Kongunadu College of Engineering and Technology (Autonomous)

Affiliated to Anna University, Chennai
M.E. Computer Science and Engineering
Regulations: KNCET-PGR2020
Choice Based Credit System
I to IV Semesters Curricula & Syllabi
(Applicable for the students Admitted from 2022-23 Onwards)

Semester I							
S.No.	Course Code	Course Title	Course Category	No. of Hours/Week			Credit
				L	T	P	
Theory							
1	PG20MA101	Applied Probability and Statistics	FC	4	0	0	4
2	PG20CS102	Advanced Data Structures and Algorithms	PCC	4	0	0	4
3	PG20CS103	Advanced Computer Architecture	PCC	3	0	0	3
4	PG20CS104	Operating System Internals	PCC	3	0	0	3
5	PG20CS105	Advanced Software Engineering	PCC	3	0	0	3
6	PG20CS106	Machine Learning Techniques	PCC	3	0	0	3
Practicals							
7	PG20CS107L	Data Structures Laboratory	PCC	0	0	4	2
			Total	**20**	**0**	**4**	**22**

Semester II							
S.No.	Course Code	Course Title	Course Category	No. of Hours/Week			Credit
				L	T	P	
Theory							
1	PG20CS201	Network Design and Technologies	PCC	3	0	0	3
2	PG20CS202	Security Practices	PCC	3	0	0	3
3	PG20CS203	Internet of Things	PCC	3	0	0	3
4	PG20CS204	Big Data Analytics	PCC	3	0	0	3
5		Professional Elective –I	PEC	3	0	0	3
6		Professional Elective –II	PEC	3	0	0	3
Practicals							
7	PG20CS205L	Data Analytics Laboratory	PCC	0	0	4	2
8	PG20EEC201L	Term Paper Writing and Seminar	EEC	0	0	2	1
			Total	**18**	**0**	**6**	**21**

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Semester III							
S.No.	Course Code	Course Title	Course Category	No. of Hours/Week			Credit
				L	T	P	
Theory							
1	PG20MC002	Universal Human Values 2: Understanding Harmony	MC	3	0	0	3
2	PG20CS302	Information and Network Security	PCC	3	0	0	3
3		Professional Elective –III	PEC	3	0	0	3
4		Professional Elective –IV	PEC	3	0	0	3
5		Professional Elective –V	PEC	3	0	0	3
Practicals							
6	PG20CS301	Project Work Phase – I	EEC	0	0	12	6
			Total	**15**	**0**	**12**	**21**

Semester IV							
S.No.	Course Code	Course Title	Course Category	No. of Hours/Week			Credit
				L	T	P	
Practicals							
1	PG20CS401	Project Work Phase – II	EEC	0	0	24	12
			Total	**0**	**0**	**24**	**12**

Total no. of credits: 76

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Professional Core Courses (PCC)

S.No.	Course Code	Course Title	Course Category	No. of Hours/Week			Credit
				L	T	P	
1	PG20CS102	Advanced Data Structures and Algorithms	PCC	4	0	0	4
2	PG20CS103	Advanced Computer Architecture	PCC	3	0	0	3
3	PG20CS104	Operating System Internals	PCC	3	0	0	3
4	PG20CS105	Advanced Software Engineering	PCC	3	0	0	3
5	PG20CS106	Machine Learning Techniques	PCC	3	0	0	3
6	PG20CS107L	Data Structures Laboratory	PC	0	0	4	2
7	PG20CS201	Network Design and Technologies	PCC	3	0	0	3
8	PG20CS202	Security Practices	PCC	3	0	0	3
9	PG20CS203	Internet of Things	PCC	3	0	0	3
10	PG20CS204	Big Data Analytics	PCC	3	0	0	3
11	PG20CS205L	Data Analytics Laboratory	PCC	0	0	4	2
12	PG20CS302	Information and Network Security	PCC	3	0	0	3

Foundation Courses (FC)

S.No.	Course Code	Course Title	Course Category	No. of Hours/Week			Credit
				L	T	P	
1	PG20MA101	Applied Probability and Statistics	FC	4	0	0	4

Employability Enhancement Courses (EEC)

S.No.	Course Code	Course Title	Course Category	No. of Hours/Week			Credit
				L	T	P	
1	PG20EEC201L	Term Paper Writing and Seminar	EEC	0	0	2	1
2	PG20CS301	Project Work Phase – I	EEC	0	0	12	6
3	PG20CS401	Project Work Phase – II	EEC	0	0	24	12

Mandatory Course (MC)

S.No.	Course Code	Course Title	Course Category	No. of Hours/Week			Credit
				L	T	P	
1	PG20MC002	Universal Human Values 2: Understanding Harmony	MC	3	0	0	3

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Professional Elective Courses (PEC)

S.No.	Course Code	Course Title	Course Category	No. of Hours/Week			Credit
				L	T	P	
1		Professional Elective I	PEC	3	0	0	3
2		Professional Elective II	PEC	3	0	0	3
3		Professional Elective III	PEC	3	0	0	3
4		Professional Elective IV	PEC	3	0	0	3
5		Professional Elective V	PEC	3	0	0	3

Professional Elective – I (SEMESTER II)

S.No.	Course Code	Course Title	Course Category	No. of Hours/Week			Credit
				L	T	P	
1	PG20CS201PE	Advanced Databases	PEC	3	0	0	3
2	PG20CS202PE	Principles of Programming Languages	PEC	3	0	0	3
3	PG20CS203PE	Image Processing and Analysis	PEC	3	0	0	3
4	PG20CS204PE	Web Engineering	PEC	3	0	0	3
5	PG20CS205PE	Cloud Computing Technologies	PEC	3	0	0	3

Professional Elective – II (SEMESTER II)

S.No.	Course Code	Course Title	Course Category	No. of Hours/Week			Credit
				L	T	P	
1	PG20CS206PE	Real Time Systems	PEC	3	0	0	3
2	PG20CS207PE	Mobile and Pervasive Computing	PEC	3	0	0	3
3	PG20CS208PE	Parallel Programming Paradigms	PEC	3	0	0	3
4	PG20CS209PE	Information Retrieval Techniques	PEC	3	0	0	3
5	PG20CS210PE	Software Architectures and Design	PEC	3	0	0	3

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Professional Elective – III (SEMESTER III)

S.No.	Course Code	Course Title	Course Category	No. of Hours/Week			Credit
				L	T	P	
1	PG20CS301PE	Performance Analysis of Computer Systems	PEC	3	0	0	3
2	PG20CS302PE	Language Technologies	PEC	3	0	0	3
3	PG20CS303PE	Computer Vision	PEC	3	0	0	3
4	PG20CS304PE	Speech Processing and Synthesis	PEC	3	0	0	3
5	PG20CS305PE	Software Quality Assurance and Testing	PEC	3	0	0	3

Professional Elective – IV (SEMESTER III)

S.No.	Course Code	Course Title	Course Category	No. of Hours/Week			Credit
				L	T	P	
1	PG20CS306PE	Formal models of software systems	PEC	3	0	0	3
2	PG20CS307PE	Embedded Software Development	PEC	3	0	0	3
3	PG20CS308PE	Social Network Analysis	PEC	3	0	0	3
4	PG20CS309PE	Bio-inspired Computing	PEC	3	0	0	3
5	PG20CS310PE	Compiler Optimization Techniques	PEC	3	0	0	3

Professional Elective – V (SEMESTER III)

S.No.	Course Code	Course Title	Course Category	No. of Hours/Week			Credit
				L	T	P	
1	PG20CS311PE	Data Visualization Techniques	PEC	3	0	0	3
2	PG20CS312PE	Reconfigurable Computing	PEC	3	0	0	3
3	PG20CS313PE	Mobile Application Development	PEC	3	0	0	3
4	PG20CS314PE	Bio Informatics	PEC	3	0	0	3
5	PG20CS315PE	Information Storage Management	PEC	3	0	0	3

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SUMMARY

S.No.	Course Category	Credits As Per Semester				Total Credit	Percentage
		I	II	III	IV		
1	MC	-	-	3	-	3	3.95
2	EEC	-	1	6	12	19	25.00
3	PCC	18	14	3	-	35	46.05
4	PEC	-	6	9	-	15	19.74
5	FC	4	-	-	-	4	5.26
Total		22	21	21	12	76	100

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PG20MA101- APPLIED PROBABILITY AND STATISTICS

L	T	P	C
4	0	0	4

OBJECTIVES:

The student should be made to:

- To introduce the basic probability concepts.
- To impart well-founded knowledge of standard distributions which can describe real life Phenomena.
- To introduce the basic concepts of two dimensional random variables.
- framed to address the issues and the principles of estimation theory.
- To address the issues and the principles testing of hypothesis and multivariate analysis.

UNIT I PROBABILITY AND RANDOM VARIABLES 12

Probability – Axioms of probability – Conditional probability – Baye's theorem - Random variables - Probability function – Moments – Moment generating functions and their properties – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions – Function of a random variable.

UNIT II TWO DIMENSIONAL RANDOM VARIABLES 12

Joint distributions – Marginal and conditional distributions – Functions of two dimensional random variables – Regression curve – Correlation.

UNIT III ESTIMATION THEORY 12

Unbiased estimators – Method of moments – Maximum likelihood estimation - Curve fitting by principle of least squares – Regression lines.

UNIT IV 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 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: 60 PERIODS

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OUTCOMES:

On successful completion of this course, the student will be able to,

- Basic probability axioms and rules and the moments of discrete and continuous random variables.
- Consistency, efficiency and unbiasedness of estimators, method of maximum likelihood estimation and Central Limit Theorem.
- Use statistical tests in testing hypotheses on data.
- Perform exploratory analysis of multivariate data, such as multivariate normal density, calculating descriptive statistics, testing for multivariate normality.
- Use the appropriate and relevant, fundamental and applied mathematical and statistical knowledge, methodologies and modern computational tools.

REFERENCES:

1. Devore J L, "Probability and Statistics for Engineering and the Sciences", Cengage Learning, 8th edition, 2014.
2. Dallas E Johnson, "Applied Multivariate Methods for Data Analysis", Thomson and Duxbury press, 2nd edition, 2000.
3. Gupta S C and Kapoor V K, "Fundamentals of Mathematical Statistics", Sultan and Sons, New Delhi, 20th edition, 2014.
4. Johnson R A and Miller I and Freund J, "Miller and Freund's Probability and Statistics for Engineers ", Pearson Education, Asia, 8th edition, 2015.
5. Richard A Johnson and Dean W Wichern, "Applied Multivariate Statistical Analysis", Pearson Education, Asia, 5th edition, 2002.

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PG20CS102 **ADVANCED DATA STRUCTURES AND ALGORITHMS**

L T P C
4 0 0 4

OBJECTIVES:

The Student should be made to:

- Understand the usage of algorithms in computing
- Learn and use hierarchical data structures and its operations
- Learn the usage of graphs and its applications
- Select and design data structures and algorithms that is appropriate for problems
- Study about NP Completeness of problems

UNIT I ROLE OF ALGORITHMS IN COMPUTING **12**

Algorithms – Algorithms as a Technology- Insertion Sort – Analyzing Algorithms – Designing Algorithms- Growth of Functions: Asymptotic Notation – Standard Notations and Common Functions- Recurrences: The Substitution Method – The Recursion-Tree Method

UNIT II HIERARCHICAL DATA STRUCTURES **12**

Binary Search Trees: Basics – Querying a Binary search tree – Insertion and Deletion- Red-Black trees: Properties of Red-Black Trees – Rotations – Insertion – Deletion -B-Trees: Definition of B- trees – Basic operations on B-Trees – Deleting a key from a B-Tree-Fibonacci Heaps: structure – Mergeable-heap operations- Decreasing a key and deleting a node-Bounding the maximum degree.

UNIT III GRAPHS **12**

Elementary Graph Algorithms: Representations of Graphs – Breadth-First Search – Depth-First Search – Topological Sort – Strongly Connected Components- Minimum Spanning Trees: Growing a Minimum Spanning Tree – Kruskal and Prim- Single-Source Shortest Paths: The Bellman-Ford algorithm – Single-Source Shortest paths in Directed Acyclic Graphs – Dijkstra's Algorithm; All-Pairs Shortest Paths: Shortest Paths and Matrix Multiplication – The Floyd- Warshall Algorithm;

UNIT IV ALGORITHM DESIGN TECHNIQUES **12**

Dynamic Programming: Matrix-Chain Multiplication – Elements of Dynamic Programming – Longest Common Subsequence- Greedy Algorithms: An Activity-Selection Problem – Elements of the Greedy Strategy- Huffman Codes.

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UNIT V NP COMPLETE AND NP HARD **12**

NP-Completeness: Polynomial Time – Polynomial-Time Verification – NP- Completeness and Reducability – NP-Completeness Proofs – NP-Complete Problems

TOTAL: 60 PERIODS

OUTCOMES:

On successful completion of this course, the students will be able to,

- Design data structures and algorithms to solve computing problems
- Design algorithms using graph structure and various string matching algorithms to solve real-life problems
- Apply suitable design strategy for problem solving
- Critically analyze the various sorting algorithms
- Apply the different linear and non-linear data structures to problem solutions

REFERENCES:

1. Alfred V. Aho, John E. Hopcroft, Jeffrey D. Ullman, "Data Structures and Algorithms", Pearson Education, Reprint 2006.
2. Robert Sedgewick and Kevin Wayne, "ALGORITHMS", Fourth Edition, Pearson Education.
3. S.Sridhar,"Design and Analysis of Algorithms", First Edition, Oxford University Press. 2014
4. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, "Introduction to Algorithms", Third Edition, Prentice-Hall, 2011.

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PG20CS103 ADVANCED COMPUTER ARCHITECTURE

L	T	P	C
3	0	0	3

OBJECTIVES:

The Student should be made to:

- Introduce the students to the recent trends in the field of Computer Architecture and identify performance related parameters.
- Learn the different multiprocessor issues.
- Expose the different types of multicore architectures.
- Understand the design of the memory hierarchy.
- Expose the students to warehouse-scale and embedded architectures

UNIT I FUNDAMENTALS OF COMPUTER DESIGN AND ILP **9**

Fundamentals of Computer Design – Measuring and Reporting Performance – Instruction Level Parallelism and its Exploitation – Concepts and Challenges –Exposing ILP - Advanced Branch Prediction - Dynamic Scheduling - Hardware-Based Speculation - Exploiting ILP - Instruction Delivery and Speculation - Limitations of ILP - Multithreading

UNIT II MEMORY HIERARCHY DESIGN **9**

Introduction – Optimizations of Cache Performance – Memory Technology and Optimizations – Protection: Virtual Memory and Virtual Machines – Design of Memory Hierarchies – Case Studies.

UNIT III MULTIPROCESSOR ISSUES **9**

Introduction- Centralized, Symmetric and Distributed Shared Memory Architectures –Cache Coherence Issues – Performance Issues – Synchronization – Models of Memory Consistency – Case Study-Interconnection Networks – Buses, Crossbar and Multi-stage Interconnection Networks

UNIT IV MULTICORE ARCHITECTURES **9**

Homogeneous and Heterogeneous Multi-core Architectures – Intel Multicore Architectures – SUN CMP architecture – IBM Cell Architecture. Introduction to Warehouse-scale computers-Architectures- Physical Infrastructure and Costs- Cloud Computing –Case Study- Google Warehouse-Scale Computer.

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UNIT V VECTOR, SIMD AND GPU ARCHITECTURES 9

Introduction-Vector Architecture – SIMD Extensions for Multimedia – Graphics Processing Units – Case Studies – GPGPU Computing – Detecting and Enhancing Loop Level Parallelism-Case Studies.

TOTAL: 45 PERIODS

OUTCOMES:

On successful completion of this course, the students will be able to,

- Identify the limitations of ILP.
- Discuss the issues related to multiprocessing and suggest solutions
- Point out the salient features of different multicore architectures and how they exploit parallelism.
- Discuss the various techniques used for optimising the cache performance
- Design hierarchal memory system
- Point out how data level parallelism is exploited in architectures

REFERENCES:

1. Darryl Gove, "Multicore Application Programming: For Windows, Linux, and Oracle Solaris", Pearson, 2011
2. David B. Kirk, Wen-mei W. Hwu, "Programming Massively Parallel Processors", Morgan Kauffman, 2010
3. David E. Culler, Jaswinder Pal Singh, "Parallel computing architecture : A hardware/software approach" , Morgan Kaufmann /Elsevier Publishers, 1999
4. John L. Hennessey and David A. Patterson, "Computer Architecture – A Quantitative Approach", Morgan Kaufmann / Elsevier, 5th edition, 2012.
5. Kai Hwang and Zhi.Wei Xu, "Scalable Parallel Computing", Tata McGraw Hill, NewDelhi, 2003

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PG20CS104 OPERATING SYSTEM INTERNALS

L	T	P	C
3	0	0	3

OBJECTIVES:

The Student should be made to:

- Able to read and understand sample open source programs and header files.
- Learn how the processes are implemented in linux.
- Understand the implementation of the Linux file system.
- Study Linux memory management data structures and algorithms.
- Acquire the knowledge in the implementation of interprocess communication.
- Understand how program execution happens in Linux.

UNIT I INTRODUCTION **9**

Basic Operating System Concepts - Overview of Unix File System - Files - Links - Types – Inodes -Access Rights - System Calls - Overview of Unix Kernels -Model - Implementation – Reentrant Kernels - Address Space - Synchronization - Interprocess Communication - Process Management - Memory Management - Device Drivers.

UNIT II PROCESSES **9**

Processes, Lightweight Processes, and Threads - Process Descriptor - State - Identifying a Process - Relationships among processes - Organization - Resource Limits - Creating Processes - - System Calls - Kernel Threads - Destroying Processes -Termination - Removal.

UNIT III FILE SYSTEM **9**

The Virtual File System (VFS) - Role - File Model -System Calls - Data Structures - Super Block, Inode, File, dentry Objects - dentry Cache - Files Associated with a Process - Filesystem Types - Special Filesystems - Filesytem Type Registration - Filesytem Handling - Namespaces – Mounting - Unmounting - Implementation of VFS System Calls.

UNIT IV MEMORY MANAGEMENT **9**

Page frame management -page descriptors - non-uniform memory access - memory zones - reserved page frames - zoned page frame allocator - kernel mappings - buddy system algorithm - page frame cache - zone allocator.

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UNIT V PROCESS COMMUNICATION AND PROGRAM EXECUTION 9

Process Communication - Pipes -Usage - Data Structures - Creating and Destroying a Pipe - Reading From and Writing into a Pipe. Program Execution - Executable Files - Process Credentials - Command-Line Arguments and Shell Environment - Libraries - Program Segments and Process Memory Regions - Execution tracing - Executable Formats - Execution Domains - The exec Functions

TOTAL: 45 PERIODS

OUTCOMES:

On successful completion of this course, the students will be able to,

- Explain the functionality of a large software system by reading its source.
- Revise any algorithm present in a system.
- Design a new algorithm to replace an existing one.
- Appropriately modify and use the data structures of the linux kernel for a different software system.
- Examine Process Scheduling and memory management strategies on Unix Operating System.

REFERENCES:

1. Daniel P. Bovet and Marco Cesati, "Understanding the Linux Kernel", 3rd Edition, O'Reilly Publications, 2005.
2. Harold Abelson, Gerald Jay Sussman and Julie Sussman, "Structure and Interpretation of Computer Programs", Second Edition, Universities Press, 2013.
3. Maurice J. Bach, "The Design of the Unix Operating System" 1st Edition Pearson Education, 2003.
4. Michael Beck, Harald Bohme, Mirko Dziadzka, Ulrich Kunitz, Robert Magnus, Dirk Verworner, "Linux Kernel Internals", 2nd Edition, Addison-Wesley, 1998.
5. Robert Love, "Linux Kernel Development", 3rd Edition, Addison-Wesley, 2010.

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PG20CS105 ADVANCED SOFTWARE ENGINEERING

L T P C
3 0 0 3

OBJECTIVES:

The Student should be made to:

- Understand Software Engineering Lifecycle Models
- Do project management and cost estimation
- Gain knowledge of the System Analysis and Design concepts.
- Understand software testing approaches
- Be familiar with DevOps practices

UNIT I INTRODUCTION **9**

Software engineering concepts – Development activities – Software lifecycle models - Classical waterfall - Iterative waterfall – Prototyping – Evolutionary - Spiral – Software project management – Project planning – Estimation – Scheduling – Risk management – Software configuration management.

UNIT II SOFTWARE REQUIREMENT SPECIFICATION **9**

Requirement analysis and specification – Requirements gathering and analysis – Software Requirement Specification – Formal system specification – Finite State Machines – Petrinets – Object modelling using UML – Use case Model – Class diagrams – Interaction diagrams – Activity diagrams – State chart diagrams – Functional modelling – Data Flow Diagram.

UNIT III ARCHITECTURE AND DESIGN **9**

Software design – Design process – Design concepts – Coupling – Cohesion – Functional independence – Design patterns – Model-view-controller – Publish-subscribe – Adapter – Command – Strategy – Observer – Proxy – Facade – Architectural styles – Layered - Client-server - Tiered - Pipe and filter.- User interface design

UNIT IV TESTING **9**

Testing – Unit testing – Black box testing– White box testing – Integration and System testing– Regression testing – Debugging - Program analysis – Symbolic execution – Model Checking

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UNIT V DEVOPS **9**

DevOps: Motivation-Cloud as a platform-Operations- Deployment Pipeline:Overall Architecture- Building and Testing-Deployment- Case study: Migrating to Microservices.

TOTAL: 45 PERIODS

OUTCOMES:

On successful completion of this course, the students will be able to,

- Understand the advantages of various Software Development Lifecycle Models
- Gain knowledge on project management approaches as well as cost and schedule estimation strategies
- Perform formal analysis on specifications
- Use UML diagrams for analysis and design
- Architect and design using architectural styles and design patterns
- Understand software testing approaches
- Understand the advantages of DevOps practices

REFERENCES:

1. Bernd Bruegge, Alan H Dutoit, Object-Oriented Software Engineering, 2nd Edition, PearsoN Education, 2004.
2. Carlo Ghezzi, Mehdi Jazayeri, Dino Mandrioli, Fundamentals of Software Engineering, 2nd Edition, PHI Learning Pvt. Ltd., 2010.
3. Craig Larman, Applying UML and Patterns, 3rd Edition, Pearson Education, 2005.
4. Len Bass, Ingo Weber and Liming Zhu, "DevOps: A Software Architect's Perspective, Pearson Education, 2016
5. Rajib Mall, Fundamentals of Software Engineering, 3rd Edition, PHI Learning Pvt. Ltd., 2009.
6. Stephen Schach, Software Engineering 7th Edition, McGraw-Hill, 2007.

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PG20CS106 MACHINE LEARNING TECHNIQUES

L T P C
3 0 0 3

OBJECTIVES:

The Student should be made to:

- Introduce students to the basic concepts and techniques of Machine Learning
- Have a thorough understanding of the Supervised and Unsupervised learning techniques
- Study the various probability based learning techniques
- Understand graphical models of machine learning algorithms
- Able to scaling up machine learning techniques and approaches

UNIT I INTRODUCTION **9**

Learning – Types of Machine Learning – Supervised Learning – The Brain and the Neuron – Design a Learning System – Perspectives and Issues in Machine Learning – Concept Learning Task – Concept Learning as Search – Finding a Maximally Specific Hypothesis – Version Spaces and the Candidate Elimination Algorithm – Linear Discriminants – Perceptron – Linear Separability – Linear Regression.

UNIT II LINEAR MODELS **9**

Multi-layer Perceptron – Going Forwards – Going Backwards: Back Propagation Error – Multi- layer Perceptron in Practice – Examples of using the MLP – Overview – Deriving Back- Propagation – Radial Basis Functions and Splines – Concepts – RBF Network – Curse of Dimensionality – Interpolations and Basis Functions – Support Vector Machines.

UNIT III TREE AND PROBABILISTIC MODELS **9**

Learning with Trees – Decision Trees – Constructing Decision Trees – Classification and Regression Trees – Ensemble Learning – Boosting – Bagging – Different ways to Combine Classifiers – Probability and Learning – Data into Probabilities – Basic Statistics – Gaussian Mixture Models – Nearest Neighbor Methods – Unsupervised Learning – K means Algorithms – Vector Quantization – Self Organizing Feature Map

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UNIT IV DIMENSIONALITY REDUCTION AND EVOLUTIONARY MODELS 9

Dimensionality Reduction – Linear Discriminant Analysis – Principal Component Analysis – Factor Analysis – Independent Component Analysis – Locally Linear Embedding – Isomap – Least Squares Optimization – Evolutionary Learning – Genetic algorithms – Genetic Offspring: - Genetic Operators – Using Genetic Algorithms – Reinforcement Learning – Overview – Getting Lost Example – Markov Decision Process

UNIT V GRAPHICAL MODELS 9

Markov Chain Monte Carlo Methods – Sampling – Proposal Distribution – Markov Chain Monte Carlo – Graphical Models – Bayesian Networks – Markov Random Fields – Hidden Markov Models – Tracking Methods

TOTAL: 45 PERIODS

OUTCOMES:

On successful completion of this course, the students will be able to,

- Distinguish between, supervised, unsupervised and semi-supervised learning
- Apply the appropriate machine learning strategy for any given problem
- Suggest supervised, unsupervised or semi-supervised learning algorithms for any given problem
- Design systems that uses the appropriate graph models of machine learning
- Modify existing machine learning algorithms to improve classification efficiency

REFERENCES:

1. Ethem Alpaydin, "Introduction to Machine Learning 3e (Adaptive Computation and Machine Learning Series), Third Edition, MIT Press, 2014
2. Jason Bell, "Machine learning – Hands on for Developers and Technical Professionals", First Edition, Wiley, 2014
3. Peter Flach, "Machine Learning: The Art and Science of Algorithms that Make Sense of Data", First Edition, Cambridge University Press, 2012.
4. Stephen Marsland, "Machine Learning – An Algorithmic Perspective", Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014.
5. Tom M Mitchell, "Machine Learning", First Edition, McGraw Hill Education, 2013.

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PG20CS107L DATA STRUCTURES LABORATORY

L T P C
0 0 4 2

OBJECTIVES:

The Student should be made to:

- Acquire the knowledge of using advanced tree structures.
- Learn the usage of heap structures.
- Understand the usage of graph structures and spanning trees.
- Optimize graphical structures with multiple nodes.
- Understand the different operations of search trees.

LIST OF EXPERIMENTS:

Each student has to work individually on assigned lab exercises. Lab sessions could be scheduled as one contiguous four-hour session per week or two two-hour sessions per week. There will be about 15 exercises in a semester. 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. Exercises should be designed to cover the following topics:

EXPERIMENTS:

1. Implementation of Merge Sort and Quick Sort-Analysis
2. Implementation of a Binary Search Tree
3. Red-Black Tree Implementation
4. Heap Implementation
5. Fibonacci Heap Implementation
6. Graph Traversals
7. Spanning Tree Implementation
8. Shortest Path Algorithms (Dijkstra's algorithm, Bellmann Ford Algorithm)
9. Implementation of Matrix Chain Multiplication
10. Activity Selection and Huffman Coding Implementation.

TOTAL: 60 PERIODS

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OUTCOMES:

On successful completion of this course, the students will be able to,

- Design and implement basic and advanced data structures extensively.
- Design algorithms using graph structures.
- Design and develop efficient algorithms with minimum complexity using design techniques.
- Suggest appropriate linear / nonlinear data structure operations for solving a given problem.
- Write functions to implement linear and non-linear data structures operations.

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PG20CS201 NETWORK DESIGN AND TECHNOLOGIES

L T P C
3 0 0 3

OBJECTIVES:

The Student should be made to:

- Understand the principles required for network design
- Explore various technologies in the wireless domain
- Study about 3G and 4G cellular networks
- Understand the paradigm of Software defined networks
- Determine the parameters of a given Two-port network

UNIT I NETWORK DESIGN **10**

Advanced multiplexing – Code Division Multiplexing, DWDM and OFDM – Shared media networks – Switched networks – End to end semantics – Connectionless, Connection oriented, Wireless Scenarios –Applications, Quality of Service – End to end level and network level solutions. LAN cabling topologies – Ethernet Switches, Routers, Firewalls and L3 switches – Remote Access Technologies and Devices – Modems and DSLs – SLIP and PPP – Core networks, and distribution networks.

UNIT II WIRELESS NETWORKS **9**

IEEE802.16 and WiMAX – Security – Advanced 802.16 Functionalities – Mobile WiMAX - 802.16e – Network Infrastructure – WLAN – Configuration – Management Operation – Security – IEEE 802.11e and WMM – QoS – Comparison of WLAN and UMTS – Bluetooth – Protocol Stack – Security – Profiles

UNIT III CELLULAR NETWORKS **9**

GSM – Mobility Management and call control – GPRS – Network Elements – Radio Resource Management – Mobility Management and Session Management – Small Screen Web Browsing over GPRS and EDGE – MMS over GPRS – UMTS – Channel Structure on the Air Interface – UTRAN –Core and Radio Network Mobility Management – UMTS Security

UNIT IV 4G NETWORKS **9**

LTE – Network Architecture and Interfaces – FDD Air Interface and Radio Networks – Scheduling – Mobility Management and Power Optimization – LTE Security Architecture – Interconnection with UMTS and GSM – LTE Advanced (3GPPP Release 10) - 4G Networks and Composite Radio Environment – Protocol Boosters – Hybrid 4G Wireless Networks

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Protocols – Green Wireless Networks – Physical Layer and Multiple Access – Channel Modelling for 4G – Introduction to 5G

UNIT V SOFTWARE DEFINED NETWORKS **9**

Introduction – Centralized and Distributed Control and Data Planes – Open Flow – SDN Controllers – General Concepts – VLANs – NVGRE – Open Flow – Network Overlays – Types – Virtualization – Data Plane – I/O – Design of SDN Framework

TOTAL: 45 PERIODS

OUTCOMES:

On successful completion of this course, the students will be able to,

- Identify the components required for designing a network
- Design a network at a high-level using different networking technologies
- Analyze the various protocols of wireless and cellular networks
- Discuss the features of 4G and 5G networks
- Experiment with software defined networks

REFERENCES:

1. Erik Dahlman, Stefan Parkvall, Johan Skold, "4G: LTE/LTE-Advanced for Mobile Broadband", Academic Press, 2013.
2. Jonathan Rodriguez, "Fundamentals of 5G Mobile Networks", Wiley, 2015.
3. Larry Peterson and Bruce Davie, "Computer Networks: A Systems Approach", 5th Edition, Morgan Kauffman, 2011
4. Martin Sauter, "From GSM to LTE, An Introduction to Mobile Networks and Mobile Broadband", Wiley, 2014.
5. Martin Sauter, "Beyond 3G - Bringing Networks, Terminals and the Web Together: LTE, WiMAX, IMS, 4G Devices and the Mobile Web 2.0", Wiley, 2009.
6. Naveen Chilamkurti, Sherali Zeadally, Hakima Chaouchi, "Next-Generation Wireless Technologies", Springer, 2013.
7. Paul Goransson, Chuck Black, "Software Defined Networks: A Comprehensive Approach", Morgan Kauffman, 2014.
8. Savo G Glisic, "Advanced Wireless Networks – 4G Technologies", John Wiley & Sons, 2007.
9. Thomas D.Nadeau and Ken Gray, "SDN – Software Defined Networks", O"Reilly Publishers, 2013.
10. Ying Dar Lin, Ren-Hung Hwang and Fred Baker, "Computer Networks: An Open Source Approach", McGraw Hill, 2011

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PG20CS202 SECURITY PRACTICES

L T P C
3 0 0 3

OBJECTIVES:

The Student should be made to:

- Learn the core fundamentals of system and web security concepts
- Have through understanding in the security concepts related to networks
- Deploy the security essentials in IT Sector
- Be exposed to the concepts of Cyber Security and encryption Concepts
- Be perform a detailed study of Privacy and Storage security and related Issues.

UNIT I SYSTEM SECURITY **9**

Building a secure organization- A Cryptography primer- detecting system Intrusion- Preventing system Intrusion- Fault tolerance and Resilience in cloud computing environments- Security web applications, services and servers.

UNIT II NETWORK SECURITY **9**

Internet Security - Botnet Problem- Intranet security- Local Area Network Security - Wireless Network Security - Wireless Sensor Network Security- Cellular Network Security- Optical Network Security- Optical wireless Security.

UNIT III SECURITY MANEGEMENT **9**

Information security essentials for IT Managers- Security Management System - Policy Driven System Management- IT Security - Online Identity and User Management System - Intrusion and Detection and Prevention System.

UNIT IV CYBER SECURITY AND CRYPTOGRAPHY **9**

Cyber Forensics- Cyber Forensics and Incidence Response - Security e-Discovery - Network Forensics - Data Encryption- Satellite Encryption - Password based authenticated Key establishment Protocols.

UNIT V PRIVACY AND STORAGE SECURITY **9**

Privacy on the Internet - Privacy Enhancing Technologies - Personal privacy Policies - Detection of Conflicts in security policies- privacy and security in environment monitoring systems. Storage Area Network Security - Storage Area Network Security Devices - Risk management - Physical Security Essentials.

TOTAL: 45 PERIODS

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OUTCOMES:

On successful completion of this course, the students will be able to,

- Understand the core fundamentals of system security
- Apply the security concepts related to networks in wired and wireless scenario
- Implement and manage the security essentials in IT Sector
- Able to explain the concepts of Cyber Security and encryption Concepts
- Able to attain a thorough knowledge in the area of Privacy and Storage security and related Issues.

REFERENCES:

1. John R.Vacca, Computer and Information Security Handbook, Second Edition, Elsevier 2013.
2. Michael E. Whitman, Herbert J. Mattord, Principal of Information Security, Fourth Edition, Cengage Learning, 2012.
3. Richard E.Smith, Elementary Information Security, Second Edition, Jones and Bartlett Learning, 2016

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PG20CS203 INTERNET OF THINGS

L T P C
3 0 0 3

OBJECTIVES:

The Student should be made to:

- Understand the fundamentals of Internet of Things
- Learn about the basics of IOT protocols
- Build a small low cost embedded system using Raspberry Pi.
- Apply the concept of Internet of Things in the real world scenario.
- Able to understand building blocks of Internet of Things and characteristics.

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 RASPERRY 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.

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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: 45 PERIODS

OUTCOMES:

On successful completion of this course, the students will be able to,

- Analyze various protocols for IoT
- Develop web services to access/control IoT devices.
- Design a portable IoT using Rasperry 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. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), "Architecting the Internet of Things", Springer, 2011.
3. Honbo Zhou, "The Internet of Things in the Cloud: A Middleware Perspective", CRC Press, 2012.
4. Jan Ho¨ ller, 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.
5. Olivier Hersent, David Boswarthick, Omar Elloumi , "The Internet of Things – Key applications and Protocols", Wiley, 2012

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PG20CS204 **BIG DATA ANALYTICS**

L T P C
3 0 0 3

OBJECTIVES:

The Student should be made to:

- Understand the competitive advantages of big data analytics
- Understand the big data frameworks
- Learn data analysis methods
- Learn stream computing
- Gain knowledge on Hadoop related tools such as HBase, Cassandra, Pig, and Hive for big data analytics

UNIT I **INTRODUCTION TO BIG DATA** **7**

Big Data – Definition, Characteristic Features – Big Data Applications - Big Data vs Traditional Data - Risks of Big Data - Structure of Big Data - Challenges of Conventional Systems - Web Data – Evolution of Analytic Scalability - Evolution of Analytic Processes, Tools and methods - Analysis vs Reporting - Modern Data Analytic Tools.

UNIT II **HADOOP FRAMEWORK** **9**

Distributed File Systems - Large-Scale File System Organization – HDFS concepts – MapReduce Execution, Algorithms using MapReduce, Matrix-Vector Multiplication – Hadoop YARN

UNIT III **DATA ANALYSIS** **13**

Statistical Methods:Regression modelling, Multivariate Analysis - Classification: SVM & Kernel Methods - Rule Mining - Cluster Analysis, Types of Data in Cluster Analysis, Partitioning Methods, Hierarchical Methods, Density Based Methods, Grid Based Methods, Model Based Clustering Methods, Clustering High Dimensional Data - Predictive Analytics – Data analysis using R.

UNIT IV **MINING DATA STREAMS** **7**

Streams: Concepts – Stream Data Model and Architecture - Sampling data in a stream - Mining Data Streams and Mining Time-series data - Real Time Analytics Platform (RTAP) Applications - Case Studies - Real Time Sentiment Analysis, Stock Market Predictions.

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UNIT V BIG DATA FRAMEWORKS 9

Introduction to NoSQL – Aggregate Data Models – Hbase: Data Model and Implementations – Hbase Clients – Examples – .Cassandra: Data Model – Examples – Cassandra Clients – Hadoop Integration. Pig – Grunt – Pig Data Model – Pig Latin – developing and testing Pig Latin scripts. Hive – Data Types and File Formats – HiveQL Data Definition – HiveQL Data Manipulation – HiveQL Queries

TOTAL: 45 PERIODS

OUTCOMES:

On successful completion of this course, the students will be able to,

- Understand how to leverage the insights from big data analytics
- Analyze data by utilizing various statistical and data mining approaches
- Perform analytics on real-time streaming data
- Understand the various NoSql alternative database models
- Able to realistically assess the application of big data analytics technologies for different usage scenarios and start with their own experiments.

REFERENCES:

1. Bill Franks, "Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics", Wiley and SAS Business Series, 2012.
2. David Loshin, "Big Data Analytics: From Strategic Planning to Enterprise Integration with Tools, Techniques, NoSQL, and Graph", 2013.
3. Michael Berthold, David J. Hand, "Intelligent Data Analysis", Springer, Second Edition, 2007.
4. Michael Minelli, Michelle Chambers, and Ambiga Dhiraj, "Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses", Wiley, 2013.
5. P. J. Sadalage and M. Fowler, "NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence", Addison-Wesley Professional, 2012.
6. Richard Cotton, "Learning R – A Step-by-step Function Guide to Data Analysis", O'Reilly Media, 2013.

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PG20CS205L DATA ANALYTICS LABORATORY

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OBJECTIVES:

The Student should be made to:

- Implement Map Reduce programs for processing big data
- Realize storage of big data using H base, Mongo DB
- Analyse big data using linear models
- Analyse big data using machine learning techniques such as SVM / Decision tree classification and clustering
- Exposure to Data Analytics with R.

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 dataset

R

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: 60 PERIODS

OUTCOMES:

On successful completion of this course, the 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
- Analyze Infosphere BigInsights Big Data Recommendations.

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LIST OF SOFTWARE FOR A BATCH OF 30 STUDENTS:

- Hadoop
- YARN
- R Package
- Hbase
- MongoDB

REFERENCES:

1. Alan Gates and Daniel Dai, "Programming Pig – Dataflow scripting with Hadoop", O'Reilley, 2nd Edition, 2016.
2. Gareth James, Daniela Witten, Trevor Hastie and Robert Tibshirani, "An Introduction to Statistical Learning with Applications in R", Springer Publications, 2015(Corrected 6th Printing)
3. Hadley Wickham,"ggplot2 – Elegant Graphics for Data Analysis", Springer Publications,2nd Edition, 2016
4. Kristina Chodorow, "MongoDB: The Definitive Guide – Powerful and Scalable Data Storage", O'Reilley, 2nd Edition, 2013.
5. Lars George, "HBase: The Definitive Guide", O'Reilley, 2015.
6. Tom White, "Hadoop: The Definitive Guide – Storage and Analysis at Internet Scale", O'Reilley, 4th Edition, 2015.

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PG20EEC201L TERM PAPER WRITING AND SEMINAR

L T P C
0 0 2 1

OBJECTIVES:

The Student should be made to:

In this course, students will develop their scientific and technical reading and writing skills that they need to understand and construct research articles. A term paper requires a student to obtain information from a variety of sources (i.e., Journals, dictionaries, reference books) and then place it in logically developed ideas. The work involves the following steps:

1. Selecting a subject, narrowing the subject into a topic
2. Stating an objective.
3. Collecting the relevant bibliography (atleast 15 journal papers)
4. Preparing a working outline.
5. Studying the papers and understanding the authors contributions and critically analysing each paper.
6. Preparing a working outline
7. Linking the papers and preparing a draft of the paper.
8. Preparing conclusions based on the reading of all the papers.
9. Writing the Final Paper and giving final Presentation

Please keep a file where the work carried out by you is maintained.

Activities to be carried out

Activity	Instructions	Submission week	Evaluation
Selection of area of interest and Topic Stating an Objective	You are requested to select an area of interest, topic and state an objective	2nd week	**3 %** Based on clarity of thought, current relevance and clarity in writing
Collecting Information about your area & topic	1. List 1 Special Interest Groups or professional society 2. List 2 journals 3. List 2 conferences, symposia or workshops 4. List 1 thesis title 5. List 3 web presences (mailing lists, forums, news sites) 6. List 3 authors who publish regularly in your area	3rd week	**3%** (the selected information must be area specific and of international and national standard)

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	7. Attach a call for papers (CFP) from your area.		
Collection of Journal papers in the topic in the context of the objective – collect 20 & then filter	➢ You have to provide a complete list of references you will be using- Based on your objective -Search various digital libraries and Google Scholar ➢ When picking papers to read - try to: • Pick papers that are related to each other in some ways and/or that are in the same field so that you can write a meaningful survey out of them, • Favour papers from well-known journals and conferences, • Favour "first" or "foundational" papers in the field (as indicated in other people's survey paper), • Favour more recent papers, • Pick a recent survey of the field so you can quickly gain an overview, • Find relationships with respect to each other and to your topic area (classification scheme/categorization) • Mark in the hard copy of papers whether complete work or section/sections of the paper are being considered	4th week	**6%** (the list of standard papers and reason for selection)
Reading and notes for first 5 papers	Reading Paper Process • For each paper form a Table answering the following questions: • What is the main topic of the article? • What was/were the main issue(s) the author said they want to discuss? • Why did the author claim it was important? • How does the work build on other's work, in the author's opinion? • What simplifying assumptions does the author claim to be making? • What did the author do? • How did the author claim they were going to evaluate their work and compare it to others?	5th week	**8%** (the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper)

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	• What did the author say were the limitations of their research? • What did the author say were the important directions for future research? Conclude with limitations/issues not addressed by the paper (from the perspective of your survey)		
Reading and notes for next5 papers	Repeat Reading Paper Process	6th week	**8%** (the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper)
Reading and notes for final 5 papers	Repeat Reading Paper Process	7th week	**8%** (the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper)
Draft outline 1 and Linking papers	Prepare a draft Outline, your survey goals, along with a classification / categorization diagram	8th week	**8%** (this component will be evaluated based on the linking and classification among the papers)
Abstract	Prepare a draft abstract and give a presentation	9th week	**6%** (Clarity, purpose and conclusion) **6%** Presentation & Viva Voce

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Introduction Background	Write an introduction and background sections	10th week	**5%** (clarity)
Sections of the paper	Write the sections of your paper based on the classification / categorization diagram in keeping with the goals of your survey	11thweek	**10%** (this component will be evaluated based on the linking and classification among the papers)
Your conclusions	Write your conclusions and future work	12th week	**5%** (conclusions – clarity and your ideas)
Final Draft	Complete the final draft of your paper	13th week	**10%** (formatting, English, Clarity and linking) **4%** Plagiarism Check Report
Seminar	A brief 15 slides on your paper	14th & 15th week	**10%** (based on presentation and Viva-voce)

TOTAL: 30 PERIODS

OUTCOMES:

On successful completion of this course, the students will be able to,

- Select the area of interest among multiple domains.
- Carry out the literature survey with latest articles.
- Design the flow/content of a document.
- Investigate the experimental result with existing techniques.
- Formulate the final draft with future enhancements.

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PG20MC002	UNIVERSAL HUMAN VALUES 2: UNDERSTANDING HARMONY	L T P C 3 0 0 3

OBJECTIVES:

The students should be made to:

- Understand the need of value education and human aspiration
- Know the difference between self and body
- Recognize the harmony in the family and society
- Understand harmony in nature
- Identify the human values and ethics

UNIT I INTRODUCTION TO VALUE EDUCATION 9

Value Education – need and process, Self-Exploration – process, Basic Human Aspirations - Continuous Happiness and Prosperity, Basic requirement for fulfillment of Human Aspirants, Understanding Happiness and Prosperity – Continuity of Happiness from Physical Facility.

UNIT II HARMONY IN THE HUMAN BEING 9

Human being as a co-existence of the self and the Body - The needs of Self and Body, Body as an Instrument - The Self as the Seer- Doer-Enjoyer, Harmony in the self, Harmony of the Self with the Body –Programme for Self – regulation and health.

UNIT III HARMONY IN THE FAMILY AND SOCIETY 9

Family as the basic unit of human interaction , Understanding Relationship, Trust as the foundational value, Respect as the Right Evaluation, Harmony in the society – Understanding Human Goal, Harmony from Family Order to World Family Order – Universal Human Order - Scope.

UNIT IV HARMONY IN THE NATURE AND EXISTENCE 9

Nature - as Collections of Units, Classification of Units into Four Orders, Interconnectedness, and mutual fulfillment among the four orders of nature, self-regulation in Nature, Understanding Existence as Units in Space, Existence as Co-existence.

UNIT V IMPLICATIONS OF THE ABOVE HOLISTIC UNDERSTANDING OF HARMONY ON PROFESSIONAL ETHICS 9

Natural Acceptance of Human Values - Definitiveness of Ethical Human Conduct, Basis for Humanistic Education, Constitution, Universal Human Order, Competence in Professional Ethics, Holistic Technologies, Production System and Management Models – Typical case, Strategies for Transition towards value based life and profession.

TOTAL: 45 PERIODS

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OUTCOMES:

On completion of this course, the students will be able to

- Understand the significance of value education and distinguish between values and skills.
- Distinguish between the Self and the Body, understand the meaning of Harmony in the Self the Co-existence of Self and Body.
- Understand the value of harmonious relationship based on trust, respect and other naturally acceptable feelings.
- Understand the harmony in nature and existence, and work out their mutually fulfilling participation in the nature.
- Distinguish between ethical and unethical practices and understand the human values.

Text Book:

1. R R Gaur, R Sangal, G P Bagaria, 2009, A Foundation Course in Human Values and Professional Ethics, Excel Books, New Delhi, 2nd Revised Edition, 2019.

References:

1. Tripathi A N, "Human Values", New Age Intl. Publishers, New Delhi, 2009.
2. Govindarajan M, Natrajan S and Senthilkumar V S, "Engineering Ethics (Including Human Values)" Eastern Economy, PHI, 12th Edition, 2011.
3. Govindarajan M and Natrajan S, "Professional Ethics and Human Values", PHI, 2011.
4. Banerjee B P, "Foundation of Ethics and Management", Excel Publication, 2005.
5. Bajpai B L, "Indian Ethos and Modern Management", New Royal Book Co, Lucknow, Reprinted 2008.
6. Seebauer and Robert L Berry, "Fundamentals of Ethics for Scientist and Engineers", Oxford University Press, 2000.

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PG20CS302 INFORMATION AND NETWORK SECURITY **L T P C**
3 0 0 3

OBJECTIVES:

The Student should be made to:

- Introduce the concepts and models of security.
- Understand the risk assessment and security standard.
- Plan for business continuity and incident response plan.
- Estimate the level of security risk faced by an organization and the countermeasures to handle the risk.
- Understand potential vulnerabilities and to develop a security blueprint.

UNIT I INFORMATION SECURITY **9**

Introduction to Information Security - Security Issues - CIA Triad - Parkerian Hexad - Introduction to Security Attacks - Types of Attacks - Threats, Vulnerabilities, and Risk – Risk Management - Incident Response Identification - Access Controls - Identity Verification - Authentication - Multifactor Authentication - Mutual Authentication - Passwords - Biometrics - Hardware Tokens.

UNIT II FUNDAMENTALS OF CRYPTOGRAPHY **9**

Foundations of Cryptology - Cipher Methods - Cryptographic Algorithms - Kerckhoffs's Principles. Keyword Ciphers - One-Time Pads - Symmetric and Asymmetric Cryptography Techniques - Hash Functions - SHA - MD5 - Digital Signatures - Certificates - Modern Cryptographic Tools.

UNIT III INTRUSION DETECTION **9**

Threat Models - Secure Communications - Intrusion Detection Systems - Intrusion Detection and Prevention Systems - Honeypots - Scanning and Analysis Tools - Traditional Reconnaissance and Attacks - Malicious Software - Preventive Measures - Intrusion Monitoring and Detection Reactive Measures - Network-Based Intrusion Protection.

UNIT IV NETWORK SECURITY **9**

Kerberos - IP Security - IP Security architecture - Key Management - Email Security - Pretty Good Privacy, S/MIME - Public Key Infrastructure - Traffic flow security - Firewalls – Design and Types of Firewalls - Personal Firewalls

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UNIT V APPLICATION SECURITY 9

Software Development Vulnerabilities - Buffer Overflows - Race Conditions - Input Validation Attacks - Authentication Attacks - Authorization Attacks - Cryptographic Attacks - Web Security - Client-Side Attacks - Server-Side Attacks - Database Security - Protocol Issues – Unauthenticated Access - Arbitrary Code Execution - Privilege Escalation - Application Security Tools - Sniffers - Web Application Analysis Tools - Fuzzers

TOTAL: 45 PERIODS

OUTCOMES:

On successful completion of this course, the students will be able to,

- Apply the basic security models and policies required by the computing system.
- Apply a cryptographic algorithm to build a secure application.
- Monitor, detect and prevent intrusions in a network.
- Predict the vulnerabilities in any computing system and propose a security solution.
- Understand the importance of network security and risk management of an organization.

REFERENCES

1. Cryptography and Network Security: William Stallings, Pearson Education, 7th Edition.
2. Security in Computing, Fifth Edition, by Charles P. Pfleeger, Pearson Education.
3. Foundations of Information Security: A Straightforward Introduction, Jason Andress. No
4. Starch Press, 2019.
5. Fundamentals of information systems security, Kim, David, Solomon, and Michael G. Jones & Bartlett Learning, third edition, 2018.
6. Information Security: Foundations, technologies and applications, Ali Ismail Awad, Michael Fairhurst. Institution of Engineering & Technology, 2018.
7. Computer and Information Security Handbook, John R. Vacca. Morgan Kaufmann, 2017.
8. Software-Defined Networking and Security, Dijiang Huang, Ankur Chowdhary, and Sandeep Pisharody. CRC Press, 2018.

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PG20CS301 **PROJECT WORK PHASE – I** L T P C
0 0 12 6

OBJECTIVES:

The students should be made to:

- Explore emerging research issues.
- Literature survey on recent developments in a selected problem domain.
- Workout with the strategies.
- Find a solution addressing the problem.
- Share the work with the peer group.

GUIDELINES FOR REVIEW AND EVALUATION

A candidate to work on projects in an Industrial / Research Organization, on the recommendations of the Head of the department under the guidance of a faculty member and prepare a comprehensive project report after completing the work to the satisfaction of the supervisor. There shall be a minimum of three members in the review committee. The guide will be an additional member of the Review Committee and he / she should be present during the presentation. The progress of the project is evaluated based on a minimum of three reviews. The candidate should prepare the project report and submit it to the head of the department at the end of the semester. The evaluation of the Project work Phase – I will be based on the project report submitted by the candidate in the Phase – I and the Viva-Voce Examination which consists of a team of Guide, an internal examiner (other than the guide) and an external Examiner. The internal examiner and the external examiner shall be appointed for the Phase – I Evaluation.

TOTAL: 180 PERIODS

OUTCOMES:

On successful completion of this course, the students will be able to,

- Identify a problem addressing an emerging research issues.
- Survey relevant literature to gain knowledge about the contemporary methodologies.
- Devise a mechanism to solve the problem.
- Implement the mechanism to arrive the results.
- Document the work for publication.

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PG20CS401	PROJECT WORK PHASE – II	L T P C 0 0 24 12

OBJECTIVES:

The students should be made to:

- Explore emerging research issues.
- Literature survey on recent developments in a selected problem domain.
- Workout with the strategies to find a solution addressing the problem.
- Make the students to compare the results.
- Share the work with the peer group.

GUIDELINES FOR REVIEW AND EVALUATION

A candidate to work on projects in an Industrial / Research Organization, on the recommendations of the Head of the department under the guidance of a faculty member and prepare a comprehensive project report after completing the work to the satisfaction of the supervisor. There shall be a minimum of three members in the review committee. The guide will be an additional member of the Review Committee and he / she should be present during the presentation. The progress of the project is evaluated based on a minimum of three reviews. The candidate should prepare the project report and submit it to the head of the department at the end of the semester. The evaluation of the Project work Phase – II will be based on the project report submitted by the candidate in the Phase – II and the Viva-Voce Examination which consists of a team of Guide, an internal examiner (other than the guide) and an external Examiner. The internal examiner and the external examiner shall be appointed for the Phase – II Evaluation.

TOTAL: 360 PERIODS

OUTCOMES:

On successful completion of this course, the students will be able to,

- Identify a problem addressing an emerging research issues.
- Survey relevant literature to gain knowledge about the contemporary methodologies.
- Devise a mechanism to solve the problem.
- Implement the mechanism to arrive the results.
- Evaluate the performance of the work with existing methodologies and document the work for publication.

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PG20CS201PE ADVANCED DATABASES

L T P C
3 0 0 3

OBJECTIVES:

The Student should be made to:

- Understand the design of databases.
- Acquire knowledge on parallel and distributed databases and its applications.
- Study the usage and applications of Object Oriented and Intelligent databases.
- Understand the emerging databases like Mobile, XML, Cloud and Big Data
- Be familiar with a commercial relational database system (Oracle) by writing SQL using the system.

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 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 XML DATABASES **9**

XML Databases: XML Data Model – DTD – XML Schema – XML Querying – Web Databases – Open Database Connectivity.

UNIT IV MOBILE 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

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UNIT V MULTIMEDIA DATABASES 9

Multidimensional Data Structures – Image Databases – Text / Document Databases – Video Databases – Audio Databases – Multimedia Database Design.

TOTAL: 45 PERIODS

OUTCOMES:

On successful completion of this course, the students will be able to,

- Develop skills on databases to optimize their performance in practice.
- Analyze each type of databases and its necessity
- Design faster algorithms in solving practical database problems
- Apply query evaluation techniques and query optimization techniques.
- Design and develop a database application system as part of a team.

REFERENCES:

1. C.J.Date, A.Kannan, S.Swamynathan, "An Introduction to Database Systems", Eighth Edition, Pearson Education, 2006.
2. Carlo Zaniolo, Stefano Ceri, Christos Faloutsos, Richard T.Snodgrass, V.S.Subrahmanian, Roberto Zicari, "Advanced Database Systems", Morgan Kaufmann publishers, 2006.
3. Henry F Korth, Abraham Silberschatz, S. Sudharshan, "Database System Concepts, Sixth Edition, McGraw Hill, 2011.
4. R. Elmasri, S.B. Navathe, "Fundamentals of Database Systems", Sixth Edition, Pearson Education/Addison Wesley, 2010.
5. Vijay Kumar, "Mobile Database Systems", John Wiley & Sons, 2006.

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PG20CS202PE PRINCIPLES OF PROGRAMMING LANGUAGES

L T P C
3 0 0 3

OBJECTIVES:

The Student should be made to:

- Understand and describe syntax and semantics of programming languages.
- Understand Data, Data types, and Bindings.
- Learn the concepts of functional and logical programming.
- Explore the knowledge about concurrent Programming paradigms.
- Learning the essence of program execution by evaluators: Interpreters, compilers.

UNIT I ELEMENTS OF PROGRAMMING LANGUAGES **9**

Reasons for studying, concepts of programming languages, Language Evaluation Criteria, influences on Language design, Language categories. Programming Language Implementation – Compilation, Hybrid Implementation, Pure Interpretation and Virtual Machines. Describing Syntax and Semantics -Introduction - The General Problem of Describing Syntax-Formal Methods of Describing Syntax - Attribute Grammars - Describing the Meanings of Programs: Dynamic Semantics.

UNIT II DATA TYPES-ABSTRACTION **9**

Introduction - Primitive Data Types- Character String Types- User-Defined Ordinal Types- Array types- Associative Arrays-Record Types- Tuple Types-List Types -Union Types - Pointer and Reference Types -Type Checking- Strong Typing -Type Equivalence - Theory and Data Types-Variables-The Concept of Binding -Scope - Scope and Lifetime - Referencing Environments - Named Constants- The Concept of Abstraction- Parameterized Abstract Data Types- Encapsulation Constructs- Naming Encapsulations

UNIT III FUNCTIONAL PROGRAMMING **9**

Introduction- Mathematical Functions- Fundamentals of Functional Programming Languages- The First Functional Programming Language: LISP- An Introduction to Scheme- Common LISP- Haskell-F# - ML : Implicit Types- Data Types- Exception Handling in ML. Functional Programming with Lists- Scheme, a Dialect of Lisp- The Structure of Lists- List Manipulation- A Motivating Example: Differentiation- Simplification of Expressions- Storage Allocation for Lists.

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UNIT IV LOGIC PROGRAMMING 9

Relational Logic Programming- Syntax- Basics- Facts- Rules- Syntax- Operational Semantics- Relational logic programs and SQL operations- Logic Programming- Syntax- Operational semantics- Data Structures-Meta-tools: Backtracking optimization (cuts); Unify; Meta-circular interpreters- The Origins of Prolog- Elements- of Prolog-Deficiencies of Prolog- Applications of Logic Programming.

UNIT V CONCURRENT PROGRAMMING 9

Parallelism in Hardware- Streams: Implicit Synchronization-Concurrency as Interleaving- Liveness Properties- Safe Access to Shared Data- Concurrency in Ada- Synchronized Access to Shared Variables- Synthesized Attributes- Attribute Grammars- Natural Semantics- Denotational Semantics -A Calculator in Scheme-Lexically Scoped Lambda Expressions- An Interpreter-Recursive Functions.

TOTAL: 45 PERIODS

OUTCOMES:

On successful completion of this course, the students will be able to,

- Describe syntax and semantics of programming languages
- Explain data, data types, and basic statements of programming languages
- Design and implement subprogram constructs, Apply object - oriented, concurrency, pro and event handling programming constructs
- Develop programs in LISP, ML, and Prolog.
- Students will be able to analyze control flow structures in different programming languages.

REFERENCES:

1. Ghezzi, "Programming Languages", 3rd Edition, John Wiley, 2008
2. John C. Mitchell, "Concepts in Programming Languages", Cambridge University Press, 2004.
3. Louden, "Programming Languages", 3rd Edition, 2012.
4. Ravi Sethi, "Programming Languages: Concepts and Constructs", 2nd Edition, Addison Wesley, 1996.
5. Robert .W. Sebesta, "Concepts of Programming Languages", 10th Edition, Pearson Education, 2002.

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PG20CS203PE IMAGE PROCESSING AND ANALYSIS

L T P C
3 0 0 3

OBJECTIVES:

The Student should be made to:

- Understand the image processing concepts and analysis
- Understand the image processing techniques
- Familiarize the image processing environment and their applications,
- Appreciate the use of image processing in various applications
- Carry out pattern recognition in 360 degree images

UNIT I IMAGE PROCESSING FUNDAMENTALS 9

Introduction – Elements of visual perception, Steps in Image Processing Systems – Digital Imaging System - Image Acquisition – Sampling and Quantization – Pixel Relationships – File Formats – colour images and models - Image Operations – Arithmetic, logical, statistical and spatial operations.

UNIT II IMAGE ENHANCEMENT AND RESTORATION 9

Image Transforms -Discrete and Fast Fourier Transform and Discrete Cosine Transform ,Spatial Domain - Gray level Transformations Histogram Processing Spatial Filtering – Smoothing and Sharpening. Frequency Domain: Filtering in Frequency Domain – Smoothing and Sharpening filters – Homomorphic Filtering., Noise models, Constrained and Unconstrained restoration models.

UNIT III IMAGE SEGMENTATION AND MORPHOLOGY 9

Detection of Discontinuities – Edge Operators – Edge Linking and Boundary Detection – Thresholding – Region Based Segmentation – Motion Segmentation, Image Morphology: Binary and Gray level morphology operations - Erosion, Dilation, Opening and Closing Operations Distance Transforms- Basic morphological Algorithms. Features – Textures - Boundary representations and Descriptions- Component Labeling – Regional descriptors and Feature Selection Techniques.

UNIT IV IMAGE ANALYSIS AND CLASSIFICATION 9

Image segmentation- pixel based, edge based, region based segmentation. Active contour models and Level sets for medical image segmentation, Image representation and analysis, Feature extraction and representation, Statistical, Shape, Texture, feature and statistical image classification.

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UNIT V IMAGE REGISTRATION AND VISUALIZATION 9

Rigid body visualization, Principal axis registration, Interactive principal axis registration, Feature based registration, Elastic deformation based registration, Image visualization – 2D display methods, 3D display methods, virtual reality based interactive visualization.

TOTAL: 45 PERIODS

OUTCOMES:

On successful completion of this course, the students will be able to,

- Design and implement algorithms for image processing applications that incorporates different concepts of medical Image Processing
- Familiar with the use of MATLAB and its equivalent open source tools
- Critically analyze different approaches to image processing applications
- Explore the possibility of applying Image processing concepts in various applications
- Ability to carry out image processing project with panoramic videos.

REFERENCES:

1. Alasdair McAndrew, "Introduction to Digital Image Processing with Matlab", Cengage Learning 2011,India
2. Anil J Jain, "Fundamentals of Digital Image Processing", PHI, 2006.
3. Kavyan Najarian and Robert Splerstor," Biomedical signals and Image processing", CRC – Taylor and Francis, New York, 2006
4. Rafael C.Gonzalez and Richard E.Woods, "Digital Image Processing", Third Edition, Pearson Education, 2008, New Delhi
5. S.Sridhar, "Digital Image Processing", Oxford University Press, 2011

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PG20CS204PE **WEB ENGINEERING**

L T P C
3 0 0 3

OBJECTIVES:

The Student should be made to:

- Understand the characteristics of web applications
- Learn to Model web applications
- Be aware of Systematic design methods
- Be familiar with the testing techniques for web applications
- Learn and use some of the client-side and server-side languages used to manipulate information on the World Wide Web

UNIT I INTRODUCTION TO WEB ENGINEERING **9**

Motivation, Categories of Web Applications, Characteristics of Web Applications. Requirements of Engineering in Web Applications- Web Engineering-Components of Web Engineering-Web Engineering Process-Communication-Planning.

UNIT II WEB APPLICATION ARCHITECTURES & MODELLING WEB APPLICATIONS **9**

Introduction- Categorizing Architectures- Specifics of Web Application Architectures, Components of a Generic Web Application Architecture- Layered Architectures, 2-Layer Architectures, N-Layer Architectures-Data-aspect Architectures, Database-centric Architectures- Architectures for Web Document Management- Architectures for Multimedia Data- Modeling Specifics in Web Engineering, Levels, Aspects, Phases Customization, Modeling Requirements, Hypertext Modeling, Hypertext Structure Modeling Concepts, Access Modeling Concepts, Relation to Content Modeling, Presentation Modeling, Relation to Hypertext Modeling, Customization Modeling, Modelling Framework-Modeling languages- Analysis Modeling for Web Apps-The Content Model-The Interaction Model-Configuration Model.

UNIT III WEB APPLICATION DESIGN **9**

Design for WebApps- Goals-Design Process-Interactive Design- Principles and Guidelines-Workflow-Preliminaries-Design Steps- Usability- Issues- Information Design- Information Architecture- structuring- Accessing Information-Navigation Design- Functional Design-Wep App Functionality- Design Process- Functional Architecture- Detailed Functional Design.

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UNIT IV TESTING WEB APPLICATIONS 9

Introduction-Fundamentals-Test Specifics in Web Engineering-Test Approaches-Conventional Approaches, Agile Approaches- Testing concepts- Testing Process -Test Scheme- Test Methods and Techniques- Link Testing- Browser Testing-Usability Testing-Load, Stress, and Continuous Testing, Testing Security, Test-driven Development, -Content Testing-User Interface testing-Usability Testing-Compatibility Testing-Component Level Testing-Navigation Testing-Configuration testing-Security and Performance Testing- Test Automation.

UNIT V PROMOTING WEB APPLICATIONS AND WEB PROJECT MANAGEMENT 9

Introduction-challenges in launching the web Application-Promoting Web Application-Content Management-Usage Analysis-Web Project Management-Challenges in Web Project Management-Managing Web Team- Managing the Development Process of a Web Application- Risk, Developing a Schedule, Managing Quality, Managing Change, Tracking the Project. Introduction to node JS - web sockets.

TOTAL: 45 PERIODS

OUTCOMES:

On successful completion of this course, the students will be able to,

- Explain the characteristics of web applications.
- Model web applications.
- Design web applications.
- Test web applications.
- Evaluate metrics for ensuring the proper operability.

REFERENCES:

1. Chris Bates, "Web Programming: Building Internet Applications", Third Edition, Wiley India Edition, 2007.
2. Gerti Kappel, Birgit Proll, "Web Engineering", John Wiley and Sons Ltd, 2006.
3. Guy W. Lecky-Thompson, "Web Programming", Cengage Learning, 2008.
4. John Paul Mueller, "Web Development with Microsoft Visual Studio 2005", Wiley Dream tech, 2006.
5. Roger S. Pressman, David Lowe, "Web Engineering", Tata McGraw Hill Publication, 2007.

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PG20CS205PE CLOUD COMPUTING TECHNOLOGIES

L T P C
3 0 0 3

OBJECTIVES:

The Student should be made to:

- Understand the concepts of virtualization and virtual machines
- Gain expertise in server, network and storage virtualization.
- Understand and deploy practical virtualization solutions and enterprise solutions
- Gain knowledge on the concept of virtualization that is fundamental to cloud computing
- Understand the various issues in cloud computing
- Be able to set up a private cloud
- Understand the security issues in the grid and the cloud environment

UNIT I VIRTUALIZATION **9**

Basics of Virtual Machines - Process Virtual Machines – System Virtual Machines – Emulation – Interpretation – Binary Translation - Taxonomy of Virtual Machines. Virtualization –Management Virtualization — Hardware Maximization – Architectures – Virtualization Management – Storage Virtualization – Network Virtualization

UNIT II VIRTUALIZATION INFRASTRUCTURE **9**

Comprehensive Analysis – Resource Pool – Testing Environment –Server Virtualization – Virtual Workloads – Provision Virtual Machines – Desktop Virtualization – Application Virtualization - Implementation levels of virtualization – virtualization structure – virtualization of CPU, Memory
and I/O devices – virtual clusters and Resource Management – Virtualization for data center automation.

UNIT III CLOUD PLATFORM ARCHITECTURE **9**

Cloud deployment models: public, private, hybrid, community – Categories of cloud computing: Everything as a service: Infrastructure, platform, software- A Generic Cloud Architecture Design – Layered cloud Architectural Development – Virtualization Support and Disaster Recovery – Architectural Design Challenges - Public Cloud Platforms : GAE,AWS – Inter-cloud Resource Management

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UNIT IV PROGRAMMING MODEL 9

Introduction to Hadoop Framework - Mapreduce, Input splitting, map and reduce functions, specifying input and output parameters, configuring and running a job –Developing Map Reduce Applications - Design of Hadoop file system –Setting up Hadoop Cluster - Cloud Software Environments -Eucalyptus, Open Nebula, Open Stack, Nimbus

UNIT V CLOUD SECURITY 9

Cloud Infrastructure security: network, host and application level – aspects of data security, provider data and its security, Identity and access management architecture, IAM practices in the cloud, SaaS, PaaS, IaaS availability in the cloud - Key privacy issues in the cloud –Cloud Security and Trust Management

TOTAL: 45 PERIODS

OUTCOMES:

On successful completion of this course, the students will be able to,

- Employ the concepts of storage virtualization, network virtualization and its management
- Apply the concept of virtualization in the cloud computing
- Identify the architecture, infrastructure and delivery models of cloud computing
- Develop services using Cloud computing
- Apply the security models in the cloud environment

REFERENCES:

1. Danielle Ruest, Nelson Ruest, "Virtualization: A Beginner"s Guide", McGraw-Hill Osborne Media, 2009.
2. Jim Smith, Ravi Nair , "Virtual Machines: Versatile Platforms for Systems and Processes", Elsevier/Morgan Kaufmann, 2005
3. John W.Rittinghouse and James F.Ransome, "Cloud Computing: Implementation, Management, and Security", CRC Press, 2010.
4. Kai Hwang, Geoffrey C Fox, Jack G Dongarra, "Distributed and Cloud Computing, From Parallel Processing to the Internet of Things", Morgan Kaufmann Publishers, 2012.
5. Tim Mather, Subra Kumaraswamy, and Shahed Latif ,"Cloud Security and Privacy", O'Reilly Media, Inc.,2009. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing, A Practical Approach", McGraw-Hill Osborne Media, 2009.
6. Tom White, "Hadoop: The Definitive Guide", Yahoo Press, 2012.

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PG20CS206PE **REAL TIME SYSTEMS**

L T P C
3 0 0 3

OBJECTIVES:

The Student should be made to:

- Learn real time operating system concepts, the associated issues & Techniques.
- Understand design and synchronization problems in Real Time System.
- Explore the concepts of real time databases.
- Understand the evaluation techniques present in Real Time System.
- Design real time operating systems which are backbone of embedded industry.

UNIT I REAL TIME SYSTEM AND SCHEDULING 9

Introduction– Structure of a Real Time System –Task classes – Performance Measures for Real Time Systems – Estimating Program Run Times – Issues in Real Time Computing – Task Assignment and Scheduling – Classical uniprocessor scheduling algorithms –Fault Tolerant Scheduling.

UNIT II SOFTWARE REQUIREMENTS ENGINEERING 9

Requirements engineering process – types of requirements – requirements specification for real time systems – Formal methods in software specification – structured Analysis and Design – object oriented analysis and design and unified modelling language – organizing the requirements document – organizing and writing documents – requirements validation and revision.

UNIT III INTERTASK COMMUNICATION AND MEMORY MANAGEMENT 9

Buffering data – Time relative Buffering- Ring Buffers – Mailboxes – Queues – Critical regions – Semaphores – other Synchronization mechanisms – deadlock – priority inversion – process stack management – run time ring buffer – maximum stack size – multiple stack arrangement – memory management in task control block - swapping – overlays – Block page management – replacement algorithms – memory locking – working sets – real time garbage collection – contiguous file systems.

UNIT IV REAL TIME DATABASES 9

Real time Databases – Basic Definition, Real time Vs General Purpose Databases, Main Memory Databases, Transaction priorities, Transaction Aborts, Concurrency control issues, Disk Scheduling Algorithms, Two– phase Approach to improve Predictability – Maintaining Serialization Consistency – Databases for Hard Real Time Systems.

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UNIT V EVALUATION TECHNIQUES AND CLOCK SYNCHRONIZATION 9

Reliability Evaluation Techniques – Obtaining parameter values, Reliability models for Hardware Redundancy–Software error models. Clock Synchronization–Clock, A Nonfault–Tolerant Synchronization Algorithm – Impact of faults – Fault Tolerant Synchronization in Hardware – Fault Tolerant Synchronization in software.

TOTAL: 45 PERIODS

OUTCOMES:

On successful completion of this course, the students will be able to,

- Apply principles of real time system design techniques to develop real time applications.
- Make use of database in real time applications.
- Make use of architectures and behaviour of real time operating systems.
- Apply evaluation techniques in application.
- Analyze the situation of fault occurrence and will be able to apply solutions accordingly.

REFERENCES:

1. C.M. Krishna, Kang G. Shin, "Real-Time Systems", McGraw-Hill International Editions, 1997
2. Philip.A.Laplante, "Real Time System Design and Analysis", Prentice Hall of India, 3rd Edition, 2004
3. Rajib Mall, "Real-time systems: theory and practice", Pearson Education, 2009
4. R.J.A Buhur, D.L Bailey, "An Introduction to Real-Time Systems", Prentice Hall International, 1999
5. Stuart Bennett, "Real Time Computer Control-An Introduction", Prentice Hall of India, 1998
6. Allen Burns, Andy Wellings, "Real Time Systems and Programming Languages, Pearson Education, 2003.

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PG20CS207PE MOBILE AND PERVASIVE COMPUTING

L T P C
3 0 0 3

OBJECTIVES:

The Student should be made to:

- Learn the basic architecture and concepts till Third Generation Communication systems.
- Understand the latest 4G Telecommunication System Principles.
- Introduce the broad perspective of pervasive concepts and management
- Explore the HCI in Pervasive environment
- Apply the pervasive concepts in mobile environment

UNIT I INTRODUCTION **9**

History – Wireless communications: GSM – DECT – TETRA – UMTS – IMT – 2000 – Blue tooth, WiFi, WiMAX, 3G ,WATM.- Mobile IP protocols -WAP push architecture-Wml scripts and applications. Data networks – SMS – GPRS – EDGE – Hybrid Wireless100 Networks – ATM – Wireless ATM.

UNIT II OVERVIEW OF A MODERN 4G TELECOMMUNICATIONS SYSTEM 9

Introduction. LTE-A System Architecture. LTE RAN. OFDM Air Interface. Evolved Packet Core. LTE Requirements. LTE-Advanced. LTE-A in Release. OFDMA – Introduction. OFDM Principles. LTE Uplink—SC-FDMA. Summary of OFDMA.

UNIT III PERVASIVE CONCEPTS AND ELEMENTS **9**

Technology Trend Overview - Pervasive Computing: Concepts - Challenges - Middleware - Context Awareness - Resource Management - Human–Computer Interaction - Pervasive Transaction Processing - Infrastructure and Devices - Wireless Networks - Middleware for Pervasive Computing Systems - Resource Management - User Tracking- Context Management -Service Management - Data Management - Security Management - Pervasive Computing Environments - Smart Car Space - Intelligent Campus

UNIT IV HCI IN PERVASIVE COMPUTING **9**

Prototype for Application Migration - Prototype for Multimodalities - Human–Computer Interface in Pervasive Environments - HCI Service and Interaction Migration - Context-Driven HCI Service Selection - Interaction Service Selection Overview - User Devices - Service-Oriented Middleware Support - User History and Preference - Context Manager - Local Service Matching - Global Combination - Effective Region - User Active Scope - Service Combination Selection Algorithm

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UNIT V PERVASIVE MOBILE TRANSACTIONS 9

Pervasive Mobile Transactions - Introduction to Pervasive Transactions - Mobile Transaction Framework - Unavailable Transaction Service - Pervasive Transaction Processing Framework - Context-Aware Pervasive Transaction Model - Context Model for Pervasive Transaction Processing - Context-Aware Pervasive Transaction Model - A Case of Pervasive Transactions - Dynamic Transaction Management - Context-Aware Transaction Coordination Mechanism - Coordination Algorithm for Pervasive Transactions - Participant Discovery - Formal Transaction Verification - Petri Net with Selective Transition.

TOTAL: 45 PERIODS

OUTCOMES:

On successful completion of this course, the students will be able to,

- Obtain a thorough understanding of Basic architecture and concepts of till Third Generation Communication systems.
- Explain the latest 4G Telecommunication System Principles.
- Incorporate the pervasive concepts.
- Implement the HCI in Pervasive environment.
- Work on the pervasive concepts in mobile environment.

REFERENCES:

1. Alan Colman, Jun Han, and Muhammad Ashad Kabir, Pervasive Social Computing Socially-Aware Pervasive Systems and Mobile Applications, Springer, 2016.
2. J.Schiller, "Mobile Communication, Addison Wesley, 2000.
3. Juha Korhonen, "Introduction to 4G Mobile Communications", Artech House Publishers, 2014
4. Kolomvatsos, Kostas, "Intelligent Technologies and Techniques for Pervasive Computing", IGI Global, 2013.
5. M.Bala Krishna, Jaime Lloret Mauri, "Advances in Mobile Computing and Communications: Perspectives and Emerging Trends in 5G Networks", CRC 2016
6. Minyi Guo, Jingyu Zhou, Feilong Tang, Yao Shen, " Pervasive Computing: Concepts, Technologies and Applications",CRC Press, 2016

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PG20CS208PE PARALLEL PROGRAMMING PARADIGMS

L T P C
3 0 0 3

OBJECTIVES:

The Student should be made to:

- Familiarize the issues in parallel computing.
- Describe distributed memory programming using MPI.
- Understand shared memory paradigm with P threads and with OpenMP.
- Learn the GPU based parallel programming using OpenCL.
- Gain practical experience in programming large scale parallel machines.

UNIT I FOUNDATIONS OF PARALLEL PROGRAMMING 9

Motivation for parallel programming – Need-Concurrency in computing – Basics of processes, multitasking and threads – cache – cache mappings – caches and programs – virtual memory – Instruction level parallelism – hardware multi-threading – Parallel Hardware-SIMD – MIMD – Interconnection networks – cache coherence –Issues in shared memory model and distributed memory model –Parallel Software- Caveats- coordinating processes/ threads- hybrid model – shared memory model and distributed memory model - I/O – performance of parallel programs–– parallel program design.

UNIT II DISTRIBUTED MEMORY PROGRAMMING WITH MPI 9

Basic MPI programming – MPI_Init and MPI_Finalize – MPI communicators – SPMD- programs– MPI_Send and MPI_Recv – message matching – MPI- I/O – parallel I/O – collective communication – Tree-structured communication -MPI_Reduce – MPI_Allreduce, broadcast, scatter, gather, allgather – MPI derived types – dynamic process management – performance evaluation of MPI programs- A Parallel Sorting Algorithm

UNIT III SHARED MEMORY PARADIGM WITH PTHREADS 9

Basics of threads, Pthreads – thread synchronization – critical sections – busy waiting – mutex – semaphores – barriers and condition variables – read write locks with examples - Caches, cache coherence and false sharing – Thread safety-Pthreads case study.

UNIT IV SHARED MEMORY PARADIGM: OPENMP 9

Basics OpenMP – Trapezoidal Rule-scope of variables – reduction clause – parallel for directive – loops in OpenMP – scheduling loops –Producer Consumer problem – cache issues – threads safety in OpenMP – Two- body solvers- Tree Search

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UNIT V GRAPHICAL PROCESSING PARADIGMS: OPENCL AND INTRODUCTION TO CUDA 9

Introduction to OpenCL – Example-OpenCL Platforms- Devices-Contexts - OpenCL programming – Built-In Functions-Programs Object and Kernel Object – Memory Objects - Buffers and Images – Event model – Command-Queue - Event Object - case study. Introduction to CUDA programming.

TOTAL: 45 PERIODS

OUTCOMES:

On successful completion of this course, the students will be able to,

- Identify issues in parallel programming.
- Develop distributed memory programs using MPI framework.
- Design and develop shared memory parallel programs using Pthreads and using OpenMP.
- Implement Graphical Processing OpenCL programs.
- Ability to apply design and development principles in the construction of software systems or computer systems of varying complexity.

REFERENCES:

1. Munshi, B. Gaster, T. G. Mattson, J. Fung, and D. Ginsburg, "OpenCL programming guide", Addison Wesley, 2011
2. M. J. Quinn, "Parallel programming in C with MPI and OpenMP", Tata McGraw Hill, 2003.
3. Peter S. Pacheco, "An introduction to parallel programming", Morgan Kaufmann, 2011.
4. Rob Farber, "CUDA application design and development", Morgan Haufmann, 2011.
5. W. Gropp, E. Lusk, and A. Skjellum, "Using MPI: Portable parallel programming with the message passing interface", Second Edition, MIT Press, 1999

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PG20CS209PE INFORMATION RETRIEVAL TECHNIQUES

L T P C
3 0 0 3

OBJECTIVES:

The Student should be made to:

- Understand the basics of information retrieval with pertinence to modeling, query operations and indexing
- Get an understanding of machine learning techniques for text classification and clustering.
- Understand the various applications of information retrieval giving emphasis to multimedia IR, web search
- Understand the concepts of digital libraries
- Analyze ranked retrieval of a very large number of documents with hyperlinks between them.

UNIT I INTRODUCTION: MOTIVATION **9**

Basic Concepts – Practical Issues - Retrieval Process – Architecture - Boolean Retrieval – Retrieval Evaluation – Open Source IR Systems–History of Web Search – Web Characteristics– The impact of the web on IR —IR Versus Web Search–Components of a Search engine

UNIT II MODELING **9**

Taxonomy and Characterization of IR Models – Boolean Model – Vector Model - Term Weighting – Scoring and Ranking –Language Models – Set Theoretic Models - Probabilistic Models – Algebraic Models – Structured Text Retrieval Models – Models for Browsing

UNIT III INDEXING **9**

Static and Dynamic Inverted Indices – Index Construction and Index Compression. Searching - Sequential Searching and Pattern Matching. Query Operations -Query Languages – Query Processing - Relevance Feedback and Query Expansion - Automatic Local and Global Analysis – Measuring Effectiveness and Efficiency

UNIT IV CLASSIFICATION AND CLUSTERING **9**

Text Classification and Naïve Bayes – Vector Space Classification – Support vector machines and Machine learning on documents. Flat Clustering – Hierarchical Clustering –Matrix decompositions and latent semantic indexing – Fusion and Meta learning

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UNIT V SEARCHING THE WEB 9

Searching the Web –Structure of the Web –IR and web search – Static and Dynamic Ranking – Web Crawling and Indexing – Link Analysis - XML Retrieval Multimedia IR: Models and Languages – Indexing and Searching Parallel and Distributed IR – Digital Libraries

TOTAL: 45 PERIODS

OUTCOMES:

On successful completion of this course, the students will be able to,

- Build an Information Retrieval system using the available tools.
- Identify and design the various components of an Information Retrieval system.
- Apply machine learning techniques to text classification and clustering which is used for efficient Information Retrieval.
- Design an efficient search engine and analyze the Web content structure.
- Illustrate algorithms used for natural language processing.

REFERENCES:

1. Christopher D. Manning, Prabhakar Raghavan, Hinrich Schutze, "Introduction to Information Retrieval", Cambridge University Press, First South Asian Edition, 2008.
2. "Implementing and Evaluating Search Engines", The MIT Press, Cambridge, Massachusetts London, England, 2010
3. Ricardo Baeza – Yates, Berthier Ribeiro – Neto, "Modern Information Retrieval: The concepts and Technology behind Search" (ACM Press Books), Second Edition, 2011.
4. Stefan Buttcher, Charles L. A. Clarke, Gordon V. Cormack, "Information Retrieval".

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PG20CS210PE SOFTWARE ARCHITECTURES AND DESIGN

L T P C
3 0 0 3

OBJECTIVES:

The Student should be made to:

- Understand the need, design approaches for software architecture to bridge the dynamic requirements and implementation.
- Learn the design principles and to apply for large scale systems
- Design architectures for distributed heterogeneous systems ,environment through brokerage interaction
- Build design knowledge on service oriented and model driven architectures and the aspect oriented architecture.
- Develop appropriate architectures for various Case studies like semantic web services, supply chain cloud services.

UNIT I **10**

Introduction to Software Architecture-Bridging Requirements and Implementation, Design Guidelines, Software Quality attributes. Software Architecture Design Space. Agile Approach to Software Architecture Design, Models for Software Architecture Description Languages (ADL).

UNIT II **8**

Object-Oriented Paradigm -Design Principles. Data-Centered Software Architecture: Repository Architecture, Blackboard Architecture. Hierarchical Architecture Main-Subroutine, Master-Slave, Layered, Virtual Machine. Interaction-Oriented Software Architectures: Model-View-Controller (MVC), Presentation-Abstraction-Control (PAC).

UNIT III **9**

Distributed Architecture: Client-Server, Middleware, Multi-tiers, Broker Architecture – MOM,CORBA Message Broker Architecture- Service-Oriented Architecture (SOA), SOAP, UDDI, SOA Implementation in Web Services, Grid/cloud Service Computing. Heterogeneous Architecture- Methodology of Architecture Decision, Quality Attributes.

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UNIT IV **9**

Architecture of User Interfaces containers, case study-web service. Product Line Architectures - methodologies, processes and tools. Software Reuse and Product Lines - Product Line Analysis, Design and implementation, configuration Models. Model Driven Architectures (MDA) –why MDA- Model transformation and software architecture, SOA and MDA. Eclipse modeling framework.

UNIT V **9**

Aspect Oriented Architectures- AOP in UML,AOP tools, Architectural aspects and middleware Selection of Architectures, Evaluation of Architecture Designs, Case Study: Online Computer Vendor, order processing, manufacture &shipping –inventory, supply chain cloud service Management, semantic web services

TOTAL: 45 PERIODS

OUTCOMES:

On successful completion of this course, the students will be able to,

- Understand the need of software architecture for sustainable dynamic systems.
- Have a sound knowledge on design principles and to apply for large scale systems
- Design architectures for distributed heterogeneous systems
- Have good knowledge on service oriented and model driven architectures and the aspect oriented architecture.
- Have a working knowledge to develop appropriate architectures through various case studies.

REFERENCES :

1. Essentials of software Architecture , Ion Gorton, Second Edition, Springer-verlag, 2011
2. Software Architecture Design Illuminated, Kai Qian Jones and Bartlett Publishers Canada, 2010

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PG20CS301PE PERFORMANCE ANALYSIS OF COMPUTER SYSTEMS

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OBJECTIVES:

The Student should be made to:

- Understand the mathematical foundations needed for performance evaluation of computer systems
- Understand the metrics used for performance evaluation
- Understand the analytical modeling of computer systems
- Enable the students to develop new queuing analysis for both simple and complex systems
- Appreciate the use of smart scheduling and introduce the students to analytical techniques for evaluating scheduling policies

UNIT I OVERVIEW OF PERFORMANCE EVALUATION 9

Need for Performance Evaluation in Computer Systems – Overview of Performance Evaluation Methods – Introduction to Queuing – Probability Review – Generating Random Variables for Simulation – Sample Paths, Convergence and Averages – Little's Law and other Operational Laws – Modification for Closed Systems.

UNIT II MARKOV CHAINS AND SIMPLE QUEUES 9

Discrete-Time Markov Chains – Ergodicity Theory – Real World Examples – Google, Aloha – Transition to Continuous-Time Markov Chain – M/M/1.

UNIT III MULTI-SERVER AND MULTI-QUEUE SYSTEMS 9

Server Farms: M/M/k and M/M/k/k – Capacity Provisioning for Server Farms – Time Reversibility and Burke's Theorem – Networks of Queues and Jackson Product Form – Classed and Closed Networks of Queues.

UNIT IV REAL-WORLD WORKLOADS 9

Case Study of Real-world Workloads – Phase-Type Distributions and Matrix-Alalytic Methods – Networks with Time-Sharing Servers – M/G/1 Queue and the Inspection Paradox – Task Assignment Policies for Server Farms.

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UNIT V SMART SCHEDULING IN THE M/G/1 **9**

Performance Metrics – Scheduling Non-Preemptive and Preemptive Non-Size-Based Policies - Scheduling Non-Preemptive and Preemptive Size-Based Policies – Scheduling - SRPT and Fairness.

TOTAL: 45 PERIODS

OUTCOMES:

On successful completion of this course, the students will be able to,

- Identify the need for performance evaluation and the metrics used for it
- Distinguish between open and closed queuing networks
- Use Little'e law and other operational laws
- Apply the operational laws to open and closed systems
- Use discrete-time and continuous-time Markov chains to model real world systems
- Develop analytical techniques for evaluating scheduling policies

REFERENCES:

1. K. S. Trivedi, "Probability and Statistics with Reliability, Queueing and Computer Science Applications", John Wiley and Sons, 2001.
2. Krishna Kant, "Introduction to Computer System Performance Evaluation", McGraw-Hill, 1992.
3. Lieven Eeckhout, "Computer Architecture Performance Evaluation Methods", Morgan and Claypool Publishers, 2010.
4. Mor Harchol - Balter, "Performance Modeling and Design of Computer Systems – Queueing Theory in Action", Cambridge University Press, 2013.
5. Paul J. Fortier and Howard E. Michel, "Computer Systems Performance Evaluation and Prediction", Elsevier, 2003.
6. Raj Jain, "The Art of Computer Systems Performance Analysis: Techniques for Experimental Design, Measurement, Simulation and Modeling", Wiley-Interscience, 1991.

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PG20CS302PE LANGUAGE TECHNOLOGIES

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OBJECTIVES:

The Student should be made to:

- Learn the fundamentals of natural language processing
- Appreciate the use of CFG and PCFG in NLP
- Understand the role of semantics and pragmatics
- Help the learner to prepare short speeches and deliver them effectively
- Ability of learners to actively participate in story writing

UNIT I INTRODUCTION **9**

Words - Regular Expressions and Automata - Words and Transducers - N-grams - Part-of-Speech – Tagging - Hidden Markov and Maximum Entropy Models.

UNIT II SPEECH **9**

Speech – Phonetics - Speech Synthesis - Automatic Speech Recognition - Speech Recognition: - Advanced Topics - Computational Phonology.

UNIT III SYNTAX **9**

Formal Grammars of English - Syntactic Parsing - Statistical Parsing - Features and Unification - Language and Complexity.

UNIT IV SEMANTICS AND PRAGMATICS **9**

The Representation of Meaning - Computational Semantics - Lexical Semantics - Computational Lexical Semantics - Computational Discourse.

UNIT V APPLICATIONS **9**

Information Extraction - Question Answering and Summarization - Dialogue and Conversational Agents - Machine Translation.

TOTAL: 45 PERIODS

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OUTCOMES:

On successful completion of this course, the students will be able to,

- Tag a given text with basic Language features
- Design an innovative application using NLP components
- Implement a rule based system to tackle morphology/syntax of a language
- Design a tag set to be used for statistical processing for real-time applications
- Compare and contrast use of different statistical approaches for different types of NLP applications.

REFERENCES:

1. Breck Baldwin, "Language Processing with Java and LingPipe Cookbook", Atlantic Publisher, 2015.
2. Daniel Jurafsky, "Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech", Pearson Publication, 2014.
3. Nitin Indurkhya and Fred J. Damerau, "Handbook of Natural Language Processing", Second Edition, Chapman and Hall/CRC Press, 2010.
4. Richard M Reese, "Natural Language Processing with Java", O_Reilly Media, 2015.
5. Steven Bird, Ewan Klein and Edward Loper, -"Natural Language Processing with Python", First Edition, O_Reilly Media, 2009.

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PG20CS303PE COMPUTER VISION

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OBJECTIVES:

The Student should be made to:

- Review image processing techniques for computer vision.
- Understand shape and region analysis.
- Understand Hough Transform and its applications to detect lines, circles, ellipses.
- Understand three-dimensional image analysis techniques.
- Understand motion analysis.
- Study some applications of computer vision algorithms.

UNIT I IMAGE PROCESSING FOUNDATIONS **9**

Review of image processing techniques – classical filtering operations – thresholding techniques – edge detection techniques – corner and interest point detection – mathematical morphology – texture.

UNIT II SHAPES AND REGIONS **9**

Binary shape analysis – connectedness – object labeling and counting – size filtering – distance functions – skeletons and thinning – deformable shape analysis – boundary tracking procedures – active contours – shape models and shape recognition – centroidal profiles – handling occlusion – boundary length measures – boundary descriptors – chain codes – Fourier descriptors – region descriptors – moments.

UNIT III HOUGH TRANSFORM **9**

Line detection – Hough Transform (HT) for line detection – foot-of-normal method – line localization – line fitting – RANSAC for straight line detection – HT based circular object detection – accurate center location – speed problem – ellipse detection – Case study: Human Iris location – hole detection – generalized Hough Transform (GHT) – spatial matched filtering – GHT for ellipse detection – object location – GHT for feature collation.

UNIT IV 3D VISION AND MOTION **9**

Methods for 3D vision – projection schemes – shape from shading – photometric stereo – shape from texture – shape from focus – active range finding – surface representations – point-based representation – volumetric representations – 3D object recognition – 3D reconstruction – introduction to motion – triangulation – bundle adjustment – translational alignment – parametric motion – spline-based motion – optical flow – layered motion.

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UNIT V APPLICATIONS 9

Application: Photo album – Face detection – Face recognition – Eigen faces – Active appearance and 3D shape models of faces Application: Surveillance – foreground-background separation – particle filters – Chamfer matching, tracking, and occlusion – combining views from multiple cameras – human gait analysis Application: In-vehicle vision system: locating roadway – road markings – identifying road signs – locating pedestrians.

TOTAL: 45 PERIODS

OUTCOMES:

On successful completion of this course, the students will be able to,

- Implement fundamental image processing techniques required for computer vision.
- Perform shape analysis.
- Implement boundary tracking techniques.
- Apply chain codes and other region descriptors.
- Apply Hough Transform for line, circle, and ellipse detections.
- Apply 3D vision techniques.
- Implement motion related techniques.
- Develop applications using computer vision techniques.

REFERENCES:

1. D. L. Baggio et al., "Mastering OpenCV with Practical Computer Vision Projects", Packt Publishing, 2012.
2. E. R. Davies, "Computer & Machine Vision", Fourth Edition, Academic Press, 2012.
3. Jan Erik Solem, "Programming Computer Vision with Python: Tools and algorithms for analyzing images", O'Reilly Media, 2012.
4. Mark Nixon and Alberto S. Aquado, "Feature Extraction & Image Processing for Computer Vision", Third Edition, Academic Press, 2012.
5. R. Szeliski, "Computer Vision: Algorithms and Applications", Springer 2011.
6. Simon J. D. Prince, "Computer Vision: Models, Learning, and Inference, Cambridge", University Press, 2012.

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PG20CS304PE SPEECH PROCESSING AND SYNTHESIS

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OBJECTIVES:

The Student should be made to:

- Understand the basic concepts and algorithms of speech processing and synthesis
- Familiarize the students with the various speech signal representation, coding and recognition techniques
- Appreciate the use of speech processing in current technologies and to expose the students to real– world applications of speech processing
- Describe basic algorithms of speech analysis common to many applications
- Give an overview of applications (recognition, synthesis, coding) and to inform about practical aspects of speech algorithms implementation

UNIT I FUNDAMENTALS OF SPEECH PROCESSING 9

Introduction – Spoken Language Structure – Phonetics and Phonology – Syllables and Words – Syntax and Semantics – Probability, Statistics and Information Theory – Probability Theory – Estimation Theory – Significance Testing – Information Theory.

UNIT II SPEECH SIGNAL REPRESENTATIONS AND CODING 9

Overview of Digital Signal Processing – Speech Signal Representations – Short time Fourier Analysis – Acoustic Model of Speech Production – Linear Predictive Coding – Cepstral Processing – Formant Frequencies – The Role of Pitch – Speech Coding – LPC Coder.

UNIT III SPEECH RECOGNITION 9

Hidden Markov Models – Definition – Continuous and Discontinuous HMMs – Practical Issues – Limitations. Acoustic Modeling – Variability in the Speech Signal – Extracting Features – Phonetic Modeling – Adaptive Techniques – Confidence Measures – Other Techniques.

UNIT IV TEXT ANALYSIS 9

Lexicon – Document Structure Detection – Text Normalization – Linguistic Analysis – Homograph Disambiguation – Morphological Analysis – Letter-to-sound Conversion – Prosody – Generation schematic – Speaking Style – Symbolic Prosody – Duration Assignment – Pitch Generation

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UNIT V SPEECH SYNTHESIS **9**

Attributes – Formant Speech Synthesis – Concatenative Speech Synthesis – Prosodic Modification of Speech – Source-filter Models for Prosody Modification – Evaluation of TTS Systems.

TOTAL: 45 PERIODS

OUTCOMES:

On successful completion of this course, the students will be able to,

- Identify the various temporal, spectral and cepstral features required for identifying speech units – phoneme, syllable and word
- Determine and apply Mel-frequency cepstral coefficients for processing all types of signals
- Justify the use of formant and concatenative approaches to speech synthesis
- Identify the apt approach of speech synthesis depending on the language to be processed
- Determine the various encoding techniques for representing speech.

REFERENCES:

1. Joseph Mariani, "Language and Speech Processing", Wiley, 2009.
2. Lawrence Rabiner and Biing-Hwang Juang, "Fundamentals of Speech Recognition", Prentice Hall Signal Processing Series, 1993.
3. Sadaoki Furui, "Digital Speech Processing: Synthesis, and Recognition", Second Edition, (Signal Processing and Communications), Marcel Dekker, 2000.
4. Thomas F.Quatieri, "Discrete-Time Speech Signal Processing", Pearson Education, 2002.
5. Xuedong Huang, Alex Acero, Hsiao-Wuen Hon, "Spoken Language Processing – A guide to Theory, Algorithm and System Development", Prentice Hall PTR, 2001.

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PG20CS305PE SOFTWARE QUALITY ASSURANCE AND TESTING

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OBJECTIVES:

The Student should be made to:

- Understand the basics of testing, test planning &design and test team organization
- Study the various types of test in the life cycle of the software product.
- Build design concepts for system testing and execution
- Learn the software quality assurance ,metrics, defect prevention techniques
- Learn the techniques for quality assurance and applying for applications.

UNIT I SOFTWARE TESTING - CONCEPTS, ISSUES, AND TECHNIQUES 9

Quality Revolution, Verification and Validation, Failure, Error, Fault, and Defect, Objectives of Testing, Testing Activities, Test Case Selection White-Box and Black ,test Planning and design, Test Tools and Automation, . Power of Test. Test Team Organization and Management-Test Groups, Software Quality Assurance Group ,System Test Team Hierarchy, Team Building.

UNIT II SYSTEM TESTING 9

System Testing - System Integration Techniques-Incremental, Top Down Bottom Up Sandwich and Big Bang, Software and Hardware Integration, Hardware Design Verification Tests, Hardware and Software Compatibility Matrix Test Plan for System Integration. Built-in Testing. functional testing - Testing a Function in Context. Boundary Value Analysis, Decision Tables. acceptance testing - Selection of Acceptance Criteria, Acceptance Test Plan, Test Execution Test. software reliability - Fault and Failure, Factors Influencing Software, Reliability Models

UNIT III SYSTEM TEST CATEGORIES 10

System test categories Taxonomy of System Tests, Interface Tests Functionality Tests. GUI Tests, Security Tests Feature Tests, Robustness Tests, Boundary Value Tests Power Cycling Tests Interoperability Tests, Scalability Tests, Stress Tests, Load and Stability Tests, Reliability Tests, Regression Tests, Regulatory Tests. Test Generation from FSM models-State-Oriented Model. Finite-State Machine Transition Tour Method, Testing with State Verification. Test Architectures-Local, distributed, Coordinated, Remote. system test design- Test Design Factors Requirement Identification, modeling a Test Design Process Test Design Preparedness, Metrics, Test Case Design Effectiveness. system test execution-Modeling Defects, Metrics for Monitoring Test Execution .Defect Reports, Defect Causal Analysis, Beta testing, measuring Test Effectiveness.

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UNIT IV SOFTWARE QUALITY **8**

Software quality - People's Quality Expectations, Frameworks and ISO-9126, McCall's Quality Factors and Criteria – Relationship. Quality Metrics. Quality Characteristics ISO 9000:2000 Software Quality Standard. Maturity models- Test Process Improvement ,Testing Maturity Model.

UNIT V SOFTWARE QUALITY ASSURANCE **9**

Quality Assurance - Root Cause Analysis, modeling, technologies, standards and methodologies for defect prevention. Fault Tolerance and Failure Containment – Safety Assurance and Damage Control, Hazard analysis using fault-trees and event-trees. Comparing Quality Assurance Techniques and Activities. QA Monitoring and Measurement, Risk Identification for Quantifiable Quality Improvement. Case Study: FSM-Based Testing of Web-Based Applications.

TOTAL: 45 PERIODS

OUTCOMES:

On successful completion of this course, the students will be able to,

- Understand the essential characteristics of tool used for test automation.
- Perform functional and nonfunctional tests in the life cycle of the software product.
- Understand system testing and test execution process.
- Identify defect prevention techniques and software quality assurance metrics.
- Apply techniques of quality assurance for typical applications.

REFERENCES:

1. Software Testing And Quality Assurance-Theory and Practice, Kshirasagar Nak Priyadarshi Tripathy, John Wiley & Sons Inc,2008
2. Software Quality Engineering: Testing, Quality Assurance, and Quantifiable Improvement, Jeff Tian, John Wiley & Sons, Inc., Hoboken, New Jersey. 2005.
3. Software Quality Assurance - From Theory to Implementation, Daniel Galin, Pearson Education Ltd UK, 2004
4. Software Quality Assurance, Milind Limaye, TMH ,New Delhi, 2011

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PG20CS306PE FORMAL MODELS OF SOFTWARE SYSTEMS

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OBJECTIVES:

The Student should be made to:

- Understand the goals, complexity of software systems, the role of Specification activities and qualities to control complexity.
- Understand the fundamentals of abstraction and formal systems
- Learn fundamentals of logic reasoning- Propositional Logic, temporal logic and apply to models systems
- Understand formal specification models based on set theory, calculus and algebra and apply to a case study
- Learn Z, Object Z and B Specification languages with case studies.

UNIT I SPECIFICATION FUNDAMENTALS **10**

Role of Specification- Software Complexity - Size, Structural, Environmental, Application, domain, Communication Complexity, How to Control Complexity. Software specification, Specification Activities-Integrating Formal Methods into the Software Life-Cycle. Specification Qualities- Process Quality Attributes of Formal Specification Languages, Model of Process Quality, Product Quality and Utility, Conformance to Stated Goals Quality Dimensions and Quality Model.

UNIT II FORMAL METHODS **8**

Abstraction- Fundamental Abstractions in Computing. Abstractions for Software Construction. Formalism Fundamentals - Formal Systems, Formalization Process in Software Engineering Components of a Formal System- Syntax, Semantics, and Inference Mechanism. Properties of Formal Systems - Consistency. Automata-Deterministic Finite Accepters, State Machine Modeling Nondeterministic Finite Accepters, Finite State Transducers Extended Finite State Machine. Case Study—Elevator Control. Classification of C Methods-Property-Oriented Specification Methods, Model-Based Specification Techniques.

UNIT III LOGIC **9**

Propositional Logic - Reasoning Based on Adopting a Premise, Inference Based on Natural Deduction. Predicate Logic - Syntax and Semantics, Policy Language Specification, knowledge Representation Axiomatic Specification. Temporal Logic -.Temporal Logic for Specification and Verification, Temporal Abstraction Propositional Temporal Logic (PTL), First Order Temporal Logic (FOTL).Formal Verification, Verification of Simple FOTL, Model Checking, Program Graphs, Transition Systems.

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UNIT IV SPECIFICATION MODELS 9

Mathematical Abstractions for Model-Based Specifications-Formal Specification Based on Set Theory, Relations and Functions. Property-Oriented Specifications- Algebraic Specification, Properties of Algebraic Specifications, Reasoning, Structured Specifications. Case Study—A Multiple Window Environment: requirements, Modeling Formal Specifications. Calculus of Communicating Systems: Specific Calculus for Concurrency. Operational Semantics of Agents, Simulation and Equivalence, Derivation Trees, Labeled Transition Systems.

UNIT V FORMAL LANGUAGES 9

The Z Notation, abstractions in Z, Representational Abstraction, Types, Relations and Functions, Sequences, Bags. Free Types-Schemas, Operational Abstraction -Operations Schema Decorators, Generic Functions, Proving Properties from Z specifications, Consistency of Operations. Additional Features in Z. Case Study: An Automated Billing System. The Object-Z Specification Language- Basic Structure of an Object-Z, Specification. Parameterized Class, Object-Orientation, composition of Operations-Parallel Communication Operator, Nondeterministic Choice Operator, and Environment Enrichment. The B-Method -Abstract Machine Notation (AMN), Structure of a B Specification, arrays, statements. Structured Specifications, Case Study- A Ticketing System in a Parking.

TOTAL: 45 PERIODS

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OUTCOMES:

On successful completion of this course, the students will be able to,

- Understand the complexity of software systems, the need for formal specifications activities and qualities to control complexity.
- Gain knowledge on fundamentals of abstraction and formal systems
- Learn the fundamentals of logic reasoning- Propositional Logic, temporal logic and apply to models systems
- Develop formal specification models based on set theory, calculus and algebra and apply to a typical case study
- Have working knowledge on Z, Object Z and B Specification languages with case studies.

REFERENCES:

1. Mathematical Logic for Computer Science, Second Edition, M.Ben-Ari, Springer, 2003.
2. Logic in Computer Science- modeling and reasoning about systems, 2nd Edition, Cambridge University Press, 2004.
3. Specification of Software Systems, V.S. Alagar, K. Periyasamy, David Grises and Fred B Schneider, Springer –Verlag London, 2011
4. The ways Z: Practical programming with formal methods, Jonathan Jacky, Cambridge University Press, 1996.
5. Using Z-Specification Refinement and Proof,Jim Woodcock and Jim Devies Prentice Hall, 1996
6. Z: An introduction to formal methods, Second Edition, Antoi Diller, Wiley, 1994.

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PG20CS307PE EMBEDDED SOFTWARE DEVELOPMENT

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OBJECTIVES:

The Student should be made to:

- Understand the architecture of embedded processor, microcontroller and peripheral devices.
- Interface memory and peripherals with embedded systems.
- Study the embedded network environment.
- Understand challenges in Real time operating systems.
- Study, analyze and design applications on embedded systems.

UNIT I EMBEDDED PROCESSORS **9**

Embedded Computers - Characteristics of Embedded Computing Applications - Challenges in Embedded Computing System Design - Embedded System Design Process- Formalism for System Design - Structural Description - Behavioural Description - ARM Processor - Intel ATOM Processor.

UNIT II EMBEDDED COMPUTING PLATFORM **9**

CPU Bus Configuration - Memory Devices and Interfacing - Input/Output Devices and Interfacing - System Design - Development and Debugging – Emulator – Simulator - JTAG Design Example – Alarm Clock - Analysis and Optimization of Performance - Power and Program Size.

UNIT III EMBEDDED NETWORK ENIVIRONMENT **9**

Distributed Embedded Architecture - Hardware And Software Architectures - Networks for Embedded Systems - I2C - CAN Bus - SHARC Link Supports – Ethernet – Myrinet – Internet - Network-based Design - Communication Analysis - System Performance Analysis - Hardware Platform Design - Allocation and Scheduling - Design Example - Elevator Controller.

UNIT IV REAL-TIME CHARACTERISTICS **9**

Clock Driven Approach - Weighted Round Robin Approach - Priority Driven Approach - Dynamic versus Static Systems - Effective Release Times and Deadlines - Optimality of the Earliest Deadline First (EDF) Algorithm - Challenges in Validating Timing Constraints in Priority Driven Systems - Off-Line versus On-Line Scheduling.

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UNIT V SYSTEM DESIGN TECHNIQUES **9**

Design Methodologies - Requirement Analysis – Specification - System Analysis and Architecture Design - Quality Assurance - Design Examples - Telephone PBX - Ink jet printer - Personal Digital Assistants - Set-Top Boxes.

TOTAL: 45 PERIODS

OUTCOMES:

On successful completion of this course, the students will be able to,

- Understand different architectures of embedded processor, microcontroller and peripheral devices. Interface memory and peripherals with embedded systems.
- Understanding and experience of state-of-the-practice industrial embedded systems and intelligent embedded system development.
- Work with embedded network environment.
- Understand challenges in Real time operating systems.
- Design and analyze applications on embedded systems.

REFERENCES:

1. Adrian McEwen, Hakim Cassimally, "Designing the Internet of Things" Wiley Publication, First edition, 2013
2. Andrew N Sloss, D. Symes, C. Wright, Arm system developers guide, Morgan Kauffman/Elsevier, 2006.
3. ArshdeepBahga, Vijay Madisetti, "Internet of Things: A Hands-on-Approach", VPT First Edition, 2014
4. C. M. Krishna and K. G. Shin, "Real-Time Systems", McGraw-Hill, 1997
5. Frank Vahid and Tony Givargis, "Embedded System Design: A Unified Hardware/Software Introduction", John Wiley & Sons.
6. Jane.W.S. Liu, "Real-Time systems", Pearson Education Asia.
7. Michael J. Pont, "Embedded C", Pearson Education , 2007.
8. Muhammad Ali Mazidi , SarmadNaimi , SepehrNaimi, "The AVR Microcontroller and Embedded Systems: Using Assembly and C", Pearson Education, First edition, 2014
9. Steve Heath, "Embedded SystemDesign" , Elsevier, 2005
10. Wayne Wolf, "Computers as Components:Principles of Embedded Computer System Design, Elsevier, 2006.

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PG20CS308PE SOCIAL NETWORK ANALYSIS

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OBJECTIVES:

The Student should be made to:

- Understand the components of the social network.
- Model and visualize the social network.
- Mine the users in the social network.
- Understand the evolution of the social network.
- Know the applications in real time systems.

UNIT I INTRODUCTION **9**

Introduction to Web - Limitations of current Web – Development of Semantic Web – Emergence of the Social Web – Statistical Properties of Social Networks -Network analysis - Development of Social Network Analysis - Key concepts and measures in network analysis - Discussion networks - Blogs and online communities - Web-based networks.

UNIT II MODELING AND VISUALIZATION **9**

Visualizing Online Social Networks - A Taxonomy of Visualizations - Graph Representation - Centrality- Clustering - Node-Edge Diagrams - Visualizing Social Networks with Matrix-Based Representations- Node-Link Diagrams - Hybrid Representations - Modelling and aggregating social network data – Random Walks and their Applications –Use of Hadoop and Map Reduce - Ontological representation of social individuals and relationships.

UNIT III MINING COMMUNITIES **9**

Aggregating and reasoning with social network data, Advanced Representations – Extracting evolution of Web Community from a Series of Web Archive - Detecting Communities in Social Networks - Evaluating Communities – Core Methods for Community Detection & Mining - Applications of Community Mining Algorithms - Node Classification in Social Networks.

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UNIT IV EVOLUTION **9**

Evolution in Social Networks – Framework - Tracing Smoothly Evolving Communities - Models and Algorithms for Social Influence Analysis - Influence Related Statistics - Social Similarity and Influence - Influence Maximization in Viral Marketing - Algorithms and Systems for Expert Location in Social Networks - Expert Location without Graph Constraints - with Score Propagation – Expert Team Formation - Link Prediction in Social Networks - Feature based Link Prediction – Bayesian Probabilistic Models - Probabilistic Relational Models.

UNIT V APPLICATIONS **9**

A Learning Based Approach for Real Time Emotion Classification of Tweets, A New Linguistic Approach to Assess the Opinion of Users in Social Network Environments, Explaining Scientific and Technical Emergence Forecasting, Social Network Analysis for Biometric Template Protection

TOTAL: 45 PERIODS

OUTCOMES:

On successful completion of this course, the students will be able to,

- Work on the internals components of the social network
- Model and visualize the social network
- Mine the behavior of the users in the social network
- Predict the possible next outcome of the social network
- Apply social network in real time applications

REFERENCES:

1. Ajith Abraham, Aboul Ella Hassanien, Václav Snasel, "Computational Social Network Analysis: Trends, Tools and Research Advances", Springer, 2012
2. Borko Furht, "Handbook of Social Network Technologies and Applications", Springer, 1st Edition, 2011
3. Charu C. Aggarwal, "Social Network Data Analytics", Springer; 2014
4. Giles, Mark Smith, John Yen, "Advances in Social Network Mining and Analysis", Springer, 2010.
5. Guandong Xu , Yanchun Zhang and Lin Li, "Web Mining and Social Networking – Techniques and applications", Springer, 1st Edition, 2012
6. Peter Mika, "Social Networks and the Semantic Web, Springer", 1st Edition, 2007.
7. Przemyslaw Kazienko, Nitesh Chawla, "Applications of Social Media and Social Network Analysis", Springer,2015

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PG20CS309PE BIO-INSPIRED COMPUTING

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OBJECTIVES:

The Student should be made to:

- Learn bio-inspired theorem and algorithms
- Understand random walk and simulated annealing
- Learn genetic algorithm and differential evolution
- Learn swarm optimization and ant colony for feature selection
- Understand bio-inspired application in image processing

UNIT I INTRODUCTION **9**

Introduction to algorithm - Newton's method - optimization algorithm - No-Free-Lunch Theorems - Nature-Inspired Mataheuristics -Analysis of Algorithms -Nature Inspires Algorithms -Parameter tuning and parameter control.

UNIT II RANDOM WALK AND ANEALING **9**

Random variables - Isotropic random walks - Levy distribution and flights - Markov chains - step sizes and search efficiency - Modality and intermittent search strategy - importance of randomization- Eagle strategy-Annealing and Boltzmann Distribution - parameters -SA algorithm - Stochastic Tunneling.

UNIT III GENETIC ALOGORITHMS AND DIFFERENTIAL EVOLUTION 9

Introduction to genetic algorithms and - role of genetic operators - choice of parameters - GA varients - schema theorem - convergence analysis - introduction to differential evolution - varients - choice of parameters - convergence analysis - implementation.

UNIT IV SWARM OPTIMIZATION AND FIREFLY ALGORITHM **9**

Swarm intelligence - PSO algorithm - accelerated PSO - implementation - convergence analysis - binary PSO - The Firefly algorithm - algorithm analysis - implementation - varients- Ant colony optimization toward feature selection.

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UNIT V APPLICATION IN IMAGE PROCESSING 9

Bio-Inspired Computation and its Applications in Image Processing: An Overview - Fine-Tuning Enhanced Probabilistic Neural Networks Using Meta-heuristic-driven Optimization - Fine-Tuning Deep Belief Networks using Cuckoo Search - Improved Weighted Thresholded Histogram Equalization Algorithm for Digital Image Contrast Enhancement Using Bat Algorithm - Ground Glass Opacity Nodules Detection and Segmentation using Snake Model - Mobile Object Tracking Using Cuckoo Search

TOTAL: 45 PERIODS

OUTCOMES:

On successful completion of this course, the students will be able to,

- Implement and apply bio-inspired algorithms
- Explain random walk and simulated annealing
- Implement and apply genetic algorithms
- Explain swarm intelligence and ant colony for feature selection
- Apply bio-inspired techniques in image processing.

REFERENCES:

1. Eiben,A.E.,Smith,James E, "Introduction to Evolutionary Computing", Springer 2015.
2. Helio J.C. Barbosa, "Ant Colony Optimization - Techniques and Applications", Intech 2013
3. Xin-She Yang , Jaao Paulo papa, "Bio-Inspired Computing and Applications in Image Processing",Elsevier 2016
4. Xin-She Yang, "Nature Ispired Optimization Algorithm", Elsevier First Edition 2014
5. Yang, Cui, XIao, Gandomi,Karamanoglu, "Swarm Intelligence and Bio-Inspired Computing", Elsevier First Edition 2013

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PG20CS310PE COMPILER OPTIMIZATION TECHNIQUES

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OBJECTIVES:

The Student should be made to:

- Be aware of different forms of intermediate languages and analyzing programs.
- Understand optimizations techniques for simple program blocks.
- Apply optimizations on procedures, control flow and parallelism.
- Learn the inter procedural analysis and optimizations.
- Explore the knowledge about resource utilization.

UNIT I INTERMEDIATE REPRESENTATIONS AND ANALYSIS 9

Review of Compiler Structure- Structure of an Optimizing Compiler – Intermediate Languages - LIR, MIR, HIR – Control Flow Analysis – Iterative Data Flow Analysis – Static Single Assignment – Dependence Relations - Dependences in Loops and Testing-Basic Block Dependence DAGs – Alias Analysis.

UNIT II EARLY AND LOOP OPTIMIZATIONS 9

Importance of Code Optimization Early Optimizations: Constant-Expression Evaluation - Scalar Replacement of Aggregates - Algebraic Simplifications and Re-association - Value Numbering - Copy Propagation - Sparse Conditional Constant Propagation. Redundancy Elimination: Common - Subexpression Elimination - Loop-Invariant Code Motion - Partial-Redundancy Elimination - Redundancy Elimination and Reassociation - Code Hoisting. Loop Optimizations: Induction Variable Optimizations - Unnecessary Bounds Checking Elimination.

UNIT III PROCEDURE OPTIMIZATION AND SCHEDULING 9

Procedure Optimizations: Tail-Call Optimization and Tail-Recursion Elimination - Procedure Integration - In-Line Expansion - Leaf-Routine Optimization and Shrink Wrapping. Code Scheduling: Instruction Scheduling - Speculative Loads and Boosting - Speculative Scheduling - Software Pipelining - Trace Scheduling - Percolation Scheduling. Control-Flow and Low-Level Optimizations : Unreachable-Code Elimination - Straightening - If Simplifications - Loop Simplifications -Loop Inversion – Un-switching - Branch Optimizations - Tail Merging or Cross Jumping - Conditional Moves - Dead-Code Elimination – Branch Prediction - Machine Idioms and Instruction Combining.

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UNIT IV INTER PROCEDURAL OPTIMIZATION 9

Symbol table – Runtime Support - Interprocedural Analysis and Optimization: Interprocedural Control Flow Analysis - The Call Graph - Interprocedural Data-Flow Analysis - Interprocedural Constant Propagation - Interprocedural Alias Analysis – Interprocedural Optimizations - Interprocedural Register Allocation - Aggregation of Global References.

UNIT V REGISTER ALLOCATION AND OPTIMIZING FOR MEMORY 9

Register Allocation: Register Allocation and Assignment - Local Methods - Graph Coloring – Priority Based Graph Coloring - Other Approaches to Register Allocation. Optimization for the Memory Hierarchy: Impact of Data and Instruction Caches - Instruction-Cache Optimization - Scalar Replacement of Array Elements - Data-Cache Optimization - Scalar vs. Memory-Oriented Optimizations.

TOTAL: 45 PERIODS

OUTCOMES:

On successful completion of this course, the students will be able to,

- Identify the different optimization techniques for simple program blocks.
- Design performance enhancing optimization techniques.
- Perform the optimization on procedures.
- Ensure better utilization of resources.
- Optimizing transformations, algorithms which take a program and transform it to produce a semantically equivalent output program.

REFERENCES:

1. Alfred V. Aho, Ravi Sethi, Jeffrey D. Ullman, "Compilers: Principles, Techniques, and Tools", Addison Wesley, Second Edition, 2007.
2. Andrew W. Appel, Jens Palsberg, "Modern Compiler Implementation in Java", Cambridge University Press, Second Edition, 2002.
3. Keith Cooper, Linda Torczon, "Engineering a Compiler", Morgan Kaufmann", Second Edition, 2011.
4. Randy Allen and Ken Kennedy, "Optimizing Compilers for Modern Architectures: A Dependence based Approach", Morgan Kaufman, 2001.
5. Robert Morgan ,"Building an Optimizing Compiler", Digital Press, 1998
6. Steven Muchnick, "Advanced Compiler Design and Implementation", Morgan Kaufman Publishers, 1997.

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PG20CS311PE DATA VISUALIZATION TECHNIQUES

L	T	P	C
3	0	0	3

OBJECTIVES:

The Student should be made to:

- Develop skills to both design and critique visualizations.
- Introduce visual perception and core skills for visual analysis.
- Understand visualization for time-series analysis.
- Understand visualization for ranking analysis.
- Understand visualization for deviation analysis.
- Understand visualization for distribution analysis.
- Understand visualization for correlation analysis.
- Understand visualization for multivariate analysis.
- Understand issues and best practices in information dashboard 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, AND DEVIATION ANALYSIS **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 – describing distributions – distribution patterns – distribution displays – 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.

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UNIT IV INFORMATION DASHBOARD DESIGN **9**

Information dashboard – Introduction– dashboard design issues and assessment of needs – Considerations for designing dashboard-visual perception – Achieving eloquence.

UNIT V INFORMATION DASHBOARD DESIGN **9**

Advantages of Graphics _Library of Graphs – Designing Bullet Graphs – Designing Sparklines – Dashboard Display Media –Critical Design Practices – Putting it all together-Unveiling the dashboard.

TOTAL: 45 PERIODS

OUTCOMES:

On successful completion of this course, the students will be able to,

- Explain principles of visual perception
- Apply core skills for visual analysis
- Apply visualization techniques for various data analysis tasks
- Design information dashboard
- Practical experience building and evaluating visualization systems.

REFERENCES:

1. Ben Fry, "Visualizing data: Exploring and explaining data with the processing environment", O'Reilly, 2008.
2. Edward R. Tufte, "The visual display of quantitative information", Second Edition, Graphics Press, 2001.
3. Evan Stubbs, "The value of business analytics: Identifying the path to profitability", Wiley, 2011.
4. Gert H. N. Laursen and Jesper Thorlund, "Business Analytics for Managers: Taking business intelligence beyond reporting", Wiley, 2010.
5. Nathan Yau, "Data Points: Visualization that means something", Wiley, 2013.
6. Stephen Few, "Information dashboard design: Displaying data for at-a-glance monitoring", second edition, Analytics Press, 2013.
7. Stephen Few, "Now you see it: Simple Visualization techniques for quantitative analysis", Analytics Press, 2009.
8. Tamara Munzner, "Visualization Analysis and Design", AK Peters Visualization Series, CRC Press, Nov. 2014

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PG20CS312PE RECONFIGURABLE COMPUTING

L T P C
3 0 0 3

OBJECTIVES:

The Student should be made to:

- Understand the need for reconfigurable computing
- Expose the students to various device architectures
- Examine the various reconfigurable computing systems
- Understand the different types of compute models for programming reconfigurable architectures
- Expose the students to HDL programming and familiarize with the development environment
- Expose the students to the various placement and routing protocols
- Develop applications with FPGAs

UNIT I DEVICE ARCHITECTURE **9**

General Purpose Computing Vs Reconfigurable Computing – Simple Programmable Logic Devices – Complex Programmable Logic Devices – FPGAs – Device Architecture - Case Studies.

UNIT II RECONFIGURABLE COMPUTING ARCHITECTURES AND SYSTEMS **9**

Reconfigurable Processing Fabric Architectures – RPF Integration into Traditional Computing Systems – Reconfigurable Computing Systems – Case Studies – Reconfiguration Management.

UNIT III PROGRAMMING RECONFIGURABLE SYSTEMS **9**

Compute Models - Programming FPGA Applications in HDL – Compiling C for Spatial Computing – Operating System Support for Reconfigurable Computing.

UNIT IV MAPPING DESIGNS TO RECONFIGURABLE PLATFORMS **9**

The Design Flow - Technology Mapping – FPGA Placement and Routing – Configuration Bitstream Generation – Case Studies with Appropriate Tools.

UNIT V APPLICATION DEVELOPMENT WITH FPGAS **9**

Case Studies of FPGA Applications – System on a Programmable Chip (SoPC) Designs.

TOTAL: 45 PERIODS

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OUTCOMES:

On successful completion of this course, the students will be able to,

- Identify the need for reconfigurable architectures.
- Discuss the architecture of FPGAs.
- Point out the salient features of different reconfigurable architectures.
- Build basic modules using any HDL.
- Develop applications using any HDL and appropriate tools.
- Design and build an SoPC for a particular application.

REFERENCES:

1. Christophe Bobda, "Introduction to Reconfigurable Computing – Architectures, Algorithms and Applications", Springer, 2010.
2. Maya B. Gokhale and Paul S. Graham, "Reconfigurable Computing: Accelerating Computation with Field-Programmable Gate Arrays", Springer, 2005.
3. FPGA Frontiers: New Applications in Reconfigurable Computing, 2017, Nicole Hemsoth, Timothy Prickett Morgan, Next Platform.
4. Reconfigurable Computing: From FPGAs to Hardware/Software Codesign 2011 Edition by Joao Cardoso (Editor), Michael Hübne, Springer
5. Scott Hauck and Andre Dehon (Eds.), "Reconfigurable Computing – The Theory and Practice of FPGA-Based Computation", Elsevier / Morgan Kaufmann, 2008.

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PG20CS313PE MOBILE APPLICATION DEVELOPMENT

L T P C
3 0 0 3

OBJECTIVES:

The Student should be made to:

- Understand system requirements for mobile applications.
- Generate suitable design using specific mobile development frameworks.
- Generate mobile application design.
- Implement the design using specific mobile development frameworks.
- Deploy the mobile applications in marketplace for distribution.

UNIT I INTRODUCTION **5**

Introduction to mobile applications – Embedded systems - Market and business drivers for mobile applications – Publishing and delivery of mobile applications – Requirements gathering and validation for mobile applications.

UNIT II BASIC DESIGN **8**

Introduction – Basics of embedded systems design – Embedded OS - Design constraints for mobile applications, both hardware and software related – Architecting mobile applications – User interfaces for mobile applications – touch events and gestures – Achieving quality constraints – performance, usability, security, availability and modifiability.

UNIT III ADVANCED DESIGN **8**

Designing applications with multimedia and web access capabilities – Integration with GPS and social media networking applications – Accessing applications hosted in a cloud computing environment – Design patterns for mobile applications.

UNIT IV ANDROID **12**

Introduction – Establishing the development environment – Android architecture – Activities and views – Interacting with UI – Persisting data using SQLite – Packaging and deployment – Interaction with server side applications – Using Google Maps, GPS and Wifi – Integration with social media applications.

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UNIT V IOS **12**

Introduction to Objective C – iOS features – UI implementation – Touch frameworks – Data persistence using Core Data and SQLite – Location aware applications using Core Location and Map Kit – Integrating calendar and address book with social media application – Using Wifi - iPhone marketplace.

TOTAL: 45 PERIODS

OUTCOMES:

On successful completion of this course, the students will be able to,

- Describe the requirements for mobile applications.
- Explain the challenges in mobile application design and development.
- Develop design for mobile applications for specific requirements.
- Implement the design using Android SDK.
- Implement the design using Objective C and iOS.
- Deploy mobile applications in Android and iPhone marketplace for distribution.

REFERENCES:

1. Charlie Collins, Michael Galpin and Matthias Kappler, "Android in Practice, DreamTech", 2012.
2. David Mark, Jack Nutting, Jeff LaMarche and Frederic Olsson, "Beginning iOS 6 a.Development: Exploring the iOS SDK", Apress, 2013.
3. http://developer.android.com/develop/index.html.
4. James Dovey and Ash Furrow, "Beginning Objective C", Apress, 2012.
5. Jeff McWherter and Scott Gowell, "Professional Mobile Application Development", Wrox,2012.
6. Reto Meier, "PProfessional android Development", Wiley-India Edition, 2012.

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PG20CS314PE BIO INFORMATICS

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OBJECTIVES:

The Student should be made to:

- Get exposed to the fundamentals of bioinformatics.
- Learn bio-informatics algorithm and phylogenetic concept.
- Understand open problems and issues in replication and molecular clocks.
- Learn assemble genomes and corresponding theorem.
- Study and exposed to the domain of human genomics.

UNIT I INTRODUCTION AND FUNDAMENTALS **9**

Fundamentals of genes , genomics , molecular evolution – genomic technologies – beginning of bioinformatics - genetic data –sequence data formats – secondary database – examples – data retrival systems – genome browsers.

UNIT II BIOINFORMATICS ALGORITHM AND ANALYSIS **9**

Sequence alignment and similarity searching in genomic databases: BLAST and FASTA – additional bioinformatics analysis involving nucleic acid sequences-additional bioinformatics analysis involving protein sequences – Phylogenetic Analysis.

UNIT III DNA REPLICATION AND MOLECULAR CLOCKS **9**

Beginning of DNA replication – open problems – multiple replication and finding replication – computing probabilities of patterns in a string-the frequency array-converting patterns- solving problems- finding frequents words-Big-O notation –case study-The Tower of Hanoi problem.

UNIT IV ASSEMBLE GENOMES AND SEQUENCES **9**

Methods of assemble genomes – string reconstruction – De Bruijn graph – Euler's theorem – assembling genomes –DNA sequencing technologies – sequence antibiotics – Brute Force Algorithm – Branch and Bound algorithm – open problems – comparing biological sequences- Case Study –Manhattan tourist Problem.

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UNIT V HUMAN GENOME **9**

Human and mouse genomes-random breakage model of chromosome evolution – sorting by reversals – greedy heuristic approach – break points- rearrangements in tumor and break point genomes-break point graps- synteny block construction -open problems and technologies.

TOTAL: 45 PERIODS

OUTCOMES:

On successful completion of this course, the students will be able to,

- Deploy the genomics technologies in Bioinformatics.
- Able to distinct efficient algorithm and issues.
- Deploy the replication and molecular clocks in bioinformatics.
- Work on assemble genomes and sequences.
- Use the Microarray technologies for genome expression.

REFERENCES:

1. Ion Mandoiu and Alexander Zelikovsky , "Computational Methods for Next Generation Sequencing Data Analysis", Wiley series 2016.
2. Istvan Miklos,Renyi Institutue, "Introduction to algorithms in bioinformatics", Springer 2016
3. Philip Compeau and Pavel pevzner, "Bioinformatics Algorithms: An Active Learning Approach", Second edition volume I , Cousera, 2015.
4. Supratim Choudhuri, "Bioinformatics For Beginners", Elsevier, 2014.

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PG20CS315PE INFORMATION STORAGE MANAGEMENT

L T P C
3 0 0 3

OBJECTIVES:

The Student should be made to:

- Understand the storage architecture and available technologies.
- Learn security aspects of storage & data center.
- Understand the Concept of Information Storage, Data centre Environment, Data Protection, Fibre Channel SAN and Backup and Archive Techniques.
- Learn to establish & manage datacenter.
- Analyze the common virtual technologies and processes.

UNIT I STORAGE TECHNOLOGY **9**

Review data creation and the amount of data being created and understand the value of data to a business, challenges in data storage and data management, Solutions available for data storage, Core elements of a data center infrastructure, role of each element in supporting business activities.

UNIT II STORAGE SYSTEMS ARCHITECTURE **9**

Hardware and software components of the host environment, Key protocols and concepts used by each component ,Physical and logical components of a connectivity environment ,Major physical components of a disk drive and their function, logical constructs of a physical disk, access characteristics, and performance Implications, Concept of RAID and its components, Different RAID levels and their suitability for different application environments: RAID 0, RAID 1, RAID 3, RAID 4, RAID 5, RAID 0+1, RAID 1+0, RAID 6, Compare and contrast integrated and modular storage systems ,Iligh-level architecture and working of an intelligent storage system.

UNIT III INTRODUCTION TO NETWORKED STORAGE **9**

Evolution of networked storage, Architecture, components, and topologies of FC-SAN, NAS, and IP-SAN, Benefits of the different networked storage options, understand the need for long-term archiving solutions and describe how CAS full fill the need, understand the appropriateness of the different networked storage options for different application environments

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UNIT IV INFORMATION AVAILABILITY, MONITORING & MANAGING DATACENTERS **9**

List reasons for planned/unplanned outages and the impact of downtime, Impact of downtime -Business continuity (BC) and disaster recovery (DR) ,RTO and RPO, Identifysingle points of failure in a storage infrastructure and list solutions to mitigate these failures, architecture of backup/recovery and the different backup/ recovery topologies, replication technologies and their role in ensuring information availability and business continuity, Remote replication technologies and their role in providing disaster recovery and business continuity capabilities. Identify key areas to monitor in a data center, Industry standards for data center monitoring and management, Key metrics to monitor for different components in a storage infrastructure, Key management tasks in a data center

UNIT V SECURING STORAGE AND STORAGE VIRTUALIZATION **9**

Information security, Critical security attributes for information systems, Storage security domains, List and analyzes the common threats in each domain, Virtualization technologies, block-level and file-level virtualization technologies and processes.

TOTAL: 45 PERIODS

OUTCOMES:

On successful completion of this course, the students will be able to,

- Select from various storage technologies to suit for required application.
- Apply security measures to safeguard storage & farm.
- Analyze QoS on Storage.
- Search, retrieve and synthesize information from a variety of systems and sources.
- Integrate emerging technologies into professional practice.

REFERENCES:

1. EMC Corporation, "Information Storage and Management: Storing, Managing, and Protecting Digital Information", Wiley, India, 2010
2. Marc Farley, "Building Storage Networks", Tata McGraw Hill ,Osborne, 2001.
3. Robert Spalding, "Storage Networks: The Complete Reference", Tata McGraw Hill , Osborne, 2003.

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KONGUNADU COLLEGE OF ENGINEERING AND TECHNOLOGY

(AUTONOMOUS)

GUIDELINES FOR PREPARATION OF M.E./M.TECH
PHASE I REPORT & PHASE II THESIS

(Prescribed Format and Specification)

1. GENERAL:

The broad guidelines to the preparation of M.E./M.Tech report/ thesis are outlined below. In general, the thesis shall report, in an organized fashion, an account of original research work of the student leading to the discovery of new facts or techniques or correlation of facts already known (analytical, experimental, hardware oriented etc) and demonstrating a quality so as to make a definite contribution to the advancement of knowledge and the student's ability to undertake sustained research and present the findings in an appropriate manner with actual accomplishments of the work plainly stated and honestly appraised.

2. NUMBER OF COPIES TO BE SUBMITTED FOR EVALUATION:

M.E. / M.Tech Report /Thesis	:	Three copies are to be submitted to the Department where the student is studying (one copy each to student, supervisor and Department library)

3. SIZE OF REPORT / THESIS:

The size of report should not be less than 25 pages for phase I and 40 pages for phase II thesis, (with more emphasis on results and discussions) of typed matter reckoned from the first page of Chapter 1 to the last page of the Appendix.

4. ARRANGEMENT OF CONTENTS OF REPORT /THESIS:

The sequence in which the report / thesis material should be arranged and bound should be as follows:

1. Cover Page & Title page
2. Bonafide Certificate
3. Abstract (Tamil and English)
4. Acknowledgement
5. Table of Contents
6. List of Tables
7. List of Figures
8. List of Symbols, Abbreviations and Nomenclature (Optional)
9. Chapters
10. Appendices
11. References

The Tables and Figures shall be introduced in the appropriate places.

5. PAGE DIMENSIONS AND MARGIN:

The dimensions of the report/thesis should be 290mm x 205mm. Standard A4 size (297mm x 210mm) paper may be used for preparing the copies.

The Report /Thesis (at the time of submission) should have the following page margins :

Top edge	:	30 to 35 mm
Bottom edge	:	25 to 30 mm
Left side	:	35 to 40 mm
Right side	:	20 to 25 mm

The report/thesis should be prepared on good quality white paper preferably not lower than 80 gsm.

Tables and figures should conform to the margin specifications. Large size figures should be photographically or otherwise reduced to the appropriate size before insertion.

6. MANUSCRIPT PREPARATION:

The general text of thesis shall be typed in font style Times New Roman and font size 13. Same quality of paper should be used for the preparation of the entire report / thesis.

The headings of all items 2 to 10 listed in section 4 should be typed in capital letters without punctuation and centered 50mm below the top of the page. The text should commence 4 spaces below this heading.

6.1 Cover Page & Title Page - A specimen copy of the Cover page & Title page for report/thesis are given in Annexure I.

6.2 Bonafide Certificate – The Bonafide Certificate shall be in 1½ and double spacing as per the format shown in Annexure II. The certificate shall carry the supervisor's signature and shall be followed by the supervisor's name, academic designation (not any other responsibilities of administrative nature), department and full address of the institution where the supervisor has guided the student. If Joint Supervisor is involved, a third column may be added after the Supervisor with the details as similar to that of Supervisor.

6.3 Abstract - Abstract should be an essay type of narration not exceeding two pages outlining the research problem, the methodology used for tackling it and a summary of the findings, typed in double line spacing.

6.4 Acknowledgement – The acknowledgement shall be brief and should not exceed one page, typed in double spacing. The student's signature shall be made at the right bottom above his / her name typed in capitals.

6.5 Table of contents - The table of contents should list all material following it as well as any material which precedes it. The title page, Bonafide Certificate and Acknowledgment will not find a place among the items listed in the Table of Contents but the page numbers in lower case Roman letters are to be accounted for them. One and a half spacing should be adopted for typing the matter under this head. A specimen copy of the Table of Contents for report / thesis is given in Annexure III.

6.6 List of Table - The list should use exactly the same captions as they appear above the tables in the text and the caption shall follow 'sentence case'. One and a half spacing should be adopted for typing the matter under this head.

6.7 List of Figures - The list should use exactly the same captions as they appear below the figures in the text and the caption shall follow 'sentence case'. One and a half spacing should be adopted for typing the matter under this head.

6.8 List of Symbols, Abbreviations and Nomenclature - One and a half spacing should be adopted for typing the matter under this head. Standard symbols, abbreviations etc. should be used.

6.9 Chapters - The chapters may include

For Phase I – Report

Chapter I - Introduction

Chapter II - Literature Review

Chapter III - Theoretical Background / Concepts/ Methodology /Design/ Modeling

The other chapters may include Project implementation / Results and Discussion as applicable.

Conclusions and Work schedule for Phase II

Appendices (if any)

References (must also be included in text).

For Phase II Thesis

Chapter I - Introduction

Chapter II - Literature Review

Chapter III - Theoretical Background / Concepts/ Methodology /Design/ Modeling

The other chapters may include Results of Analytical / Design / Modeling and Simulation / Experimental study and discussion as applicable.

Conclusions and Scope for future work

Appendices (if any)

References (must also be included in text)

- The main text may have several chapters and each chapter may be divided into several divisions and sub-divisions.
- Each chapter should be given an appropriate title.
- Tables and Figures in a chapter should be placed in the immediate vicinity of the reference where they are cited.
- Footnotes should be used sparingly. They should be typed single space and placed directly underneath in the very same page, which refers to the material they annotate.

6.10 Appendices - Appendices are provided to give supplementary information, which if included in the main text may serve as a distraction and cloud the central theme under discussion.

* Appendices should be numbered using Arabic numerals, e.g. Appendix 1, Appendix 2, etc.

* Appendices, Tables and references appearing in Appendices should be numbered and referred to at appropriate places just as in the case of chapters.

* Appendices shall carry the title of the work reported and the same title shall be made in the contents page also.

* The list of publications made by research student during the period of research, shall be brought in the Appendix titled, as List of Publications and the same shall be reported in the contents. The author can refer the publications mentioned in the Appendix, in the text of the Report / Thesis, by mentioning his/her name followed by Appendix number and the year of publication, in brackets.

6.11 List of References - Any works of other researchers, if used either directly or indirectly, should be indicated at appropriate places in the report/thesis. The citation may assume any one of the following forms.

The authors publications during the period of research should not be included in the references and can be separately mentioned as in 6.10.

Examples of citation

(i) An improved algorithm has been adopted in literature (Tsychiya 1980)

(ii) Jankins and Walts (1968) have dealt at length this principle.

(iii) The problem of mechanical manupulators has been studied by Shin et al (1984) and certain limitations of the method used, has been pointed out by Shin et al (1984 a).

The listing should be typed 4 spaces below the heading "REFERENCES" in alphabetical order in single spacing left-justified. The reference material should be listed in the alphabetical order of the first author. The name of the author/authors should be immediately followed by the year and other details. A typical illustrative list given below relates to the citation example quoted above.

REFERENCES

1. Ariponnammal S. and Natarajan S. (1994), 'Transport Phonomena of Sm Se1-x Asx', Pramana – Journal of Physics, Vol. 42, No.5, pp.421-425.

2. Barnard R.W. and Kellogg C. (1980) 'Applications of Convolution operators to Problems in univalent function theory', Michigan Mach. Journal, Vol. 27, pp.1-94.

3. Jankins G.M. and Walts D.G. (1968),‘ Spectral Analysis and its Applications', Holder Day, Sanfrancisco.

4. Shin K.G. and Mckay N.D. (1984), ‘ Open loop minimum time control of mechanical manipulations and its applications’, Proc. Amer. Contr. Conf., San Diego, CA, pp.1231-1236.

6.12 Tables and Figures - By the word Table, is meant tabulated numerical data in the body of the thesis as well as in the appendices. All other non-verbal material used in the body of the thesis and appendices such as charts, graphs, maps, photographs and diagrams may be designated as figures.

* A table or figure including caption should be accommodated within the prescribed margin limits and should appear on the page, where the first reference is made as far as possible.

* Tables and figures on half page or less in length may appear on the same page along with the text. However, they should be separated from the text both above and below by triple spacing.

* Two or more small tables or figures may be grouped if necessary in a single page.

* Photographs if any, should be included as colour print only. More than one photograph can be included in a page.

* Samples of Fabric, Leather, etc., if absolutely necessary may be attached evenly in a page and fixed/pasted suitably and should be placed in Appendix only.

The caption of figure should follow sentence case, centre aligned and placed below the figure. The caption of table should be at the top of the table, left aligned and placed above the table.

7. TYPING INSTRUCTIONS

7.1 General

This section includes additional information for final typing of the thesis. Some information given earlier under 'Manuscript preparation' shall also be referred. The impressions on the typed/duplicated/printed copies should be black in colour. Corrections, interlineations and crossing out of letters or words will not be permitted in any of the copies of the report/thesis intended for submission. Erasures, if made, should be neatly carried out in all copies. A sub-heading at the bottom of a page must have at least two full lines below it or else it should be carried over to the next page. The last word of any page should not be split using a hyphen. One and a half spacing should be used for typing the general text. The general text shall be typed in Font Style Times New Roman and Font Size 13.

Single spacing should be used for typing:

(i) Long Tables
(ii) Long quotations
(iii) Foot notes
(iv) Multilane captions
(v) References

All quotations exceeding one line should be typed in an indented space, the indentation being 15mm from either margin. Double spacing should be used for typing the Bonafide Certificate and Acknowledgement.

7.2 Chapters

The format for typing chapter headings, division headings and sub division headings shall be same as given in Table of Contents.

The word CHAPTER without punctuation should be centred 50mm down from the top of the page. Two spaces below, the title of the chapter should be typed centrally in capital letters. The text should commence 4 spaces below this title, the first letter of the text starting 20mm, inside from the left hand margin.

The division and sub-division captions along with their numberings should be left-justified. The captions should start at 20 mm from left margin. The typed material directly below division or sub-division heading should commence 2 spaces below it and should be offset 20mm from the left hand margin. Within a division or sub-division paragraphs are permitted. The paragraph should commence 3 spaces below the last line of the preceding paragraph or caption, the first letter in the paragraph being offset from the left hand margin by 20 mm.

8. NUMBERING INSTRUCTIONS

8.1 Page Numbering

All pages numbers (whether it be in Roman or Arabic numbers) should be typed without punctuation on the upper right hand corner 20mm from top with the last digit in line with the right hand margin. The preliminary pages of the thesis (such as Title page, Acknowledgement, Table of Contents etc.) should be numbered in lower case Roman numerals. The title page will be numbered as (i) but this should not be typed. The page immediately following the title page shall be numbered (ii) and it should appear at the top right hand corner as already specified. Pages of main text, starting with Chapter 1 should be consecutively numbered using Arabic numerals.

8.2 Numbering of Chapters, Divisions and Sub-Divisions

The numbering of chapters, divisions and sub-divisions should be done using Arabic numerals only and further decimal notation should be used for numbering the divisions and sub-divisions within a chapter. For example division / sub-division 4 under division 3 belonging to chapter 2 should be numbered as 2.3.4. The title for the division/sub-division shall start at 20mm from the left margin, following the number assigned to it.

Every chapter beginning with the first chapter should be serially numbered using Arabic numerals. Appendices included should also be numbered in an identical manner starting with Appendix 1.

8.3 Numbering of Tables and Figures

Tables and Figures appearing anywhere in the thesis should bear appropriate numbers. The rule for assigning such numbers is illustrated through an example. Thus, if a figure in Chapter 3, happens to be the fourth then assign 3.4 to that figure. Identical rules apply for tables except that the word Figure is replaced by the word Table. If figures (or tables) appear in appendices then figure 3 in Appendix 2 will be designated as Figure A 2.3. If a table to be continued into the next page this may be done, but no line should be drawn underneath an unfinished table. A table continued into the next page should have a caption like, Table 2.1 (continued), placed centrally and underlined.

8.4 Numbering of Equations

Equations appearing in each Chapter or Appendix should be numbered serially, the numbering shall commence freshly for each Chapter or Appendix. Thus for example, an equation appearing in Chapter 2, if it happens to be the eighth equation in that Chapter should be numbered (2.8), while referring to this equation in the body of the thesis it should be referred to as Equation (2.8).

9. BINDING SPECIFICATIONS

Thesis should be bound using flexible cover of thick white art paper. The cover should be printed in black colour and the text for printing should be identical as prescribed for the title page.

APPENDIX I A:

(A typical Specimen of Cover Page & Title Page – Phase I Report)

<Font Style - Times New Roman - Bold>

TITLE OF REPORT

<Font Size 18> <1.5 line spacing>

PHASE I REPORT

<Font Size 14>

Submitted by

<Font Size 14> <Italic>

NAME OF THE CANDIDATE

<Font Size 16>

in partial fulfillment for the award of the degree of

<Font Size 14> <1.5 line spacing>

MASTER OF ENGINEERING IN
NAME OF THE PROGRAMME

<Font Size 16>

KONGUNADU COLLEGE OF ENGINEERING AND TECHNOLOGY
(AUTONOMOUS)

<Font Size 14>

NAME OF THE DIVISION OR CENTRE
DEPARTMENT OF CIVIL ENGINEERING
ANNA UNIVERSITY, CHENNAI <Font Size 16><1.5 line spacing>

MONTH AND YEAR

APPENDIX I B:

(A typical Specimen of Cover Page & Title Page –Thesis)

<Font Style Times New Roman - Bold>

TITLE OF THESIS

<Font Size 18> <1.5 line spacing>

A THESIS

<Font Size 14>

Submitted by

<Font Size 14> <Italic>

NAME OF THE CANDIDATE

<Font Size 16>

in partial fulfillment for the award of the degree of

<Font Size 14> <1.5 line spacing>

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(AUTONOMOUS)

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NAME OF THE DIVISION OR CENTRE
DEPARTMENT OF CIVIL ENGINEERING
ANNA UNIVERSITY, CHENNAI

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MONTH AND YEAR

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APPENDIX I C:

(A sample Cover Page & Title Page –Thesis)

STUDIES ON SOLID STATE ANAEROBIC DIGESTION OF MUNICIPAL SOLID WASTE

A THESIS

Submitted by

GIRIJA DEVI G

in partial fulfillment for the award of the degree of

MASTER OF ENGINEERING IN ENVIRONMENTAL ENGINEERING

KONGUNADU COLLEGE OF ENGINEERING AND TECHNOLOGY (AUTONOMOUS)

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CENTRE FOR ENVIRONMENTAL STUDIES
DEPARTMENT OF CIVIL ENGINEERING
ANNA UNIVERSITY, CHENNAI

APRIL 2014

APPENDIX – II A: ***(A typical Specimen of Bonafide Certificate for Phase I Report)***

Font Style <Times New Roman >

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ANNA UNIVERSITY, CHENNAI

<Font Style Times New Roman – Size - 18>

BONAFIDE CERTIFICATE

<Font Style Times New Roman – Size - 16>

<Font Style Times New Roman – Size - 13>

Certified that this Report titled "**TITLE OF THE PROJECT**" is the bonafide work of **NAME OF THE CANDIDATE (Register No.....)** who carried out the work under my supervision. Certified further that to the best of my knowledge the work reported herein does not form part of any other thesis or dissertation on the basis of which a degree or award was conferred on an earlier occasion on this or any other candidate.

<<Signature of the HOD with date>>	<<Signature of the Supervisor with date>>
<<Name of the HOD >>	<<Name of the Supervisor >>
Professor and Head	<<Academic Designation of Supervisor>>
Department of Civil Engineering	<<Name of Division/Centre>>
Anna University	Anna University
Chennai – 600 025	Chennai – 600 025

Submitted for the project viva-voce examination held on _____

INTERNAL EXAMINER **EXTERNAL EXAMINER**

APPENDIX – II B: ***(A typical Specimen of Bonafide Certificate for Thesis (Phase II))***

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ANNA UNIVERSITY, CHENNAI

<Font Style Times New Roman – Size - 18>

BONAFIDE CERTIFICATE

<Font Style Times New Roman – Size - 16>

<Font Style Times New Roman – Size - 13>

Certified that this Thesis titled "**TITLE OF THE PROJECT**" is the bonafide work of **NAME OF THE CANDIDATE (Roll No.....)** who carried out the work under my supervision. Certified further that to the best of my knowledge the work reported herein does not form part of any other thesis or dissertation on the basis of which a degree or award was conferred on an earlier occasion on this or any other candidate.

<<Signature of the HOD with date>>	<<Signature of the Supervisor with date>>
<<Name of HOD >>	<<Name of the Supervisor >>
Professor and Head	<<Academic Designation of Supervisor>>
Department of Civil Engineering	<<Name of Division/Centre>>
Anna University	Anna University
Chennai – 600 025	Chennai – 600 025

Submitted for the project viva-voce examination held on _____

INTERNAL EXAMINER **EXTERNAL EXAMINER**

ANNEXURE III

(A typical Specimen of Table of Contents)
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TABLE OF CONTENTS