L3	Apply

List of Laboratory Experiments

Suggested List of Experiments:

1. Object Detection (CNN): Cancer Cells Detection using Medical Image Processing.
2. Object Detection (CNN): Comparative analysis of different CNN models on Image Dataset.
3. Object Detection (YOLO): Identifying vehicle from a Road Traffic CCTV video Footage.
4. Implement transfer learning using the models (CNN, YOLO, etc.).
5. Similarity-Based Image Matching Using Siamese Networks.
6. Fine-Grained Image Recognition for Subcategory Classification.
7. Face Recognition: Facial Key Point Detection, Face verification, Hybrid image formation for identification of facial expression classification and detection.
8. GAN: Converting Black and white image into Colored image.
9. GAN: Deep fake Detection.
10. Image Segmentation: Image Categorization for a given Vision Dataset.
11. Motion Analysis: Spatio-Temporal Analysis for Body Postures.
12. Mini Project

Minimum 06 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.

Evaluation Scheme:

Laboratory:

Continuous Assessment (A):

Laboratory work will be based on 22PCCS6030T with at least 06 experiments from the above list to be incorporated. The distribution of marks for term work shall be as follows:

1. Performance in Experiments: 05 Marks
2. Journal Submission: 05 Marks
3. Viva-voce: 05 Marks
4. Subject Specific Lab Assignment/Case Study: 10 Marks

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

End Semester Examination (C):

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

Programming Laboratory (22PCCS6040L)

Practical Scheme	Examination Scheme
Lecture : 02 Hrs./week	Teacher Assessment : 50 Marks
Practical : 02 Hrs./week	End Sem Exam : 50 Marks
Credits : 03	Total : 100 Marks

Prerequisite: 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 and microservices architecture.

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.	L3, L6	Apply, Create
CO3	Build secure, database-driven web applications using Spring and Spring Boot, with an understanding of microservices and RESTful web services.	L6	Create

Course Contents

Unit-I — 03 Hrs.

Advanced Object-Oriented Concepts

Design Patterns: Introduction to design patterns: Singleton, Factory, Observer, Strategy, Implementing design patterns in Java.

SOLID Principles: Understanding and applying SOLID principles for better design, Examples and case studies.

Interfaces and Abstract Classes: Advanced uses of interfaces and abstract classes, Default methods in interfaces (Java 8 and above).

Unit-II — 06 Hrs.

Java Collections Framework and Advanced Streams

Collections: List, Set, Map, and Queue interfaces, ArrayList, LinkedList, HashSet, Tree Set, HashMap, LinkedHashMap.

Generics: Introduction to generics in Java, Creating generic classes and methods Bounded type parameters.

Java Streams: Introduction to Streams API (Java 8 and above), Creating streams from collections, arrays, and I/O, Stream operations: map, filter, reduce, collect, Parallel streams for performance optimization.

Unit-III — 03 Hrs.

Java Reflection API

Introduction to Reflection: Understanding the Java Reflection API Accessing and manipulating class properties at runtime.

Use Cases of Reflection: Creating instances of classes dynamically Inspecting methods, fields, and annotations Use of Reflection in frameworks like Spring.

Unit-IV — 04 Hrs.

Java Database Connectivity (JDBC)

JDBC Overview: Connecting to databases using JDBC, Executing SQL queries and managing results, ORM Frameworks.

Introduction to Object-Relational Mapping (ORM): Overview of Hibernate and JPA,Creating a simple application using Hibernate.

Unit-V — 04 Hrs.

Spring Framework

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

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

Spring AOP (Aspect-Oriented Programming): Introduction to AOP concepts, Creating and using aspects in Spring.

Unit-VI 06 Hrs.

Spring Boot Framework Introduction to Spring Boot: Understanding its purpose and advantages over traditional Spring.

Setting Up Spring Boot Applications: Project structure and configuration.

Building RESTful Web Services: Creating REST APIs using Spring Boot.

Spring Data JPA: Introduction to database interactions and repository pattern.

Securing Spring Boot Applications: Basics of security in Spring Boot using Spring Security.

Suggested List of Laboratory Experiments:

1. Implementation of Functional Interfaces, Comparable and Comparator
2. Implementation of Optional Class, Date/Time API.
3. Implementation of Annotations.
4. Implementation of Singleton Design Patterns.
5. Implementation of Structural Design Patterns Behavioural Design Patterns.
6. Creating JDBC application
7. Implementation of different collection types (stacks, queues, vectors etc)
8. Creation of generic classes, methods
9. Use reflection API to examine or modify the behaviour of methods, classes, and interfaces at runtime.
10. Using streams API to implement program logic by composing functions and executing them in a data flow.
11. Create a Spring application configured with both XML and Java annotations.
12. Implement logging functionality using Spring AOP.
13. Create a Spring Boot application with Spring Data JPA for database interaction.

A minimum of 10 experiments or any other experiment based on syllabus will be included, which would help the learner to apply the concept learnt.

Text Books:

1. Anita Seth, B.L. Juneja, "JAVA: ONE STEP AHEAD", Oxford University Press, 1st Edition, May 2017.
2. Patrick Niemeyer, Daniel Leuck, "Learning Java", O'Reilly Media, Inc, 4th Edition, June 2013.
3. Mert Caliskan, Kenan Sevindik, Rod Johnson, Jürgen Höller, "Beginning Spring", Wrox February 2015.

Reference Books:

1. Herbert Schildt, "Java: The Complete Reference", 9th Edition, McGraw Hill.
2. Uttam K. Roy, "Advanced Java Programming, Oxford University Press, 2015.

Digital Resources:

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

Evaluation Scheme:

Laboratory:

Continuous Assessment (A): 50 Marks:

Laboratory work will be based on 22PCCS6040L with minimum 10 experiments to be incorporated. The distribution of marks for term work shall be as follows:

1. Performance in Experiments: 10 Marks
2. Journal Submission: 10 Marks
3. Viva-voce: 10 Marks
4. Subject Specific Lab Assignment/Case Study: 20 Marks

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

End Semester Examination (C): 50 Marks:

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

Cloud Computing (22PECS6051T)

Teaching Scheme
Lectures : 03 Hrs./week
Credits : 03

Examination Scheme
Term Test : 10 Marks
Teacher Assessment : 25 Marks
End Sem Exam : 65 Marks
Total Marks : 100 Marks

Prerequisite: 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.

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

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, 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

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, Exploring Cloud Backup Solutions, Cloud Storage Interoperability

Database as a Service: Key advantages of Database as a service offering, Amazon S3, Elastic Block Store (ESB), Amazon SimpleDB

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 flor clouds, industry implementation for AAA, authentication management standards for controlling access, SAML, authorization management, accounting for resource utilization.

Text Books:

1. Kailash Jayaswal, Jagannath Kallakurchi, Donald J. Houde, Dr. Deven Shah, "Cloud computing Black Book", Dreamtech Publication, 2014.
2. Rajkumar Buyya,"Mastering Cloud Computing", McGraw Hill Education, 2017
3. Ray Rafaels, "Cloud Computing: From Beginning to End", CreateSpace Independent Publishing, 2015.

Reference Books:

1. Temitayo Fagbola, Kamal Kant Hiran, "Cloud Computing: Master The Concepts, Architecture and Applications with Real-World Examples And Case Studies", BPB Publications, 2019.
2. Dr. Sunilkumar, S. Manvi, "Cloud Computing: Concepts and Technologies", CRC Press, 2021.
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.

Weblinks:

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

Evaluation Scheme:

Theory :

Continuous Assessment (A):

Subject teacher will declare Teacher Assessment criteria at the start of semester.

Continuous Assessment (B):

1. Two term tests of 10 marks each will be conducted during the semester.
2. Average of the marks scored in both the tests will be considered for final grading.

End Semester Examination (C):

1. Question paper based on the entire syllabus, summing up to 65 marks.
2. Total duration allotted for writing the paper is 2 hrs.

Cloud Computing Laboratory(22PECS6051L)

Practical Scheme
Practical : 02 Hrs./week
Credit : 01

Examination Scheme
Teacher Assessment : 25 Marks
Total : 25 Marks

Course Objectives:

To guide students in mastering the practical skills required for effective cloud computing, covering a wide range of key cloud services and architectural techniques.

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Apply virtualization techniques and cloud infrastructure concepts.	L3	Apply
CO2	Configure and manage cloud compute and cloud networking.	L4	Analyze
CO3	Implement user authentication and cloud storage solutions.	L3	Apply

List of Laboratory Experiments

Suggested List of 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

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.

Evaluation Scheme:

Laboratory:

Continuous Assessment (A):

Laboratory work will be based on 22PECS6051T with at least 10 experiments from the above list to be incorporated. The distribution of marks for term work shall be as follows:

1. Performance in Experiments: 05 Marks
2. Journal Submission: 05 Marks
3. Viva-voce: 05 Marks
4. Subject Specific Lab Assignment/Case Study: 10 Marks

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

Recommender systems (22PECS6052T)

Teaching Scheme
Lectures : 03 Hrs./week
Credits : 03

Examination Scheme
Term Test : 10 Marks
Teacher Assessment : 25 Marks
End Sem Exam : 65 Marks
Total Marks : 100 Marks

Prerequisite: Statistics for Data Science, and Machine Learning – I

Course Objectives:

To provide students with the basic concepts of Recommender Systems, design space, trade-offs and its application in various domain.

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Compare different types of Recommender Systems.	L5	Evaluate
CO2	Understand various issues related to recommender system development.	L2	Understand
CO3	Design a recommender system for a given problem.	L6	Create
CO4	Relate data collected from a recommender system to understand user preferences and/or behavior.	L4	Analyze

Course Contents

Unit-I — 09 Hrs.

Introduction to Recommender Systems:

Recommender Systems Function, Techniques, Application and Evaluation, Recommender Systems and Human Computer Interaction, Trust, 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.

Performance evaluation of RSs Experimental settings:

Evaluation metrics: Rating prediction and accuracy, Ranking Measures: NDPM, Spearman's , 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 — 06 Hrs.

Neighborhood-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, Advanced Techniques: Dimensionality Reduction Methods, Graph-based Methods, Feature selection. Item representation, Methods for learning user profiles. Model based and preprocessing based approaches, Attacks on collaborative recommender systems.

Unit-IV — 06 Hrs.

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. **Neigh-**

borhood models:

Similarity measures, Similarity-based interpolation, jointly derived interpolation weights. Global neighborhood model, Factorized neighborhood model, Temporal models. Step-by-step solution of the RS problem. Temporal dynamics at neighborhood models and Between neighborhood and factorization.

Unit-V 07 Hrs.

Constraint-based Recommenders:

Development of Recommender Knowledge Bases, User Guidance in Recommendation Processes, Calculating Recommendations.

Context-Aware Recommender Systems Trust:

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 06 Hrs.

Hybrid approaches:

Deep Recommender systems, Multimodal Recommenders, Monolithic hybridization design: Feature combination, Feature augmentation, Parallelized hybridization design: Weighted, Switching, Mixed, Pipelined hybridization design: Cascade Meta-level, Limitations of hybridization strategies, deployment of recommender systems for given timeframe/users/items, Testing and Explainability in recommenders.

Text Books:

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. Agarwal, "Recommender Systems: The Textbook", Springer, 1st Edition, 2016.

Reference Books:

1. M.D. Ekstrand, J.T. Riedl, J.A. Konstan, "Collaborative filtering recommender systems", Now publishers, 1st Edition, 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.

Weblinks:

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

Evaluation Scheme:

Theory :

Continuous Assessment (A):

Subject teacher will declare Teacher Assessment criteria at the start of semester.

Continuous Assessment (B):

1. Two term tests of 10 marks each will be conducted during the semester.
2. Average of the marks scored in both the tests will be considered for final grading.

End Semester Examination (C):

1. Question paper based on the entire syllabus, summing up to 65 marks.
2. Total duration allotted for writing the paper is 2 hrs.

Recommender systems Laboratory (22PECS6052L)

Practical Scheme	Examination Scheme
Practical : 02 Hrs./week	Teacher Assessment : 25 Marks
Credit : 01	Total : 25 Marks

Course Objectives:

1. To equip students with the knowledge and skills to analyze, design, and evaluate various recommendation system algorithms.
2. To enable students to implement advanced recommender systems using advanced algorithms and technologies, optimize their performance for real-world applications.

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Analyze recommender system datasets, algorithms, and performance across diverse applications.	L4	Analyze
CO2	Design and implement advanced recommendation systems using machine learning techniques and algorithms.	L3, L6	Apply, Create
CO3	Develop and deploy context-aware and constraint-based recommender systems for real-world e-commerce and network applications.	L3, L6	Create, Apply
CO4	Optimize and deploy scalable recommender systems leveraging cloud platforms and innovative algorithms like PageRank and association mining.	L3, L5	Apply, Evaluate

List of Laboratory Experiments

Suggested List of 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 dataset.
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.
13. Mini Project

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.

Evaluation Scheme:

Laboratory:

Continuous Assessment (A):

Laboratory work will be based on 22PECS6052T with at least 10 experiments from the above list to be incorporated. The distribution of marks for term work shall be as follows:

1. Performance in Experiments: 05 Marks

2. Journal Submission: 05 Marks

3. Viva-voce: 05 Marks

4. Subject Specific Lab Assignment/Case Study: 10 Marks

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

Embedded Systems & RTOS (22PECS6053T)

Teaching Scheme
Lectures : 03 Hrs./week
Credits : 03

Examination Scheme
Term Test : 10 Marks
Teacher Assessment : 25 Marks
End Sem Exam : 65 Marks
Total Marks : 100 Marks

Prerequisite: Microprocessors and Microcontrollers

Course Objectives:

To study concepts involved in embedded hardware and software for system realization.

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Identify and describe various characteristic features and applications of embedded systems.	L3	Apply
CO2	Analyze and identify hardware for embedded system implementations.	L3,L4	Apply, Analyze
CO3	Analyze and identify various software issues involved in embedded systems for real time requirements.	L3,L4	Apply, Analyze
CO4	Analyze and explain the design life-cycle for embedded system implementation.	L4,L5	Analyze, Evaluate

Course Contents

Unit-I — 04 Hrs.

Introduction to embedded systems

Characteristics and Design metrics of Embedded system, Real time systems: Need for Real-time systems, Hard-Soft Real-time systems., Challenges in Embedded System Design: Power, Speed and Code density, Power supply considerations in Embedded systems: Low power features-Idle Power, down mode, Sleep mode, and Brown-out detection

Unit-II — 08 Hrs.

Embedded Hardware

Introduction to Embedded Architecture: Embedded cores, Types of memories, Sensor Interface, Communication Interfaces: Comparative study of serial communication interfaces (RS-232, RS-485), SPI, I2C, CAN, USB, Wired LAN (Ethernet) (IEEE 802.3), Wireless LANs Long Distance Comm. Wireless Fidelity – LoRA Mesh. Selection criteria of above interfaces.

Unit-III — 08 Hrs.

ARM Architecture

Comparative study of A, R & M series of processors with introduction to different families and their capabilities- use cases. Understanding the Cortex M0/0+, M3, M4, M33, M55 and M7 in terms of scalability from low performance applications to base server applications and moving towards 64-bit architecture. Introducing Pipelining Concepts & basic instruction features such as ARM Mode, Thumb and Thumb 2 mode, Instruction and Data Caches (Cortex-M7 and Cortex-A); FPU MPU Co-processors. Introducing the STM 32 F446 RE Nucleo Board and its capabilities with sensor interfacing ...

Unit-IV — 08 Hrs.

Introduction to RTOS

Real-time Operating system: Need of RTOS in Embedded system software and comparison with GPOS, Foreground/Background processes, Interrupt latency, Task, Task- states, Multi-tasking, Context switching, Task scheduling, Scheduling algorithms - Rate Monotonic Scheduling, Earliest Deadline First, Inter-process communication, Semaphore, Mailbox, Message queues, Event timers, Task synchronization- Shared data, Priority inversion, Deadlock. Memory Management, Shared Devices and Mutex (Priority Inversion within it) Critical Code Sections (Disable Scheduler temporarily).

Unit-V — 06 Hrs.

Practical Implementation of RTOS Concepts with FreeRTOS

Introduction to FreeRTOS: Overview of FreeRTOS and its features, Benefits of using FreeRTOS in

embedded systems. Setting up the STM32 F446 Nucleo Board for FreeRTOS, Implementation of task scheduling. Context switching in FreeRTOS. Synchronization Mechanisms in FreeRTOS. Creating and using semaphores. Managing memory in FreeRTOS. Demonstrating task synchronization techniques (e.g., shared data management, priority inversion handling).

Unit-VI 05 Hrs.

System Integration, Testing and Debugging Methodology

Embedded Product Design Life-Cycle (EDLC). Hardware-Software Co-design **Testing & Debugging:** Boundary-scan/JTAG interface concepts, Black-Box testing, White-Box testing, hardware emulation, logic analyzer.

Text Books:

1. Dr. K. V. K. K. Prasad, "Embedded Real Time System: Concepts, Design and Programming", Dreamtech, New Delhi, 2014.
2. Perry Xiao, "Designing Embedded Systems & Internet of Things with ARM mbed", Wiley, 1st Edition, 2018.
3. Sriram Iyer, Pankaj Gupta, "Embedded Real Time Systems Programming", Tata McGraw Hill Publishing Company ltd., 1st Edition, 2017.

Reference Books:

1. David Simon, "An Embedded Software Primer", Pearson, 1st Edition, 2009.
2. Jonathan W. Valvano, "Embedded Microcomputer Systems–Real Time Interfacing", Publisher-Cengage Learning, 3rd Edition, 2012.
3. Andrew Sloss, Domnic Symes, Chris Wright, "ARM System Developers Guide Designing and Optimising System Software", Elsevier, 1st Edition, 2004
4. Frank Vahid, Tony Givargis, "Embedded System Design–A Unified Hardware/Software Introduction", John Wiley & Sons Inc., 1st Edition, 2002.
5. Shibu K. V., "Introduction to Embedded Systems", Tata McGraw Hill Education Private Limited, New Delhi, 1st Edition, 2009.

Weblinks:

1. A course on Embedded System Design with ARM:
   https://archive.nptel.ac.in/courses/106/105/106105193/
2. A course on Real Time Operating System:
   https://onlinecourses.nptel.ac.in/noc20_cs16/preview

3. A course on Design of Internet of Things:
   https://onlinecourses.nptel.ac.in/noc21_ee85/preview

Evaluation Scheme:

Theory :

Continuous Assessment (A):

Subject teacher will declare Teacher Assessment criteria at the start of semester.

Continuous Assessment (B):

1. Two term tests of 10 marks each will be conducted during the semester.
2. Average of the marks scored in both the tests will be considered for final grading.

End Semester Examination (C):

1. Question paper based on the entire syllabus, summing up to 65 marks.
2. Total duration allotted for writing the paper is 2 hrs.

Embedded Systems & RTOS Laboratory(22PECS6053L)

Practical Scheme
Practical : 02 Hrs./week
Credit : 01

Examination Scheme
Teacher Assessment : 25 Marks
Total : 25 Marks

Course Objectives:

1. To introduce the Building Blocks of Embedded System.
2. To Educate in Various Embedded Development Strategies.
3. To Introduce Bus Communication in processors, Input/output interfacing.
4. To impart knowledge in various processor scheduling algorithms.

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Adapt a basic knowledge about fundamentals of microcontrollers.	L6	Create
CO2	Understand a basic knowledge about programming and system control to demonstrate a specific task.	L2	Understand
CO3	Understand knowledge about devices and buses used in embedded networking.	L2	Understand
CO4	Develop programming skills in embedded systems for various applications.	L3	Apply
CO5	Illustrate of knowledge about basic concepts of circuit emulators.	L2	Understand
CO6	Demonstrate of Life cycle of embedded design and its testing.	L2	Understand

List of Laboratory Experiments

Suggested List of Experiments:

1. Introduction to STM 32 446 Nucleo Board & Getting started with Mbed.
2. Introduction to the FRDM 64F Platform & Getting Started with Mbed.
3. Porting, Compiling, Downloading & Running your first program – Blinky LED.
4. Interfacing LCD, Speaker, Temperature Sensor & Accelerometer with Nucleo Board.
5. Introduction to FreeRTOS and FreeRTOS Task Creation – Understanding the System Core Clock.
6. FreeRTOS Hello World App, Semi hosting & UART Setup.
7. FreeRTOS App Debugging using Segger System View Tools.
8. FreeRTOS Scheduler, Kernel Interrupts, RTOS Tick and SysTick Timer.
9. FreeRTOS Context Switching & Task Notification and Task Deletions.
10. FreeRTOS Queue Management, Semaphore for Synchronizations, Mutual Exclusion and Memory Management.

Minimum 06 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.

Evaluation Scheme:

Laboratory:

Continuous Assessment (A):

Laboratory work will be based on 22PECS6053T with at least 06 experiments from the above list to be incorporated. The distribution of marks for term work shall be as follows:

1. Performance in Experiments: 05 Marks
2. Journal Submission: 05 Marks
3. Viva-voce: 05 Marks
4. Subject Specific Lab Assignment/Case Study: 10 Marks

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

Computational Neuroscience (22PECS6054T)

Teaching Scheme
Lectures : 03 Hrs./week
Credits : 03

Examination Scheme
Term Test : 10 Marks
Teacher Assessment : 25 Marks
End Sem Exam : 65 Marks
Total Marks : 100 Marks

Prerequisite: Artificial Intelligence, Machine Learning, Statistics and Programming Skills.

Course Objectives:

This course aims to provide students with a strong foundation in the field of Cognitive Neuroscience, a field that studies the intricate links between the mind, the brain, and behaviour. Students will learn methods to replicate human behaviour of how to sense and perceive the world, act in it, learn and think about it, and remember it.

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Understand the computational neural structure.	L2	Understand
CO2	Illustrate coding and decoding models.	L2	Understand
CO3	Describe neural circuit and network models.	L2	Understand
CO4	Apply information theory concepts on Brain mapping.	L3	Apply

Course Contents

Unit-I — 06 Hrs.

Introduction:

Descriptive model, Mechanistic model and Interpretive model, Properties of Neurons, recording neuronal responses, Spike trains and firing rates: Measuring Firing Rates, Tuning curves; Stimulus: The spike Triggered Average, White noise Stimuli, Multiple Spike Triggered Averages and Spike Triggered correlations, Spike-Train Statistics – Homogenous and Inhomogeneous Poisson Process, Auto correction Function, The Poisson Spike Generator, The Neural Code

Unit-II — 08 Hrs.

Neural Encoding:

Introduction to retina, LGN, V1, area 17, Techniques of neural data collection, Reverse-Correlation Methods: Simple Cells, Spatial Receptive Fields, Temporal Receptive Fields, Response of a simple cell to counterphase grating, Space-time Receptive Fields; Linear Filtering, Non-linear input-output function, Basic encoding model, Impact of PCA on encoding model, Non-linear representation with Gaussian, Binomial and Poisson representation, The generalized linear model.

Unit-III — 07 Hrs.

Neural Decoding:

Encoding decoding, Discrimination: ROC curves, The likelihood ratio test; Population Decoding: optimal decoding method, Fisher Information; Spike-Train Decoding

Unit-IV — 06 Hrs.

Information Theory:

Entropy and Mutual Information, Information and entropy maximization: for single Neuron, populations of neurons; Utilization in Retinal Ganglion cell Receptive Fields- Application, Entropy and information for spike trains

Unit-V — 06 Hrs.

Model Neurons (Neuroelectronic):

Significance of Neuroelectronic in neuroscience, Neuronal Biophysics- Membrane potentials, Single compartment models, Integrated and fire models, Voltage dependent conductance, The Hodgkin-Huxley Model, Channel Simulation, Synaptic Transmission Models, Synaptic Inputs to Integrate-and-Fire Models

Unit-VI

06 Hrs.

Network Models:

Introduction - Importance of connectivity and dynamics, Firing-Rate Models - Dynamics of average firing rates, Feedforward - Neural mapping, Recurrent Networks: Linear and Nonlinear Recurrent Networks, Stability and oscillatory dynamics.

Text Books:

1. Jose Luis Bermudez, "Cognitive Science: An Introduction to the Science of the Mind", Cambridge University Press, New York, 2nd Edition, 2014.

2. Jay Friedenberg, Gordon Silverman and Michael J. Spivey, "Cognitive Science: An Introduction to the Study of Mind", SAGE Publication, 4th Edition, 2021.

Reference Books:

1. Michael Gazzaniga, Richard B Ivry, George R Mangun, "Cognitive Neuroscience the Biology of the Mind", W. W. Norton & Company Publication, 5th Edition, 2019.

2. Daniel Kolak, William Hirstein, Peter Mandik, Jonathan Waskan, "Cognitive Science: An Introduction to Mind and Brain", Taylor and Francis, 1st Edition, 2006.

Weblinks:

1. Cognitive Science:
   https://plato.stanford.edu/entries/cognitive-science/

2. Cognitive Neuroscience:
   https://plato.stanford.edu/entries/cognitive-science/

Evaluation Scheme:

Theory :

Continuous Assessment (A):

Subject teacher will declare Teacher Assessment criteria at the start of semester.

Continuous Assessment (B):

1. Two term tests of 10 marks each will be conducted during the semester.

2. Average of the marks scored in both the tests will be considered for final grading.

End Semester Examination (C):

1. Question paper based on the entire syllabus, summing up to 65 marks.

2. Total duration allotted for writing the paper is 2 hrs.

Computational Neuroscience Laboratory (22PECS6054L)

Practical Scheme
Practical : 02 Hrs./week
Credit : 01

Examination Scheme
Teacher Assessment : 25 Marks
Total : 25 Marks

Course Objectives:

1. Introduce the Basics of EEG Recording and Analysis.
2. Equip Participants with Experimental Design Skills.
3. Familiarize Participants with Brain Data Exploration Tools.
4. Develop Competence in Statistical Data Analysis.
5. Guide Participants in EEG Data Processing and Analysis.

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Understand the Fundamentals of EEG Recording and Analysis.	L2	Understand
CO2	Design Robust Experiments for EEG Studies.	L3	Apply
CO3	Utilize Advanced Tools for Brain Data Exploration and Simulation.	L3	Apply
CO4	Apply Statistical Techniques to Evaluate Experimental Data.	L3	Apply
CO5	Perform Comprehensive EEG Data Analysis.	L4	Analyze

List of Laboratory Experiments

Suggested List of Experiments:

1. Introduction to EEG recordings. Theory, physiology, practical aspects of recording and analysing scalp- recorded brain potentials.
2. Designing experiments: Control, manipulation, repeated trials, and balanced conditions. Application to studies with brain recordings.
3. Experimental approach to studying the working human brain and body. How to use Brain Voyager Brain Tutor. How to use the BESA dipole simulator.
4. Research design and the traditional statistical foundations of experimental research: T-test. Analysis of variance. Evaluate sample data and data from a standard experiment.
5. Recording dense-array EEG: Practical introduction.
6. EEG analysis: How to get from the raw recording to brain waves. An example analysis.
7. Mini Project

Minimum 06 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.

Evaluation Scheme:

Laboratory:

Continuous Assessment (A):

Laboratory work will be based on 22PECS6054T with at least 06 experiments from the above list to be incorporated. The distribution of marks for term work shall be as follows:

1. Performance in Experiments: 05 Marks
2. Journal Submission: 05 Marks
3. Viva-voce: 05 Marks
4. Subject Specific Lab Assignment/Case Study: 10 Marks

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

Project Stage-I (22PJCS6060L)

Practical Scheme
Practical : 04 Hrs./week
Credits : 02

Examination Scheme
Teacher Assessment : 25 Marks
End Sem Exam : 25 Marks
Total : 50 Marks

Course Objectives:

- To implement the solution as per the problem statement.
- To develop the team building, writing, logical reasoning and management skills.
- To provide the connections between the designs and concepts across different disciplinary boundaries.
- To encourage students to become independent personnel, critical thinkers and lifelong learners.

Course Outcomes:

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Apply engineering knowledge to produce solution of a problem considering cultural, social, environmental, and economic factors using appropriate tool and method. .	L4	Analyze
CO2	Demonstrate project based learning that allows students to transfer existing ideas into new applications.	L2	Understand
CO3	Develop an ability to work in teams and manage the conduct of the research study.	L3	Apply
CO4	Integrate different perspectives from relevant disciplines which help them to get internships, jobs and admission for higher studies.	L3	Apply
CO5	Present the research in the form of technical writing, understand what constitutes to plagiarism and how to use proper referencing styles.	L2	Understand

Syllabus:

Domain knowledge (any beyond) needed from the areas of Computer Science & Engineering(Data Science)for the effective implementation of the project.

The areas can be updated based on the technological innovations and development needed for specific project.

Guidelines:

The main purpose of this activity is to improve the students' technical skills, communication skills by integrating writing, presentation and teamwork opportunities.

- Each group will be reviewed twice in a semester and marks will be allotted based on the various points mentioned in the evaluation scheme.
- In the first review of this semester, each group is expected to complete 30 percent of project.
- In the second review of this semester, each group is expected to complete 50 percent of project.
- Interaction with alumni mentor will also be appreciated for the improvement of project.

Student is expected to:

- Maintain Log Book of weekly work done(Log Book Format will be as per Table 4).
- Report weekly to the project guide along with log book.

Table 4: Log Book Format

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

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 stage I (at the end of the semester) will be done by the departmental committee (including project guide).
- Oral examination should be conducted by Internal and External examiners. Students have to give presentation and demonstration based on their project.

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 Stage I 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 5.

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

Each group will be reviewed twice in a semester by faculty guide and faculty coordinator based on the following criteria:

- Project progress
- Documentation/Technical paper writing
- Key findings
- Validation of results

Table 5: Continuous Assessment Table

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

Each review consists of 25 marks. Average of the marks scored in both the two reviews will be considered for final grading. The final certification and acceptance of TA ensures the satisfactory performance on the above aspects.

Departmental committee (including project guide) will evaluate project as per Table 6.

Table 6: Evaluation Table

Sr	Exam Seat No	Name of Student	Project Selection	Design/ Methodology	Fabrication/ Modeling/ Simulation	Result Verification	Presentation	Total
			5	5	5	5	5	25