PAAVAI ENGINEERING COLLEGE, NAMAKKAL - 637018

(AUTONOMOUS)

M.E. COMPUTER SCIENCE AND ENGINEERING

REGULATIONS 2016

SEMESTER I

Course Code	Course Title	L	T	P	C
PMA16102	Applied Probability and Statistics	3	2	0	4
PCE16101	Next Generation Networks	3	0	0	3
PCE16102	Advanced Data Structures and Algorithms	3	0	0	3
PCE16103	Multicore Architecture	3	0	0	3
PCE16104	Advanced Operating Systems	3	0	0	3
PCE16105	Machine Learning Techniques	3	0	0	3
PCE16106	Advanced Data Structures and Algorithms Laboratory	0	0	4	2

SEMESTER II

Course Code	Course Title	L	T	P	C
PCE16201	Soft Computing	3	0	0	3
PCE16202	Advanced Databases and Information Systems	3	0	0	3
PCE16203	Ad-hoc and Wireless Networks	3	0	0	3
PCE16204	Cloud Computing	3	0	0	3
PCE1615*	Elective I	3	0	0	3
PCE1625*	Elective II	3	0	0	3
PCE16205	Cloud Computing Laboratory	0	0	4	2
PCE16206	Technical Report Preparation and Presentation	0	0	4	2

SEMESTER III

Course Code	Course Title	L	T	P	C
PCE16301	Software Architecture	3	0	0	3
PCE16302	Network and Information Security	3	0	0	3
PCE163**	Elective III	3	0	0	3
PCE164**	Elective IV	3	0	0	3
PCE16303	Project Work (Phase I)	0	0	12	6

SEMESTER IV

Course Code	Course Title	L	T	P	C
PCE16401	Project Work (Phase II)	0	0	24	12

LIST OF ELECTIVES

Category	Course Code	Course Title	L	T	P	C
PROFESSIONAL ELECTIVE I (PE)						
PE	PCE16151	Digital Image Processing and Analysis	3	0	0	3
PE	PCE16152	Massive Parallel Processing	3	0	0	3
PE	PCE16153	Data Visualization Techniques	3	0	0	3
PE	PCE16154	Speech Processing and Synthesis	3	0	0	3
PROFESSIONAL ELECTIVE II(PE)						
PE	PCE16251	Big Data Analytics	3	0	0	3
PE	PCE16252	Storage Area Networks	3	0	0	3
PE	PCE16253	Information Retrieval	3	0	0	3
PE	PCE16254	Bio Informatics	3	0	0	3
PROFESSIONAL ELECTIVE III (PE)						
PE	PCE16351	Internet of Things	3	0	0	3
PE	PCE16352	Real Time Systems	3	0	0	3
PE	PCE16353	Computer Vision	3	0	0	3
PE	PCE16354	Research Methodology	3	0	0	3
PE	PCE16355	Design and Analysis of Parallel	3	0	0	3
PROFESSIONAL ELECTIVE IV(PE)						
PE	PCE16451	Model Checking and Program	3	0	0	3
PE	PCE16452	Robotics	3	0	0	3
PE	PCE16453	Bio - inspired Computing	3	0	0	3
PE	PCE16454	Pattern Recognition and Analysis	3	0	0	3
PE	PCE16455	Multimedia Systems	3	0	0	3

SEMESTER I

PMA16102 APPLIED PROBABILITY AND STATISTICS 3 2 0 4

COURSE OBJECTIVES

- To introduce the basic concepts of one dimensional and two dimensional random variables.
- To provide information about estimation theory, correlation, regression and testing of hypothesis.
- To enable the students to use the concepts of multivariate normal distribution and principle components analysis.
- To learn different testing hypothesis.
- To analyse multivariate normal density.

UNIT I ONE DIMENSIONAL RANDOM VARIABLES 15

Random variables - Probability function – Moments – Moment generating functions and their properties – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions – Functions of a Random Variable.

UNIT II TWO DIMENSIONAL RANDOM VARIABLES 15

Joint distributions – Marginal and Conditional distributions – Functions of two dimensional random variables – Regression Curve – Correlation.

UNIT III ESTIMATION THEORY 15

Unbiased Estimators – Method of Moments – Maximum Likelihood Estimation - Curve fitting by Principle of least squares – Regression Lines.

UNIT IV TESTING OF HYPOTHESES 15

Sampling distributions - Type I and Type II errors - 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 V MULTIVARIATE ANALYSIS 15

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: 75 PERIODS

COURSE OUTCOMES

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

- acquire the basic concepts of probability and statistical techniques for solving mathematical problems which will be useful in solving engineering problems.
- evaluate the strength of evidence from the sample and provide a framework for making determinations related to the population.
- understand the notation of the population distribution, sampling distributions.

- develop efficient algorithms for solving dynamic programming problems and acquire skills in handling situation involving random variable.
- evaluate the different testing hypothesis.

REFERENCES

1. Oliver C.Ibe, "Fundamentals of Applied probability and Random Process", Academic Press, (An imprint of Elsevier), 2010.
2. T.Veerarajan, "Probability, Statistics and Random Process",2nd edition, Tata McGraw-Hill, New Delhi 2008.
3. Johnson, R.A., and Gupta.C.B, Miller and Freund's Probability and Statistics for
4. Engineers,"11th Edition, Pearson Education, Asia 2011.
5. Taha, H.A., "Operations Research, An introduction", 10th edition, Pearson education, New Delhi, 2010.
6. Abraham, "Statistical Methods for Forecasting", wiley, 2010.

Mapping of Course Outcomes with Programming Outcomes
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	Programme Outcomes(POs)												Programme Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	3	3	-	-	-	-	-	-	-	3	3	3
CO2	3	2	3	3	-	-	-	-	-	-	-	2	3	3
CO3	2	3	1	-	-	-	1	-	-	-	-	2	3	3
CO4	3	3	3	3	-	-	-	-	-	-	-	2	1	3
CO5	3	3	3	-	-	2	-	-	-	-	-	3	3	2

PCE16101 NEXT GENERATION NETWORKS 3 0 0 3

COURSE OBJECTIVES

- To learn the technical, economical and service advantages of next generation networks.
- To understand the role of IP Multimedia Sub-system (IMS), network attachment and admission control functions.
- To learn the basic architecture of a next generation network (NGN) with reference and to understand NGN services.
- To compare the various methods of providing connection-oriented services over a NGN with reference to MPLS, MPLS-TE.
- To learn the various NGN virtual network services with reference to VPNs.

UNIT I INTRODUCTION 9

Evolution of public mobile services - motivations for IP based services, Wireless IP network architecture – 3GPP packet data network architecture. Introduction to next generation networks - Changes, Opportunities and Challenges, Technologies, Networks, and Services, Next Generation Society, future Trends.

UNIT II IMS AND CONVERGENT MANAGEMENT 9

IMS Architecture - IMS services, QoS Control and Authentication, Network and Service management for NGN, IMS advantages, Next Generation OSS Architecture – standards important to oss architecture, Information framework, OSS interaction with IMS, NGN OSS function/ information view reference model, DMTF CIM.

UNIT III MPLS AND VPN 9

Technology overview –MPLS & QoS, MPLS services and components – layer 2 VPN, layer 2 internetworking, VPN services, signaling, layer 3 VPN –Technology overview, Remote Access and IPsec integration with MPLS VPN.

UNIT IV MULTICAST 9

MPLS Multicast VPN overview – Applications, examples, IPv6 and MPLS – Technology overview, Future of MPLS –Integrating IP and optical networks, Future layer 3 services, future layer 2 services.

UNIT V NGN MANAGEMENT 9

Network Management and Provisioning – Configuration, Accounting, performance, security, case study for MPLS, Future enhancements – Adaptive self-healing networks

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

- evaluate mobile and IP based services.
- develop the NGN architecture and the underlying technologies with a focus on the network transport stratum from a network carrier perspective.

- identify the market incentives for NGN development, examined fundamental technologies required to realize the expected NGN functions especially in the transport stratum.
- implement NGN related issues.
- explore the principles and practice of legacy wireless networks.

REFERENCES

1. Thomas Plavyk, "Next generation Telecommunication Networks, Services and Management", Wiley & IEEE Press Publications, 2012.
2. Neill Wilkinson, "Next Generation Network Services", John Wiley Publications, 2002.
3. Monique J. Morrow, "Next Generation Networks", CISCO Press, 2007.
4. Robert Wood, "MPLS and Next Generation Networks: Foundations for NGN and Enterprise Virtualization", CISCO Press, 2006.
5. Ina Minie, Julian Lucek, "MPLS enabled Applications – Emerging developments and new technologies", 3rd edition, Wiley. 2011.

Mapping of Course Outcomes with Programming Outcomes
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	Programme Outcomes(POs)												Programme Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	3	3	-	-	-	-	-	-	-	3	3	3
CO2	3	2	3	3	-	-	-	-	-	-	-	2	3	3
CO3	2	3	1	-	-	-	1	-	-	-	-	2	3	3
CO4	3	3	3	3	-	-	-	-	-	-	-	2	1	3
CO5	3	3	3	-	-	2	-	-	-	-	-	3	3	2

PCE16102 ADVANCED DATA STRUCTURES AND ALGORITHMS 3 0 0 3

COURSE OBJECTIVES

- To learn elementary data structures and the significance of writing efficient algorithms.
- To study data structures for concurrency.
- To study advanced data structures such as search trees, hash tables, heaps and operations on them.
- To understand the principles of efficient algorithm design.
- To learn various advanced algorithms.

UNIT I DATA STRUCTURES AND CONCURRENCY 9

Review of algorithm design and analysis – review of elementary data structures – data structures and concurrency – locking linked lists – coarse-grained synchronization – fine-grained synchronization – lazy synchronization – non-blocking synchronization – concurrent queues – bounded partial queues – unbounded lock-free queues – dual data structures – concurrent stacks – elimination back off stack

UNIT II SEARCH TREES, HASH TABLES AND STRINGS 9

Search Trees – Weight Balanced trees – Red Black trees – Finger Trees and level linking – Skip lists – joining and splitting balanced search trees – Hash trees – extendible hashing- Strings – tries and compressed tries – dictionaries – suffix trees – suffix arrays

UNIT III HEAPS 9

Heaps - Array-Based Heaps - Heap-Ordered Trees and Half-Ordered Trees - Leftist Heaps – Skew Heaps - Binomial Heaps - Changing Keys in Heaps - Fibonacci Heaps - Double-Ended Heap structures – multidimensional heaps.

UNIT IV ADVANCED CONCURRENT DATA STRUCTURES 9

Concurrent hashing – closed-address hash sets – lock-free hash sets – open-addressed hash sets – lock-based concurrent skip lists – lock-free concurrent skip lists – concurrent priority queues – bounded priority queue – unbounded priority queue – concurrent heap – skip list based unbounded priority queues.

UNIT V ADVANCED ALGORITHMS 9

Introduction to Approximation algorithms – job scheduling on a single machine – knapsack problem – minimizing weighted sum of completion time on a single machine – MAX SAT and MAX CUT. Introduction to Randomized algorithms – min cut. Introduction to parallel algorithms – parallel sorting algorithms.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

- implement concurrent linked lists, stacks, and queues.
- perform operations in search trees, hash tables and strings
- understand different types of heap.
- apply data structures for strings and advanced concurrent structures.
- develop advanced parallel sorting algorithms.

REFERENCES

1. M. Herlihy and N. Shavit, “The Art of Multiprocessor Programming”, Morgan Kaufmann, 2012.
2. Peter Brass, “Advanced Data Structures”, Cambridge University Press, 2008.
3. Gavpai, “Data Structures and Algorithms – Concepts, techniques and Applications”, First Edition, Tata McGraw-Hill, 2008.
4. S.K. Chang, “Data Structures and Algorithms – Series of Software Engineering and Knowledge Engineering”, Vol. 13, World Scientific Publishing, 2003.
5. Jon Kleinberg, "Algorithm Design", Addison-Wesley, 2013.
6. David P. Williamson, David B. Shmoys, “The Design of Approximation Algorithms”, Cambridge University Press, 2011.
7. Michael J. Quinn, “Parallel Computing: Theory & Practice”, Tata McGraw Hill Edition, 2003.

Mapping of Course Outcomes with Programming Outcomes
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	Programme Outcomes(POs)												Programme Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	3	3	-	-	-	-	-	-	-	3	3	3
CO2	3	2	3	3	-	-	-	-	-	-	-	2	3	3
CO3	2	3	1	-	-	-	1	-	-	-	-	2	3	3
CO4	3	3	3	3	-	-	-	-	-	-	-	2	1	3
CO5	3	3	3	-	-	2	-	-	-	-	-	3	3	2

PCE16103 MULTICORE ARCHITECTURE 3 0 0 3

COURSE OBJECTIVES

- To understand the recent trends in the field of Computer Architecture.
- To identify architecture performance related parameters.
- To learn the need for parallel processing.
- To expose problems related to multiprocessing and embedded architectures.
- To understand the different types of multicore architectures.

UNIT I FUNDAMENTALS OF QUANTITATIVE DESIGN AND ANALYSIS 9

Classes of Computers– Trends in Technology, Power, Energy and Cost– Dependability– Measuring, Reporting and Summarizing Performance–Quantitative Principles of Computer Design–Classes of Parallelism- ILP, DLP, TLP and RLP-Multithreading-SMT and CMP Architectures–Limitations of Single Core Processors-The Multicore era –Case Studies of Multicore Architectures.

UNIT II DLP INVECTOR, SIMD AND GPU ARCHITECTURES 9

Vector Architecture-SIMD Instruction Set Extensions for Multimedia–Graphics Processing Units-Detecting and Enhancing Loop Level Parallelism-SIMD, MIMD Performance-Case Studies.

UNIT III TLP AND MULTIPROCESSORS 9

Symmetric and Distributed Shared Memory Architectures– Cache Coherence Issues- Performance Issues– Synchronization Issues–Models of Memory Consistency- Interconnection Networks–Buses, Cross bar and Multi-stage Interconnection Networks Simple Program Multiple Data.

UNIT IV RLP AND DLP INWARE HOUSE-SCALE ARCHITECTURES 9

Programming Models and Workloads for Warehouse-Scale Computers –Architectures for Warehouse-Scale Computing – Physical Infrastructure and Costs – Cloud Computing – Case Studies.

UNIT V ARCHITECTURES FOR EMBEDDED SYSTEMS 9

Features and Requirements of Embedded Systems –Signal Processing and Embedded Applications–The Digital Signal Processor–Embedded Multiprocessors -Case Studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

- identify the limitations of ILP and the need for multicore architectures
- discuss the issues related to multiprocessing and suggest solutions
- point out the salient features of different multicore architectures and how they exploit parallelism
- analyse the different types of inter connection networks critically.
- discuss the architecture of GPUs, warehouse-scale computers and embedded processors

REFERENCES

1. John L.Hennessey and David A. Patterson, "Computer Architecture –A Quantitative Approach", Morgan Kaufmann/Elsevier, 5th edition, 2012.
2. KaiHwang, "Advanced Computer Architecture", Tata McGraw- Hill Education, 2003.
3. Richard Y. Kain, "Advanced Computer Architecture a Systems Design Approach", Prentice Hall, 2011.
4. David E.Culler, Jaswinder Pal Singh, "Parallel Computing Architecture: A Hardware / Software Approach", Morgan Kaufmann/ Elsevier, 1997.
5. Govindarajalu.B, " Computer Architecture and Organization: Design principles and applications", Tata McGraw- Hill Education, 2014.

Mapping of Course Outcomes with Programming Outcomes
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	Programme Outcomes(POs)												Programme Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	3	3	-	-	-	-	-	-	-	3	3	3
CO2	3	2	3	3	-	-	-	-	-	-	-	2	3	3
CO3	2	3	1	-	-	-	1	-	-	-	-	2	3	3
CO4	3	3	3	3	-	-	-	-	-	-	-	2	1	3
CO5	3	3	3	-	-	2	-	-	-	-	-	3	3	2

PCE16104 ADVANCED OPERATING SYSTEMS 3 0 0 3

COURSE OBJECTIVES

- To learn the fundamentals of operating systems.
- To understand storage management and I/O systems.
- To gain knowledge in distributed operating system concepts.
- To know the components and management aspects of real time mobile operating systems.
- To understand the working principles of Linux operating system.

UNIT I FUNDAMENTALS OF OPERATING SYSTEMS 9

Overview–Operating system structure and operation- Processes and Threads-Process Scheduling– Process Synchronization Mechanisms–Deadlocks: Avoidance, Detection, Prevention and Memory Management Techniques.

UNIT II STORAGE MANAGEMENT AND I/O SYSTEMS 9

Main memory – Paging-Segmentation – Segmentation with Paging –Virtual memory – Demand paging – Page replacement – Allocation – Thrashing. I/O Systems – Mass storage structure – disk scheduling and management – File system Interface – Directory and disk structure – File system implementation – Allocation methods – Free space management - I/O systems.

UNIT III DISTRIBUTED OPERATING SYSTEMS 9

Issues in Distributed Operating System – Architecture – Communication Primitives – Lamport's Logical clocks –Causal Ordering of Messages –Distributed Mutual Exclusion Algorithms – Centralized and Distributed Deadlock Detection Algorithms – Agreement Protocols. – Distributed resource management – distributed file systems.

UNIT IV REAL TIME AND MOBILE OPERATING SYSTEMS 9

Basic Model of Real Time Systems-Characteristics- Applications of Real Time Systems– Real Time Task Scheduling -Handling Resource Sharing -Mobile Operating Systems – Micro Kernel Design- Client Server Resource - Access–Processes and Threads- Memory Management-File system.

UNIT V CASE STUDIES 9

Linux System: Design Principles -Kernel Modules -Process Management Scheduling - Memory Management-Input-Output Management - File System - Inter process Communication. IOS and Android: Architecture and SDK Framework - Media Layer – Services Layer-Core OS Layer-File System.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

- analyse the various synchronization, scheduling and deadlock issues.
- understand the primary and secondary memory management and file systems.

- demonstrate the mutual exclusion, deadlock detection and agreement protocols of distributed operating system.
- identify the different features of real time and mobile operating systems.
- modify existing open source kernels in terms of functionality or features used.

REFERENCES

1. Mukesh Singhal and Niranjan G.Shivaratri, "Advanced Concepts in Operating Systems –Distributed, Database, and Multiprocessor Operating Systems", Tata McGraw-Hill,2001.
2. Abraham Silberschatz; Peter Baer Galvin; Greg Gagne, "Operating System Concepts", 9th Edition, John Wiley & Sons, 2012.
3. Daniel P Bovet and Marco Cesati, "Understanding the Linux kernel", 3rd edition, O'Reilly, 2005.
4. RajibMall, "Real-Time Systems: Theory and Practice", Pearson Education India, 2006.
5. NeilSmyth, "iPhone iOS4 Development Essentials–Xcode", Fourth Edition, Payload media, 2011.
6. William stallings, "operating systems- Internals and design principles" 7th edition, Prentice Hall, 2011.

Mapping of Course Outcomes with Programming Outcomes
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	Programme Outcomes(POs)												Programme Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	3	3	-	-	-	-	-	-	-	3	3	3
CO2	3	2	3	3	-	-	-	-	-	-	-	2	3	3
CO3	2	3	1	-	-	-	1	-	-	-	-	2	3	3
CO4	3	3	3	3	-	-	-	-	-	-	-	2	1	3
CO5	3	3	3	-	-	2	-	-	-	-	-	3	3	2

PCE16105 MACHINE LEARNING TECHNIQUES 3 0 0 3

COURSE OBJECTIVES

- To learn the concepts of machine learning.
- To understand linear and non-linear learning models.
- To apply distance-based clustering techniques.
- To build tree and rule based models.
- To apply reinforcement learning techniques.

UNIT I FOUNDATIONS OF LEARNING 9

Components of learning– learning models–geometric models– probabilistic models– logic models–grouping and grading– learning versus design–types of learning–supervised– unsupervised–reinforcement–theory of learning– feasibility of learning–error and noise– training versus testing–theory of generalization – generalization bound–approximation- generalization tradeoff–bias and variance–learning curve

UNIT II LINEAR MODELS 9

Linear classification – univariate linear regression – multivariate linear regression – regularized regression – Logistic regression –perceptions–multilayer neural networks – learning neural networks structures–support Vector machines– soft margin SVM– going beyond linearity–generalization and over fitting– regularization– validation

UNIT III DISTANCE-BASEDMODELS 9

Nearest neighbour models–K-means–clustering around medoids –silhouettes– hierarchical clustering–k-dtrees–locality sensitive hashing–non-parametric regression–ensemble learning– bagging and random forests– boosting–meta learning

UNIT IV TREE AND RULEMODELS 9

Decision trees – learning decision trees – ranking and probability estimation trees –regressiontrees– clusteringtrees–learningorderedrulelists–learningunorderedrulelists–descriptiverulelearning– associationrulemining– first-order rule learning

UNIT V REINFORCEMENT LEARNING 9

Passive reinforcement learning–direct utility estimation– adaptive dynamic programming– temporal-difference learning – active reinforcement learning – exploration –learning an action-utility function – Generalization in reinforcement learning – policy search – application sin game playing– applications in robot control

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

- understand theory of underlying machine learning.
- construct algorithms to learn linear and non-linear models.
- implement data clustering algorithms.

- construct algorithms to learn tree and rule-based models.
- apply reinforcement learning techniques.

REFERENCES

1. Y.S.Abu-Mostafa, M.Magdon-Ismail, and H.-T.Lin, "Learning from Data", AML Book Publishers, 2012.
2. K.P.Murphy, "Machine Learning: A probabilistic perspective", MIT Press, 2012.
3. C.M.Bishop, "Pattern Recognition and Machine Learning", Springer, 2007.
4. D. Barber, "Bayesian Reasoning and Machine Learning", Cambridge University Press, 2012.
5. M.Mohri, A.Rostamizadeh, and A.Talwalkar, "Foundations of Machine Learning", MITPress, 2012.
6. T.M.Mitchell, "Machine Learning", McGraw-Hill, 1997.
7. S.Russel and P.Norvig, "Artificial Intelligence: A Modern Approach", Third Edition, Prentice Hall, 2009.

Mapping of Course Outcomes with Programming Outcomes
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	Programme Outcomes(POs)												Programme Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	3	3	-	-	-	-	-	-	-	3	3	3
CO2	3	2	3	3	-	-	-	-	-	-	-	2	3	3
CO3	2	3	1	-	-	-	1	-	-	-	-	2	3	3
CO4	3	3	3	3	-	-	-	-	-	-	-	2	1	3
CO5	3	3	3	-	-	2	-	-	-	-	-	3	3	2

PCE16106 ADVANCED DATA STRUCTURES AND ALGORITHMS LABORATORY 0 0 4 2

COURSE OBJECTIVES

- To learn implementation of data structures for concurrency
- To study implementation of advanced data structures such as search trees, hash tables, heaps and operations on them
- To implement advanced concurrent data structures
- To apply the principles of efficient algorithm design and learn various advanced algorithms

Each student has to work individually on assigned lab exercises. Lab sessions could be scheduled as one contiguous three-hour session per week. The students have to complete a minimum of 12 exercises. It is recommended that all implementations are carried out in Java. If C or C++ has to be used, then the threads library will be required for concurrency.

Implementation and applications of classic linear data structures, namely, linked lists, queues, and stacks.

1. Implementation of various locking and synchronization mechanisms for concurrent linked lists, concurrent queues, and concurrent stacks.
2. Implementation of weight balanced search trees and skip lists.
3. Implantation of suffix trees and pattern matching
4. Implementation of various heap structures.
5. Implementation of concurrent hashing, concurrent skip lists, and concurrent priority queues.
6. Implementation of approximation and randomized algorithms.
7. Implementation of parallel sorting algorithms.
8. Developing an application involving concurrency and data structures.

TOTAL PERIODS: 60

COURSE OUTCOMES

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

- implement concurrent linked lists, stacks, and queues.
- apply operations on different types of heaps and design techniques for advanced algorithms.
- implement and apply data structures for strings and advanced concurrent structures.
- implement advanced concurrent data structures.

REFERENCES

1. M. Herlihy and N. Shavit, “The Art of Multiprocessor Programming”, Morgan Kaufmann, 2012.
2. Peter Brass, “Advanced Data Structures”, Cambridge University Press, 2008.
3. Gavpai, “Data Structures and Algorithms – Concepts, techniques and Applications”, First Edition, Tata McGraw-Hill, 2008.
4. S.K. Chang, “Data Structures and Algorithms – Series of Software Engineering and Knowledge Engineering”, Vol. 13, World Scientific Publishing, 2003.
5. Jon Kleinberg, "Algorithm Design", Addison-Wesley, 2013.

CO/PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	**Programme Outcomes(POs)**												**Programme Specific Outcomes (PSOs)**	
	PO1	**PO 2**	**PO3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO1 0**	**PO1 1**	**PO1 2**	**PS O1**	**PS O2**
CO1	3	1	1	-	1	-	-	-	-	-	-	-	3	3
CO2	2	1	2	-	2	-	1	-	-	-	-	-	1	3
CO3	3	2	-	-	3	-	-	-	-	-	-	-	-	3
CO4	3	1	-	-	-	2	-	-	-	-	-	-	1	3

SEMESTER II

PCE16201 SOFT COMPUTING 3 0 0 3

COURSE OBJECTIVES

- To learn soft computing concepts and techniques.
- To understand neural network and fuzzy logic methods.
- To design and develop intelligent systems in the framework of soft computing,
- To learn and implement research oriented genetic algorithms.
- To acquire knowledge in scientific application-driven environments.

UNIT I SOFT COMPUTING BASICS 9

Introduction-soft computing vs. hard computing-various types of soft computing techniques- applications of soft computing-Basic tools of soft computing – Fuzzy logic-neural network-evolutionary computing-Introduction: Neural networks- application scope of neural networks-fuzzy logic-genetic algorithm-hybrid systems.

UNIT II NEURAL NETWORKS 9

Neuron-Nerve structure and synapse-Artificial Neuron and its model-activation functions-Neural network architecture: single layer and multilayer feed forward networks-recurrent networks. Various learning techniques; perception and convergence rule-Auto associative and hetro-associative memory-perceptron model-single layer artificial neural network-multilayer perception model; back propagation learning methods-effect of learning rule co-efficient ;back propagation algorithm-factors affecting back propagation training-applications.

UNIT III FUZZY LOGIC 9

Basic concepts of fuzzy logic-Fuzzy sets and Crisp sets-Fuzzy set theory and operations-Properties of fuzzy sets-Fuzzy and Crisp relations- Fuzzy to Crisp conversion. Membership functions-interference in fuzzy logic-fuzzy if-then rules-Fuzzy implications and Fuzzy algorithms-Fuzzyfications & Defuzzifications-Fuzzy Controller-Fuzzy rule base and approximate reasoning: truth values and tables in fuzzy logic-fuzzy propositions formation of rules-decomposition of compound rules-aggregation of fuzzy rules-fuzzy reasoning, fuzzy inference system-fuzzy expert systems.

UNIT IV GENETIC ALGORITHM 9

Basic concepts-working principle- procedures of GA-flow chart of GA-Genetic representations-(encoding) Initialization and selection- Genetic operators,-Mutation-Generational Cycle-Traditional algorithm vs. genetic algorithm-simple GA-general genetic algorithm-schema theorem-Classification of genetic algorithm-Holland classifier systems-genetic programming-applications of genetic algorithm-Convergence of GA-Applications & advances in GA-Differences & similarities between GA & other traditional method-applications.

UNIT V EVOLUTIONARY COMPUTING 9

Role of biologically inspired software-Difficulties in search-optimization and machine learning-Overview of natural evolution and its abilities-Evolutionary Programming/Evolutionary Strategies Issues in evolutionary search-applying an evolutionary algorithm-Artificial Life- Ant colony optimization-Swarm intelligence.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

- identify and describe soft computing techniques and their roles in building intelligent machines.
- recognize the feasibility of applying a soft computing methodology for a particular problem.
- apply fuzzy logic and reasoning to handle uncertainty and solve engineering problems.
- develop genetic algorithm based applications.
- acquire knowledge in evolutionary computing environment.

REFERENCES

1. S.Rajsekaran & G.A. Vijayalakshmi Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis and Applications" ,Prentice Hall of India.
2. N.P.Padhy,"Artificial Intelligence and Intelligent Systems" ,Oxford University Press.
3. J S R Jang and E.Mizutani, "Neuro-Fuzzy and Soft Computing", PHI Pvt Ltd.
4. Sivandudam and Deepa , "Principles of soft computing", John Mikey India.
5. Ross Timothy J, "Fuzzy Logic with Engineering Applications", Wiley India Pvt Ltd, New Delhi, 2010

Mapping of Course Outcomes with Programming Outcomes
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	Programme Outcomes(POs)												Programme Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	3	3	-	-	-	-	-	-	-	3	3	3
CO2	3	2	3	3	-	-	-	-	-	-	-	2	3	3
CO3	2	3	1	-	-	-	1	-	-	-	-	2	3	3
CO4	3	3	3	3	-	-	-	-	-	-	-	2	1	3
CO5	3	3	3	-	-	2	-	-	-	-	-	3	3	2

PCE16202 ADVANCED DATABASES AND INFORMATION SYSTEMS 3 0 0 3

COURSE OBJECTIVES

- To acquire knowledge in parallel and distributed databases and its applications.
- To study the usage and applications of object oriented database
- To understand the principles of intelligent databases.
- To understand the usage of advanced data models.
- To learn the emerging databases such as XML, cloud , big data and information systems

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–Case Studies.

UNIT II OBJECT AND OBJECT RELATIONAL DATABASES 9

Concepts for Object Databases: Object Identity–Object structure –Type Constructors – Encapsulation of Operations – Methods –Persistence – Type and Class Hierarchies – Inheritance – Complex Objects – Object Database Standards, Languages and Design: ODMG Model–ODL– OQL–Object Relational and Extended–Relational Systems: Object Relational features in SQL/Oracle–Case Studies.

UNIT III 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: Logic of Query Languages – Data log- Recursive Rules- Syntax and Semantics of Data log Languages-Implementation of Rules and Recursion- Recursive Queries in SQL-Spatial Databases-Spatial Data Types-Spatial Relationships- Spatial Data Structures-Spatial Access Methods-Spatial DB Implementation.

UNIT IV ADVANCED DATA MODELS 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- Information Retrieval-Data Warehousing-Data Mining-Text Mining.

UNIT V EMERGING TECHNOLOGIES AND INFORMATION SYSTEMS 9

XML Databases- Web Databases- Geographic Information Systems-Biological Data Management-Cloud Based Databases- Big Data-Storage. Information System - Critical Characteristics of Information, NSTISSC Security Model-Components of an Information System, Securing the Components, Balancing Security and Access.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

- select the appropriate high performance database like parallel and distributed database.
- model and represent the real world data using object oriented database.
- design a semantic based database to meaningful data access.
- embed the rule set in the database to implement intelligent databases.
- represent the data using XML database for better interoperability.

REFERENCES

1. R.Elmasri, S.B.Navathe, "Fundamentals of Database Systems", Fifth Edition, Pearson Education /Addison Wesley, 2007.
2. Thomas Cannolly and Carolyn Begg, "Database Systems, A Practical Approach to Design, Implementation and Management", Third Edition, 2007.
3. Henry F Korth, Abraham Silberschatz, S.Sudharshab, "Database System Concepts", Fifth Edition, Mc Graw Hill, 2006.
4. C.J.Date, A.Kannanand S.Swamynathan, "An Introduction to Database Systems", Eighth Edition, Pearson Education, 2006.
5. Raghu Ramakrishnan, Johannes Gehrke, "Database Management Systems", Mc Graw Hill, Third Edition, 2004.

Mapping of Course Outcomes with Programming Outcomes
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	Programme Outcomes(POs)												Programme Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	3	3	-	-	-	-	-	-	-	3	3	3
CO2	3	2	3	3	-	-	-	-	-	-	-	2	3	3
CO3	2	3	1	-	-	-	1	-	-	-	-	2	3	3
CO4	3	3	3	3	-	-	-	-	-	-	-	2	1	3
CO5	3	3	3	-	-	2	-	-	-	-	-	3	3	2

PCE16203 AD- HOC AND WIRELESS NETWORKS 3 0 0 3

COURSE OBJECTIVES

- To learn the basics of wireless ADHOC network.
- To enhance knowledge in routing protocols for ADHOC wireless networks.
- To understand multi cast routing methods in ADHOC wireless networks.
- To study security protocols for ADHOC wireless networks.
- To gain knowledge on energy management in ADHOC wireless networks.

UNIT I INTRODUCTION 9

Ad Hoc Wireless Networks- Issues in Ad Hoc Wireless Networks, Ad Hoc Wireless Internet; MAC Protocols for Ad Hoc Wireless Networks-Issues in Designing a MAC Protocol for Ad Hoc Wireless Networks - Classifications of MAC Protocols.

UNIT II ROUTING PROTOCOLS FOR AD HOC WIRELESS NETWORKS 9

Issues in Designing a Routing Protocol for Ad Hoc Wireless Networks - Classifications of Routing Protocols - Power Aware Routing Protocols.

UNIT III MULTI CAST ROUTING IN AD HOC WIRELESS NETWORKS 9

Issues in Designing a Multicast Routing Protocol - Classifications of Multicast Routing Protocols –Energy Efficient Multicasting -Multicasting with Quality of Service Guarantees -Application Dependent Multicast Routing.

UNIT IV SECURITY PROTOCOLS FOR AD HOC WIRELESS NETWORKS 9

Security in Ad Hoc Wireless Networks -Network Security Requirements -Issues and Challenges in Security Provisioning- Network Security Attacks-Key Management-Secure Routing in Ad Hoc Wireless Networks.

UNIT V ENERGY MANAGEMENT IN AD HOC WIRELESS NETWORKS 9

Classification of Energy Management Schemes - Transmission Power Management Schemes, -System Power Management Schemes - Special topics in Ad-hoc and wireless networks.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

- understand the basics of wireless ADHOC network.
- enhance knowledge in routing protocols for ad hoc wireless networks.
- implement multi cast routing methods in ad hoc wireless network.
- apply security protocols for ad hoc wireless networks.
- gain knowledge on energy management in Ad Hoc wireless networks.

REFERENCES

1. C S. Ram Murthy, B. S. Manoj, “Ad Hoc Wireless Networks: Architectures and Protocols”, Prentice Hall of India, 2nd ed. 2012.

2. R. Hekmat, “Ad hoc Networks: Fundamental Properties and Network Topologies”, Springer, 1st ed. 2006.
3. B. Tavli and W. Heinzelman, “Mobile Ad Hoc Networks: Energy Efficient Real Time Data Communications”, Springer, 1st ed. 2006.
4. G. Anastasi, E. Ancillotti, R. Bernasconi, and E. S. Biagioni, “Multi Hop Ad Hoc Newtorks from Theory to Reality”, Nova Science Publishers, 2008.
5. Daniel Minoli, “Wireless sensor networks”, Wiley, 2013.

Mapping of Course Outcomes with Programming Outcomes
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	**Programme Outcomes(POs)**												**Programme Specific Outcomes (PSOs)**	
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	3	3	3	-	-	-	-	-	-	-	3	3	3
CO2	3	2	3	3	-	-	-	-	-	-	-	2	3	3
CO3	2	3	1	-	-	-	1	-	-	-	-	2	3	3
CO4	3	3	3	3	-	-	-	-	-	-	-	2	1	3
CO5	3	3	3	-	-	2	-	-	-	-	-	3	3	2

PCE16204 CLOUD COMPUTING 3 0 0 3

COURSE OBJECTIVES

- To analyze different virtualization concepts
- To understand the concept of cloud and utility computing.
- To understand the various issues in cloud computing.
- To familiarize themselves with the types of virtualization and lead players in cloud.
- To learn the emergence of cloud as the next generation computing paradigm.

UNIT I OVERVIEW OF VIRTUALIZATION 8

Basics of Virtualization - Virtualization Types – Desktop Virtualization – Network Virtualization – Server and Machine Virtualization – Storage Virtualization – System-level of Operating Virtualization – Application Virtualization- Virtualization Advantages - Virtual Machine Taxonomy of Virtual Machines - Process Virtual Machines - System Virtual Machines – Hypervisor – Interpretation and Binary translation.

UNIT II VIRTUALIZATION STRUCTURES 8

Implementation Levels of Virtualization - Virtualization Structures - Tools and Mechanisms - Virtualization of CPU, Memory, I/O Devices - Virtual Clusters and Resource Management – Virtualization for Data-Center Automation.

UNIT III CLOUD INFRASTRUCTURE 9

Scalable Computing over the Internet – Technologies for Network based Systems - System Models for Distributed and Cloud Computing – Service Oriented Architecture – NIST Cloud Computing Reference Architecture. Cloud Computing and Services Model – Public, Private and Hybrid Clouds – Cloud Eco System - IaaS -PaaS – SaaS. Architectural Design of Compute and Storage Clouds – Layered Cloud Architecture Development – Design Challenges - Inter Cloud Resource Management – Resource Provisioning and Platform Deployment – Global Exchange of Cloud Resources Case Study: Amazon Web Service reference, GoGrid, Rackspace.

UNIT IV PROGRAMMING MODEL 10

Parallel and Distributed Programming Paradigms – Map Reduce , Twister and Iterative Map Reduce – Hadoop Library from Apache – Mapping Applications - Programming Support - Google App Engine, Amazon AWS - Cloud Software Environments -Eucalyptus, Open Nebula, Open Stack. Cloud Sim – Architecture - Cloudlets – VM creation – Broker – VM allocation – Hosts.

UNIT V SECURITY IN THE CLOUD AND RESOURCE MANAGEMENT 10

Cloud Computing Risk Issues – Cloud Computing Security Challenges – Cloud Computing Security Architecture – Trusted cloud Computing – Identity Management and Access Control – Autonomic Security. Dynamic Resource Allocation Using Virtual Machines for Cloud Computing Environment - Optimization of Resource Provisioning Cost in Cloud Computing.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

- recognize the strengths and limitations of cloud computing.
- identify the architecture, infrastructure and delivery models of cloud computing applications.
- suggest solutions for the core issues of cloud computing such as security, privacy and interoperability.
- understand the appropriate technologies, algorithms and approaches for the related issues.
- deal security challenges in cloud environment.

REFERENCES

1. Kai Hwang, Geoffrey C Fox, Jack G Dongarra, "Distributed and Cloud Computing, From Parallel Processing to the Internet of Things", Morgan Kaufmann Publishers, 2012.
2. Ronald L. Krutz, Russell Dean Vines, "Cloud Security – A comprehensive Guide to Secure Cloud Computing", Wiley – India, 2010.
3. John W.Rittinghouse and James F.Ransome, "Cloud Computing: Implementation, Management, and Security", CRC Press, 2010.
4. George Reese, "Cloud Application Architectures: Building Applications and Infrastructure in the Cloud", O'Reilly
5. SivadonChaisiri, Bu-Sung Lee, and DusitNiyato, "Optimization of Resource Provisioning Cost in Cloud Computing", IEEE Transactions on Services Computing, Vol. 5, No. 2, April-June 2012.

Mapping of Course Outcomes with Programming Outcomes
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	Programme Outcomes(POs)												Programme Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	3	3	-	-	-	-	-	-	-	3	3	3
CO2	3	2	3	3	-	-	-	-	-	-	-	2	3	3
CO3	2	3	1	-	-	-	1	-	-	-	-	2	3	3
CO4	3	3	3	3	-	-	-	-	-	-	-	2	1	3
CO5	3	3	3	-	-	2	-	-	-	-	-	3	3	2

PCE16205 CLOUD COMPUTING LABORATORY 0 0 4 2

COURSE OBJECTIVES

- To learn the implementation of cloud computing and architecture
- To know the concepts of Hadoop
- To learn the implementation of map reduce
- implementation of cloud computing and architecture

LIST OF EXPERIMENTS

Use Eucalyptus or Open Nebula or equivalent to set up the cloud and demonstrate:

1. Study of Cloud Computing & Architecture.
2. Find procedure to run the virtual machine of different configuration. Check how many virtual machines can be utilized at particular time.
3. Study and implementation of Infrastructure as a Service and Study and installation of Storage as Service.
4. Implementation of identity management.
5. Find procedure to attach virtual block to the virtual machine and check whether it holds the data even after the release of the virtual machine.
6. Install a C compiler in the virtual machine and execute a sample program.
7. Show the virtual machine migration based on the certain condition from one node to the other.
8. Find procedure to install storage controller and interact with it.
9. Find procedure to set up the one node Hadoop cluster.
10. Mount the one node Hadoop cluster using FUSE.
11. Write a program to use the API's of Hadoop to interact with it.
12. Write a word count program to demonstrate the use of Map and Reduce tasks.
13. Mini project.

TOTAL PERIODS 60

COURSE OUTCOMES

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

- use the grid and cloud tool kits.
- design and implement applications on the grid.
- design and implement applications on the cloud.
- Design and implementation of cloud computing and architecture

REFERENCES

1. Kai Hwang, Geoffrey C Fox, Jack G Dongarra, "Distributed and Cloud Computing, From Parallel Processing to the Internet of Things", Morgan Kaufmann Publishers, 2012.
2. Ronald L. Krutz, Russell Dean Vines, "Cloud Security – A comprehensive Guide to Secure Cloud Computing", Wiley – India, 2010.
3. John W.Rittinghouse and James F.Ransome, "Cloud Computing: Implementation, Management, and Security", CRC Press, 2010.

4. George Reese, “Cloud Application Architectures: Building Applications and Infrastructure in the Cloud”, O'Reilly
5. SivadonChaisiri, Bu-Sung Lee, and DusitNiyato, “Optimization of Resource Provisioning Cost in Cloud Computing”, IEEE Transactions on Services Computing, Vol. 5, No. 2, April-June 2012.

CO/PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	**Programme Outcomes(POs)**												**Programme Specific Outcomes (PSOs)**	
	PO1	**PO 2**	**PO3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO1 0**	**PO1 1**	**PO1 2**	**PS O1**	**PS O2**
CO1	3	1	1	-	1	-	-	-	-	-	-	-	3	3
CO2	2	1	2	-	2	-	1	-	-	-	-	-	1	3
CO3	3	2	-	-	3	-	-	-	-	-	-	-	-	3
CO4	3	1	-	-	-	2	-	-	-	-	-	-	1	3

PCE16206 TECHNICAL REPORT PREPARATION AND PRESENTATION 0 0 4 2

COURSE OBJECTIVES

- To provide exposure to the students to refer, read and review the research articles in referred journals and conference proceedings.
- To expose the presentation skill of the students.
- To improve the technical report writing skills of the students.
- read and review the research articles in referred Journals and conference proceedings.

COURSE OUTCOMES

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

- understand how to refer, read and review the research articles.
- gain knowledge in presenting technical papers in national and international conferences.
- write a technical paper in the referred journals and conference proceedings.
- technical papers in national and international conferences.

TOTAL PERIODS: 60

Mapping of Course Outcomes with Programming Outcomes
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	Programme Outcomes(POs)												Programme Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	3	3	-	-	-	-	-	-	-	3	3	3
CO2	3	2	3	3	-	-	-	-	-	-	-	2	3	3
CO3	2	3	1	-	-	-	1	-	-	-	-	2	3	3
CO4	3	3	3	3	-	-	-	-	-	-	-	2	1	3
CO5	3	3	3	-	-	2	-	-	-	-	-	3	3	2

ELECTIVE I

PCE16151 DIGITAL IMAGE PROCESSING AND ANALYSIS 3 0 0 3

COURSE OBJECTIVES

- To understand image models and its processing.
- To learn spatial, frequency domain filters.
- To study basic image analysis segmentation, edge detection, and corner detection.
- To learn morphological operations and texture analysis.
- To acquire knowledge in image analysis.

UNIT I IMAGE MODELS AND PROCESSING 9

Introduction to image processing–imaging modalities–image file formats–image sensing and acquisition – image sampling and quantization – noise models – spatial filtering operations–histograms–smoothing filters– sharpening filters– fuzzy techniques for spatial filtering–spatial filters for noise removal - Colour models – pseudo colours - colour transformations.

UNIT II FREQUENCY DOMAIN PROCESSING 9

Frequency domain–Review of Fourier Transform(FT),Discrete Fourier Transform (DFT), and Fast Fourier Transform (FFT) –filtering infrequency domain –image smoothing – image sharpening –selective filtering– frequency domain noise filters–wavelets –Haar Transform– multi resolution expansions– wavelet transforms– wave lets based image processing.

UNIT III SEGMENTATION AND EDGE DETECTION 9

Thresholding techniques– region growing methods– region splitting and merging– adaptive thresholding– threshold selection–global valley– histogram concavity– edge detection– template matching–gradient operators– circular operators– differential edge operators– hysteresis thresholding– Canny operator –Laplacian operator –active contours–object segmentation.

UNIT IV INTEREST POINTS, MORPHOLOGY, AND TEXTURE 9

Corner and interest point detection – template matching – second order derivatives – median filter based detection –Harris interest point operator –corner orientation –local invariant feature detectors and descriptors – morphology – dilation and erosion – morphological operators– gray scale morphology– noise and morphology–texture–texture analysis –co-occurrence matrices –Laws' texture energy approach –Ade's Eigen filter approach.

UNIT V IMAGE ANALYSIS 9

Feature extraction – reduction – Image retrieval and its performance – Syntax and introduction to semantic based retrieval – introduction to watermarking – steganography –Image Compression – redundancy in images – coding redundancy – irrelevant information in images – image compression models – basic compression methods – Introduction to compression standards.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

- implement spatial, frequency filter operations.
- know the frequency domain filters.
- apply segmentation algorithms and edge detection techniques.
- perform texture analysis.
- analyse images and implement image compression algorithms.

REFERENCES

1. E.R.Davies, "Computer& Machine Vision", Fourth Edition, Academic Press, 2012.
2. W. Burger and M. Burge, "Digital Image Processing: An Algorithmic Introduction using Java", Springer, 2008.
3. John C.Russ, "The Image Processing Handbook", Sixth Edition, CRC Press, 2011.
4. R.C.Gonzalez and R.E.Woods, "Digital Image Processing", Third Edition, Pearson, 2008.
5. Mark Nixonand Alberto S. Aquado, "Feature Extraction & Image Processing for Computer Vision", Third Edition, Academic Press, 2012.
6. D.L.Baggioetal., "Mastering Open CV with Practical Computer Vision Projects", Packt Publishing, 2012.
7. Jan Erik Solem, "Programming Computer Vision with Python: Tools and algorithms for analyzing images", O'Reilly Media, 2012.

Mapping of Course Outcomes with Programming Outcomes
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	Programme Outcomes(POs)												Programme Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	3	3	-	-	-	-	-	-	-	3	3	3
CO2	3	2	3	3	-	-	-	-	-	-	-	2	3	3
CO3	2	3	1	-	-	-	1	-	-	-	-	2	3	3
CO4	3	3	3	3	-	-	-	-	-	-	-	2	1	3
CO5	3	3	3	-	-	2	-	-	-	-	-	3	3	2

PCE16152 MASSIVE PARALLEL PROCESSING 3 0 0 3

COURSE OBJECTIVES

- To study about the cache memory and cache performance issue.
- To learn detailed study of different architectures.
- To understand vector pipeline architectures and pipelined CPU architecture.
- To analyse RISC, CISC Scalar processor architecture.
- To know virtual channels and parallel processing applications.

UNIT I OVERVIEW OF MODERN PROCESSOR ARCHITECTURES 9

Memory Hierarchy - Cache and Cache Coherence Caches- associatively - allocation and replacement policies - sub-block placement. Multilevel caches -multilevel inclusion - Cache performance issues.

UNIT II BUS ARCHITECTURE IMPLEMENTATIONS OF SHARED MEMORY 9

The cache coherence problem - Update vs. invalidation - The bus-based snooping protocol design space - Scalable-shared memory using directory-based cache coherency - MESI protocol.

UNIT III VECTOR PIPELINE AND PIPELINED CPU ARCHITECTURE 9

Instruction set design and pipeline structure- instruction Pipeline Design -Arithmetic pipeline design –Super - scalar and Super pipeline design -Dynamic scheduling using score boarding and Tomasulo's algorithm - Software instruction scheduling and software pipelining -Super-scalar and long-instruction-word architectures -Branch prediction and speculative execution.

UNIT IV REPLICATED ARCHITECTURES 9

SIMD/MIMD-Shared Memory and Distributed Memory -RISC, CISC Scalar processors - super Scalar and VLIW Computers - Multi-vector Computers - Connectivity Interconnection networks: topology- routing - flow control -deadlock avoidance - static and dynamic interconnection networks.

UNIT V VIRTUAL CHANNELS 9

Program and Network Properties- Conditions of parallelism- Program Partitioning -and Scheduling- Program flow mechanisms- Principles of Scalable Performance- Performance Metrics and Measures- Parallel processing Applications Speedup Performance laws.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

- understand the cache memory and cache performance issue.
- expose the detailed study of different architectures.
- implement vector pipeline architectures and pipelined CPU architecture.
- understand RISC, CISC scalar processor architecture.
- analyze the Memory and I/O systems and their performance issues.

REFERENCES

1. John L. Hennessy, David A. Patterson, "Computer Architecture, A Quantitative approach", Morger Kaufmann Publishers, 3rd Edition, 2003.
2. Kai Hwang, "Advanced Computer Architecture: Parallelism, Scalability and Programmability" McGrawHill, 2001.
3. John L. Hennery, David A. Patterson, "Computer organization and design: The hardware / software interface, 2nd Edition, Morgan Kaufman Publishers, 2012.
4. Morris Mano M, " Computer System Architecture", Pearson Education, 2014.
5. William stallings, "Computer Organization and Architecture: Designing for Performance" , Prentice Hall, 2014.

Mapping of Course Outcomes with Programming Outcomes
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	Programme Outcomes(POs)												Programme Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
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CO2	3	2	3	3	-	-	-	-	-	-	-	2	3	3
CO3	2	3	1	-	-	-	1	-	-	-	-	2	3	3
CO4	3	3	3	3	-	-	-	-	-	-	-	2	1	3
CO5	3	3	3	-	-	2	-	-	-	-	-	3	3	2

PCE16153 DATA VISUALIZATION TECHNIQUES 3 0 0 3

COURSE OBJECTIVES

- To learn visual perception and core skills for visual analysis
- To understand visualization for time-series analysis
- To study correlation analysis techniques.
- To know visualization for ranking, deviation and distribution analysis
- To acquire knowledge in dash board design

UNIT I CORE SKILLS FOR VISUAL ANALYSIS 9

Information visualization - effective data analysis - traits of meaningful data - visual perception -making abstract data visible -building blocks of information visualization - analytical interaction -analytical navigation -optimal quantitative scales-reference lines and regions -trellises and crosstabs -multiple concurrent views -focus and context - details on demand- over-plotting reduction- analytical patterns-pattern examples

UNIT II TIME-SERIES, RANKING, ANDDEVIATIONANALYSIS 9

Time-series analysis - time-series patterns - time-series displays - time-series best practices-part-to-whole and ranking patterns-part-to-whole and ranking displays-best practices - deviation analysis - deviation analysis displays - deviation analysis best practices

UNIT III DISTRIBUTION, CORRELATION, AND MULTIVARIATE ANALYSIS 9

Distribution analysis- describingdistributions-distributionpatterns-distributiondisplays- distribution analysis best practices - correlation analysis - describing correlations - correlation patterns - correlation displays - correlation analysis techniques and best practices-multivariate analysis- multivariate patterns- multivariate displays- multivariate analysis techniques and best practices

UNIT IV INFORMATION DASHBOARD DESIGN-I 9

Information dashboard -categorizing dashboards -typical dashboard data-dashboard design issues and best practices - visual perception- limits of short-term memory- visually encodingdata-Gestaltprinciples-principlesofvisualperceptionfordashboarddesign

UNIT V INFORMATION DASH BOARD DESIGN-II 9

Characteristics of dashboards -key goals in visual design process -dashboard display media – designing dashboards for usability - meaningful organization - maintaining consistency - aesthetics of dashboards - Testing for usability - case studies: sales dashboard, CIO dashboard, Telesales Data board, marketing analysis dashboard

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

- understand principles of visual perception

- apply core skills for visual analysis
- apply visualization techniques for various data analysis tasks
- analyse multivariate patterns.
- design information dashboard

REFERENCES

1. Stephen Few, "Now you see it: Simple Visualization techniques for quantitative analysis", Analytics Press, 2009.
2. Stephen Few, "Information dashboard design: The effective visual communication of data",O'Reilly, 2006.
3. Edward R. Tufte, "The visual display of quantitative information", Second Edition, GraphicsPress,2001.
4. NathanYau, "Data Points: Visualization that means something", Wiley, 2013.
5. Ben Fry, "Visualizing data: Exploring and explaining data with the processing environment", O'Reilly, 2008.
6. EvanStubbs, "The value of business analytics: Identifying the path to profitability", Wiley, 2011.

Mapping of Course Outcomes with Programming Outcomes
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	Programme Outcomes(POs)												Programme Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	3	3	-	-	-	-	-	-	-	3	3	3
CO2	3	2	3	3	-	-	-	-	-	-	-	2	3	3
CO3	2	3	1	-	-	-	1	-	-	-	-	2	3	3
CO4	3	3	3	3	-	-	-	-	-	-	-	2	1	3
CO5	3	3	3	-	-	2	-	-	-	-	-	3	3	2

PCE16154 SPEECH PROCESSING AND SYNTHESIS 3 0 0 3

COURSE OBJECTIVES

- To study the fundamental concepts of speech processing.
- To design the solution of LPC equations.
- To learn various speech enhancement techniques.
- To know system pattern and markov model for speech recognition
- To acquire knowledge of homomorphic systems.

UNIT I INTRODUCTION TO SPEECH PROCESSING 9

Anatomy & Physiology of Speech Organs, The process of Speech Production, The Acoustic Theory of Speech Production, Digital models for speech signals. Window considerations, Short time energy and average magnitude Short time average zero crossing rate, Speech vs. silence discrimination using energy and zero crossing, Pitch period estimation using a parallel processing approach, The short time autocorrelation function, The short time average magnitude difference function, Pitch period estimation using the autocorrelation function

UNIT II LINEAR PREDICTIVE ANALYSIS 9

Basic principles of Linear Predictive Analysis: The Autocorrelation Method, The Covariance Method, Solution of LPC Equations: Cholesky Decomposition Solution for Covariance Method, Durbin's Recursive Solution for the Autocorrelation Equations, Pitch Detection and using LPC Parameters.

UNIT III HOMOMORPHIC SYSTEMS 9

Homomorphic Systems for Convolution: Properties of the Complex Cepstrum, Computational Considerations, The Complex Cepstrum of Speech, Pitch Detection, Formant Estimation, Mel frequency cepstrum computation.

UNIT IV SPEECH ENHANCEMENT TECHNIQUES AND PATTERN 9

Nature of interfering sounds, Speech enhancement techniques: spectral subtraction, Enhancement by resynthesis, Comb filter, Wiener filter. Basic pattern recognition approaches, parametric representation of speech, evaluating the similarity of speech patterns, isolated digit Recognition System, Continuous digit Recognition System.

UNIT V SPEECH RECOGNITION MODELS 9

Hidden Markov Model (HMM) for speech recognition, Viterbi algorithm, Training and testing using HMMs, Adapting to variability in speech (DTW), and Language models. Issues in speaker recognition and speech synthesis of different speakers. Text to speech conversion, Calculating acoustic parameters, synthesized speech output performance and characteristics of text to speech, Voice processing hardware and software architectures.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

- build and apply speech processing in real models

- analysis the speech recognition techniques
- develop homomorphic systems
- simulate speech recognition models
- test the speech processing models

REFERENCES

1. L.R Rabiner and S.W. Schafer, “Digital processing of speech signals”, Pearson Education.
2. Douglas O'Shaughnessy, “Speech Communications: Human & Machine”, 2nd ed., IEEE Press.
3. Thomas F. Quateri, “Discrete Time Speech Signal Processing: Principles and Practice”, 1st ed., PE.
4. Ben Gold & Nelson Morgan, “Speech & Audio Signal Processing”, 1 ed., Wiley, 2012.
5. Claudio Becchetti and Lucio Prina Ricotti, “Speech Recognition”, Wiley.

Mapping of Course Outcomes with Programming Outcomes
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	**Programme Outcomes(POs)**												**Programme Specific Outcomes (PSOs)**	
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	3	3	3	-	-	-	-	-	-	-	3	3	3
CO2	3	2	3	3	-	-	-	-	-	-	-	2	3	3
CO3	2	3	1	-	-	-	1	-	-	-	-	2	3	3
CO4	3	3	3	3	-	-	-	-	-	-	-	2	1	3
CO5	3	3	3	-	-	2	-	-	-	-	-	3	3	2

ELECTIVE II

PCE16251 BIG DATA ANALYTICS 3 0 0 3

COURSE OBJECTIVES

- To explore the fundamental concepts of big data and analytics.
- To learn various techniques for mining data stream.
- To analyze big data using intelligent techniques.
- To apply search methods and visualization.
- To design applications using map reduce concepts.

UNIT I INTRODUCTION TO BIG DATA 9

Introduction to Big Data Platform – Challenges of Conventional Systems - Intelligent data analysis – Nature of Data - Analytic Processes and Tools - Analysis Vs Reporting - Modern Data Analytic Tools – Statistical Concepts: Sampling Distributions - Re-Sampling - Statistical Inference - Prediction Error

UNIT II DATA ANALYSIS 9

Regression Modelling - Multivariate Analysis – Bayesian Methods – Bayesian Paradigm - Bayesian Modeling - Inference and Bayesian Networks - Support Vector and Kernel Methods - Analysis of Time Series: Linear Systems Analysis - Nonlinear Dynamics - Rule Induction - Fuzzy Logic: Extracting Fuzzy Models from Data - Fuzzy Decision Trees

UNIT III SEARCH METHODS AND VISUALIZATION 9

Search by simulated Annealing – Stochastic, Adaptive search by Evaluation – Evaluations Strategies – Genetic Algorithm – Genetic Programming – Visualization – Classification of Visual Data Analysis Techniques – Data Types – Visualization Techniques – Interaction techniques – Specific Visual data analysis Techniques

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 - Real time Analytics Platform(RTAP) Applications - Case Studies - Real Time Sentiment Analysis, Stock Market Predictions

UNIT V FRAMEWORKS 9

Map Reduce – Hadoop, Hive, MapR – Sharding – NoSQL Databases - S3 - Hadoop Distributed File Systems– Case Study- Preventing Private Information Inference Attacks on Social Networks-Grand Challenge: Applying Regulatory Science and Big Data to Improve Medical Device Innovation.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

- work in big data platform and its analysis techniques.
- design efficient algorithms for mining the data from large volumes.

- model a framework for human activity recognition.
- analyze the big data for useful business applications.
- implement search methods and Visualization.

REFERENCES

1. Michael Berthold, David J. Hand, "Intelligent Data Analysis", Springer, 2007.
2. Anand Rajaraman and Jeffrey David Ullman, "Mining of Massive Datasets", Cambridge University Press, 2012.
3. Bill Franks, "Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics", John Wiley & sons, 2012.
4. Glenn J. Myatt, "Making Sense of Data", John Wiley & Sons, 2007.
5. Pete Warden, "Big Data Glossary", O'Reilly, 2011.
6. Jiawei Han, MichelineKamber "Data Mining Concepts and Techniques", Second Edition, Elsevier, Reprinted 2008.
7. Raymond Heatherly, Murat Kantarcioglu and Bhavani Thuraisingham, "Preventing Private Information Inference Attacks on Social Networks" IEEE Transaction on Knowledge and Data Engineering, Vol 25, No.8 August 2013.

Mapping of Course Outcomes with Programming Outcomes
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CO3	2	3	1	-	-	-	1	-	-	-	-	2	3	3
CO4	3	3	3	3	-	-	-	-	-	-	-	2	1	3
CO5	3	3	3	-	-	2	-	-	-	-	-	3	3	2

PCE16252 STORAGE AREA NETWORKS 3 0 0 3

COURSE OBJECTIVES

- To learn the necessity for storage area networks
- To study the appropriateness of the different networked storage options for different application environments
- To learn NAS – IP SAN.
- To understand the architecture of virtualization technologies.
- To understand the securing and managing storage Infrastructure.

UNIT I INTRODUCTION TO INFORMATION STORAGE AND MANAGEMENT– STORAGE SYSTEM ENVIRONMENT 9

Information Storage - Evolution of Storage Technology and Architecture - Data Center Infrastructure - Key Challenges in Managing Information - Information Lifecycle Components of Storage System Environment - Disk Drive Components - Disk Drive Performance - Fundamental Laws Governing Disk Performance - Logical Components of the Host - Application Requirements and Disk Performance.

UNIT II DIRECT-ATTACHED STORAGE–SCSI AND STORAGE AREA NETWORKS 9

Types of DAS – DAS Benefits and Limitations – Disk Drive Interfaces – Introduction to Parallel SCSI – Overview of Fibre Channel – The SAN and Its Evolution – Components of SAN – FC Connectivity – Fibre Channel Ports – Fibre Channel Architecture – Zoning – Fibre Channel Login Types – FC Topologies.

UNIT III NAS– IP SAN 9

General – Purpose Service vs. NAS Devices – Benefits of NAS – NAS File I / O – Components of NAS – NAS Implementations – NAS File-Sharing Protocols – NAS I/O Operations – Factors Affecting NAS Performance and Availability. iSCSI – FCIP.

UNIT IV CONTENT-ADDRESSED STORAGE– STORAGE VIRTUALIZATION 9

Fixed Content and Archives – Types of Archive – Features and Benefits of CAS – CAS Architecture – Object Storage and Retrieval in CAS – CAS Examples Forms of Virtualization – SNIA Storage Virtualization Taxonomy – Storage Virtualizations Configurations – Storage Virtualization Challenges – Types of Storage Virtualization.

UNIT V SECURING THE STORAGE INFRASTRUCTURE– MANAGING THE STORAGE INFRASTRUCTURE 9

Storage Security Framework – Risk Triad – Storage Security Domains – Security Implementations in Storage Networking Monitoring the Storage Infrastructure – Storage Management Activities – Storage Infrastructure Management Challenges – Developing an Ideal Solution.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

- understand the need for storage area networks.
- choose the best option for any given application environment.
- apply architecture of backup/recovery and virtualization technologies
- implement storage visualization methods.
- understand securing storage infrastructure.

REFERENCES

1. Ulf Troppens,Rainer Erkens and Wolfgang Muller, "Storage Networks Explained", John Wiley&Sons,2011.
2. Robert Spalding, "Storage Networks: The Complete Reference", Tata McGraw Hill, 2008.
3. Tom Clark, "Designing Storage Area Networks: A practical reference for implementing fibre channel and IP SANs", Addison Wesley,2003.
4. Mike Jackson "SAS Storage Architecture: Serial Attached SCSI", TMH, 2012.
5. Pankaj Sharma, "Information Storage and Management" , Wiley, 2013.

Mapping of Course Outcomes with Programming Outcomes
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CO3	2	3	1	-	-	-	1	-	-	-	-	2	3	3
CO4	3	3	3	3	-	-	-	-	-	-	-	2	1	3
CO5	3	3	3	-	-	2	-	-	-	-	-	3	3	2