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 2022-23

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

R. C. PATEL
INSTITUTE OF TECHNOLOGY
An Autonomous Institute

R. C. Patel Institute of Technology, Shirpur

Institute Vision

To become a leading Institute in Technical education fostering innovation, research, ethical values, and sustainable development for the betterment of society.

Institute Mission

To impart high quality Technical Education through:

M1: Innovative and Interactive learning process and high quality, globally recognized instructional programs.

M2: Fostering a collaborative scientific temper among students with ethical responsibility towards the society.

M3: Preparing students from diverse backgrounds to have aptitude for employment, entrepreneurship and research with a spirit of professionalism.

M4: To contribute to nation's sustainable development.

Department of Computer Science & Engineering (Data Science)

Department Vision

To provide cutting-edge Computer Engineering education in Data Science while instilling socio-moral values.

Department Mission

M1: To deliver state-of-the-art, ICT-enabled teaching and learning to achieve excellence in Data Science education.

M2: To develop professionally competent Data Science Engineers, meeting evolving industrial and societal needs.

M3: To prepare employable professionals with ethical values and a commitment to professional and social responsibility.

Program Educational Objectives (PEOs) of the Department

PEO1: Graduates will achieve proficiency in Data Science and pursue lifelong learning to advance as professionals, entrepreneurs, and leaders.

PEO2: Graduates will operate effectively in diverse, dynamic professional and cultural environments, respecting societal perspectives.

PEO3: Graduates will demonstrate ethical values and social responsibility in their professional and personal lives.

Program Specific Outcomes (PSOs) of the Department

PSO1: Apply programming concepts, algorithms, and data structures to develop data-driven software and web solutions.

PSO2: Develop intelligent solutions using machine learning, data analysis, and cloud technologies for practical problem-solving.

Third Year B. Tech Computer Science and Engineering (Data Science) Semester-V (w.e.f. 2022-23)

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)	Best of (TT1 & TT2)	ESE			
				L	T	P	[A]			[B]	[C]	[A+B+C]		
1	PC	PCCS5010T	Machine Learning-II	3			20	15	15	15	65	100	3	4
	PC	PCCS5010L	Machine Learning-II Laboratory			2	25				25	50	1	
2	PC	PCCS5020T	Artificial Intelligence	3			20	15	15	15	65	100	3	4
	PC	PCCS5020L	Artificial Intelligence Laboratory			2	25					25	1	
3	PC	PCCS5030T	Information Security	3			20	15	15	15	65	100	3	4
	PC	PCCS5030L	Information Security Laboratory			2	25				25	50	1	
4	PC	PCCS5040L	Java and Scala Laboratory			4	50				50	100	2	2
5@	PE	PECS5051T	Distributed Computing	3			20	15	15	15	65	100	3	4
		PECS5051L	Distributed Computing Laboratory			2	25				25	50	1	
		PECS5052T	Time Series Analysis	3			20	15	15	15	65	100	3	
		PECS5052L	Time Series Analysis Laboratory			2	25				25	50	1	
		PECS5053T	Digital System Design	3			20	15	15	15	65	100	3	
		PECS5053L	Digital System Design Laboratory			2	25				25	50	1	
		PECS5054T	Probabilistic Graph Models	3			20	15	15	15	65	100	3	
		PECS5054L	Probabilistic Graph Models Laboratory			2	25				25	50	1	
6	HM	HMCS5060T	Professional and Business Communication	2			50					50	2	2
7	PJ	PJCS5070L	Semester Project-III			2	25				25	50	1	1
8	HM	HMCS5080L	Employability Skill Development Program-II			2	50					50	1	1
			Total	14		16	355			60	410	825	22	

@Any 1 Professional Elective Course

Prepared by:
Dr. P. S. Sanjekar

Checked by:
Prof. S. P. Salunkhe

Prof. Dr. U. M. Patil
BOS Chairman

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

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

Prof. Dr. J. B. Patil
Director

R. C. Patel Institute of Technology

Third Year B. Tech Computer Science and Engineering (Data Science) Semester-VI (w.e.f. 2022-23)

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)	Best of (TT1 & TT2)	ESE			
				L	T	P	[A]			[B]	[C]	[A+B+C]		
1	PC	PCCS6010T	Machine Learning-III(Reinforcement Learning)	3			20	15	15	15	65	100	3	4
	PC	PCCS6010L	Machine Learning-III Laboratory			2	25					25	1	
2	PC	PCCS6020T	Computational Linguistic	3			20	15	15	15	65	100	3	4
	PC	PCCS6020L	Computational Linguistic Laboratory			2	25				25	50	1	
3	PC	PCCS6030T	Image Processing and Computer Vision-I	3			20	15	15	15	65	100	3	4
	PC	PCCS6030L	Image Processing and Computer Vision-I Laboratory			2	25				25	50	1	
4	PC	PCCS6040L	Big Data Engineering Laboratory			4	50				50	100	2	2
5@	PE	PECS6051T	Cloud Computing	3			20	15	15	15	65	100	3	4
		PECS6051L	Cloud Computing Laboratory			2	25					25	1	
		PECS6052T	Recommender System	3			20	15	15	15	65	100	3	
		PECS6052L	Recommender System Laboratory			2	25					25	1	
		PECS6053T	Embedded System & RTOS	3			20	15	15	15	65	100	3	
		PECS6053L	Embedded System & RTOS Laboratory			2	25					25	1	
		PECS6054T	Cognitive Neuroscience	3			20	15	15	15	65	100	3	
		PECS6054L	Cognitive Neuroscience Laboratory			2	25					25	1	
6	PJ	PJCS6060L	Project Stage-I			2	25				25	50	1	1
7	MC	MCCS6070T	Environmental Engineering	1								Audit Course		
			Total	13		14	255			60	385	700	19	

@Any 1 Professional Elective Course

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R. C. Patel Institute of Technology, Shirpur
SES Shindhe Education Society
Autonomous

Semester - V

Program: Computer Science & Engineering (Data Science)	T. Y. B.Tech	Semester: V
Machine Learning-II (PCCS5010T)		
Machine Learning-II Laboratory (PCCS5010L)		

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

Course Objective(s):

1. To introduce students with the fundamental concepts of artificial neural network and different learning algorithms: supervised and unsupervised neural networks.
2. Develop in-depth understanding of the key techniques in designing Deep Network, Explainable AI and GAN.
3. To expose Deep Network based methods to solve real world complex problems.

Course Outcomes:

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

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

Machine Learning-II (PCCS5010T)
Course Contents

Unit-I Introduction to Artificial Neural Learning 04 Hrs.

History of Deep Learning, Fundamental concepts of biological Neural Networks, Important terminologies of ANN: Activation functions: weights, bias, threshold, learning rate, momentum factor; McCulloch Pitts Neuron: Theory and Architecture; Linear separability; Hebb Network: Theory and Algorithm.

Unit-II Supervised Learning Networks 10 Hrs.

Perceptron: Representational power of Perceptron, The Perceptron Training Rule, Gradient Descent and Delta Rule; Multilayer Networks: A differentiable Threshold Unit, Representational Power of Feedforward Networks; Backpropagation Algorithm: Convergence and local minima, Hypothesis space search and Inductive Bias, Generalization, overfitting and stopping criteria. Regularization for Deep Learning: Parameter Norm Penalties, Dataset Augmentation, Noise Robustness, Early Stooping, Sparse Representation, Dropout. Optimization for Training Deep Models: Challenges in Neural network Optimization, Basic Algorithms, Parameter Initialization Strategies.

Unit-III Convolutional Networks 06 Hrs.

The Convolution Operation, sparse interactions, parameter sharing, Pooling, Convolution and Pooling as an Infinity Strong Prior, Variants of Basic Convolution Function, Efficient Convolution Algorithms.

Unit-IV Sequence Modelling 06 Hrs.

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.

Unit-V Unsupervised Learning Networks 10 Hrs.

Kohonen Self-Organizing Feature Maps – architecture, training algorithm, Kohonen Self-Organizing Motor Map.

Autoencoders: Linear Factor Methods such as Probabilistic PCA and Factor Analysis, Independent Component Analysis, Sparse Coding; Undercomplete Autoencoders, Regularized Autoencoders, Stochastic Encoders and Decoders, Denoising Autoencoders, Contractive Autoencoders, Applications of Autoencoders. **Generative Adversarial Networks:** Generative Vs Discriminative Modeling, Probabilistic Generative Model, Generative Adversarial Networks (GAN), GAN challenges: Oscillation Loss, Mode Collapse, Uninformative Loss, Hyperparameters, Tackling GAN challenges, Wa stein GAN, Cycle GAN, Neural Style Transfer.

Unit-VI Explainable AI 06 Hrs.

Explaining and Interpreting, From black box to white box models, SHAP (Shapley Additive Explanation) and LIME (Local Interpretable Model-agnostic Explanation).

Machine Learning-II Laboratory (PCCS5010L)

List of Laboratory Experiments

Suggested Experiments:(At least 10 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. Build Generative adversarial model for fake (news/image/audio/video) prediction.
12. Build Explainable AI to improve human decision-making using a two-choice classification experiment with real-world data.

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

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

Text Books:

1. 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.

3. David Foster, "Generative Deep Learning", O'Reilly Media, 2019.

4. Denis Rothman, "Hands-On Explainable AI (XAI) with Python", Packt, 2020.

Reference Books:

1. Ian Goodfellow and Yoshua Bengio and Aaron Courville, "Deep Learning", An MIT Press, 2016.

2. François Chollet, "Deep Learning with Python", Manning Publication, 2017.

3. Josh Patterson, Adam Gibson, "Deep Learning: A Practitioner's Approach", O'Reilly Publication, 2017.

4. Andrew W. Trask, Grokking, "Deep Learning", Manning Publication, 2019.

5. John D. Kelleher, "Deep Learning", MIT Press Essential Knowledge series, 2019.

Web Links:

1. Learning Rule: http://vlabs.iitb.ac.in/vlabs-dev/labs/machine_learning/labs/explist.php

2. ANN Virtual Lab: http://cse22-iiith.vlabs.ac.in/List%20of%20experiments.html

3. Deep Learning: https://vlab.spit.ac.in/ai/#/experiments

4. NPTEL Course: Deep Learning Part 1: https://onlinecourses.nptel.ac.in/noc19_cs85/preview

Program: Computer Science & Engineering (Data Science)	T. Y. B.Tech	Semester: V
Artificial Intelligence (PCCS5020T)		
Artificial Intelligence Laboratory (PCCS5020L)		

Prerequisite: Basic Mathematics and Data Structures

Course Objective(s):

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

Course Outcomes:

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

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Describe given problem and identify the need of intelligent agent.	L2	Understand
CO2	Apply appropriate search-based method for a given problem.	L3	Apply
CO3	Analyze various AI approaches to knowledge–intensive problem solving, reasoning and planning.	L4	Analyze
CO4	Design an expert system for a given AI problem.	L6	Create

Artificial Intelligence (PCCS5020T)
Course Contents

Unit-I 04 Hrs.

Introduction to Artificial Intelligence: Introduction, History of Artificial Intelligence. Intelligent Systems: Categorization of Intelligent System, Components of AI Program, Foundations of AI, Sub-areas of AI, Current trends in AI.

Intelligent Agents: Agents and Environments, the concept of rationality, the nature of environment, the structure of Agents, Types of Agents, Learning Agent.

Unit-II 08 Hrs.

Problem solving: Solving problem by Searching: Problem Solving Agent, Formulating Problems, and Example Problems.

State Space Search: Uninformed search, Breadth First Search (BFS), Depth First Search (DFS), Depth Limited Search, Depth First Iterative Deepening (DFID).

Heuristic Search: Best first Search, Hill Climbing, Solution Space, and Travelling Salesman Problem.

Unit-III 08 Hrs.

Population Based Methods: Simulated annealing, Local beam search, Genetic algorithms, Ant Colony optimization.

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 and SSS*

Unit-IV 06 Hrs.

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

Unit-V 04 Hrs.

Expert System: Introduction, Phases in building Expert Systems, Architecture, Rule base systems, Inference Engine, Match-Resolve-Execute, Rete Net.

Unit-VI 12 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.

Artificial Intelligence Laboratory (PCCS5020L)

List of Laboratory Experiments

Suggested Experiments:(At least 10 experiments)

1. Study of Intelligent Agents and PEAS 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. Develop a knowledge base using Prolog.
8. Develop a Rule based System using SWRL on Protégé software.
9. Implement Fuzzy operations for given input values.
10. Design a fuzzy logic controller for a given problem.

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

Text Books:

1. Deepak Khemani, "A First Course in Artificial Intelligence", McGraw Hill Education, (India), 2013.
2. Stuart J. Russell and Peter Norvig, "Artificial Intelligence A Modern Approach", 4^{th} Edition, Pearson Education, 2010.
3. John Yen and Reza Langari, "Fuzzy Logic: Intelligence, Control and Information", Pearson, 2002.

Reference Books:

1. Saroj Kaushik, "Artificial Intelligence", 1^{st} Edition, Cengage Learning, 2011.
2. Ivan Bratko, "PROLOG Programming for Artificial Intelligence",4^{th} 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.

Web Links:

1. Game Theory: https://plato.stanford.edu/entries/game-theory/

2. Fuzzy Logic: https://plato.stanford.edu/entries/logic-fuzzy/

3. AI: https://www.functionize.com/blog/when-is-an-ai-not-an-ai-on-the-intelligent-use-of-ai

4. Logic and Ontology: https://plato.stanford.edu/entries/logic-ontology/

Program: Computer Science & Engineering (Data Science)	T. Y. B.Tech	Semester: V
Information Security (PCCS5030T)		
Information Security Laboratory (PCCS5030L)		

Prerequisite: Computer Basics

Course Objectives: The objective of the course is to introduce indicators of system security, recognize various threats, attacks and vulnerabilities.

Course Outcomes:

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

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Summarize system security goals and concepts, classical encryption techniques and acquire fundamental knowledge on the concepts of modular arithmetic and number theory.	L2	Understand
CO2	Use different encryption and decryption techniques to solve problems related to confidentiality and authentication.	L3	Apply
CO3	Apply cryptographic checksums through different message digest algorithms for verifying the integrity of varying message sizes.	L3	Apply
CO4	Apply different digital signature algorithms to achieve authentication and design secure applications.	L3	Apply
CO5	Summarize network security basics and categorize different attacks on networks and systems.	L4	Analyze
CO6	Discuss software vulnerability and its preventive measures.	L2	Understand

Information Security (PCCS5030T)
Course Contents

Unit-I Introduction 10 Hrs.

Introduction: Cyber Attacks, Need of Security, Security Approaches, Principles of security (confidentiality, authentication, integrity, non-repudiation, access control availability), types of attacks.

Networking Basics: Local Area Network, Protocols - Network Layer, Transport Layer and Application Layer.

Unit-II Number Theory 06 Hrs.

Modulo Arithmetic, Euclid's Algorithm, Fermat's and Euler's Theorem, Chinese Remainder Theorem, Cipher Properties, Substitution Ciphers – Monoalphabetic Ciphers, Polyalphabetic Ciphers, Transposition Ciphers.

Unit-III Symmetric Cryptography 08 Hrs.

Block Cipher, Fiestel Structure, Block Cipher Modes of Operation, S-DES, Double DES, Triple DES, AES Algorithm.

Unit-IV Asymmetric Cryptography 06 Hrs.

Private Key and Public Key Cryptography, The RSA algorithm, Key Management, Diffie-Hellman Key Exchange, Elliptic Curve Operations, Elliptic Curve Diffie-Hellman (ECDH) Key Exchange Algorithm.

Unit-V Integrity and Authentication 06 Hrs.

Hashing: Properties of cryptographic hash, message digest, MD-5, SHA-1. Public Key Infrastructure (PKI), One way and mutual authentication, Needham-Schroeder Protocol, Authentication methods, Kerberos Authentication Protocol, Biometrics, Digital Certificates: X.509.

Unit-VI Network Security 06 Hrs.

Network attacks, DoS and DDoS attack, Sniffing, Session hijacking, Spoofing, Phishing, Cross-site Scripting (XSS), IPSec Protocol, SSL Handshake Protocol, Firewalls, IDS Prevention and Detection.

Information Security Laboratory (PCCS5030L)

List of Laboratory Experiments

Suggested Experiments:(At least 10 experiments)

1. Create a network using CISCO packet tracer.

2. Connect the computers in Local Area Network.
3. Implement Playfair Cipher with key entered by user.
4. Implement polyalphabetic Cipher.
5. Implement Simple and Advanced Columner Transposition technique.
6. Implement Simplified DES.
7. Implement Simple RSA Algorithm with small numbers.
8. Implement Diffie-Hellman Key Exchange.
9. Implement DoS and DDoS attack using Hping.
10. Implement phishing attack using HTTrack Website Cloning.
11. Implement static code analysis using Flawfinder Python Distribution.
12. Implement packet sniffing using Wireshark and TCP Dump.
13. Implement cross site request forgery in a controlled virtual environment using DVWA Web Server.
14. Implement firewalls using IP tables.
15. Implement Network Intrusion Detection System (NIDS).
16. Implement Host based Intrusion Detection System (HIDS).

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

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

Text Books:

1. William Stallings, "Crpyptography and Network Security Principles and Practices", 7^{th} Edition, Pearson Education, 2017.
2. Behrouz A. Forouzan, Debdeep Mukhopadhyay, "Cryptography and Network Security", 3^{rd} Edition, McGraw Hill, 2015.

Reference Books:

1. Atul Kahate, "Cryptography and Network Security", 3rd Edition, McGraw Hill, 2017.
2. Bernard Menezes, "Network Security and Cryptography", 1st Edition, Cengage Learning, 2010.
3. Wade Trappe, Lawrence C Washington, "Introduction to Cryptography with coding theory", 2nd Edition, Pearson, 2005.
4. W. Mao, "Modern Cryptography, "Theory and Practice", 1st Edition, Pearson Education, 2003.
5. Charles P. Pfleeger, Shari Lawrence Pfleeger, Jonathan Margulies, "Security in computing", Pearson, 5th Edition, 2015.

Web Links:

1. Damn Vulnerable Web Application (DVWA): http://dvwa.co.uk
2. Open Web Application Security Project: https://owasp.org
3. Web penetration testing: https://pentesterlab.com
4. Penetration Testing: https://kali.org

Program: Computer Science & Engineering (Data Science)	T. Y. B.Tech	Semester: V
JAVA and Scala Laboratory (PCCS5040L)		

Prerequisite: Programming Fundamentals

Course Objective(s):

1. To learn JAVA and Scala programming concepts.
2. To understand the difference in Object oriented programming and Functional programming.

Course Outcomes:

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

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Apply Java and Scala programs that provide solutions for a given problem.	L3	Apply
CO2	Select a suitable programming language based on the scalability requirements of an application.	L4	Analyze

JAVA and Scala Laboratory (PCCS5040L)
Course Contents

Unit-I Introduction to Object Oriented Programming 03 Hrs.

1. Features of Java, JVM.
2. Basic Constructs/Notions: Constants, variables and data types, Operators and Expressions, Revision of Branching and looping.
3. Implementation of First Java Program.

Unit-II Classes, Object and Packages 04 Hrs.

1. Implement a Java program to demonstrate Class, Object, Methods.
2. Implement Java program to demonstrate Constructor, Static members and methods.
3. Implement a Java program to solve a given problem using object-oriented concept.
4. Implement a Java program to demonstrate the use of build in packages.

Unit-III Array, String and Vector 06 Hrs.

1. Implement a Java program using 1 D and 2D Array.
2. Implement Java program to demonstrate Strings and String Buffer class.
3. Implement Java program to demonstrate use of Wrapper classes.
4. Implement Java program on Vector.

Unit-IV Inheritance and Interface 04 Hrs.

1. Implement Java program to demonstrate types of inheritance, super keyword.
2. Implement Java program on abstract class and Abstract Method.
3. Implement Java program on interface demonstrating concept of multiple inheritance.
4. Implement Java program on dynamic method dispatch using base class and interface reference.

Unit-V Exception Handling and Multithreading 04 Hrs.

1. Implement Java program to demonstrate try, catch, throw, throws and finally. Also, implement user defined exception.
2. Program to demonstrate concept of Multithreading.
3. Implement Java program to demonstrate the concepts of Thread Synchronization.

Unit-VI GUI Programming in JAVA 06 Hrs.

1. Implement a JAVA program to create GUI applications with event handling using SWING (Swing components, Containers, JLabel, JButton, JCheckBox, JRadio Buttons, JTextField etc).
2. Implement a JAVA program to create application using SPRING Framework.
3. Implement a JAVA program to demonstrate Database connectivity using JDBC.

Unit-VII Functional Programming Basics Using Scala 03 Hrs.

1. Introduction to Scala: -Characteristics of Functional Programming, Benefits of Scala, Evolution of Scala.
2. Installation of Scala, Run REPL (Read, Evaluate, Print Loop) in Scala.
3. Scala Using Eclipse.

Unit-VIII Scala Programming Basics 04 Hrs.

1. Implement a program to demonstrate Scala programming basic Variable, Data types, Special escape Sequence, String interpolation, Type Conversion, Scope of Variable.
2. Implement a program in SCALA to demonstrate Operators, Precedence Rules, Mathematical Functions.
3. Implement program to demonstrate Conditional Statements and Loops.

Unit-IX Scala Collection 04 Hrs.

1. Implement Program to demonstrate Array, List and Sets in Scala.
2. Implement Program to demonstrate Tuple, Maps, iterator and String in Scala.

Unit-X Scala Functions 05 Hrs.

1. Implement Scala programs to demonstrate Functions Without Any Argument and Return Type, Function to accept another Function as an Argument, Function accepting list and an anonymous Function as argument.
2. Implement programs to demonstrate In-built Functions in Scala.
3. Implement Scala programs to demonstrate Call by value and call by name.

Unit-XI Scala Class object and Inheritance 04 Hrs.

1. Implement Scala programs to demonstrate class and objects.
2. Implement Scala programs to demonstrate inheritance.

Unit-XII Traits and Packages and Pattern Matching in Scala 05 Hrs.

1. Implement program to demonstrate Traits and packages in Scala.
2. Implement program to demonstrate multiple Inheritance in Scala.
3. Implement program to demonstrate Pattern matching in Scala.

Unit-XIII Exception Handling and File Handling in Scala 04 Hrs.

1. Implement program to demonstrate Exception Handling in Scala.
2. Implement program to demonstrate File Handling in Scala.

Minimum 10 experiments from above topics to be incorporated. Any other experiment based on syllabus may be included which would help the learner to understand topic/concept.

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

Text Books:

1. Herbert Schildt, "JAVA: The Complete Reference", 9^{th} Edition, Oracle Press, 2014.
2. Partha Sarathi Bishnu, "Functional Programming using Scala", 2012.

Reference Books:

1. Dean Wampler and Alex Payne, "Programming Scala", O'Reilly, 2014.
2. Ivor Horton, "Beginning JAVA", Wiley India, 2011.
3. Deiteland Deitel, "Java: How to Program", 8^{th} Edition, PHI, 2010.
4. "JAVA Programming", Black Book, Dreamtech Press.
5. "Learn to Master Java programming", Staredusolutions
6. Sachin Malhotra and Saurabh Chaudhary, "Programming in Java", Oxford University Press, 2010.

Web Links:

1. Virtual Lab: https://java-iitd.vlabs.ac.in
2. Virtual Lab: http://vlabs.iitb.ac.in/vlabs-dev/labs/java-iitd/experiments/java-intro-iitd/index.html
3. NPTEL video course link: Programming in Java: https://onlinecou rses.nptel.ac.in/noc22_c

Program: Computer Science & Engineering (Data Science)	T. Y. B.Tech	Semester: V
Distributed Computing (PECS5051T)		
Distributed Computing Laboratory (PECS5051L)		

Prerequisite: Operating Systems

Course Objective(s): 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.

Course Outcomes:

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

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Demonstrate Interprocess Communication and Synchronization in a Distributed System.	L3	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

Distributed Computing (PECS5051T)
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 08 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 08 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.

Distributed Computing Laboratory (PECS5051L)

List of Laboratory Experiments

Suggested Experiments:(At least 10 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.

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

Text Books:

1. Andrew S. Tanenbaum and Maarten Van Steen,"Distributed Systems: Principles and Paradigms", 2^{nd} 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", 2^{nd} 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", 5^{th} 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

Program: Computer Science & Engineering (Data Science)	T. Y. B.Tech	Semester: V
Time Series Analysis (PECS5052T)		
Time Series Analysis Laboratory (PECS5052L)		

Prerequisite: Probability, Statistics and Linear Models

Course Objective(s): 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.

Course Outcomes:

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

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

Time Series Analysis (PECS5052T)
Course Contents

Unit-I 06 Hrs.

Introduction: Types of forecasting methods, Types of Time Series, simple descriptive techniques, trends in time series (Parametric trends, differencing, non parametric methods, noise), seasonality, Stationary stochastic processes, the correlogram.

Stationary Time Series: Formal definition of a time series, the sample mean and its standard error, Stationary processes: types of stationarity, statistical inference of time series.

Unit-II 06 Hrs.

Linear Time Series: Motivation, Linear time series and moving average models, The AR model, simulating from an autoregressive process, The ARMA model, The ARIMA model, Unit roots, integrated and non-invertible processes, Box – Jenkins Model Selection, Seasonality, The SARIMA model.

Unit-III 08 Hrs.

Prediction: Using prediction in estimating, forecasting for autoregressive processes, forecasting for AR, forecasting for general time series using infinite past, One-step ahead predictors based on the finite past: Levinson -Durbin algorithm; Forecasting for ARMA processes, The Kalman filter.

Unit-IV 10 Hrs.

Models with Trend: Removing trend, Unit Root and Regression Residuals, The Monte Carlo Method, Dickey-Fuller tests.

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

Unit-V 06 Hrs.

Multivariate Time Series: Background: Sequences and Functions, Convolution, Spectral Representations and mean squared errors; Multivariate time series regression: Conditional independence, Partial correlation and coherency between time series.

Unit-VI 06 Hrs.

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

Time Series Analysis Laboratory (PECS5052L)

List of Laboratory Experiments

Suggested Experiments:(At least 10 experiments)

1. Time Series Characteristics: Time Series Data, Cross-Section Data, Panel data/ Longitudinal data.
2. Trends:
   (a) Detecting trends using Hodrick -Prescott Filter.
   (b) Detrending a Time Series.
3. Seasonality:
   (a) Multiple Box Plots.
   (b) Autocorrelation Plot.
   (c) Deseasoning of Time-Series Data.
   (d) Seasonal Decomposition.
   (e) Detecting Cyclic Variations.
4. Data Wrangling and Preparation for Time Series Data
5. Smoothing Methods: Simple exponential, Double exponential and Triple exponential.
6. Making Data Stationary: Plots, Summary Statistics, Statistics Unit Root Tests, Augmented Dickey – Fuller Test.
7. Autoregressive Model
8. Moving Average Model
9. ARMA Model
10. ARIMA Model
11. SARIMA Model
12. Anomaly Detection in Time Series Data.

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

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

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/s̃uhasini/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

Program: Computer Science & Engineering (Data Science)	T. Y. B.Tech	Semester: V
Digital System Design (PECS5053T)		
Digital System Design Laboratory (PECS5053L)		

Prerequisite: Basic Electrical and Electronics Engineering

Course Objective(s):

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.

Course Outcomes:

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

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Explain different digital codes and their conversions.	L2	Understand
CO2	Design 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

Digital System Design (PECS5053T)
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 09 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 08 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.

Digital System Design Laboratory (PECS5053L))

List of Laboratory Experiments

Suggested Experiments:(At least 10 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.

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

Text Books:

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

Program: Computer Science & Engineering (Data Science)	T. Y. B.Tech	Semester: V
Probabilistic Graph Models (PECS5054T)		
Probabilistic Graph Models Laboratory (PECS5054L)		

Prerequisite: Machine learning, Probability

Course Objective(s): 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.

Course Outcomes:

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

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

Probabilistic Graph Models (PECS5054T)
Course Contents

Unit-I 06 Hrs.

Fundamentals: Structured Probabilistic Models, Marginal and Joint Distributions, Independence and Conditional Independence.

Bayesian Networks: Independence and Separation, Markov properties and minimalism, Examples (HMM, diagnostic system, etc.).

Unit-II 06 Hrs.

Markov Networks: Boltzmann machine and Ising models, Markov random field, Parameterization, Cliques and potentials, Markov Network Independencies, Factor graphs.

Gaussian Network Models and Exponential Family: Multivariate Gaussians and Gaussian Networks, Exponential families, Entropy and Relative Entropy, Projections.

Unit-III 06 Hrs.

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

Unit-IV 06 Hrs.

Sampling Methods: MCMC method, Gibbs sampling Algorithm, Importance sampling, Particle filtering. Approximate inference: Loopy belief propagation, Variational inference and optimization view of inference, Mean field approach.

Unit-V 12 Hrs.

Parameter learning: Parameterizing graphical models, Parameter estimation in fully observed Bayesian networks: (Maximum likelihood estimation, Bayesian parameter estimation, Example: HMM), Parameter estimation in fully observed Markov networks: Maximum likelihood estimation (Iterative Proportional Fitting (IPF), Generalized Iterative Scaling (GIS)), Parameter estimation in partially observed graphical models (Expectation-Maximization (EM) - Example: HMM), Learning Conditional Random Fields.

Nonparametric Learning: Gaussian processes, Dirichlet processes, Indian Buffet processes.

Unit-VI 06 Hrs.

Structure learning: Score based approach, Chow-Liu algorithm for Bayesian networks, l1-regularized convex optimization for Markov random fields, Low-rank regularized learning of latent variable mo

Probabilistic Graph Models Laboratory (PECS5054L)

List of Laboratory Experiments

Suggested Experiments:(At least 10 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. Implementation of Parameter Learning in Discrete Bayesian Networks
9. Implementation of Learning using Chow-Liu Algorithm.
10. Implementation of learning Tree-augmented Naive Bayes (TAN).

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

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

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", 2^{nd} Edition, Springer, 2002.
2. Kevin P. Murphy, "Machine Learning: A Probabilistic Perspective", 4^{th} Printing. MIT Press, 2013.
3. Barber, D. "Bayesian Reasoning and Machine Learning",1^{st} Edition, Cambridge University Press, 2011.
4. Bishop, C. M. "Pattern Recognition and Machine Learning (Information Science and Statistics)", 2^{nd} printing, Springer, 2011.
5. Wainwright, M. and Jordan, M. "Graphical Models, Exponential Families, and Variat Inference", Foundations and Trends in Machine Learning, 2008.

Program: Computer Science & Engineering (Data Science)	T. Y. B.Tech	Semester: V
Professional and Business Communication (HMCS5060T)		

Prerequisite: Basic course in Effective Communication Skills

Course Objective(s):

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

Course Outcomes:

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

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Design and produce well-structured technical documents—such as reports, proposals, and research papers—by organizing content, composing original text, and integrating ethical standards in written communication.	L6	Create
CO2	Apply techniques of writing resume, participating in a group discussion and facing interviews.	L3	Apply
CO3	Use the principles of interpersonal skills and describe their application in professional and personal situations.	L3	Apply
CO4	Create professional meeting documentation and design effective meeting procedures demonstrating advanced communication and leadership skills.	L6	Create
CO5	Apply effective communication strategies to interact across diverse cultures and demonstrate appropriate professional work ethics in real-life scenarios.	L3	Apply
CO6	Design and deliver effective professional presentations using appropriate PowerPoint tools and presentation strategies.	L6	Create

Professional and Business Communication (HMCS5060T) Course Contents

Unit-I Technical Writing 08 Hrs.

Report Writing : Types of report, parts of formal report, collection of data and survey analysis, pre-writing of report, language and style in reports, formatting of reports, referencing in report.

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

Technical Paper Writing: parts of a technical paper, language and formatting, referencing in IEEE format.

Plagiarism : Types of plagiarism, consequences of plagiarism.

Unit-II Employment Skills 06 Hrs.

Group Discussion: Purpose of a GD, types of GD, criteria for evaluating a GD, Dos and Don'ts of a GD, Tips to be successful in GD.

Cover Letter & Resume Writing: Format and content of cover letter, 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.

Unit-III 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 team work, 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-IV Meetings and Documentation 02 Hrs.

Planning and preparation for meetings, strategies for conducting effective meetings, notice, agenda and minutes of a meeting, business meeting etiquettes.

Unit-V Cross-cultural communication and Ethics 04 Hrs.

Communication across cultures, professional and work ethics, responsible use of social media, introduction to Intellectual Property Rights.

Unit-VI Presentation Skills 03 Hrs.

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

List of Assignments(Each assignment carries 06 marks):

1. Business Proposal (PowerPoint presentation)
2. Resume writing
3. Interpersonal Skills (Documentation of activity)
4. Meetings and Documentation (Notice, Agenda, Minutes of Mock Meetings)
5. Business ethics

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.

Reference Books:

1. Fred Luthans, "Organizational Behavior", McGraw Hill,12th Edition.
2. Lesiker and Petit, "Report Writing for Business", McGraw Hill, 10th Edition.
3. Huckin and Olsen, "Technical Writing and Professional Communication", McGraw Hill, 2nd Edition.
4. Wallace and Masters, "Personal Development for Life and Work", 10th Edition, Thomson Learning.
5. Heta Murphy, "Effective Business Communication", Mc Graw Hill, 7th Edition.
6. Sharma R.C. and Krishna Mohan, "Business Correspondence and Report Writing", Tata McGraw-Hill Education, 6th Edition .
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, 3rd Edition.
10. Subramaniam, R., "Professional Ethics" Oxford University Press, 2nd Edition, 2017.

Evaluation Scheme:

Teacher Assessment(TA):

Continuous Assessment shall consist of Presentation, Group Discussion and Assignments. The distribution of marks will be as follows:

1. Presentation: 10 Marks
2. Group Discussion: 10 Marks
3. Assignments: 30 Marks

Total : 50 Marks

Program: Computer Science & Engineering (Data Science)	T. Y. B.Tech	Semester: V
Semester Project-III (PJCS5070L)		

Course Objective(s):

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

Course Outcomes:

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

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Analyze a survey of several available literatures in the preferred field of study.	L4	Analyze
CO2	Describe various/alternate approaches to complete a project.	L2	Understand
CO3	Apply a collaborative project environment by interacting and dividing project work among team members.	L3	Apply
CO4	Use technical communication skills to present project work in the form of a technical report/paper.	L3	Apply
CO5	Apply teamwork and project management skills to plan, execute, and manage the research study.	L3	Apply

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.

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/ Methodology	Implementation	Result Verification	Presentation	Total
			5	5	5	5	5	25

Program: Computer Science & Engineering (Data Science)	T. Y. B.Tech	Semester: V
Employability Skill Development Program-II (HMCS5080L)		

Prerequisite: Basic Mathematics, Basic knowledge of C programming

Course Objective(s):

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.

Course Outcomes:

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

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Solve logical problems based on words, Venn diagrams, etc.	L3	Apply
CO2	Solve English comprehension, sentence completion, and sentence correction problems.	L3	Apply
CO3	Illustrate the concepts of Exception Handling and Garbage Collection.	L3	Apply
CO4	Describe the fundamentals of DBMS, NoSQL, and MongoDB.	L2	Understand

Employability Skill Development Program-II (HMCS5080L) Course Contents

Unit-I 06 Hrs.

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 06 Hrs.

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 05 Hrs.

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 05Hrs

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 06Hrs

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

Semester - VI

Program: Computer Science & Engineering (Data Science)	T. Y. B.Tech	Semester: VI
Machine Learning-III (Reinforcement Learning)(PCCS6010T)		
Machine Learning-III Laboratory (PCCS6010L)		

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

Course Objective(s):

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

Course Outcomes:

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

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

Machine Learning -III (Reinforcement Learning)(PCCS6010T) 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, €-greedy method, Incremental Implementation, Non-stationary problem, Optimistic Initial values, UCB algorithm, Thompson Sampling.

Policy Gradient Approaches: Linear reward Penalty Algorithm, Parameterised policy representation (Θ), Evaluation of policy $\eta(\Theta)$, 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, Generalized Policy Iteration (GPI), 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 08 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) :

ward view, backward view, Traces: Accumulating trace, Dutch trace, Replacing trace, Equivalence of forward and backward view, SARSA(λ)

Unit-VI 08 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, Algorithm Summary, DDPG, Case study on AlphaGo by Google DeepMind

Machine Learning-III Laboratory (PCCS6010L)

List of Laboratory Experiments

Suggested Experiments:(At least 08 experiments)

1. Bandit Problem:
   (a) Implement Greedy and Epsilon greedy methods.
   (b) Comparison between Greedy and Epsilon Greedy Policy
   (c) UCB: Upper Confidence Bound
2. Policy Gradient (Convergence)
   (a) Implement REINFORCE algorithm on a CartPole/ Lunar Lander.
3. Dynamic Programming and Monte Carlo Methods
   (a) Implementation of GridWorld using Dynamic Programming
   (b) Jack's Car Rental using Dynamic Programming
   (c) Gamblers Problem using Dynamic Programming
   (d) BlackJack using Monte Carlo
   (e) Race Track Problem
4. Temporal Difference
   (a) Implement Frozen lake using SARSA
   (b) Implement Grid world using Q learning
5. Deep Reinforcement Learning

(a) Compare the performance of Reinforcement Learning and Deep Reinforcement Learning on a Cartpole problem.

(b) Implementation of Deep Q-Network algorithm

(c) Actor Critic: Find the optimal policy using the Actor Critic method.

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

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", 1st Edition, O'Reilly,2020.

2. Csaba Szepesvari, "Algorithms for Reinforcement Learning", 1st Edition, Morgan & Claypool Publishers, 2019.

3. Enes Bilgin, "Mastering Reinforcement Learning with Python", 1st Edition, Packt publication, 2020.

4. Brandon Brown, Alexander Zai, "Deep Reinforcement Learning in Action", 1st Edition, Manning Publications, 2020.

5. Micheal Lanham, "Hands-On Reinforcement Learning for Games", 1st Edition, Packt Publishing, 2020

6. Abhishek Nandy, Manisha Biswas, "Reinforcement Learning: With Open AI, TensorFlow and Keras using Python", 1st Edition, Apress, 2018.

Web Links:

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-

Program: Computer Science & Engineering (Data Science)	T. Y. B.Tech	Semester: VI
Computational Linguistics (PCCS6020T)		
Computational Linguistics Laboratory (PCCS6020L)		

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

Course Objective(s):

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

Course Outcomes:

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

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Describe the pre-processing techniques required for linguistic data types.	L2	Understand
CO2	Apply appropriate pre-processing technique on linguistic data.	L3	Apply
CO3	Discuss the pre-processing techniques for linguistic data to real world problems.	L2	Understand
CO4	Develop applications based on natural language processing.	L6	Create

Computational Linguistics (PCCS6020T)
Course Contents

Unit-I 06 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 06 Hrs.

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.

Unit-III 09 Hrs.

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-IV 09 Hrs.

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

Information Extracting: Relation Extraction algorithms, Extracting events and their times, Template filling.

Unit-V 04 H

Discourse Coherence: Coherence Relation, Discourse Structure Parsing, Centring and Er

Based Coherence Global Coherence.

Unit-VI 08 Hrs.

Applications: Machine Learning Model for Sentiment Analysis, Question Answer in NLP, Deep Learning Architecture for Sequence Processing: Recurrent Neural Network, Managing Context in RNNs: LSTMs, Self – Attention Networks: Transformers.

Computational Linguistics Laboratory (PCCS6020L)

List of Laboratory Experiments

Suggested Experiments:(At least 08 experiments)

1. Perform Preprocessing 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. Generate recursive set of sentences using Context Free Grammar Identify the word senses using "synset" in NLTK
5. Implement Spelling Check, Spelling Correction and Auto complete using Language models or CFG.
6. Implement a Spam classifier in Natural Language Processing.
7. Implement Fake News Classifier Using LSTM-Deep Learning in NLP.
8. Implement a Sentiment Analysis in Natural Language Processing.
9. Implement NLP application on Regional Language.
10. Implement Question Answering in NLP.
11. Implement Catboats in NLP.
12. Implement Information Retrieval for extracting Text from Webpages and Images.
13. Mini Project

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

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

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", 1st Edition, O'Reilly, 2020.

Web Links:

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

Program: Computer Science & Engineering (Data Science)	T. Y. B.Tech	Semester: VI
Image Processing and Computer Vision-I (PCCS6030T)		
Image Processing and Computer Vision-I Laboratory (PCCS6030L)		

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

Course Objective(s):

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

Course Outcomes:

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

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Describe the need of different image and video pre-processing.	L2	Understand
CO2	Apply different techniques for image and video corrections.	L3	Apply
CO3	Analyze different image and video processing methods.	L4	Analyze

Image Processing and Computer Vision-I (PCCS6030T) Course Contents

Unit-I 04 Hrs.

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

Unit-II 12 Hrs.

Image Enhancement (point processing): Image Negative, Thresholding, Gray-level slicing with and without background, power law and log transform, Contrast Stretching, Histogram equalization and Histogram Specification **Image Enhancement in Spatial Domain (Neighbourhood processing):** Low Pass and High Pass filtering for image enhancement, 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 10 Hrs.

Morphology: Erosion and Dilation, Opening and Closing, The Hit or-Miss Transformation. Restoration: Noise models – Mean Filters – Order Statistics – Adaptive filters –wiener 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, The SIFT operators, The SURF operators.

Unit-IV 08 Hrs.

Point, Line, and Edge Detection: Detection of Isolated Points, Line detection, edge models, basic and advance edge detection, 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, Fourier Transform of boundaries, Boundary description using segment sequences

Unit-V 08 H

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

Image Processing and Computer Vision-I Laboratory (PCCS6030L)

List of Laboratory Experiments

Suggested Experiments:(At least 08 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.
3. To perform Spatial Domain Image Enhancement using different Neighbourhood Processing techniques.
4. To perform Histogram equalization.
5. Application of Harr transform in image processing.
6. To perform frequency domain Image Enhancement techniques.
7. To perform region-based segmentation.
8. To perform morphological operations on Image.
9. To perform edge detection using basic and advanced techniques.
10. To perform Image restoration using various filters.
11. To extract the key frames from a video.
12. To perform background subtraction in a video
13. To perform Steganography operation in a video.

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

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

Text Books:

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

Reference Books:

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

Program: Computer Science & Engineering (Data Science)	T. Y. B.Tech	Semester: VI
Big Data Engineering Laboratory (PCCS6040L)		

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

Course Objective(s):

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

Course Outcomes:

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

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Describe Big Data and its analytics in the real world.	L2	Understand
CO2	Analyze the Big Data framework like Hadoop and NOSQL to efficiently store and process Big Data to generate analytics.	L4	Analyze
CO3	Design of Algorithms to solve Data Intensive Problems using Kubernetes and Docker.	L6	Create
CO4	Design and Implementation of Big Data Analytics using Spark and Hive to solve data intensive problems and to generate analytics.	L6	Create
CO5	Illustrate and apply different Data query techniques via Amazon Athena, Amazon EMR etc.	L3	Apply
CO6	Build Big Data Activities using Cold Data Retrieval AWS S3.	L6	Create

Big Data Engineering Laboratory (PCCS6040L)

List of Laboratory Experiments

Detail of the Experiment:

Hadoop Ecosystem — 05 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 — 05 Hrs.

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

Messaging Service — 04 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 — 04 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 04 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 04 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 06 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 06 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 06 H

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.

Minimum 10 experiments to be performed from above topics. Any other experiment based on syllabus may be included which would help the learner to understand topic/concept.
Practical examination will be based on the entire syllabus including, the practicals performed during laboratory sessions.

Text Books:

1. 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 G - 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

Program: Computer Science & Engineering (Data Science)	T. Y. B.Tech	Semester: VI
Cloud Computing (PECS6051T)		
Cloud Computing Laboratory (PECS6051L)		

Prerequisite: System Fundamentals and Basic Networking

Course Objective(s):

The analysis of massive networks which provide many computational, algorithmic modelling challenges, and analysis of large networks.

Course Outcomes:

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

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Differentiate between different virtualization methods and cloud computing technologies.	L2	Understand
CO2	Evaluate the need of cloud migration and available infrastructure for cloud deployment.	L5	Evaluate
CO3	Develop secure cloud-based applications.	L6	Create
CO4	Evaluate the risk in various cloud deployments.	L5	Evaluate

Cloud Computing (PECS6051T)
Course Contents

Unit-I 08 Hrs.

Introduction to Cloud Computing: Components of cloud computing, peer-to-peer, client-server, grid computing, NIST Model for cloud, Cloud Types: private, public, community and hybrid, delivery models.

Virtualization: Benefits, implementation levels of virtualization, Structure: hosted, bare-metal, Hypervisor and Xen Architecture, Binary Translation with full Virtualization, Paravirtualization with Compiler Support, CPY Virtualization, Memory Virtualization.

Unit-II 08 Hrs.

Cloud Services and Business Value: Infrastructure as a service (IaaS), Platform as a service (PaaS), Software as a service (SaaS), Database as a Service, key drivers, types of scalabilities, use of load balancing, levels of business value.

Cloud Deployment: Network problems and their migration, cloud network topologies, automation for cloud deployments, self-service features and federated cloud deployment, cloud performance monitoring and tuning, impact of memory on cloud performance, improving cloud database performance, Cloud Services Brokerage (CSB).

Unit-III 08 Hrs.

Data Security: Challenges with Cloud Data – Data Redundancy, Disaster Recovery, Data Backup, Data Replication, Data Residency or Location, Data Reliability, Data Fragmentation, Data Integration, Data Transformation, Data Migration, challenges with data security

Data Confidentiality and Encryption – Key Protection, Key Length, Backup Data, Data Availability, Data Integrity, Cloud Data Management Interface, Cloud Storage Gateways (CSGs), Cloud and Virtual Firewall.

Unit-IV 08 Hrs.

Cloud Programming: Programming Support for Google Apps Engine – Google File System, BigTable as Google's NoSQL System, Chubby as Google Distributed Lock Service, Programming support from Amazon EC2 – Amazon S3, Elastic Block Store (ESB), Amazon SimpleDB, Identity and Access Management (IAM).

Migrating Applications to the Cloud: Key aspects, cloud migration techniques, phases during migration, cloud emulators.

Unit-V 06 H

Risks of Cloud Computing and Related Costs: Various risks and issues, risk assessment and management, issues with cendor lock-in and mitigation mechanism, risk of failure of supply chain, risk of inadequate SLA, malware and internet attacks, risks in the cloud environment and the overall impact on customer business, security and compliance requirement, calculating total cost of ownership (TCO), indirect and indirect costs, chargeback methodology, pricing model, chargeback tools and solution.

Unit-VI 04 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.

Cloud Computing Laboratory (PECS6051L)

List of Laboratory Experiments

Suggested Experiments:(At least 08 experiments)

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

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

Text Books:

1. Kailash Jayaswal, Jagannath Kallakurchi, Donald J. Houde, Dr. Deven Shah, "Cloud computing Black Book" 1st Edition, Dreamtech Publication, 2014.

2. Rajkumar Buyya, "Mastering Cloud Computing", 1st Edition, McGraw Hill Education, 2017.

3. Ray Rafaels, "Cloud Computing: From Beginning to End," 1st Edition, 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", 1st Edition, BPB Publications, 2019.

2. Dr. Sunilkumar, S. Manvi, "Cloud Computing: Concepts and Technologies", 1st Edition, CRC Press, 2021.

3. Ricardo Puttini, Thomas Erl, and Zaigham Mahmood, "Cloud Computing: Concepts, Technology & Architecture", 1st Edition, Pearson Publication, 2014.

4. Michael J Kavis, "Architecting the Cloud", 1st Edition, Wiley, 2014.

Web Links:

1. A course on Cloud Computing: https://onlinecourses.nptel.ac.in/noc22_cs20/preview

2. A comprehensive guide to Social Network Analysis: https://www.analyticsvidhya.com/blog/2021/04/what-is-cloud-computing/

3. AWS Cloud Services: https://docs.aws.amazon.com//?nc2=h_ql_doc_do

Program: Computer Science & Engineering (Data Science)	T. Y. B.Tech	Semester: VI
Recommender systems(PECS6052T)		
Recommender Systems Laboratory (PECS6052L)		

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

Course Objective(s):

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

Course Outcomes:

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

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Differentiate various types of Recommender Systems.	L2	Understand
CO2	Interpret various issues related to recommender system development.	L2	Understand
CO3	Design a recommender system for a given problem.	L6	Create
CO4	Analyze data from a recommender system to determine user preferences and behaviors.	L4	Analyze

Recommender systems(PECS6052T)
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 ρ, R-Score, MAP, NDCG, MRR, implicit/explicit. Other metrics: fairness, coverage, diversity, novelty, serendipity.

Unit-II 05 Hrs.

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

Unit-III 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.

Neighborhood models: Similarity measures, Similarity-based interpolation, jointly derived i
polation weights. Global neighborhood model, Factorized neighborhood model, Temporal mo

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 09 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.

Recommender Systems Laboratory (PECS6052L)

List of Laboratory Experiments

Suggested Experiments:(At least 08 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 Net 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

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

Text Books:

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

Reference Books:

1. M.D. Ekstrand, J.T. Riedl, J.A. Konstan, "Collaborative filtering recommender systems", 1st Edition, Now publishers, 2011.
2. J. Leskovec, A. Rajaraman and J. Ullman, "Mining of massive datasets", 2st Edition, Cambridge, 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", 1st Edition, CRC Press, 2021.

Web Links:

1. Udemy course on Recommender Systems and Deep Learning in Python:
   https://realpython.com/build-recommendation-engine-collaborative-filtering

2. Coursera course on Recommender Systems Specialization:
   https://www.coursera.org/specializations/recommender-systems

Program: Computer Science & Engineering (Data Science)	T. Y. B.Tech	Semester: VI
Embedded Systems & RTOS (PECS6053T)		
Embedded Systems & RTOS Laboratory (PECS6053L)		

Prerequisite: Microprocessors and Microcontrollers

Course Objective(s):

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

Course Outcomes:

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

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Describe various characteristic features and applications of embedded systems.	L2	Understand
CO2	Analyze and identify hardware for embedded system implementations.	L4	Analyze
CO3	Analyze and identify various software issues involved in embedded systems for real time requirements.	L4	Analyze
CO4	Analyze and explain the design life-cycle for embedded system implementation.	L4	Analyze

Embedded Systems & RTOS (PECS6053T)
Course Contents

Unit-I 05 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 16 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.

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 Coprocessors. Introducing the STM 32 F446 RE Nucleo Board and its capabilities with sensor interfacing

Unit-III 16 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).

Introduction to FreeRTOS: Testing above concepts of RTOS on STM 32 F446 Nucleo Board such as task scheduling, context switching, semaphore creations and memory management

Unit-IV 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

testing, hardware emulation, logic analyzer.

Embedded Systems & RTOS Laboratory (PECS6053L)

List of Laboratory Experiments

Suggested Experiments:(At least 06 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.

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

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", 1st Edition, Wiley, 2018.
3. Sriram Iyer, Pankaj Gupta, "Embedded Real Time Systems Programming", 1st Edition, Tata McGraw Hill Publishing Company ltd., 2017.

Reference Books:

1. David Simon, "An Embedded Software Primer", 1st Edition, Pearson, 2009.

2. Jonathan W. Valvano, "Embedded Microcomputer Systems–Real Time Interfacing", 3rd Edition, Publisher- Cengage Learning, 2012.

3. Andrew Sloss, Domnic Symes, Chris Wright, "ARM System Developers Guide Designing and Optimising System Software", 1st Edition, Elsevier, 2004

4. Frank Vahid, Tony Givargis, "Embedded System Design–A Unified Hardware/Software Introduction", 1st Edition, John Wiley & Sons Inc., 2002.

5. Shibu K. V., "Introduction to Embedded Systems", 1st Edition, Tata McGraw Hill Education Private Limited, New Delhi, 2009.

Program: Computer Science & Engineering (Data Science)	T. Y. B.Tech	Semester: VI
Cognitive Neuroscience (PECS6054T)		
Cognitive Neuroscience Laboratory (PECS6054L)		

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

Course Objective(s):

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.

Course Outcomes:

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

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Analyze the methods of knowledge representation in cognitive processing.	L4	Analyze
CO2	Design cognitive architectures.	L6	Create
CO3	Describe the connection between brain and cognition.	L2	Understand
CO4	Apply neural network models to cognition.	L3	Apply
CO5	Apply reasoning & decision making to design dynamic systems.	L3	Apply

Cognitive Neuroscience (PECS6054T)
Course Contents

Unit-I 06 Hrs.

Introduction to Cognitive Science: The Cognitive view –Some Fundamental Concepts – Computers in Cognitive Science – Applied Cognitive Science – The Interdisciplinary Nature of Cognitive Science – Artificial Intelligence: Knowledge representation -The Nature of Artificial Intelligence - Knowledge Representation – Artificial Intelligence: Search, Control, and Learning.

Unit-II 08 Hrs.

Cognitive Philosophy: Cognitive Psychology – The Architecture of the Mind - The Nature of Cognitive Psychology- A Global View of The Cognitive Architecture- Propositional Representation- Schematic Representation- Cognitive Processes, Working Memory, and Attention- The Acquisition of Skill- The Connectionist Approach to Cognitive Architecture

Unit-III 10 Hrs.

Cognitive Neuroscience: Brain and Cognition Introduction to the Study of the Nervous System – Neural Representation – Neuropsychology- Computational Neuroscience - The Organization of the mind - Organization of Cognitive systems - Strategies for Brain mapping – A Case study: Exploring mindreading.

Unit-IV 10 Hrs.

Language Acquisition, Semantics and Processing Models: Milestones in Acquisition – Theoretical Perspectives- Semantics and Cognitive Science – Meaning and Entailment – Reference – Sense – Cognitive and Computational Models of Semantic Processing – Information Processing Models of the Mind- Physical symbol systems and language of thought- Applying the Symbolic Paradigm- Neural networks and distributed information processing- Neural network models of Cognitive Processes.

Unit-V 08 Hrs.

Higher-Level Cognition: Reasoning – Decision Making – Computer Science and AI: Foundations & Robotics – New Horizons - Dynamical Systems and Situated Cognition-Challenges – Emotions and Consciousness – Physical and Social Environments – Applications.

Cognitive Neuroscience Laboratory (PECS6054L)

List of Laboratory Experiments

Suggested Experiments:(At least 06 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

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

Text Books:

1. Jose Luis Bermudez, "Cognitive Science: An Introduction to the Science of the Mind", Cambridge University Press, New York, 2^{nd} Edition, 2014.
2. Jay Friedenberg, Gordon Silverman and Michael J. Spivey, "Cognitive Science: An Introduction to the Study of Mind", SAGE Publication, 4^{th} Edition, 2021.

Reference Books:

1. Michael Gazzaniga, Richard B Ivry, George R Mangun, "Cognitive Neuroscience the Biology of the Mind",5^{th} Edition, W. W. Norton & Company Publication, 2019.
2. Daniel Kolak, William Hirstein, Peter Mandik, Jonathan Waskan, "Cognitive Science: An Introduction to Mind and Brain", 1^{st} Edition, Taylor and Francis, 2006.

Program: Computer Science & Engineering (Data Science)	T.Y. B.Tech.	Semester: VI
Project Stage-I (PJCS6060L)		

Course Objectives:

1. To understand the basic concepts and principles of project development.
2. To formulate/identify the problem statement.
3. To implement the solution as per the problem statement.
4. To develop the team building, writing, logical reasoning and management skills.
5. To provide the connections between the designs and concepts across different disciplinary boundaries.
6. To encourage students to become independent personnel, critical thinkers and lifelong learners.

Course Outcomes:

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

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Analyze the problem statement and produce solution of the problem considering cultural, social, environmental and economic factors using appropriate tool and method.	L4	Analyze
CO2	Interpret project based learning that allows students to transfer existing ideas into new applications.	L2	Understand
CO3	Apply the ability to work in teams and manage to conduct the project development activity.	L3	Apply
CO4	Use different perspectives from relevant disciplines which help them to get internships, jobs, and admission for higher studies.	L3	Apply
CO5	Explain the project development in the form of technical writing, and interpret what constitutes plagiarism and the use of 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% of project stage-I.
- In the second review of this semester, each group is expected to complete 50% of project stage-I.
- Interaction with alumni mentor will also be appreciated for the improvement of project stage-I.

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

Prescribed project report guidelines:

Size of report shall be of minimum 30 pages (excluding cover and front pages). Project stage-I report should include appropriate content for:

- **Abstract**

- **Introduction**
  - Background
  - Motivation
  - Problem Statement
  - Objectives
  - Scope
- **Literature Survey**
  - Review of Existing System(s)
  - Limitations of Existing System(s)
- **Proposed System**
  - Analysis/Framework/ Algorithm
  - Details of H/W and S/W required
  - Design details
  - Methodology (your approach to solve problem)
- **Implementation Plan for Project Stage-II**
- **Conclusion**
- **References**

Assessment criteria for the departmental committee for Continuous Assessment:
Guide will monitor weekly progress and marks allocation will be as per Table 5.
Assessment criteria for the departmental committee for End Semester Exam:
Departmental committee will evaluate project as per Table 6.

Table 5: Continuous Assessment Sheet

Sr	P.R.N.	Name of Student	Student Attendance	Log Book Maintenance	Literature Review	Depth of Understanding	Report	Total
			5	5	5	5	5	25

Table 6: Evaluation Sheet

Sr	P.R.N.	Name of Student	Project Topic Selection	Design /Methodology	Implementation /Modelling /Simulation	Result Verification	Presentation	Total
			5	5	5	5	5	25

Program: Computer Science & Engineering (Data Science)	T. Y. B.Tech	Semester: VI
Environmental Engineering (MCCS6070T)		

Prerequisite: Nil

Course Objective(s):

1. Understand environmental issues such as depleting resources, pollution, ecological problems and the renewable energy scenario.
2. Familiarize environment related legislation.

Course Outcomes:

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

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Describe how human activities affect environment.	L2	Understand
CO2	Describe the various technology options that can make a difference.	L2	Understand

Environmental Engineering (MCCS6070T)
Course Contents

Unit-I Social Issues and Environment 05 Hrs.

Ecological footprint and Carrying Capacity, Depleting nature of Environmental resources such as soil, water minerals and forests ,Carbon emissions and Global Warming.

Unit-II Technological growth for Sustainable Development 04 Hrs.

Technological growth for Sustainable Development: Social, Economic and Environmental aspects of Sustainable Development, Renewable Energy Harvesting ,Concept of Carbon credit, Green Building ,Power and functions of Central Pollution Control Board and State Pollution Control Board.

Unit-III Environmental impact due to technology 05 Hrs.

Environmental impact due to technology: Impact of Energy on Environment, Flow of Energy in Eco- logical system, Environment Degradation due to Energy, Control of pollution from Energy, Consumer electronics, power saving devices, energy from waste, energy use and conservation.

Text Books:

1. R. Rajagopalan, "Environmental Studies From Crisis to Cure", 2012.
2. Textbook for Environmental Studies For Undergraduate Courses of all Branches of Higher Education, Erach Bharucha.
3. Iyyanki V. Murlikrishna and valli Manickam., "Environmental Management Science and Engineering for industry".

Evaluation Scheme:

1. Student should submit a report on the case study declared by teacher.
2. Audit point shall be awarded subject to submission of report of the case study declared by teacher.