PAAVAI ENGINEERNG COLLEGE
(Autonomous)

M.E. –COMPUTER SCIENCE AND ENGINEERING
REGULATIONS 2023
(CHOICE BASED CREDIT SYSTEM)
CURRICULUM

(For the candidates admitted during the Academic Year 2023-24)

SEMESTER - I

S.No.	Category	Course Code	Course Title	L	T	P	C
Theory							
1	FC	PMA23101	Applied Linear Algebra and Statistical Methods	3	1	0	4
2	RFC	PEN23101	Research Methodology and IPR	3	0	0	3
3	PC	PCE23101	Advanced Data Structures	3	1	0	4
4	PC	PCE23102	Machine Learning Techniques	3	0	0	3
5	PC	PCE23103	Advanced Database Management Systems	3	0	0	3
6	PE	PCE231**	Professional Elective I	3	0	0	3
7	AC	PAC23101	English for Research Paper Writing (Audit Course I)	2	0	0	0
Practical							
1	PC	PCE23104	Advanced Data Structures Laboratory	0	0	4	2
			TOTAL	**20**	**2**	**4**	**22**

SEMESTER - II

S.No.	Category	Course Code	Course Title	L	T	P	C
Theory							
1	PC	PCE23201	Internet of Things	3	0	0	3
2	PC	PCE23202	Deep Learning Techniques	3	1	0	4
3	PC	PCE23203	Agent Based Intelligent Systems	3	0	0	3
4	PC	PCE23204	Data Analytics	3	0	0	3
5	PE	PCE231**	Professional Elective II	3	0	0	3
6	PE	PCE231**	Professional Elective III	3	0	0	3
7	AC	PAC23201	Pedagogy Studies (Audit Course II)	2	0	0	0
Practical							
1	PC	PCE23205	Data Analytics Laboratory	0	0	4	2
			TOTAL	**20**	**1**	**4**	**21**

SEMESTER - III

S.No.	Category	Course Code	Course Title	L	T	P	C
Theory							
1	PC	PCE23301	Security Practices	3	0	0	3
2	PE	PCE231**	Professional Elective IV	3	0	0	3
3	PE	PCE231**	Professional Elective V	3	0	0	3
4	OE	*******	Open Elective I	3	0	0	3
Practical							
1	PC	PCE23302	Project Work - Phase I	0	0	12	6
			TOTAL	**12**	**0**	**12**	**18**

SEMESTER – IV

S.No.	Category	Course Code	Course Title	L	T	P	C
Practical							
1	PC	PCE23401	Project Work - Phase II	0	0	24	12
			TOTAL	**0**	**0**	**24**	**12**

TOTAL CREDITS: 73

PROFESSIONAL ELECTIVE

S.No.	Category	Course Code	Course Title	L	T	P	C
1.	PE	PCE23151	Digital Image Processing	3	0	0	3
2.	PE	PCE23152	Cognitive Computing	3	0	0	3
3.	PE	PCE23153	Block Chain Technologies	3	0	0	3
4.	PE	PCE23154	GPU Computing	3	0	0	3
5.	PE	PCE23155	Bioinformatics	3	0	0	3
6.	PE	PCE23156	Human Computer Interaction	3	0	0	3
7.	PE	PCE23157	Information Storage Management	3	0	0	3
8.	PE	PCE23158	Advanced Parallel architecture and Programming	3	0	0	3
9.	PE	PCE23159	Reinforcement Learning	3	0	0	3
10.	PE	PCE23160	Quantum Computing	3	0	0	3
11.	PE	PCE23161	Agile Methodologies	3	0	0	3
12.	PE	PCE23162	Digital Forensics	3	0	0	3
13.	PE	PCE23163	Data Visualization Techniques	3	0	0	3
14.	PE	PCE23164	Speech and Natural Language Processing	3	0	0	3
15.	PE	PCE23165	Cloud Computing Technologies	3	0	0	3
16.	PE	PCE23166	High Performance Computing for Big Data	3	0	0	3
17.	PE	PCE23167	Web Analytics	3	0	0	3
18.	PE	PCE23168	Social Network Analysis	3	0	0	3
19.	PE	PCE23169	Randomized Algorithms	3	0	0	3
20.	PE	PCE23170	Compiler Optimization Techniques	3	0	0	3

PMA23101 **APPLIED LINEAR ALGEBRA AND STATISTICAL METHODS** 3 1 0 4

COURSE OBJECTIVES

To enable the students to

- apply the dependent and independent relations of vector spaces.
- learn and apply the concepts of linear transformation and diagonalization.
- apply the small / large sample tests through Tests of hypothesis.
- equip with statistical techniques for designing experiments, analyzing, interpreting and presenting research data.
- enable the students to use the concepts of multivariate normal distribution and principal components analysis.

UNIT I VECTOR SPACES **12**

Vector spaces; Subspaces; Linear combinations and Linear system of equations; Linear dependence and Linear independence; Bases and Dimensions.

UNIT II LINEAR TRANSFORMATION AND INNER PRODUCT SPACES **12**

Linear Transformation, Null spaces and ranges – Dimension theorem; Matrix representation of a linear transformations; Review of Eigen values and Eigen vectors; Diagonalizability; Inner product, norms; Gram Schmidt orthogonalization process; Adjoint of linear operations; Least square approximation.

UNIT III TESTING OF HYPOTHESIS **12**

Sampling distributions – Type I and Type II errors – Small and Large samples – Tests based on Normal, t, Chi square and F distributions for testing of mean, variance and proportions – Tests for independence of attributes and goodness of fit.

UNIT IV DESIGN OF EXPERIMENTS **12**

ANOVA; One way and Two-way classifications; Completely randomized design; Randomized block design; Latin square design; 2^2 factorial design.

UNIT V MULTIVARIATE ANALYSIS **12**

Random vectors and matrices – Mean vectors and covariance matrices – Multivariate normal density and its properties – Principal components – Population principal components – Principal components from standardized variables.

TOTAL PERIODS 60

COURSE OUTCOMES

At the end of this course, students will be able to

- employ the dependent and independent relations of vector spaces.
- demonstrate the knowledge of linear transformation and Diagonalization.
- use statistical tests in testing hypotheses on data.

- be aware of the principles to be adopted for designing the experiments.
- be familiar with some of the commonly encountered two dimensional random variables and be equipped for a possible extension to multivariate analysis.

REFERENCES

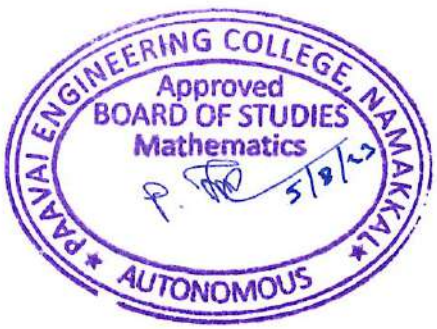
1. Dallas E Johnson, "Applied multivariate methods for data Analysis", Thomson and Duxbury press, Singapore, 1998.
2. Richard A. Johnson and Dean W. Wichern, "Applied multivariate statistical Analysis", Pearson Education, Fifth Edition, 6th Edition, New Delhi, 2013.
3. Bronson, R.,"Matrix Operation" Schaum's outline series, Tata McGraw Hill, New York, 2011.
4. Oliver C. Ibe, "Fundamentals of Applied probability and Random Processes", Academic Press, Boston, 2014.
5. Johnson R. A. and Gupta C.B., "Miller and Freund's Probability and Statistics for Engineers", Pearson India Education, Asia, 9th Edition, New Delhi, 2017.

CO – PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:

(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	-	-	-	-	-	-	-	3	-	-
CO2	3	2	2	2	-	-	-	-	-	-	-	3	-	-
CO3	3	3	2	2	-	-	-	-	-	-	-	3	-	-
CO4	3	3	2	2	-	-	-	-	-	-	-	3	-	-
CO5	3	3	2	2	-	-	-	-	-	-	-	3	-	-



PEN23101 **RESEARCH METHODOLOGY AND IPR** **3 0 0 3**

COURSE OBJECTIVES

To enable the students to

- understand the formulation of research problem
- be familiar with data collection and literature survey process
- know the statistical concepts in experimentation
- acquire knowledge in writing research proposal
- learn about patent rights and its importance

UNIT I RESEARCH PROBLEM FORMULATION **9**

Meaning of research, Objectives of Research, Types of research, Significance of Research, Research process, Selecting the problem, Necessity of defining the problem, Meaning of Research design, Need for research design, features of a good design, Different research designs.

UNIT II LITERATURE SURVEY **9**

Quantitative and Qualitative data, Scaling, Scaling Techniques, Experiments and Surveys, Collection of primary and secondary data, Data preparation process. Research problems, Effective literature studies approaches, Survey for existing literature, Procedure for reviewing the literature, Analysis and assessment.

UNIT III DESIGN OF EXPERIMENTS **9**

Strategy of Experimentation - Typical applications of experimental design, Guidelines for designing experiments; Basic statistical concepts - Statistical concepts in experimentation, Regression approach to analysis of variance.

UNIT IV RESEARCH PROPOSAL AND WRITING **9**

Contents of a research proposal, Writing a research report - Research writing in general, Referencing, Writing a bibliography, Presentation and assessment by a review committee, Plagiarism, Research ethics.

UNIT V INTELLECTUAL PROPERTY RIGHTS **9**

Intellectual Property - Definition, WTO, Fundamentals of Patent, Copyright, Rights of the owner, Term of copyright, Register of trademark, Procedure for trade mark, Term of trademark; New Developments in IPR- Administration of patent system, IPR of Biological Systems, Computer Software.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of the course, the students will be able to

- identify research problems.
- collect and prepare suitable data for research.
- design experiments for different statistical concepts.
- write research proposals and reports.
- apply the research work for patent through IPR.

REFERENCES

1. C.R Kothari and Gaurav Garg, "Research Methodology Methods and Techniques", 4th Edition, New Age International Publishers, 2019.
2. Ranjit Kumar, "Research Methodology": A step by Step Guide for beginners, 2nd Edition, Pearson Education, 2010.
3. Douglas C. Montgomery, "Design and Analysis of Experiments", 9th edition, Wiley Publishers, 2017.
4. Neeraj Pandey and Khushdeep Dharni, "Intellectual Property Rights", Prentice Hall India Learning, 2014.

CO/PO Mapping:

Mapping of course outcome with Programme outcomes (1/2/3 indicates strength of correlation1-Low; 2-Medium ; 3-High)														
COs	**Programme Outcomes (POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	3	1	-	-	1	-	2	-	-	3	2	2
CO2	3	3	-	1	2	-	1	-	2	3	-	3	2	2
CO3	3	3	3	2	2	-	-	-	3	2	1	3	2	2
CO4	3	3	-	-	1	1	-	3	2	3	-	3	2	2
CO5	3	-	-	2	2	3	1	3	3	-	2	2	2	2

PCE23101 **ADVANCED DATA STRUCTURES** **3 1 0 4**

COURSE OBJECTIVES

To enable the students to

- study Parallel algorithms.
- learn divide and conquer techniques.
- understand randomized algorithms.
- learn Graph algorithms.
- learn string matching applications.

UNIT I INTRODUCTION **12**

Advanced data structures: B-Trees, Fibonacci heaps, data structures for disjoint sets, hash tables Role of Algorithms in Computing - Analyzing Algorithms – Designing Algorithms Growth Functions: Asymptotic Function - Standard Notations and common Functions.

UNIT II DIVIDE AND CONQUER TECHNIQUES **12**

Divide and Conquer: Maximum - subarray problem - Strassen's algorithm for matrix multiplication - Substitution method for solving recurrence - Recursion-tree method for solving recurrences - Master method for solving recurrences. Randomized Algorithms: Hiring Problem - Indicator Random Variables.

UNIT III ADVANCED DESIGN AND ANALYSIS TECHNIQUES **12**

Dynamic Programming: Rod Cutting - Matrix-Chain Multiplication - Elements of Dynamic Programming - Longest Common Subsequence - Optimal Binary Search Trees. Greedy Algorithms: Elements of Greedy Strategy - Huffman Codes - Matroids and Greedy Methods Amortized Analysis: Aggregate Analysis - The Accounting Method.

UNIT IV ADVANCED GRAPH ALGORITHMS **12**

Johnsons Algorithm for Sparse Graphs Maximum Flow: Flow Networks - The Ford-Fulkerson Method - Maximum Bipartite Matching. Multithreaded Algorithms: Basics of Dynamic Multithreading - Multithreaded Matrix Multiplication - Multithreaded Merge Sort.

UNIT V STRING MATCHING AND APPROXIMATION ALGORITHMS **12**

String Matching Algorithms: Naïve approach - Rabin-Karp Algorithm - String Matching with Finite Automata -The Knutt Morris-Pratt Algorithm-NP Completeness.

TOTAL PERIODS 60

COURSE OUTCOMES

At the end of this course, students will be able to

- explain randomized algorithms in problem solving.
- implement graph algorithms in constraint satisfaction problems.
- perform dynamic programming-based algorithms.
- define multithreaded algorithms.
- understand string matching and with finite automata.

REFERENCES

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, Introduction to Algorithms, MIT Press, 2009.
2. Ellis Horowitz, SartajShani, SanguthevarRajasekaran, Computer Algorithms, Computer Science Press, 1998.
3. S. Dasgupta, C. H. Papadimitriou, and U. V. Vazirani, Algorithms, McGrawHill, 2008.
4. G. Brassard and P. Bratley, Algorithmics: Theory and Practice, Prentice -Hall, 1988.
5. J. Kleinberg and E. Tardos, Algorithm Design, Pearson Education, 2006.
6. Rajeev Motwani and Prabhakar Raghavan, Randomized Algorithms, Cambridge University Press, 1995.

CO – PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:

(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	1	1	-	-	1	1	1	1	1	1
CO2	3	2	2	2	1	1	-	-	1	1	1	1	1	1
CO3	3	3	2	2	1	1	-	-	1	1	1	1	1	1
CO4	3	2	2	2	1	1	-	-	1	1	1	1	1	1
CO5	3	3	2	2	1	1	-	-	1	1	1	1	1	1

PCE23102 **MACHINE LEARNING TECHNIQUES** **3 0 0 3**

COURSE OBJECTIVES

To enable the students to

- learn the various regression methods.
- acquire the knowledge in supervised learning techniques
- gain the knowledge of ANN and Genetic algorithm techniques
- impart the unsupervised learning techniques
- design appropriate ensemble learning algorithms for problem solving

UNIT I STATISTICAL THEORY AND REGRESSION **9**

Linear methods for Regression – Gauss-Markov theorem – Multiple regression – Subset selection – Ridge regression – Principal components regression – Partial least squares - Linear discriminant analysis – Logistic regression.

UNIT II SUPERVISED LEARNING **9**

Decision Tree Learning – Issues in Decision tree Learning - Bayes Theorem – Concept Learning – Maximum Likelihood – Minimum Description Length Principle – Bayes Optimal Classifier – Gibbs Algorithm – Naïve Bayes Classifier – Bayesian Belief Network – EM Algorithm.

UNIT III ARTIFICIAL NEURAL NETWORKS AND GENETIC ALGORITHM **9**

Introduction – Perceptron – Multilayer Networks and Back Propagation Algorithm-Remarks on the Back - Propagation Algorithm-Alternative Error Function - Alternative Error Minimization Procedures - Recurrent Networks-Instance Based Learning - Genetic Algorithm.

UNIT IV UNSUPERVISED LEARNING **9**

Association rules – Cluster analysis – Self organizing maps – Principal components, curves and surfaces – Non-negative matrix factorization – Independent component analysis – Multidimensional scaling.

UNIT V RANOM FORESTS AND ENSEMBLE LEARNING **9**

Introduction -Details of Random Forests – Analysis of Random Forests –Ensemble Learning Introduction- Boosting and Regularization Paths – Learning Ensembles.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

- compare and contrast about various regression methods.
- illustrate various supervised learning algorithms.
- create and deploy deep neural network applications.
- synthesize the usage of unsupervised learning algorithms.
- apply the appropriate ensemble learning strategy for any given problem.

REFERENCES

1. Tom M. Mitchell, "Machine Learning", McGraw-Hill Education (India) Private Limited, 2013.
2. Trevor Hastie, Robert Tibshirani, Jerome Friedman, "The Elements of Statistical Learning: DataMining, Inference, and Prediction", Springer; Second Edition, 2009.
3. Alpaydin Ethem, "Introduction to Machine Learning", MIT Press, Second Edition, 2010.
4. Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, "An Introduction to Statistical Learning: with Applications in R", Springer; First Edition 2013.
5. Stephen Marsland, Machine Learning An Algorithmic Perspective, CRC Press Taylor & Francis Group, United States, Second Edition, 2015.

CO – PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:

(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	1	2	3	3	3	2	1	-	1	1	2	2	2	3
CO2	1	3	3	3	2	2	1	-	1	1	2	2	2	3
CO3	1	2	2	3	3	2	1	-	1	1	2	2	2	3
CO4	1	2	3	3	2	2	1	-	1	1	2	2	2	3
CO5	1	3	3	3	3	2	1	-	1	1	2	2	2	3

PCE23103 ADVANCED DATABASE MANAGEMENT SYSTEMS 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- acquire knowledge on parallel and distributed databases and its applications.
- study the usage and applications of intelligent databases.
- study the usage and applications of object oriented and xml databases.
- understand the emerging databases like mobile and multimedia.
- understand the advanced indexing techniques, block chain databases.

UNIT I PARALLEL AND DISTRIBUTED DATABASES 9

Database System Architectures: Centralized and Client-Server Architectures – Server System Architectures – Parallel Systems - Distributed Systems – Parallel Databases: I/O Parallelism – Inter and Intra Query Parallelism – Inter and Intra operation Parallelism – Design of Parallel Systems Distributed Database Concepts - Distributed Data Storage – Distributed Transactions – Commit Protocols – Concurrency Control – Distributed Query Processing.

UNIT II INTELLIGENT DATABASES 9

Active Databases: Syntax and Semantics (Starburst, Oracle, DB2) - Taxonomy – Applications - Design Principles for Active Rules - Temporal Databases: Overview of Temporal Databases TSQL2 - Deductive Databases - Recursive Queries in SQL - Spatial Databases- Spatial Data Types - Spatial Relationships - Spatial Data Structures - Spatial Access Methods - Spatial DB Implementation.

UNIT III OBJECT AND XML DATABASES 9

Concepts for Object Databases: Object Identity – Object structure – Type Constructors – Encapsulation of Operations – Methods – Persistence – Type and Class Hierarchies – Inheritance. XML Databases: XML - Related Technologies - XML Schema - XML Query Languages - Storing XML in Databases - XML and SQL.

UNIT IV MOBILE AND MULTIMEDIA DATABASES 9

Mobile Databases: Location and Handoff Management - Effect of Mobility on Data Management - Location Dependent Data Distribution - Mobile Transaction Models - Concurrency Control - Transaction Commit Protocols - Multimedia Databases - Image Databases – Audio Databases - Video Databases.

UNIT V ADVANCED TECHNIQUES AND APPLICATION DEVELOPMENT 9

Advanced Indexing Techniques - Bloom Filter - Log-Structured Merge Tree and Variants - Bitmap Indices - Hash Indices; Advanced Application Development - Performance Tuning - Performance Benchmarks - Other Issues in Application Development; Blockchain Databases - Blockchain Properties - Achieving Blockchain Properties via Cryptographic Hash Functions - Data Management in a Block chain - Emerging Applications.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

- demonstrate the usage of high-performance database like parallel and distributed database.
- apply the rule set in the database to implement intelligent databases.
- model the real-world data using object-oriented database and organize the data using xml database for better interoperability.
- make use of mobile and multimedia databases.
- make use of block chain technologies and advancement in application development.

REFERENCES

1. Henry F Korth, Abraham Silberschatz, S. Sudharshan, Database System Concepts, Seventh Edition, McGraw Hill, 2019.
2. Carlo Zaniolo, Stefano Ceri, Christos Faloutsos, Richard T. Snodgrass, V.S.Subrahmanian, Roberto Zicari, Advanced Database Systems, Morgan Kaufmann publishers,2006.
3. C.J.Date, A.Kannan, S.Swamynathan, An Introduction to Database Systems, Eighth Edition, Pearson Education, 2006.
4. Vijay Kumar, Mobile Database Systemsǁ, John Wiley & Sons, 2006.
5. R. Elmasri, S.B. Navathe, Fundamentals of Database Systemsǁ, Sixth Edition, Pearson Education/Addison Wesley, 2010.
6. Thomas Cannolly and Carolyn Begg, "Database Systems, A Practical Approach to Design, Implementation and Management", Third Edition, Pearson Education, 2007.

CO – PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:

(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	2	2	3	2	3	-	-	1	1	1	2	1	2	3
CO2	2	2	2	2	3	-	-	1	1	1	2	1	2	3
CO3	3	2	2	3	3	-	-	1	1	1	2	1	2	3
CO4	2	2	2	2	3	-	-	1	1	1	2	1	2	3
CO5	2	2	2	3	3	-	-	1	1	1	2	1	2	3

PAC23101 **ENGLISH FOR RESEARCH PAPER WRITING** **2 0 0 0**

COURSE OBJECTIVES

To enable the students to

- improve the writing skills and level of readability.
- learn about what to write in each section and to understand the skills required to develop a title.
- choose a topic of interest and paraphrase, summarize, using correct attribution and following documentation guidelines.
- craft a research paper in their discipline.
- ensure the good quality of a research paper at first-time submission.

UNIT I PLANNING AND PREPARATION **6**

Precision of Words; Breaking up long sentences; Structuring Paragraphs and Sentences; Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness. Expressing independent thought with grace, clarity and force.

UNIT II LITERATURE REVIEWS AND CITATIONS **6**

Key skills required - write a title, an abstract, write an introduction, write the review of the literature, conduct a literature review of all current research in their field; Review of the Literature; Methods; Results; Discussion and Conclusions; citing references correctly and avoiding plagiarism.

UNIT III WRITING STANDARDS **6**

Useful phrases - to ensure paper is as good as it could possibly be the first-time submission - first draft, second draft, final draft of research report; journal article; literature review; chapters, grant proposal; Avoid inadequate support of generalizations, slipshod or hurried style, poor attention to detail, straying from directions, mechanical errors, underwritten and/or marred by confused purpose, lack of organization, repetition of ideas, improper use of words, and frequent grammatical, spelling and punctuation errors.

UNIT IV STRUCTURE OF A PAPER **6**

Details of all the parts, Clarifying Who Did What; Highlighting the Findings; Hedging and Criticizing; Skills to identify something we really need to know, some ways to find a topic; to venture out across the swamp of research without losing our bearings; Paraphrasing; Sections of a Paper - Abstract, Introduction to Free writing.

UNIT V EDITING AND ORGANISING SKILLS **6**

Skills required - write the Methods, write the Discussion, write the Results, write Conclusions; write about what we've learned truthfully so the reader really gets it in thought and expression, demonstrating a clear understanding and execution of the research.

TOTAL PERIODS: 30

COURSE OUTCOMES

At the end of the course, the students will be able to

- plan and write a research paper in their discipline
- understand the basics of citations, avoiding plagiarism and literature reviews
- write paraphrase, results and conclusions.
- culminate the actual crafting and revising of a research paper
- use suitable vocabulary, grammar and punctuation to write flawless piece of writing

REFERENCES

1. Goldbort R (2006) Writing for Science, Yale University Press.
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press.
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM.Highman's book.
4. Adrian Wallwork , English for Writing Research Papers, Springer New York DordrechtHeidelberg London, 2011

CO - PO Mapping

Mapping of Course Outcomes with Programme Outcomes:

(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	2	-	1	-	-	3	-	1	-	-	-
CO2	-	3	-	2	2	2	-	1	3	3	2	-	-	-
CO3	-	1	-	-	-	-	2	3	3	-	-	-	-	-
CO4	-	-	-	3	-	-	-	2	3	-	-	-	-	-
CO5	-	2	2	3	-	-	-	-	3	-	-	2	-	-

PCE23104 ADVANCED DATA STRUCTURES LABORATORY 0 0 4 2

COURSE OBJECTIVES

To enable the students to

- learn implementation of data structures for concurrency.
- study implementation of advanced data structures such as search trees, hash tables, heaps and operations on them
- learn implementation of graph traversal
- study implementation of trees and their traversal operations.

LIST OF EXPERIMENTS

1. Write a program to perform the following operations on Singly linked list.
   i) Creation ii) Insertion iii) Deletion iv) Traversal.
2. Write a program to perform the following operations on doubly linked list.
   i) Creation ii) Insertion iii) Deletion iv) Traversal in both ways.
3. Write a program that implements stack (its operations) using
   i) Arrays ii) linked list
4. Write a program that implements Queue (its operations) using
   i) Arrays ii) linked list
5. Write C program that implements the Quick sort method to sort a Given list of integers in ascending order.
6. Write C program that implement the Merge sort method to sort a Given list of integers in ascending order.
7. Write C program that implement the SHELL sort method to sort a Given list of integers in ascending order.
8. Write a program to perform the following:
   i) Creating a Binary Tree of integers
   ii) Traversing the above binary tree in preorder, in order and post order.
9. Write a C program to perform the following:
   i) Creating an AVL Tree of integers
   ii) Traversing the above binary tree in preorder, in order and post order.
10. Write a C program that uses functions to perform the following:
    i) Creating a Splay Tree of integers
    ii) Traversing the above binary tree in preorder, in order and post order.
11. Write a C program to perform the following:
    i) Creating a B-Tree of integers.

TOTAL PERIODS 60

COURSE OUTCOMES

At the end of this course, students will be able to

- implement List ADTs and their operations.
- develop programs for sorting.
- implement graph traversal algorithms.
- develop programs for implementing trees and their traversal operations.

CO – PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:

(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	2	2	3	3	-	-	-	-	-	-	-	1	1
CO2	1	2	2	3	3	-	-	-	-	-	-	-	1	1
CO3	1	2	2	3	3	-	-	-	-	-	-	-	1	1
CO4	1	2	2	3	3	-	-	-	-	-	-	-	1	1

PCE23201 **INTERNET OF THINGS** **3 0 0 3**

COURSE OBJECTIVES

To enable the students to

- understand the fundamentals of Internet of Things.
- learn about the IoT architecture.
- learn about the IoT protocols.
- build a small low-cost embedded system using Raspberry Pi & Arduino.
- apply the concept of Internet of Things in the real-world scenario.

UNIT I INTRODUCTION TO IoT **9**

Internet of Things - Physical Design- Logical Design- IoT Enabling Technologies - IoT Levels & Deployment Templates - Domain Specific IoTs - IoT and M2M - IoT System Management with NETCONF-YANG- IoT Platforms Design Methodology.

UNIT II IoT ARCHITECTURE **9**

M2M high-level ETSI architecture - IETF architecture for IoT - OGC architecture - IoT reference model - Domain model - Information model - Functional model - Communication model - IoT Reference architecture.

UNIT III IoT PROTOCOLS **9**

Protocol Standardization for IoT – Efforts – M2M and WSN Protocols – SCADA and RFID Protocols – Unified Data Standards – Protocols – IEEE 802.15.4 – BACNet Protocol – Modbus– Zigbee Architecture – Network layer – 6LowPAN - CoAP – Security.

UNIT IV BUILDING IoT WITH RASPBERRY PI & ARDUINO **9**

Building IoT with RASPBERRY PI- IoT Systems - Logical Design using Python – IoT Physical Devices & Endpoints - IoT Device -Building blocks -Raspberry Pi - Board - Linux on Raspberry Pi - Raspberry Pi Interfaces -Programming Raspberry Pi with Python - Other IoT Platforms - Arduino.

UNIT V CASE STUDIES AND REAL-WORLD APPLICATIONS **9**

Real world design constraints - Applications - Asset management, Industrial automation, Smart grid, Commercial building automation, Smart cities - Participatory sensing - Data Analytics for IoT – Software & Management Tools for IoT Cloud Storage Models & Communication APIs - Cloud for IoT- Amazon Web Services for IoT.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

- analyze various protocols for IoT
- develop Web services to access/control IoT devices.
- design a portable IoT using Raspberry Pi
- deploy an IoT application and connect to the cloud.
- analyze applications of IoT in real time scenario

REFERENCES

1. Arshdeep Bahga, Vijay Madisetti, "Internet of Things – A hands-on approach",Universities Press, 2015.
2. Olivier Hersent, David Boswarthick, Omar Elloumi, "The Internet of Things – Key applications and Protocols", Wiley, 2012.
3. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), "Architecting the Internet of Things", Springer, 2011.
4. Honbo Zhou,"The Internet of Things in the Cloud: A Middleware Perspective", CRC Press, 2012.
5. Jan Holler, Vlasios Tsiatsis , Catherine Mulligan, Stamatis , Karnouskos, Stefan Avesand. David Boyle, "From Machine-to-Machine to the Internet of Things - Introduction to a New Age of Intelligence", Elsevier, 2014.

CO – PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:

(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	1	2	3	2	3	2	1	-	1	1	2	2	2	3
CO2	1	3	3	3	2	2	1	-	1	1	2	2	2	3
CO3	1	2	2	3	3	2	1	-	1	1	2	2	2	3
CO4	1	2	3	2	2	2	1	-	1	1	2	2	2	3
CO5	1	3	3	3	3	2	1	-	1	1	2	2	2	3

PCE23202 **DEEP LEARNING TECHNIQUES** **3 1 0 4**

COURSE OBJECTIVES

To enable the students to

- learn various parameters of deep learning model.
- study about functional components of deep learning.
- acquire knowledge of deep learning algorithms.
- predict the uses of CNN and RNN.
- apply deep learning Concepts.

UNIT I FOUNDATIONS OF DEEP LEARNING **12**

Introduction – Math behind machine learning – Linear Algebra – Statistics –Machine Learning works – Logistic regression –Evaluating Models – Neural Networks – Training Neural Networks – Activation functions – Loss functions – Hyper parameters.

UNIT II ARCHITECTURAL DESIGN **12**

Defining Deep Learning – Common Architectural Principles of Deep Networks: Parameters – Layers - Activation functions – Loss functions - Optimization Algorithms – Hyper parameters. Building blocks of Deep Networks: RBMS – Auto encoders – Variational Auto encoders.

UNIT III TYPES OF DEEP NETWORKS **12**

Unsupervised pretrained Networks – Convolutional Neural Networks (CNNs) – Recurrent Neural Networks – Recursive Neural Networks – Applications.

UNIT IV CNN AND RNN **12**

Convolutional Neural Networks: Applying Pooling layers – Optimizing with Batch Normalization – Understanding padding and strides – Experimenting with Different types of initialization – Implementing a convolutional auto encoder – Applying a 1D CNN to text. Recurrent Neural Networks: Implementing a simple RNN – Adding LSTM – Using GRUs – Implementing Bidirectional RNNs – Character-level text generation.

UNIT V APPLICATIONS OF DEEP LEARNING **12**

Large scale deep learning – Computer vision: Introduction –Augmenting images with computer Vision Techniques –Classifying objects in images – Speech recognition – Natural language processing: Analyzing sentiment –Translating Sentences.

TOTAL PERIODS 60

COURSE OUTCOMES

At the end of this course, students will be able to

- experiment with the various parameters of deep learning model
- know the functional components of deep learning

- know the categories of deep learning algorithms
- understood the uses of CNN and RNN
- develop the simple deep learning applications

REFERENCES

1. Josh Patterson and Adam Gibson, "Deep Learning – A Practitioner's Approach", 1st Edition, O"Reilly Series, August 2017.
2. Indra den Bakker, "Python Deep Learning Cookbook", 1st Edition, Packt Publishing, October 2017.

CO – PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:

(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	1	2	3	2	3	3	1	-	1	1	2	2	2	3
CO2	1	3	3	3	2	2	1	-	1	1	2	2	2	3
CO3	1	3	2	3	3	3	1	-	1	1	2	2	2	3
CO4	1	2	3	2	2	2	1	-	1	1	2	2	2	3
CO5	1	3	3	3	3	2	1	-	1	1	2	2	2	3

PCE23203 AGENT BASED INTELLIGENT SYSTEMS 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- study the fundamental concepts, principles and techniques employed in agent-based systems.
- define the algorithmic foundation of agents and multi agent systems.
- explain theoretical foundations of agent-based system.
- apply Bayesian networks for probabilistic reasoning.
- create logical agents to do inference using first order logic.

UNIT I INTRODUCTION 9

Definitions - Foundations - History - Intelligent Agents - Problem Solving - Searching - Heuristics - Constraint Satisfaction Problems - Game playing.

UNIT II KNOWLEDGE REPRESENTATION AND REASONING 9

Logical Agents - First order logic-First Order Inference - Unification - Chaining - Resolution Strategies-Knowledge Representation-Objects-Actions-Events.

UNIT III PLANNING AGENTS 9

Planning Problem - State Space Search - Partial Order Planning - Graphs - Nondeterministic Domains - Conditional Planning - Continuous Planning - Multi Agent Planning.

UNIT IV AGENTS AND UNCERTAINITY 9

Acting under uncertainty – Probability Notation - Bayes Rule and use – Bayesian Networks - Other Approaches - Time and Uncertainty - Temporal Models - Utility Theory - Decision Network – Complex Decisions.

UNIT V HIGHER LEVEL AGENTS 9

Knowledge in Learning - Relevance Information - Statistical Learning Methods - Reinforcement Learning Communication Formal Grammar – Augmented Grammars - Future of AI.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

- understand the about agents and need of intelligent systems.
- analyze the impact of inference mechanism through knowledge representation and reasoning.
- design and the analysis of agent systems.
- formalize real-world problems, select, and apply relevant ai models in projects that require inferences, perceptions, problem solving, intelligent control, and training.
- conduct scientific discussions on ai, its current scope and limitations, as well as social implications.

REFERENCES

1. Stuart Russell and Peter Norvig, "Artificial Intelligence - A Modern Approach",2ndEdition, Prentice Hall, 2002
2. Zili Zhang and Chengqi Zhang, "Agent-Based Hybrid Intelligent Systems: An Agent-Based Framework for Complex Problem-solving.
3. Michael Wooldridge, "An Introduction to Multi Agent System", John Wiley, 2002.
4. Patrick Henry Winston, Artificial Intelligence, 3rd Edition, AW, 1999.
5. Nils.J.Nilsson, Principles of Artificial Intelligence, Narosa Publishing House, 1992
6. Winston, Patrick Henry, Artificial intelligence, Addison Wesley ,2008.

CO – PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:

(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	1	3	3	2	3	1	1	1	1	1	2	2	2	3
CO2	1	3	3	3	2	1	1	1	1	1	2	2	2	3
CO3	1	3	3	2	3	1	1	1	1	1	2	2	2	3
CO4	1	3	3	2	2	1	1	1	1	1	2	2	2	3
CO5	1	3	3	3	3	1	1	1	1	1	2	2	2	3

PCE23204 DATA ANALYTICS 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- introduce data analytics and preparing the data.
- impart knowledge on data summarization and visualization.
- familiar with the types of machine learning and data streams.
- learn big data frameworks.
- learn the design of data analytics.

UNIT I OVERVIEW OF DATA ANALYTICS 9

Data Analytics Life Cycle – Different types of Data – Different types of Data Analytics – Data Analytics Challenges Application areas of Data Analytics –Introduction to Big Data, Characteristics of Big Data, Big data ecosystem.

UNIT II DATA PREPARATION 9

Data Cleaning - Handle Missing Values- Handle Noise and Outliers, Remove Unwanted data; Data Transformation - Aggregation, Normalization, Discretization, Concept hierarchy generation, Generalization: Data Reduction Dimensionality Reduction, Numerosity Reduction, Data Compression.

UNIT III DATA SUMMARIZATION 9

Statistical data elaboration, Numerical Descriptive Measures - Central Tendency - Variation and Shape - Exploring Numerical Data - Numerical Descriptive Measures for a Population - Covariance and the Coefficient of Correlation - Summarizing Data through graphs.

UNIT IV MINING DATA STREAMS 9

Introduction to Streams Concepts - Stream data model and architecture - Stream Computing, Sampling data in a stream - Filtering streams - Counting distinct elements in a stream - Estimating moments - Counting oneness in a window – Decaying window-Realtime Analytics Platform (RTAP)applications-case studies-real time sentiment analysis, stock market predictions.

UNIT V BIG DATA TOOLS 9

Need of Big data tools - understanding distributed systems - Overview of Hadoop comparing SQL databases and Hadoop Eco System - Distributed File System: HDFS, Design of HDFS-writing files to HDFS, Reading files from HDFS.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

- prepare the data for further use.
- apply the statistical analysis in big data.
- understand and apply Supervised and Unsupervised learning approaches.
- understand Data stream mining concepts.

- understand big data frameworks.

REFERENCES

1. Jure Leskovec, Anand Rajaraman and Jeffrey David Ullman, Mining of Massive Datasets,2019,3rd edition,Cambridge University Press, New York.
2. Anderson D.R, Sweeney D.J, Williams T.A, (2019), Statistics for Business and Economics, 13th edition, Cengage Learning.
3. Bill Franks, Tamingthe Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with advanced analytics, 2012, 1st edition, John Wiley and sons, Hoboken, New Jersey.
4. Glenn J.Myatt, Making Sense of Data,2011,2nd edition, John Wiley and Sons, Hoboken, New Jersey.
5. Jiawei Han, Micheline Kamber, Data Mining Concepts and Techniques, 2008, 2nd edition, Elsevier, India
6. Gareth James, Daniela Witten,Trevor Hastie, Robert Tibshirani, An Introduction to Statistical Learning, 2013, Springer Texts in Statistics.

CO – PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:

(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	2	3	-	1	-	1	1	2	2	2	3
CO2	2	3	3	3	2	-	1	-	1	1	2	2	2	3
CO3	2	2	2	3	3	-	1	-	1	1	2	2	2	3
CO4	2	3	3	2	2	-	1	-	1	1	2	2	2	3
CO5	2	3	3	3	3	-	1	-	1	1	2	2	2	3

PAC23201 **PEDAGOGY STUDIES** **2 0 0 0**

COURSE OBJECTIVES

To enable the students to

- understand the aims, objectives and educational philosophies of education.
- acquire the knowledge of Instructional objectives of teaching and teaching skills.
- apply the knowledge of methods and strategies of teaching in real classroom situation.
- utilize the instructional aids and tools for effective classroom teaching.
- acquaint with the knowledge of professional development of teachers.

UNIT I EDUCATION AND ITS PHILOSOPHY **6**

Education- Definition, Aims, Objectives, Scope, Educational philosophy of Swami Vivekananda, Mahatma Gandhi, Rabindranath Tagore, Sri Aurobindo and J.Krishnamoorthy, Montessori, Jean - Jacques Rousseau, Friedrich Froebel and John Dewey. Current trends and issues in Education - Educational reforms and National policy on Education - 1968 and 1986 - its objectives and features.

UNIT II INSTRUCTIONAL OBJECTIVES AND DESIGN **6**

Instructional Objectives: Taxonomy of Educational objectives - Writing of general and specific objectives. Instructional design: Planning and designing the lesson, Writing of lesson plan: meaning, its need and importance, format of lesson plan. Types of lesson plan Skills of teaching: various ways of introducing lessons, explaining skills, problem solving skills, illustrative skills, scaffolding skills, integrating ICT skills, questioning skills, Reinforcement skills, skill of probing questions, skill of Stimulus variation and computation skills.

UNIT III INSTRUCTIONAL METHODS AND STRATEGIES **6**

Instructional strategies Lecture, demonstration, laboratory, Inductive method, Deductive method, Inquiry method, seminar, panel discussion, symposium, problem solving, project based learning (PBL), Learning by doing, workshop, role - play (socio-drama), Recent trends: Constructivist learning - Problem - based learning - Brain - based learning - Collaborative learning - Flipped learning - Blended learning - e-Learning trends - Videoconferencing.

UNIT IV INSTRUCTIONAL MEDIA **6**

Key concepts in the selection and use of media in education, Developing learning resource material using different media, Instructional aids - types, uses, selection, preparation, utilization. Dale cone of Experience, Teacher's role in procuring and managing instructional Aids - Projected and non-projected aids, multimedia, video - teleconferencing etc.

UNIT V TEACHER PREPARATION **6**

Teacher - roles and responsibilities, functions, characteristics, competencies, qualities, Preparation of Professional teacher, Organizing professional aspects of teacher preparation programs, Professional Development of teachers - In-service training, Refresher programmes, workshop and higher studies.

TOTAL PERIODS: 30

PRACTICUM

- Writing of three lesson plans
- Practice teaching for 15 days
- Preparation of one teaching aid
- A seminar on one educational philosophy
- Assignment on any of these five units

COURSE OUTCOMES

At the end of the course, the students will be able to

- explain the educational philosophies of education.
- write instructional and specific objectives in lesson plan.
- utilize the teaching skills and methods effectively.
- use instructional media efficiently.
- update themselves in the area of professional development.

REFERENCE

1. National Policy on Education 1968 and 1986- National Policy on Education 1986-Programme of Action1992.
2. Benjamin S.Bloometal.(1987).Taxono my of educational objectives. Longman Group.
3. Siddiqui, Mujibul Hasan(2005). Techniques of classroom teaching A.P.H.
4. Jeffrey Bennett(2014).On Teaching Science: Principles and Strategies That Every Educator Should Know. Big Kid Science: Boulder, CO
5. Bawa,M.S.&Nagpal,B.M.(2010).Developing teaching competencies. New Delhi: Viva Book House.

CO - PO Mapping

Mapping of Course Outcomes with Programme Outcomes:

(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	2	-	3	-	-	-	-	-	-
CO2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-	-	-	-	-	-	-	3	2	3	-	3	-	-
CO4	-	-	-	-	1	-	-	-	3	3	-	3	-	-
CO5	-	-	-	-	-	-	-	3	3	3	-	3	-	-

PAVAI ENGINEERING COLLEGE, NAMAKKAL
Approved
BOARD OF STUDIES
English
24/6/25
AUTONOMOUS

PCE23205 **DATA ANALYTICS LABORATORY** 0 0 4 2

COURSE OBJECTIVES

To enable the students to

- implement map reduce programs for processing big data.
- realize storage of big data using h base, mongo db.
- analyze big data using linear models.
- analyze big data using machine learning techniques such as svm / decision tree classification and clustering.

LIST OF EXPERIMENTS

HADOOP

1. Install, configure and run Hadoop and HDFS.
2. Implement word count / frequency programs using MapReduce
3. Implement an MR program that processes a weather data set

R Programming

4. Implement Linear and logistic Regression
5. Implement SVM / Decision tree classification techniques
6. Implement clustering techniques
7. Visualize data using any plotting framework
8. Implement an application that stores big data in Hbase / MongoDB / Pig using Hadoop / R.

TOTAL PERIODS 60

COURSE OUTCOMES

At the end of this course, students will be able to

- process big data using Hadoop framework
- build and apply linear and logistic regression models
- perform data analysis with machine learning methods
- perform graphical data analysis

CO – PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:

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COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	2	3	-	1	-	1	1	2	2	2	3
CO2	2	3	3	3	2	-	1	-	1	1	2	2	2	3
CO3	2	2	2	3	3	-	1	-	1	1	2	2	2	3
CO4	2	3	3	2	2	-	1	-	1	1	2	2	2	3

PCE23151 DIGITAL IMAGE PROCESSING 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- become familiar with digital image fundamentals.
- get exposed to simple image enhancement techniques in Spatial and Frequency domain.
- learn concepts of degradation function and restoration techniques.
- study the image segmentation and representation techniques.
- become familiar with image compression and recognition methods.

UNIT I DIGITAL IMAGE FUNDAMENTALS 9

Steps in Digital Image Processing – Components – Elements of Visual Perception – Image Sensing and Acquisition – Image Sampling and Quantization – Relationships between pixels – Color image fundamentals – RGB, HSI models, Two-dimensional mathematical preliminaries, 2D transforms – DFT, DCT.

UNIT II IMAGE ENHANCEMENT 9

Spatial Domain: Gray level transformations – Histogram processing – Basics of Spatial Filtering– Smoothing and Sharpening Spatial Filtering, Frequency Domain: Introduction to Fourier Transform– Smoothing and Sharpening frequency domain filters – Ideal, Butterworth and Gaussian filters, Homomorphic filtering, Color image enhancement.

UNIT III IMAGE RESTORATION 9

Image Restoration – degradation model, Properties, Noise models – Mean Filters – Order Statistics – Adaptive filters – Band reject Filters – Band pass Filters – Notch Filters – Optimum Notch Filtering – Inverse Filtering – Wiener filtering.

UNIT IV IMAGE SEGMENTATION 9

Edge detection, Edge linking via Hough transform – Thresholding – Region based segmentation – Region growing – Region splitting and merging – Morphological processing- erosion and dilation, Segmentation by morphological watersheds – basic concepts – Dam construction – Watershed segmentation algorithm.

UNIT V IMAGE COMPRESSION AND RECOGNITION 9

Need for data compression, Huffman, Run Length Encoding, Shift codes, Arithmetic coding, JPEG standard, MPEG. Boundary representation, Boundary description, Fourier Descriptor, Regional Descriptors – Topological feature, Texture – Patterns and Pattern classes – Recognition based on matching.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

- know and understand the basics and fundamentals of digital image processing, such as digitization, sampling, quantization, and 2d-transforms.

- operate on images using the techniques of smoothing, sharpening and enhancement.
- understand the restoration concepts and filtering techniques.
- learn the basics of segmentation, features extraction, compression and recognition methods for color models.
- know and understand the basics and fundamentals of digital image processing, such as digitization, sampling, quantization, and 2d-transforms.

REFERENCES

1. Rafael C. Gonzalez, Richard E. Woods, Digital Image Processing Pearson, Third Edition, 2010.
2. Anil K. Jain, Fundamentals of Digital Image Processing Pearson, 2002.
3. Kenneth R. Castleman, Digital Image Processing Pearson, 2006.
4. Rafael C. Gonzalez, Richard E. Woods, Steven Eddins,Digital Image Processing using MATLAB Pearson Education, Inc., 2011.
5. D,E. Dudgeon and RM. Mersereau,Multidimensional Digital Signal Processing Prentice Hall Professional Technical Reference, 1990.
6. William K. Pratt, Digital Image Processing John Wiley, New York, 2002.
7. Milan Sonka et al Image processing, analysis and machine vision Brookes/Cole, Vikas Publishing House, 2nd edition.

CO – PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:

(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	1	1	2	1	2	-	1	-	1	1	2	2	2	3
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CO3	1	1	2	1	2	-	1	-	1	1	2	2	2	3
CO4	1	1	2	1	2	-	1	-	1	1	2	2	2	3
CO5	1	1	2	1	2	-	1	-	1	1	2	2	2	3

PCE23152 **COGNITIVE COMPUTING** **3 0 0 3**

COURSE OBJECTIVES

To enable the students to

- familiarize Use the Innovation Canvas to justify potentially successful products.
- learn various ways in which to develop a product idea.
- understand about how Big Data can play vital role in Cognitive Computing.
- know about the business applications of Cognitive Computing.
- get into all applications of Cognitive Computing.

UNIT I FOUNDATION OF COGNITIVE COMPUTING **9**

Foundation of Cognitive Computing: cognitive computing as a new generation, the uses of cognitive systems, system cognitive, gaining insights from data, Artificial Intelligence as the foundation of cognitive computing, understanding cognition Design Principles for Cognitive Systems: Components of a cognitive system, building the corpus, bringing data into cognitive system, machine learning, hypotheses generation and scoring, presentation, and visualization services.

UNIT II NATURAL LANGUAGE PROCESSING IN COGNITIVE SYSTEMS **9**

Natural Language Processing in support of a Cognitive System: Role of NLP in a cognitive system, semantic web, Applying Natural language technologies to Business problems Representing knowledge in Taxonomies and Ontologies: Representing knowledge, Defining Taxonomies and Ontologies, knowledge representation, models for knowledge representation, implementation considerations.

UNIT III BIG DATA AND COGNITIVE COMPUTING **9**

Relationship between Big Data and Cognitive Computing: Dealing with human-generated data, defining big data, architectural foundation, analytical data warehouses, Hadoop, data in motion and streaming data, integration of big data with traditional data Applying Advanced Analytics to cognitive computing: Advanced analytics is on a path to cognitive computing, Key capabilities in advanced analytics, using advanced analytics to create value, Impact of open source tools on advanced analytics.

UNIT IV BUSINESS IMPLICATIONS OF COGNITIVE COMPUTING **9**

Preparing for change ,advantages of new disruptive models , knowledge meaning to business, difference with a cognitive systems approach , meshing data together differently, using business knowledge to plan for the future , answering business questions in new ways , building business specific solutions , making cognitive computing a reality, cognitive application changing the market The process of building a cognitive application: Emerging cognitive platform, defining the objective, defining the domain, understanding the intended users and their attributes, questions and exploring insights, training and testing.

UNIT V APPLICATION OF COGNITIVE COMPUTING **9**

Building a cognitive health care application: Foundations of cognitive computing for healthcare, constituents in healthcare ecosystem, learning from patterns in healthcare Data, Building on a foundation of big data analytics, cognitive applications across the health care eco system, starting with

a cognitive application for healthcare, using cognitive applications to improve health and wellness, using a cognitive application to enhance the electronic medical record Using cognitive application to improve clinical teaching.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

- explain applications in Cognitive Computing.
- describe Natural language processor role in Cognitive computing.
- explain future directions of Cognitive Computing.
- evaluate the process of taking a product to market.
- comprehend the applications involved in this domain.

REFERENCES

1. Judith H Hurwitz, Marcia Kaufman, Adrian Bowles, "Cognitive computing and Big Data Analytics", Wiley, 2015.
2. Robert A. Wilson, Frank C. Keil, "The MIT Encyclopedia of the Cognitive Sciences", The MIT Press, 1999.

CO – PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:

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COs	Programme Outcomes (POs)													
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CO3	1	2	2	2	2	-	-	-	1	1	2	2	2	2
CO4	1	2	2	2	2	-	-	-	1	1	2	2	2	2
CO5	1	2	2	2	1	-	-	-	1	2	2	2	2	2

PCE23153 BLOCK CHAIN TECHNOLOGIES 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- study the basics of Blockchain technology.
- understand about bitcoin and cryptocurrency.
- learn the mechanisms of Ethereum.
- know the basics of Hyperledger and Solidity programming
- know about the applications of blockchain.

UNIT I INTRODUCTION OF CRYPTOGRAPHY AND BLOCKCHAIN 9

Introduction to Blockchain, Blockchain Technology Mechanisms & Networks, Blockchain Origins Objective of Blockchain, Blockchain Challenges, Transactions and Blocks, P2P Systems, Keys as Identity, Digital Signatures, Hashing, and public key cryptosystems, private vs. public Blockchain.

UNIT II BITCOIN AND CRYPTOCURRENCY 9

Introduction to Bitcoin, The Bitcoin Network, The Bitcoin Mining Process, Mining Developments, Bitcoin Wallets, Decentralization and Hard Forks, Ethereum Virtual Machine (EVM), Merkle Tree, Double-Spend Problem, Blockchain and Digital Currency, Transactional Blocks, Impact of Blockchain Technology on Cryptocurrency.

UNIT III INTRODUCTION TO ETHEREUM 9

Introduction to Ethereum, Consensus Mechanisms, Metamask Setup, Ethereum Accounts, Transactions, Receiving Ethers, Smart Contracts.

UNIT IV INTRODUCTION TO HYPERLEDGER AND SOLIDITY PROGRAMMING 9

Introduction to Hyperledger, Distributed Ledger Technology & its Challenges, Hyperledger & Distributed Ledger Technology, Hyperledger Fabric, Hyperledger Composer. Solidity - Language of Smart Contracts, Installing Solidity & Ethereum Wallet, Basics of Solidity, Layout of a Solidity Source File & Structure of Smart Contracts, General Value Types.

UNIT V BLOCKCHAIN APPLICATIONS 9

Internet of Things, Medical Record Management System, Domain Name Service and Future of Blockchain, Alt Coins.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

- understand and explore the working of blockchain technology
- analyze the working of smart contracts
- understand and analyze the working of Hyperledger
- apply the learning of solidity to build de-centralized apps on Ethereum
- develop applications on blockchain

REFERENCES

1. Imran Bashir, "Mastering Blockchain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained", Second Edition, Packt Publishing, 2018.
2. Narayanan, J. Bonneau, E. Felten, A. Miller, S. Goldfeder, "Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction" Princeton University Press, 2016
3. Antonopoulos, Mastering Bitcoin, O'Reilly Publishing, 2014.
4. Antonopoulos and G. Wood, "Mastering Ethereum: Building Smart Contracts and Dapps", O'Reilly Publishing, 2018.
5. D. Drescher, Blockchain Basics. Apress, 2017.

CO – PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:

(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	1	2	2	2	3	-	-	-	1	1	2	2	1	2
CO2	1	2	2	2	3	-	-	-	1	1	2	2	1	2
CO3	1	2	2	2	3	-	-	-	1	1	2	2	1	2
CO4	1	2	2	2	3	-	-	-	1	1	2	2	1	2
CO5	1	2	2	2	3	-	-	-	1	2	2	2	1	2

PCE23154 GPU COMPUTING 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- define terminology commonly used in parallel computing, such as efficiency and speedup.
- describe common GPU architectures and programming models.
- implement efficient algorithms for common application kernels, such as matrix multiplication.
- able to debug and execute GPU program
- be familiar with case study.

UNIT I INTRODUCTION 9

History, GPU Architecture, Clock speeds, CPU / GPU comparisons, Heterogeneity, Accelerators, Parallel Programming, CUDA OpenCL / OpenACC, Kernels Launch parameters, Thread hierarchy, Warps/Wavefronts, Thread blocks/Workgroups, Streaming.

UNIT II MEMORY 9

Memory hierarchy, DRAM / global, local / shared, private / local, textures, Constant Memory, Pointers, Parameter Passing, Arrays and dynamic Memory, Multi-dimensional Arrays, Memory Allocation, Memory copying across devices, Programs with matrices, Performance evaluation with different memories.

UNIT III SYNCHRONIZATION AND FUNCTIONS 9

Memory Consistency, Barriers (local versus global), Atomics, Memory fence. Prefix sum, Reduction. Programs for concurrent Data Structures such as Worklists, Linked-lists. Synchronization across CPU and GPU Functions: Device functions, Host functions, Kernels functions, using libraries (such as Thrust), and developing libraries.

UNIT IV SUPPORT AND STREAMS 9

Support: Debugging GPU Programs. Profiling, Profile tools, Performance aspects Streams: Asynchronous processing, tasks, Task-dependence, overlapped data transfers, Default Stream, Synchronization with streams. Events, Event- based- Synchronization - Overlapping data transfer and kernel execution, pitfalls.

UNIT V CASE STUDIES AND ADVANCED TOPICSCASE STUDIES AND ADVANCED TOPICS 9

Image Processing, Graph algorithms, Simulations, Deep Learning Dynamic parallelism, Unified Virtual Memory, Multi-GPU processing, Peer access, Heterogeneous processing.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

- understand and Given a problem, develop an efficient parallel algorithm to solve it.
- analyze and implement an efficient and correct code to solve it, analyze its performance.
- analyze and Implement programs for common application kernels

- apply synchronization functions in GPU programs
- implement programs for case study

REFERENCES

1. David Kirk and Wen-meiHwu, Programming Massively Parallel Processors: A Hands-On Approach, 2nd Edition, Publisher: Morgan Kaufman, 2012, ISBN: 9780124159921.
2. Shane Cook, CUDA Programming: A Developer's Guide to Parallel Computing with GPUs, Morgan Kaufman; 2012 (ISBN: 978-0124159334).
3. Wilkinson, M.Allen, Parallel Programming Techniques and Applications using networked workstations and parallel computers, Prentice Hall, 1999.

CO – PO MAPPING

Mapping of Course Outcomes with Programme Outcomes: **(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak**														
COs	**Programme Outcomes (POs)**													
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CO1	3	1	1	1	1	-	-	-	1	1	2	2	1	2
CO2	3	2	2	2	1	-	-	-	1	1	2	2	1	2
CO3	3	2	2	2	1	-	-	-	1	1	2	2	1	2
CO4	3	2	2	2	1	-	-	-	1	1	2	2	1	2
CO5	3	1	2	2	1	-	-	-	1	1	2	2	1	2

PCE23155 **BIOINFORMATICS** **3 0 0 3**

COURSE OBJECTIVES

To enable the students to

- exposed to the need for Bioinformatics technologies.
- be familiar with the modeling techniques.
- learn microarray analysis.
- exposed to Pattern Matching and Visualization.
- know about Microarray Analysis.

UNIT I INTRODUCTION **9**

Need for Bioinformatics technologies – Overview of Bioinformatics technologies Structural bioinformatics – Data format and processing – Secondary resources and applications – Role of Structural bioinformatics – Biological Data Integration System.

UNIT II DATAWAREHOUSING AND DATAMINING IN BIOINFORMATICS **9**

Bioinformatics data – Data warehousing architecture – data quality – Biomedical data analysis – DNA data analysis – Protein data analysis – Machine learning – Neural network architecture and applications in bioinformatics.

UNIT III MODELING FOR BIOINFORMATICS **9**

Hidden Markov modeling for biological data analysis – Sequence identification –Sequence classification – multiple alignment generation – Comparative modeling –Protein modeling – genomic modeling – Probabilistic modeling – Bayesian networks – Boolean networks – Molecular modeling – Computer programs for molecular modeling.

UNIT IV PATTERN MATCHING AND VISUALIZATION **9**

Gene regulation – motif recognition – motif detection – strategies for motif detection – Visualization – Fractal analysis – DNA walk models – one dimension – two dimension – higher dimension –Game representation of biological sequences – DNA, Protein, Amino acid sequences.

UNIT V MICROARRAY ANALYSIS **9**

Microarray technology for genome expression study – image analysis for data extraction – preprocessing – segmentation – gridding – spot extraction – normalization, filtering – cluster analysis – gene network analysis – Compared Evaluation of Scientific Data Management Systems – Cost Matrix – Evaluation model – Benchmark – Tradeoffs.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

- understand the different Data formats.
- develop machine learning algorithms.
- develop models for biological data.
- apply pattern matching techniques to bioinformatics data – protein data genomic data.

- apply micro array technology for genomic expression study.

REFERENCES

1. Yi-Ping Phoebe Chen (Ed), "Bioinformatics Technologies", First Indian Reprint, Springer Verlag, 2007.
2. Bryan Bergeron, "Bio Informatics Computing", Second Edition, Pearson Education, 2015.
3. Arthur M Lesk, "Introduction to Bioinformatics", Second Edition, Oxford University Press, 2019.

CO – PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:

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COs	Programme Outcomes (POs)													
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CO4	1	1	1	2	2	-	-	-	1	1	1	1	1	2
CO5	1	1	1	2	2	-	-	-	1	1	1	1	1	2

PCE23156 **HUMAN COMPUTER INTERACTION** **3 0 0 3**

COURSE OBJECTIVES

To enable the students to

- learn the foundations of human computer interaction.
- understanding interaction styles and to become familiar with the design technologies for individuals and persons with disabilities.
- understand the process of evaluation of interaction design.
- clarify the significance of task analysis for ubiquitous computing.
- get insight on web and mobile interaction.

UNIT I FOUNDATIONS OF HCI **9**

Context of Interaction –Ergonomics - Designing Interactive systems – Understanding Users- cognition and cognitive frameworks, User Centered approaches Usability, Universal Usability, Understanding and conceptualizing interaction, Guidelines, Principles and Theories. Importance of User Interface: Definition-Importance of good design-Benefits of good design-Human-centered development and Evaluation-Human Performance models-A Brief history of screen design.

UNIT II INTERACTION STYLES **9**

GUI: Popularity of graphics - The concept of direct manipulation - Graphical system -Characteristics - Web user - Interface Popularity - Characteristics and Principles of User Interface. Understanding interaction styles, Direct Navigation and Immersive environments, Fluid navigation, Expressive Human and Command Languages, Communication and Collaboration Advancing the user experience, Timely user Experience, Information search, Data Visualization Design process: Human Interaction with computers - Importance of Human Characteristics - Human Consideration -Human Interaction Speeds and Understanding Business Junctions.

UNIT III EVALUATION OF INTERACTION **9**

Evaluation Techniques- assessing user experience- usability testing – Heuristic evaluation and walkthroughs, analytics predictive models. Cognitive models, Socio-organizational issues and stakeholder requirements, Communication and collaboration models.

UNIT IV MODELS AND THEORIES **9**

Task analysis, dialog notations and design, Models of the system, Modeling rich interaction, Ubiquitous computing.

UNIT V WEB AND MOBILE INTERACTION **9**

Hypertext, Multimedia and WWW, Designing for the web Direct Selection, Contextual Tools, Overlays, Inlays and Virtual Pages, Process Flow. Use Transitions-Lookup patterns-Feedback patterns Mobile apps, Mobile navigation, content and control idioms, Multi-touch gestures, Inter- app integration, Mobile web.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

- understand the basics of human computer interactions via usability engineering and cognitive modelling.
- understand the basic design paradigms, complex interaction styles.
- understand the models and theories for user interaction.
- examine the evaluation of interaction designs and implementations.
- elaborate the above issues for web and mobile applications.

REFERENCES

1. Ben Shneiderman, Catherine Plaisant, Maxine Cohen, Steven Jacobs, NiklasElmqvist, "Designing the User Interface: Strategies for Effective Human-Computer Interaction", Sixth Edition, Pearson Education, 2016.
2. Alan Dix, Janet Finlay, G D Abowd and Russel Beale, "Human Computer Interaction", Pearson Education, Third Edition, 2004.
3. Helen Sharp Jennifer Preece Yvonne Rogers, "Interaction Design: Beyond Human -Computer Interaction", Wiley, 5th Edition, 2019.
4. Alan Cooper,RobertReimann, David Cronin, Christopher Noessel,"About Face: TheEssentials of Interaction Design", 4th Edition, Wiley, 2014.
5. Donald A. Norman, "Design of Everyday Things", MIT Press, 2013.

CO – PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:

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COs	Programme Outcomes (POs)													
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CO1	1	1	1	1	3	-	-	-	1	1	1	1	1	2
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CO3	1	1	1	1	3	-	-	-	1	1	1	1	1	2
CO4	1	1	1	1	3	-	-	-	1	1	1	1	1	2
CO5	1	1	1	1	3	-	-	-	1	1	1	1	1	2

PCE23157 INFORMATION STORAGE MANAEGMENT 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- understand essential details about various storage systems.
- learn about networking technologies and its components.
- clarify the significance of backup and replication.
- learn about cloud computing technologies.
- understand the concept of storage and infrastructure.

UNIT I STORAGE SYSTEM 9

Introduction - evolution of storage architecture, key characteristics of data center - virtualization, and cloud computing. Data center environment: Host (or computer), connectivity, storage, and access to data, direct attached storage, storage design based on application requirements and disk performance - VMware ESXi. Data Protection: RAID implementations, techniques, levels, impact of RAID on disk performance. Intelligent Storage System: Components, storage provisioning, types and intelligent storage implementations.

UNIT II STORAGE NETWORKING TECHNOLOGIES 9

Fiber channel SAN components – FC SAN connectivity – FC protocol stack – FC addressing – zoning – FC SAN topologies – virtualization in SAN. iSCSI – FCIP – FCoE – Network Attached Storage (NAS): components, I/O operation, file sharing protocols, file level virtualization. Object based storage platform – unified storage platform.

UNIT III BACKUP, ARCHIVE AND REPLICATION 9

Business continuity terminologies – BC planning life cycle – failure analysis – BC technology solutions – Backup and archive: purpose, methods, architecture, operations, topologies, targets, data deduplication, backup in virtualized environment and data archive. Local replication in classic and virtual environments – Remote replication in classic and virtual environment.

UNIT IV CLOUD COMPUTING 9

Cloud enabling technologies – characteristics of cloud computing – benefits of cloud computing – cloud service models – cloud deployment models: public cloud, private cloud, community cloud, hybrid cloud. Cloud computing infrastructure: physical infrastructure, virtual infrastructure, applications and platform software, cloud management and service creation tools. Cloud challenges – cloud adoption considerations.

UNIT V SECURING AND MANAGING STORAGE INFRASTRUCTURE 9

Information security framework – risk triad – storage security domains – security implementations in storage networking: FC SAN, NAS, IP SAN – Securing storage infrastructure in virtualized and cloud environments – monitoring the storage infrastructure – storage infrastructure management activities – storage infrastructure management challenges – developing an ideal solution – Information lifecycle management (ILM) – storage tiering.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

- demonstrate the various storage systems and raid implementations.
- identify various storage networking technologies and its components.
- apply business continuity solutions – backup and replication, and archive for managing fixed content.
- make use of cloud computing concepts for information storage.
- use the storage security framework and practice storage monitoring and management activities.

REFERENCES

1. EMC Corporation, "Information Storage and Management", 2nd Edition, Wiley, 2012.
2. Robert Spalding, "Storage Networks: The Complete Reference", Tata McGraw Hill, Osborne, 2003.
3. Marc Farley, "Building Storage Networks", 2nd Edition, Tata McGraw Hill, Osborne, 2001.

CO – PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:

(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	2	2	3	2	3	-	-	1	1	1	2	1	2	3
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CO3	3	2	2	3	3	-	-	1	1	1	2	1	2	3
CO4	2	2	2	2	3	-	-	1	1	1	2	1	2	3
CO5	2	2	2	3	3	-	-	1	1	1	2	1	2	3

PCE23158	ADVANCED PARALLEL ARCHITECTURE AND PROGRAMMING	3 0 0 3

COURSE OBJECTIVES

To enable the students to

- understanding of the fundamental principles and engineering trade-offs
- get knowledge about MPI programming
- clear idea about shared memory programming using Pthreads
- analysis about shared memory paradigm openMP
- knowledge on OPENCL language

UNIT I PARALLEL ARCHITECTURE AND FOUNDATIONS OF PARALLEL PROGRAMMING 9

Parallel Architecture: Need, Convergence, Design issues – Parallel Application Case Studies – The von Neumann architecture - Processes, multitasking, and threads – Modifications to the von Neumann Model – Parallel Hardware and Software – Input and Output – Performance – Parallel Program Design – Writing and Running Parallel Programs.

UNIT II MESSAGE PASSING PARADIGM 9

Basic MPI programming – MPI_Init and MPI_Finalize – MPI communicators – SPMD programs – message passing – MPI_Send and MPI_Recv – message matching – MPI I/O – parallel I/O – collective communication – derived types – Performance evaluationof MPI programs – A Parallel Sorting Algorithm.

UNIT III SHARED MEMORY PARADIGM PTHREADS 9

Basics of Pthreads – Execution, Error checking of threads – Matrix-Vector Multiplication – Critical sections – Busy waiting – Mutexes – Producer-Consumer Synchronization and Semaphores – Barriers and Condition variables – Read Write locks – Caches, Cache Coherence and False sharing – Thread-Safety – Pthreads case study.

UNIT IV SHARED MEMORY PARADIGM OPENMP 9

Basic OpenMP constructs – The Trapezoidal Rule – Scope of Variables – Reduction Clause – Parallel for Directive – Loops in OpenMP – Scheduling loops – Synchronization in OpenMP – Case Study: Producer Consumer problem– Cache Issues – Threads safety in OpenMP.

UNIT V OPENCL LANGUAGE 9

Introduction to OpenCL – OpenCL example – Platforms, Contexts and Devices – OpenCL programming in C – Simple Programs.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

- examine the issues in Parallel Architecture and Programming
- develop message passing parallel programs using MPI framework
- build shared memory parallel programs using Pthreads
- experiment with OpenMP for shared memory applications
- solve the given problem with parallel programs using OpenCL

REFERENCES

1. Peter S. Pacheco, "An introduction to parallel programming", Morgan Kaufmann, 2011. (Unit I, II, III, IV).
2. David E. Culler, Jaswinder Pal Singh, "Parallel Computing Architecture: A Hardware/ Software Approach", MorganKaufmann, Elsevier, 2013. (Unit I).
3. Munshi Aaftab, Gaster R. Benedict,"OpenCL Programming Guide", Addision-Wesley, 2011.(Unit V).

CO – PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:

(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

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CO3	2	2	2	2	2	-	-	-	1	1	1	2	2	2
CO4	2	2	2	3	3	-	-	-	1	1	1	2	2	2
CO5	2	2	2	3	3	-	-	-	1	1	1	2	2	2

PCE23159 **REINFORCEMENT LEARNING** 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- know about the basics of Reinforcement Learning.
- use analysis tools and techniques for problems of dynamic decision making under uncertainty.
- appreciate the concepts and algorithms of advanced learning.
- know about the components and building block hypothesis of genetic algorithm.
- understand the theoretical and practical aspects of Probabilistic Graphical Models.

UNIT I INTRODUCTION AND BASICS OF RL 9

Reinforcement Learning - Examples - Elements of Reinforcement Learning - Limitations and Scope - An Extended Example: Tic-Tac-Toe - History of Reinforcement Learning.

UNIT II TABULAR SOLUTION METHODS 9

Multi-arm Bandits - An n-Armed Bandit Problem- Action-Value Methods- Incremental Implementation- Tracking a Non stationary Problem- Optimistic Initial Values- Upper - Confidence - Bound Action Selection- Gradient Bandit - Associative Search.

UNIT III FINITE MARKOV DECISION PROCESSES 9

The Agent–Environment Interface - Goals and Rewards - Returns - Unified Notation for Episodic and Continuing Tasks- The Markov Property- Markov Decision Processes - Value Functions - Optimal Value Functions - Optimality and Approximation.

UNIT IV DYNAMIC PROGRAMMING AND MONTE CARLO METHODS 9

Dynamic Programming - Policy Evaluation- Policy Improvement- Policy Iteration- Value Iteration- Generalized Policy Iteration. Monte Carlo Methods: Monte Carlo Prediction- Monte Carlo Estimation of Action Values- Monte Carlo Control- Monte Carlo Control without Exploring Starts.

UNIT V TEMPORAL-DIFFERENCE LEARNING 9

TD Prediction- Advantages of TD Prediction Methods- Optimality of TD (0) -Sarsa: On-Policy TD Control- Q- Learning: Off-Policy TD Control- Games, After states, and Other Special Cases.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

- illustrate RL tasks and the core principles behind the RL.
- apply tabular methods to solve classical control problems.
- utilize Markov decision process in optimization of complex problems.
- solve problems using dynamic programming and Monte-Carlo methods.
- outline temporal-difference learning and Q-learning.

REFERENCES

1. Richard S. Sutton and Andrew G. Barto, "Reinforcement Learning: An Introduction", 2nd Edition, MIT Press, London, 2018.
2. S.Sridhar, M.Vijayalakshmi, "Machine Learning", 1st Edition, Oxford University Press, 2021.
3. Phill winder, "Reinforcement Learning: Industrial applications of intelligent agents", 1st Edition, O'Reilly Media, 2020.
4. Kevin P. Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 2012.
5. Stephen Marsland, "Machine Learning – An Algorithmic Perspective", Chapman and Hall, CRC Press, Second Edition, 2014.
6. George J. Klir and Bo Yuan, "Fuzzy Sets and Fuzzy Logic-Theory and Applications", Prentice Hall, 1996.

CO – PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:

(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

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CO3	1	2	2	3	3	1	-	-	1	1	2	2	2	3
CO4	1	2	3	3	2	1	-	-	1	1	2	2	2	3
CO5	1	2	2	3	3	1	-	-	1	1	2	2	2	3

PCE23160 **QUANTUM COMPUTING** **3 0 0 3**

COURSE OBJECTIVES

To enable the students to

- know the background of classical computing and quantum computing.
- learn the fundamental concepts behind quantum computation.
- study the details of quantum mechanics and its relation to Computer Science.
- gain knowledge about the basic hardware and mathematical models of quantum computation.
- learn the basics of quantum information and the theory behind it.

UNIT I QUANTUM COMPUTING BASIC CONCEPTS **9**

Complex Numbers - Linear Algebra - Matrices and Operators - Global Perspectives Postulates of Quantum Mechanics Quantum Bits - Representations of Qubits– Superpositions.

UNIT II QUANTUM GATES AND CIRCUITS **9**

Universal logic gates - Basic single qubit gates - Multiple qubit gates - Circuit development - Quantum error correction.

UNIT III QUANTUM ALGORITHMS **9**

Quantum parallelism - Deutsch's algorithm - The Deutsch–Jozsa algorithm - Quantum Fourier transform and its applications - Quantum Search Algorithms: Grover's Algorithm.

UNIT IV QUANTUM INFORMATION THEORY **9**

Data compression - Shannon's noiseless channel coding theorem - Schumacher's quantum noiseless channel coding theorem - Classical information over noisy quantum channels.

UNIT V QUANTUM CRYPTOGRAPHY **9**

Classical cryptography basic concepts - Private key cryptography - Shor's Factoring Algorithm - Quantum Key Distribution - BB84 - Ekart 91.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

- understand the basics of quantum computing.
- understand the background of quantum mechanics.
- analyse the computation models.
- model the circuits using quantum computation. environments and frameworks.
- understand the quantum operations such as noise and error–correction.

REFERENCES

1. Parag K Lala, McGraw Hill Education, "Quantum Computing, A Beginners Introduction", First edition (1 November 2020).
2. Michael A. Nielsen, Issac L. Chuang, "Quantum Computation and Quantum Information", Tenth Edition, Cambridge University Press, 2010.

3. Chris Bernhardt, The MIT Press; Reprint edition (8 September 2020), "Quantum Computing for Everyone".
4. N. David Mermin, "Quantum Computer Science: An Introduction", Cambridge University Press, 2007.
5. Scott Aaronson, "Quantum Computing Since Democritus", Cambridge University Press, 2013.
6. Y.B.Band and Y.Avishai, Quantum Mechanics with Applications to Nanotechnology and Information Science, Academic Press, 2013

CO – PO MAPPING

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CO3	1	2	2	3	3	1	-	-	1	1	2	2	2	3
CO4	1	2	3	3	2	1	-	-	1	1	2	2	2	3
CO5	1	3	2	3	3	1	-	-	1	1	2	2	2	3

PCE23161 AGILE METHODOLOGIES 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- learn the fundamental principles and practices associated with each of the agile development methods
- apply the principles and practices of agile software development on a project of interest and relevance to the student.
- provide a good understanding of software design and a set of software technologies and APIs.
- do a detailed examination and demonstration of agile development and testing techniques
- understand agile development and testing.

UNIT I AGILE SOFTWARE DEVELOPMENT 9

Basics and Fundamentals of Agile Process Methods, Values of Agile, Principles of Agile, stakeholders, Challenges Lean Approach: Waste Management, Kaizen and Kanban, add process and products add value. Roles related to the life cycle, differences between Agile and traditional plans, differences between Agile plans at different life cycle phases. Testing plan links between testing, roles and key techniques, principles, understand as a means of assessing the initial status of a project/ How Agile helps to build quality.

UNIT II AGILE AND SCRUM PRINCIPLES 9

Agile Manifesto, Twelve Practices of XP, Scrum Practices, Applying Scrum. Need of scrum, working of scrum, advanced Scrum Applications, Scrum and the Organization, scrum values.

UNIT III AGILE PRODUCT MANAGEMENT 9

Communication, Planning, Estimation Managing the Agile approach Monitoring progress, Targeting and motivating the team, Managing business involvement, Escalating issue. Quality, Risk, Metrics and Measurements, Managing the Agile approach Monitoring progress, Targeting and motivating the team, managing business involvement and Escalating issue.

UNIT IV AGILE REQUIREMENTS AND AGILE TESTING 9

User Stories, Backlog Management. Agile Architecture: Feature Driven Development. Agile Risk Management: Risk and Quality Assurance, Agile Tools. Agile Testing Techniques, Test-Driven Development, User Acceptance Test.

UNIT V AGILE REVIEW AND SCALING AGILE FOR LARGE PROJECTS 9

Agile Metrics and Measurements, The Agile approach to estimating and project variables, Agile Measurement, Agile Control: the 7 control parameters. Agile approach to Risk, The Agile approach to Configuration Management, The Atern Principles, Atern Philosophy, the rationale for using Atern, Refactoring, Continuous integration, Automated Build Tools. Scrum of Scrums, Team collaborations, Scrum, estimate a Scrum Project, Track Scrum Projects, Communication in Scrum Projects, Best Practices to Manage Scrum.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

- analyse existing problems with the team, development process and wider organization.
- apply a thorough understanding of agile principles and specific practices.
- the most appropriate way to improve results for a specific circumstance or need.
- judge and craft appropriate adaptations to existing practices or processes depending up on analysis of typical problems.
- evaluate likely successes and formulate plans to manage likely risks or problems.

REFERENCES

1. Robert C. Martin, Agile Software Development, Principles, Patterns, and Practices Alan AptSeries (2011)
2. Succeeding with Agile: Software Development Using Scrum, Pearson (2010).
3. David J. Anderson and Eli Schragenheim, "Agile Management for Software Engineering: Applying the Theory of Constraints for Business Results, Prentice Hall, 2003.
4. Hazza and Dubinsky, "Agile Software Engineering, Series: Undergraduate Topics in Computer Science, Springer, 2009.
5. Craig Larman, "Agile and Iterative Development: A Managers Guide, Addison-Wesley,2004.
6. Kevin C. Desouza, "Agile Information Systems: Conceptualization, Construction, and Management, Butterworth-Heinemann, 2007.

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	2	2	3	3	3	-	-	-	1	1	2	2	2	2
CO2	2	2	3	3	2	-	-	-	1	1	2	2	2	2
CO3	1	2	3	3	3	-	-	-	1	1	2	2	2	2
CO4	2	2	3	3	3	-	-	-	1	1	2	2	2	3
CO5	2	3	2	3	3	-	-	-	1	1	2	2	2	3

PCE23162 **DIGITAL FORENSICS** **3 0 0 3**

COURSE OBJECTIVES

To enable the students to

- learn digital forensics fundamentals.
- know about evidence collection on a threat.
- understand the procedures to uncover hidden information in digital systems, documenting the investigation.
- explore forensics in web, email, network layers, cloud, and mobile devices.
- understand and learn about the business of digital forensics.

UNIT I ANATOMY OF DIGITAL INVESTIGATIONS **9**

Digital Forensics Fundamentals: understanding the scope of investigation - the art of documentation - the laws affecting forensic investigation - constitutional implications of forensic investigation - the right to privacy - the expert witness - popular myths about computer forensics, its importance - types of forensic evidence recovered - skills to be possessed by a computer forensic investigator.

UNIT II EVIDENCE COLLECTION AND DATA SEIZURE **9**

Search warrants - what is a search and when it is legal - the warrant less search - legislated - privacy concerns - general privacy - privacy in healthcare and education - privileged information - the admissibility of evidence - the first response and the digital investigator - forensics and controlling the scene of the crime - handling evidence.

UNIT III DATA ACQUISITION, ANALYSIS, DOCUMENTING THE INVESTIGATION **9**

Data acquisition - memory and running process - acquiring media - finding lost files: file recovery - the deleted file – data carving - document analysis; file identification - understanding meta data - mining the temporary files - identifying the alternate places of hiding data - online investigations: working undercover - website evidence - background searches - online crime - capturing online communications, Documenting: Obtaining evidence - seizing evidence - documenting the evidence - Using tools - writing reports - using expert witnesses at trial - admissibility of digital evidence.

UNIT IV TOOLS -FORENSICS IN EMAIL, WEB, NETWORKS, CLOUD **9**

Email: Email technology - information stores - the anatomy of an email - an approach to email analysis, Web: Internet addresses - web browsers - web servers, proxy servers, DHCP servers, SMTP servers, DNS servers, routers, IDS, Firewalls, ports, Networks: Searching the network -an eagle's eye view - initial response - understanding the OSI model - advanced persistent threats -investigating a network attack - proactive collection of evidence - post incident collection of evidence - router and switch forensics, Excavating a cloud: What is cloud - cloud computing - shaping the cloud - the Implications of cloud forensics - on virtualization - constitutional issues

UNIT V FORENSIC WORK STATION AND BUSINESS OF DIGITAL FORENSICS 9

Forensic workstation - building a forensic work station from scratch - licensing and certification: digital forensic certification - vendor neutral certification programs - vendor specific certification program - digital forensic Licensing requirements - starting and maintaining a forensic organization, generating revenue, organizational Certification.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

- analyze the digital investigation and find the evidence for the given problem.
- gain knowledge in collecting the evidences.
- analyze and document an investigation.
- gain information on various digital forensics.
- acquire information about building a career on digital forensics.

REFERENCES

1. Michael Graves, "Digital Archaeology: The Art and Science of Digital Forensics", Addison Wesley Professional, 2014.
2. Darren R.Hayes, "Practical Guide to Computer Forensics Investigation", Pearson, 2015.
3. Albert J. Marcella and Frederic Guillos sou, "Cyber Forensics: From Data to Digital Evidence", Wiley, 2015.
4. Andrew Hoog, "Android Forensics: Investigation, Analysis and Mobile Security for Google Android", Elsevier publications, 2011.
5. Angus M.Marshall, "Digitalforensics: Digital evidence in criminal investigation", John Wiley and Sons, 2008.

CO – PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:

(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	1	2	3	3	3	1	-	1	1	1	2	2	2	2
CO2	1	2	3	3	2	1	-	1	1	1	2	2	2	2
CO3	1	2	2	3	3	1	-	1	1	1	2	2	2	2
CO4	1	2	3	3	2	1	-	1	1	1	2	2	2	2
CO5	1	3	2	3	3	1	-	1	1	1	2	2	2	2