Parvatibai Chowgule College of Arts and Science

(Autonomous)

DEPARTMENT OF COMPUTER SCIENCE

M.Sc [Information Technology] COURSE STRUCTURE
(2021-2022)

Semester I (20 credits)

Course Code	**Course Type**	**Course Title**	**Credits**	**Contact hours/week**	
				L	**P**
PGM-IT.C.1	Core – I	Data Structures and Algorithms	4	4	0
PGM-IT.C.2	Core – II	Operating Systems and Networks	4	4	0
PGM-IT.C.3	Core III Lab – I	Data Structures and Algorithms Lab	2	0	4
PGM-IT.C.4	Core IV Lab – II	Operating Systems and Networks Lab	2	0	4
	Elective - I	Elective Course	4	4	0
	Elective – II	Elective Course	4	4	0

Semester II (22 credits)

Course Code	**Course Type**	**Course Title**	**Credits**	**Contact hours/week**	
				L	**P**
PGM-IT.C.5	Core – V	Software Architecture, Design Patterns and Frameworks	4	4	0
PGM-IT.C.6	Core – VI	Design and Analysis of Algorithms	4	4	0
PGM-IT.C.7	Core - VII	Statistical Computing	2	2	0
PGM-IT.C.8	Core VIII Lab – III	Software Architecture, Design Patterns and Frameworks Lab	2	0	4

PGM-IT.C.9	Core IX Lab – IV	Design and Analysis of Algorithms Lab	2	0	4
	Elective – III	Seminar	2	2	0
	Elective IV	Elective Course	4	4	0
	Elective V Lab – V	Elective Lab	2	0	4

Semester III (14 credits)

Course Code	**Course Type**	**Course Title**	**Credits**	**Contact hours/week**	
				L	**P**
PGM-IT.C.10	Core – X	Information Retrieval	4	4	0
PGM-IT.C.11	Core XI Lab – VI	Information Retrieval Lab	2	0	4
	Elective - VI	Elective Course	4	4	0
	Elective – VII	Elective Course	4	4	0

Semester IV (8Credits)

Course Code	**Course Type**	**Course Title**	**Credits**	**Contact hours/week**	
				L	**P**
	Elective– IX	Industrial Project/Dissertation	8	0	0

Legend:

L– Lectures
P –Practicals

- The course codes of elective courses are mentioned in the list of electives.

Course Title: Data Structures and Algorithms
Course Code: PGM-IT.C.1
Marks: 100
Credits: 4
Duration: 48 Hrs

Course Prerequisites:

Familiarity with basic data structures like Stacks, Queues, Linked Lists and Binary Trees.

Course Objectives:

The objective of the course is to understand the real-life applications of data structures and be familiar with writing recursive and iterative methods using data structures.

Course Outcomes:
At the end of the course students will be able to:
CO1: Design an algorithm for the use case.
CO2: Choose efficient data structures and apply them to solve problems.
CO3: Design and analyze the time and space efficiency of the data structure.
CO4: Formulate new solutions for programing problems or improve existing code using learned algorithms and data structures,

Syllabus:

Unit I: **[8 Hrs]**

Overview of Linear Data Structures

ADT, Sparse matrices, Linked Lists:, Doubly linked list, Circular linked list. Stack and Queues: Need and justification of the study, Multiple stacks and queues, Implementation of recursion using stack, Application of stacks, queues and linked lists.

Unit II: **[16 Hrs]**

Non Linear Data Structures
Trees: Definitions, terminologies and properties, Binary tree representation and traversals , AVL Trees, Red Black Tree, suffix trees, Segment Tree, Splay trees ,M-way Search Trees, B-trees, B*- trees, B+- trees. Graphs: Graph representations; Graph Traversals , Eulerian Graphs , Hamiltonian Graphs. Priority Queues, Heap Structures.

Unit III: **[9 Hrs]**

Complexity of Sorting and Searching Algorithms
Mathematical Background, Big-O notation, Running Time computation, Radix Sort, Heap sort, Quick Sort, Merge Sort ,Shell Sort, Interpolation search, Symbol Tables.

Unit IV: **[15 Hrs]**

File Organization and Processing
Dynamic memory management. Sequential files, Hashing techniques: Approaches to collision problem, Indexed sequential files: organization, Creation, Update and Maintenance, Multi-key files, Inverted file,
Multi-list file, Tries: Standard Tries and Compressed Tries,,Huffman Algorithm.

REFERENCES:

Mandatory:
1. R. Venkatesan , S. Lovelyn Rose (2019) "Data structures" (2nd Ed) Wiley.
2. Prof Peter Brass (2014) "AdvancedData Structures ",(1st Ed), Cambridge University Press.

Supplementary:
1. Alfred V. Aho, John E Hoproft, Jeffrey D. Ullman, "Data structures and algorithms",(2nd Ed) Pearson Education India Delhi,
2. Jean-Paul Tremblay, Paul Sorenson (2017), An Introduction to Data Structures with Application, (2 nd Ed), McGraw Hill Education.

Web References:
1: http://www.cs.cmu.edu/~ab/15-121N11/
2: https://www.cse.iitb.ac.in/~ranade/cs213/
3: http://cse.iitrpr.ac.in/ckn/courses/f2015/csl201/w4.pdf
4: https://www.cpp.edu/~ftang/courses/CS241/notes/b-tree.html
5: https://www.cs.usfca.edu/~galles/visualization/Algorithms.html

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Course Title: Operating Systems and Networks
Course Code: PGM-IT.C.2
Marks: 100
Credits:4
Duration: 48 Hrs

Course Pre-Requisites:
- Basics of Operating Systems and Networks

Course Objectives:

- To understand Real time operating systems
- To gain understanding in specific areas of networking such as the design and maintenance of individual networks.

Course Outcomes:

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

CO1: Analyze the structure of Operating system.

CO2: Analyze various Resource management and fault tolerance techniques for real time systems. **CO3:** Discuss the fundamentals of IP addressing.

CO4: Apply subnet masking concepts to allocate space for host in subnet.

CO5: Examine techniques to protect the network.

Syllabus:

Unit I: Overview of Operating Systems [12Hrs]

Processes and Threads - Process Scheduling -Synchronization Mechanisms -Deadlocks – Models of Resources – Memory Management Techniques.

Real time Operating systems: Basic model of real time systems, Characteristics, Applications of real time systems, Real time task scheduling, handling resource sharing, Micro kernel design, Processes and Threads, Memory Management, File system. Failure Recovery and Fault Tolerance, Approaches of fault tolerance

Unit II: Network Service Design [12Hrs]

Introduction, Strategy for Network Service Implementation

TCP/IP: Introduction to TCP/IP, Benefits of using TCP/IP,IP addressing, IP Network and Host addressing, Classfull and classless IP addresses, IPV6, Subnet mask, Subnetting and supernetting

Switch Technology: Switch fundamentals (Bridges vs. Switches) – Spanning Tree Protocol: Overview, Spanning tree protocol, Rapid Spanning tree protocol.

Unit III: Routed Networks [12Hrs]

VLANs and VLAN Trunking:VLAN- concepts, broadcast domains with VLANs and routers, preventing broadcast storms. VLAN Trunking Protocol, VTP modes of operation, Routing between VLANs, Inter-VLAN routing issues.

Routing: Static V/s Dynamic routes, Adding and deleting static routes, Routing protocol, RIP, OSPF, IGP, Secure IP routing.

Unit IV: Network Administration [12Hrs]

Network administration:SNMP& RMON - Overview and features, MIB Management Information base Installing SNMP Servers, SNMP communities, Authentication and securing Monitoring and analysis and troubleshooting, Overview and installation: fire wall, NAT, E-mail (Send mail), Radius, Remote access servers, proxy servers.

Wireless Networking: Overview, Infrastructure mode, Ad Hoc Mode, ESSID, wireless channels, wireless security, Authentication.

References:

Mandatory:

1. Singhal, M. &Shivaratri, N.G (2000), *Advanced concepts in operating systems.* Delhi, India: McGraw-Hill. 2. Beasley, J S. &Nilkaew, P. (2015), *A practical guide to advanced networking*, Chennai, India: Pearson.

Supplementary:

1. Stallings, W.(2009), *Wireless communications and networks,* (2nd Ed), New Delhi, India: Prentice Hall of India

Web Resources:

1. https://swayam.gov.in/nd1_noc20_cs16/preview
2. https://swayam.gov.in/nd1_noc20_cs23/preview
3. http://study-ccna.com/
4. http://www.packettracernetwork.com/

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Course Title: Data Structures and Algorithms Lab
Course Code: PGM-IT.C.3
Marks: 50
Credits: 2
Duration: 48 Hrs

Course Prerequisites:

Theoretical Knowledge of Data Structures

Course Objective:

- Introduce students to a number of highly efficient algorithms and data structures for fundamental computational problems across a variety of areas.
- Analyze a problem and determine the appropriate data structure for the problem.
- Analyze the asymptotic performance of algorithms .

Course Outcomes:

At the end of the course students will be able to:
CO1: Select algorithm design approaches in a problem specific manner.
CO2: Become proficient in applying knowledge from the theory of Data Structures to various application areas.
CO3: Design Algorithms to solve the problems.
CO4: Discuss different Data Structures to represent real world problems.

List of suggested assignments:

1. Implementation of Basic Data Structure such as Stack, Queue, Linked List etc.	[6 Hrs]
2. Implementation of a Huffman code for the text file.	[5 Hrs]
3. Implementation of AVL Tree.	[6 Hrs]
4. Implementation of Red Black tree.	[6 Hrs]
5. Implementation of Sorting Techniques(Quick Sort and Merge Sort)	[4 Hrs]
6. Implementation of Graph Traversal Techniques.	[4 Hrs]
7. Implementation of linear probing, quadratic hashing and Double hashing.	[6 Hrs]
8: Implementation of Trie.	[5 Hrs]
9. Implementation of B Trees and B+ Trees	[6 Hrs]

Mini Project on the application of Data Structures.

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Course Title: Operating Systems and Networks Lab

Course Code: PGM-IT.C.4

Marks: 50

Credits: 2

Duration: 48 Hrs.

Course Pre-Requisites:
- Theoretical Knowledge of operating systems and networks.

Course Objectives:
- To provide practical base in operating system and networks.

Course Outcomes:
At the end of the course students will be able to:
CO1: Manage processes, memory and file system using system calls.
CO2: Illustrate socket communication involving sender process and receiver process using TCP and UDP.
CO3: Analyze network traffic by using network analyzer tool.
CO4: Design and demonstrate VLAN's by using simulation tool.

Syllabus:
Implementation of:

1. File operations. **[4Hrs]**
2. Identifiers, fork, exec, and wait functions **[4Hrs]**
3. Iterative TCP client and server application **[4Hrs]**
4. Concurrent TCP client and server application **[4Hrs]**
5. UDP client and server application **[4Hrs]**
6. Using nmap for port scanning and vulnerability detection. **[4Hrs]**
7. Configuration of a Firewall. **[4Hrs]**
8. Configuration of Intrusion detection system**.** **[4Hrs]**
9. Using ethereal or tcp dump to analyze network traffic. **[4Hrs]**
10. Creating subnets and supernets using simulation tools. **[4Hrs]**
11. Configuring static and dynamic route using routing tools. **[4Hrs]**
12. Configuring VLANs. **[4Hrs]**

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Course Title: Software Architecture, Design Patterns and Frameworks
Course Code: PGM-IT.C.5
Marks: 100
Credits: 4
Duration: 48 Hrs.

Course Pre-Requisites:

- Familiarity with requirement elicitation techniques and knowledge of basics of software design, programming and testing

Course Objectives:

- Learning Software Development using good OO Design andArchitecture
- Understanding of Design and Architectural patterns and Frameworks.

Course Outcomes:

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

CO1: Apply various concepts of Object-Oriented Analysis and Design while solving problems.

CO2: Analyze a problem scenario and prepare various models of the solution.

CO3: Analyze a given problem and study the applicability of Design Patterns to the problem.

CO4: Generate code skeletons in any OO programming language from UML class diagram.

Syllabus:

Unit I OO Design, Use case &Structural Modeling [12 Hrs]

Encapsulation, Abstraction, Implementation Hiding, Inheritance, Dynamic binding, Polymorphism, Overriding and Overloading, SOLID Principles of Object-Oriented Design. Scenarios, Actors & Use Cases, The include and extend relationships, Use Case Generalization, Writing Use Cases formally, Choosing System Boundary, Finding Actors and Use cases, Using use cases for Verification and Validation, Use-Case Realization Classes, Objects, Attributes and Operations, Visibility of attributes and operations, Class-Scope Attributes, Attributes withdefault values, Association, Multiplicity, Role-Name, Qualified Association, Association Class**,** Ternary Association, Recursive Association, Multiple Association between two classes, Composite and Shared Aggregation, Generalization and sub-class partitioning, Generalization Set, Interfaces and their realization, Packages and Grouping of classes into Packages , ParameterizedClasses.

Unit II Dynamic Modelling and DesignPatterns [12Hrs]

Modelling object interaction using Interaction Diagrams, Modelling the behaviour of reactive objects using State chart diagrams; Modelling systems workflows or operations using Activity diagram. Motivation, reusability, extendibility, cataloging patterns, "GoF" patterns

Unit III Software architecture &ArchitecturalPatterns [12 Hrs]

Software Architecture & its importance, Various types of Architectural Structures - Module, Conceptual, Process,Physical, Uses, Calls, Data Flow, Control flow, Class, System Quality attributes discernible at runtime, Business Qualities, Architecture Qualities, Architectural means for achieving architectural qualities, Data Flow Architecture, Virtual machine Architecture, Call & Return Architecture, Independent Component Architecture, Definition, advantages, components and connectors, views, documenting, evaluating, mining, Layered, pipe & filter, MVC, broker, Microkernel, Component and Deployment Diagrams.

Unit IV Frameworks, Software Product Lines and AntiPatterns [12Hrs]

Enterprise frameworks, EJBs, Economies of scope, Product Line Development, Product Development. Anti-patterns Case Studies

References:

Mandatory:

1. Erich Gamma, Richard Helm, Ralph Johnson, John Vlissides, Design Patterns: Elements of Reusable Object-Oriented Software, Pearson Education, First Edition.

Supplementary:

1. Bass L, Clements P &Kazman R (2019), *Software Architecture in Practice* (3rd Ed),Westford, USA: PearsonEducation.
2. Buchmann F, Munier R,RohnertH, Sommerland P & Stahl M (2008), *Pattern Oriented Software Architecture-I* (First Ed),Wiley.

Web References:

1. https://www.coursera.org/learn/object-oriented-design
2. https://cosmolearning.org/courses/software-architecture-design/video-lectures/
3. https://swayam.gov.in/nd1_noc19_cs69/

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Course Title: Design and Analysis of Algorithms
Course Code: PGM-IT.C.6
Marks: 100
Credits: 4
Duration: 48 Hrs.

Course Pre-Requisites: Understanding of basic Data Structures, Recursion, Matrix operations, Proof by Induction

Course Objectives:

- Understand the basic concepts related to the design and analysis of algorithms
- Understand classical algorithms and their complexity
- Apply the algorithms to real-world problems

Course Outcomes:

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

CO1: Analyze the running time of various algorithms.

CO2: Apply the algorithms and techniques to solve various problems.

CO3: Analyze the complexities of various problems in different domains.

CO4: Design their own algorithmic strategies to solve problems and analyze their correctness.

Syllabus:

Unit I: Foundations for Design and Analysis of Algorithms [12 Hrs]

Introduction: The Role of Algorithm in computing, Framework for design and analysis of algorithms, Growth of functions: asymptotic notation; Recurrences: substitution method, recursion-tree method, master method; Probabilistic analysis and randomized algorithms, indicator random variables.

Dynamic programming: Assembly line scheduling, matrix-chain multiplication, elements of DP, longest common subsequence, Optimal BST.

Unit II: Advanced Design and Analysis Techniques [12 Hrs]

Greedy algorithms: Elements of greedy strategy, Huffman codes, Optimal storage on tapes,Minimum cost spanning tree- Kruskal and Prim's algorithms, performance analysis.

Backtracking: The general method,8 Queens problem , sum of subsets,Graph coloring.

Branch-and-Bound: The method, 0/1 Knapsack problem

Amortized analysis: Aggregate analysis, accounting method, potential method, dynamic tables.

Unit III: Graph and Text Processing Algorithms **[12 Hrs]**

Graph Algorithms: Elementary graph algorithms- Minimum spanning tree: growing a spanning tree, Single-source shortest paths: Bellman-ford algorithm, Djikstra's algorithm. All pairs shortest paths: shortest paths and matrix multiplication, Floyd-Warshall algorithm.

Text Processing Algorithms: Strings and patterns matching algorithms, Tries, Text compression. Text similarity testing.

Unit IV: NP Completeness and Approximation Algorithms **[12 Hrs]**

NP-Completeness: Polynomial time, polynomial time verification, NP-completeness and reducibility.

Approximation algorithms: The vertex cover problem, Traveling salesman problem, the set covering problem.

References

Mandatory:

1. Cormen, T. H., Leisorson, C. E., Rivest, R. L.& Stein, C., (2010), *Introduction to algorithms,* (3rd ed), New Delhi, India: PHI, Eastern Economy Edition

Supplementary:

1. Knuth, D. E. (2011), *The art of computer programming Vol I, II, III*, Boston, United States: Addison Wesley
2. Horowitz, E., Sahni, S., Rajasekaran, S. (2008), *Fundamentals of computer algorithm* (2nd ed), New Delhi, India: Galgotia Publications
3. Aho, A., Hopcroft, J., Ullman, J. (2004),*The design and analysis of computer algorithms*, New Delhi, India: Pearson Education, LPE
4. Gilberg, R., Forouzan, B. (2004).*Data Structure: a pseudo code approach with C*, USA: Thomas Learning Inc.

Web Resources:

1. https://nptel.ac.in/courses/106106131/
2. https://www.geeksforgeeks.org/fundamentals-of-algorithms/
3. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-006-introduction-to-algorithms-fall-2011/
4. https://www.udemy.com/course/introduction-to-algorithms-and-data-structures-in-c

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Course Title: Statistical Computing
Course Code: PGM-IT.C.7
Marks: 50
Credits: 2
Duration: 24 Hrs

Course Pre-Requisites: None

Course Objectives:

- To introduce Statistical Computing using a tool like R or equivalent.

Course Outcomes:

At the end of the course students will be ableto:

CO1: Configure software environment to develop programs to implement statisticalconcepts.

CO2: Generate various types of plots andcharts.

CO3: Determine and apply relevant statistical test for real-life problems.

CO4: Use various types of distributions and statistical tests for solving problems.

Syllabus:

Unit I Introduction, Charts and Plots [12 Hrs]

Configuration of the environment, Assigning objects to values, Basic Mathematical functions, Creating vectors and matrices, importing and exporting data, subsetting data, Logic statements and cbind and rbind commands, setting of working directory, scripts for reproducible research, installing packages, apply and functions. Bar Charts, Stacked Bar Charts, Grouped Bar Charts, Pie Charts, Box Plots and Box Plots with Groups, Stratified Box Plots, Histograms, Stem and Leaf Plots, Mosaic Plots, Scatter Plots.

Unit II Distributions, Tests, Correlation and Regression [12 Hrs]

Introduction to Binomial, Poisson and normal distribution, computing probabilities, Introduction to T scores and Z scores and their computation. Parametric tests such as ;One-Sample t-test, 2-

Sample t-test, Paired t-test, Analysis of Variance, Cross Tabulations, Non parametric test : Chi Square Test, Fisher's Exact Test, Introduction to bi-variate data, correlation coefficient , simple and multiple regression, Changing a Numeric to a categorical variable, Indicator variables, Variable Selection in Linear Regression using Partial F-Test, Polynomial Regression

References:

Mandatory:

1. Rizzo M (2019), *Statistical Computing with R* (2nd Ed), Florida, USA: CRC Press.

Supplementary:

1. Srinivasa K, Siddesh G, Shetty C & J Soumya (2017), *Statistical Programming in R*(1st Ed), Noida, Uttar Pradesh, India: Oxford UniversityPress

Web References:

1. https://www.tutorialspoint.com/r/index.htm
2. https://www.w3schools.in/r/

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Course Title: Software Architecture, Design Patterns and Frameworks Lab
Course Code: PGM-IT.C.8
Marks: 50
Credits: 2
Duration: 48 Hrs.

Course Pre-Requisites:

- Theoretical knowledge of Object-oriented concepts, design patterns and frameworks

Course Objectives:

- Implement the various concepts of ObjectOrientation.
- Implement the various DesignPatterns.
- Usage of various Architectural patterns andFrameworks.

Course Outcomes:

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

CO1: Implement the various concepts of Object-Oriented Programming.

CO2: Illustrate Creational, Structural and Behavioural Design Patterns.

CO3: Analyze a given problem and apply Design Patterns to it solve problems by using a framework.

CO4: Work with a framework.

This course will have programming assignments for the various types of patterns and frameworks discussed in the corresponding theory paper.

1. Implementation of various concepts of Object Orientation **[12 Hrs]**

2. Implementation of the 21 Design patterns (Creational, StructuralandBehavioural) **[18 Hrs]**

3. Experiments on Enterprise Frameworks [**18Hrs]**

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Course Title: Design and Analysis of Algorithms Lab
Course Code: PGM-IT.C.9
Marks: 50
Credits:2
Duration: 48 Hrs.

Course Pre-Requisites:

- Theoretical knowledge of Design and Analysis of Algorithms

Course Objectives:

- Understand the various algorithm design approach

Course Outcomes:

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

CO1: Implement various algorithms using dynamic programming approach.

CO2: Implement various Internet algorithms.

CO3: Implement various graph Algorithms.

CO4: Implement algorithms for real life problems

List of suggested Assignments:

1. Implementation of algorithms using divide and conquer approach. **[08 Hrs]**
   a. Binary Search
   b. Quick Sort
   c. Merge Sort
2. Implementation of algorithms using dynamic programming approach. **[08Hrs]**
   a. Assembly Line Scheduling
   b. Longest Common Subsequence
   c. Matrix Chain Multiplication
   d. Optimal Binary Search Tree
3. Implementation of algorithms using Greedy programming approach. **[08Hrs]**
   a. Huffman Codes
   b. Optimal Storage on Tapes
   c. Minimum Cost Spanning Tree(Prim's and Kruskal Algorithm)
4. Implementation of Backtracking approach for various problems. **[08 Hrs]**
   a. 8-Queen's Problem
   c. Graph Coloring
5. Implementation of various Graph algorithms. **[08 Hrs]**
   a. Djikstra's Algorithm
   b. Bellman Ford Algorithm c. Floyd War shall Algorithm
6. Implementation of various internet algorithms. **[08 Hrs]**
   a. Tries
   b. Text Compression
   c. Text Similarity Testing

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Course Title: Information Retrieval
Course Code: PGM-IT.C.10
Marks: 100
Credits: 4
Duration: 48 Hrs.

Course Pre-Requisites: None

Course Objectives:

- Introduce students to the theoretical underpinnings of information retrieval (IR),an active and rapid growing branch of applied computationalscience.
- Impart knowledge on document representation, document indexing, digitalinformation storage, retrieval, and distribution.
- Emphasize application of IR theories and practices to web indexing and web search engines

Course Outcomes:

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

CO1: Develop system for IR using various models.

CO2: Perform Query evaluation and Relevance feedback.

CO3: Design systems that include hyperlinks, multimedia and the web.

CO4: Apply XML, Parallel, Distributed and Multimedia IR concepts to relevant problems.

Syllabus:

Unit I **[15 Hrs]**

Introduction
Function of an IR system, Kinds of IR system, Components of an IR system, Problems in designing an IR system

Boolean Retrieval
Term-Document Incidence matrix, Building an inverted index, Processing boolean queries

Term Vocabulary and Postings Lists
Obtaining character sequence in a document, Choosing a document unit, Tokenization, Stop word removal, Equivalence classing of terms, Stemming and Lemmatization, Porter's Algorithm for Stemming, Skip Pointers, Biword indexes, Positional indexes,

Dictionaries and Tolerant Retrieval
Search structures for dictionaries, Wildcard queries, Permuterm indexes, k-gram indexes for wildcard queries, Spelling correction, computation of Levenshtein distance, k-gram indexesfor spelling correction, Context-sensitive spelling correction, Phonetic correction, Soundex Algorithms

Unit II **[15 Hrs]**

Index Construction and Compression
Hardware basics, Blocked sort-based indexing, Single-pass in-memory indexing, Distributed and Dynamic indexing, Statistical properties of terms, Dictionary compression, Postings file compression

Vector Space and Probabilistic Models
Term frequency and Weighting, Inverse Document frequency, Computing Similarity Coefficient, Cosine Similarity between query and document vectors, Review of Probability theory, Ranking documents by using probabilistic retrieval

Evaluation in IR
Standard test collections, Evaluation of unranked retrieval sets, Precision, Recall and F-measure, Assessing relevance, Kappa measure for inter- judge agreement, A/B testing, Result snippets

Relevance feedback and Query Expansion
Relevance feedback and pseudo-relevance feedback, Rocchio algorithm, Global methods for query re-formulation, Query expansion and automatic thesaurus generation

Unit III **[10 Hrs]**

XML IR
Basic XML concepts, Challenges in XML retrieval, A Vector Space Model for XML retrieval, Evaluation of XML retrieval, Text-centric versus data-centric XML retrieval

Web IR
Background and history, web characteristics, Advertizing as the economic model, Search user experience, Index size and estimation, Near duplicates and shingling, Web crawling, Distributed indexes, Connectivity servers, The web as a graph, PageRank, Hubs and authorities

Unit IV **[08 Hrs]**

Parallel and Distributed IR
Parallel Computing, Performance Measures, MIMD and SIMD architectures, Distributed Computing, Collection partitioning, source selection, Query processing, web issues,

Multimedia IR
Multimedia data support in commercial DBMSs, MULTOS data model, Query languages, request specification, conditions on multimedia data, uncertainty, proximity and weights in query expressions, spatial access methods, a generic multimedia indexing approach, one-dimensional time-series, two dimensional colour images, automatic feature extraction

References:

Mandatory:

1. Manning C, Raghavan P &Schutze H (2008): *Introduction to Information Retrieval* (1st Ed), Delhi,India: Cambridge University Press.

Supplementary:

1. Grossman D & Frieder O (2008), *Information Retrieval: Algorithms and Heuristics* (2nd Ed), Hyderabad, India: Springer

2. Yates R & Ribeiro-Neto B (2003), *Modern Information Retrieval* (1st Ed), New Delhi, India:Pearson Education.

3. Buttcher S, Clarke C & Cormack G (2016),Information Retrieval: Implementing and Evaluating Search Engines (2nd Edition), London, England, MIT Press

Web References:

1. https://www.coursera.org/learn/text-retrieval

2. https://www.youtube.com/watch?v=q0srNT_XM_Y&list=PL0ZVw5-GryEkGAQT7lX7oIHqyDPeUyOMQ

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Course Title: Information Retrieval Lab
Course Code: PGM-IT.C.11
Marks: 50
Credits: 2
Duration: 48 Hrs.

Course Pre-Requisites: None

Course Objectives:

- The objective of the course is to introduce students to the actual implementation of latest technologies that are used in the IT industry & implementation of concepts in Information Retrieval and Data Mining Techniques.

Course Outcomes:

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

CO1: Illustrate Stop-Word removal, Stemming and handling of wildcard queries.

CO2: Employ techniques of Index Construction and Compression and implement soundex algorithms.

CO3: Implement Vector Space and Probabilistic Models to identify similarities between Queries and documents.

List of Experiments

1. Program to implement Boolean Model	**[04 Hrs]**
2. Program to implement stop word removal.	**[04 Hrs]**
3. Program to implement Porter's Stemming algorithm	**[04 Hrs]**
4. Program to implement Permuterm Indexes	**[04 Hrs]**
5.Programs to implement K-gram indexes	**[04 Hrs]**
6.Program to implement Phonetic correction	**[04 Hrs]**
7.Program to implement Vector Space Model (Similarity Coefficient)	**[08 Hrs]**
8. Program to implement Vector Space Model (Cosine Similarity)	**[04 Hrs]**
9.Program to implement Probabilistic Model	**[08 Hrs]**
10. Program to implement Variable Byte and Gamma Codes	**[04 Hrs]**

Use of Apache Lucene and NLTK tools is recommended.

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Department of Computer Science

LIST OF ELECTIVE COURSES FOR M.Sc. IT

PGM-IT.E.1	Computer Graphics
PGM-IT.E.2	Mobile Computing
PGM-IT.E.3	Cloud Computing
PGM-IT.E.4	Seminar
PGM-IT.E.5	Advanced Database Management Systems
PGM-IT.E.6	Advanced Database Management Systems Lab
PGM-IT.E.7	Natural Language Processing
PGM-IT.E.8	Natural Language Processing Lab

PGM-IT.E.9	Data Mining
PGM-IT.E.10	Machine Learning
PGM-IT.E.11	Software Metrics & Project Management
PGM-IT.E.12	Compiler Design
PGM-IT.E.13	Software Testing
PGM-IT.E.14	Communication Skills Course
PGM-IT.E.15	Applied Probability and Statistics
PGM-IT.E.16	Middleware Technology
PGM-IT.E.17	Educational Technology
PGM-IT.E.18	Network Security
PGM-IT.E.19	Image Processing
PGM-IT.E.20	Industrial Project
PGM-IT.E.21	Dissertation

Course Title: Computer Graphics
Course Code: PGM-IT.E.1
Marks: 100
Credits: 4
Duration: 48 Hrs

Course Prerequisites:

Knowledge of Data Structures and Algorithms

Course Objectives:

To understand the concepts of Graphic Algorithms, Geometrical transformations and Modeling

Course Outcomes:
At the end of the course students will be able to :
CO1: Describe the purpose of Computer Graphics and its applications.
CO2:Comprehend and analyze the fundamentals of animation, underlying principles, and applications.
CO3: Apply 3D Transformation on the object.
CO4: Extract scene with different clipping methods and its transformation to graphics display device.
CO5: Develop familiarity with key algorithms for modelling and rendering graphical data.
CO6: Design interactive computer graphics programs using Babylon JS.

Syllabus:
Unit I: [12 Hrs]

Introduction to Computer Graphics and Graphics Transformation
History of Computer Graphics, graphics primitives, scan conversion. 2D Transformations, composite transformation, viewing transformation, clipping algorithms.

Unit II: [13 Hrs]

3D Transformation and Representation of Curve
Viewing pipeline, Parallel and Perspective projections, view volumes, clipping ,Parametric, curves, continuity conditions, cubic splines, Hermite interpolation, Bezier curves and surfaces, B-spline Curves, Fractals.

Unit III: [15 Hrs]

Visible Surface Detection and Rendering Algorithm
Regularized Boolean operators, Sweep methods, Boundary Methods Constructive solid geometry methods, representation through quad trees and Octrees. Issues in Visible surface determination Coherence, backface culling, Z-Buffer and A-Buffer Algorithms, use of Binary Space Partitioning trees, Boolean operations on Octrees, Visible surface ray tracing. Diffuse and
Specular illumination model, reflection vector computation, Shading models for polygons – polygon mesh shading, Gouraud and Phong Shading, problems with interpolated shading, Transparency, shadows, Ray tracing.

Unit IV: **[8 Hours]**

Animation
Perception, Animation production, use in film and videos, orientation representation and Interpolation, Motion along a curve –computing are length, speed control – sine interpolation, rigid body simulation, collision detection, Particle systems – particle generation, modeling water, fire, explosions.

References:

Mandatory:
1. Foley, Van Dam, Feiner, Hughes(2013), Computer Graphics – Principles and Practices (3 rd Ed), Pearson Education India New Delhi.

Supplementary:
1. Rick Parent(2012), "Computer Animation: Algorithms and Techniques(3rd Ed), Morgan-Kaufman California.
2. Hearn &Baker(2010), Computer Graphics with OpenGL(4th Ed), Prentice Hall of India Delhi.

Web References:
1: https://nptel.ac.in/courses/106106090/
2: http://cs.wellesley.edu/~cs110/lectures/M01-color/graphics.pdf
3: http://gamma.cs.unc.edu/graphicscourse/solid_modeling.pdf
4: https://link.springer.com/chapter/10.1007%2F978-3-642-77263-4_20

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Course Title: Mobile Computing
Course Code: PGM-IT.E.2
Marks: 100
Credits: 4
Duration: 48 Hrs

Course Pre-Requisites: None

Course Objectives:
- To understand the basic concepts of Mobile Computing

Course Outcomes:
At the end of the course students will be able to:

CO1: Apply data communicating methods and networking protocols for wireless and mobile environments.

CO2: Understand positioning techniques and location based services and applications.

CO3: Utilize and employ application frameworks for developing mobile applications.

CO4: Use java for wireless devices and understand wireless messaging.

Syllabus:

Unit I: Introduction to Mobile Computing **[12 Hrs]**

Introduction and need for Mobile computing, Mobility and portability, Mobile and Wireless devices, Applications, Brief History of wireless communication

Wireless Transmission: General Concepts of multiplexing and modulation, Spread Spectrum, Cellular Systems, Cellular Phone Array, Mobile Phone Technologies (1G, 2G, 2.5G, 3G, 4G, LTE)

Medium Access Control Layer: Why specialized MAC? - hidden and exposed terminals- near and far terminals, General Concepts and comparison of SDMA, FDMA, TDMA ,CDMA

Unit II: Mobile Telecommunication Systems **[12 Hrs]**

Global System for Mobile Communication: Mobile Services (Bearer, Tele-and-supplementary services). System Architecture- Radio subsystem - Network and switching subsystem - Operation subsystem, Protocols - Localization and calling – Handover. Value Added Services- SMS Architecture, Mobile Originated and Mobile Terminated ,procedures - Cell Broadcast Service Architecture, Message Transfer Procedure – MMS Architecture, Protocol framework, Message
Transfer. Procedure - Location Services, Logical Reference Model, Control Procedures, Network Architecture, determination of Location Information, Location based services.GPRS

Wireless Messaging : Architecture for Messaging application, Messaging API, Types of applications, Pros and cons of messaging

Unit III: Mobile Internet **[15 Hrs]**

Mobile IP: Goals, assumptions and requirements, Entities and terminologies, Agent Discovery. Registration, Tunnelling and encapsulation, Reverse Tunnelling, IPv6, IP micro-mobility support – Cellular IP, Hawaii, Hierarchical mobile IPv6 , Mobile Routing : Destination sequence distance Vector, Dynamic Source Routing, Alternative Matrix, Ad hoc Routing Protocols -Flat, Hierarchical, geographic-position assisted

Mobile TCP: Traditional TCP - Congestion Control, Slow start, Fast retransmit / Fast recovery - Implications on mobility. Classical TCP improvements Indirect TCP, Snooping TCP, Mobile TCP, Fast retransmit / Fast recovery, Transmission / Timeout freezing, Selective Retransmission, Transaction oriented TCP.TCP over 2.5/3G wireless networks.

Wireless Application Protocol: Architecture, Wireless datagram protocol, Wireless transport layer security, Wireless transaction protocol, Wireless session protocol, Wireless application environment, WML, WML Scripts, Push Architecture, Push – Pull Services

Unit IV: Mobile Platforms and Support **[09 Hrs]**

Operating Systems: Palm OS, Windows CE, Embedded Linux, J2ME (Introduction), Symbian (Introduction), iOS, Chromium. File Systems

Java for Wireless Devices: Setting up the development environment, Basic Data types,Libraries (CLDC, MIDP)

UI Controls : Displayable and Display- Image, Events and Event Handling, List and choice, Text box, Alerts

Persistent Storage: Record Stores, Records, Record Enumeration

Network MIDlets: The Connection Framework, Connection Interface, Making a connection using HTTP, Using datagram connection

References

Mandatory:

1. Schiller, J. (2008) *Mobile communications*(2nd ed), New Delhi, India: Pearson Education

Supplementary:

1. Feng, Y. &Zhu, J.(2001) *Wireless Java programming with J2ME*,New Delhi, India: Techmedia Publications.
2. Talukdar, A. K., Ahmed, H. &Yavagal, R. R. (2011) *Mobile computing: technology, applications and service creation* (2nd ed), New Delhi, India: TataMcGrawHill
3. Hansmann, U., Merk, L., Nicklons, M. S. &Stober, T. (2006)*Principles of mobile computing*(2nd ed), New York, USA: Springer
4. Lee, W.C.Y. (2017) *Mobile cellular telecommunications-Analog and digital systems*, (2nd ed), New Delhi, India: Tata Mc Graw Hill Edition
5. Toh, C.K. (2007) *AdHoc mobile wireless networks*, New Delhi, India: Pearson Education,

Web References

1. http://ftp.mi.fu-berlin.de/pub/schiller/
2. Android Developers :http://developer.android.com/index.html
3. Apple Developer :https://developer.apple.com/
4. Windows Phone Dev Center :http://developer.windowsphone.com
5. BlackBerry Developer :http://developer.blackberry.com/
6. https://nptel.ac.in/courses/106/106/106106147/

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Course Title: Cloud Computing
Course Code: PGM-IT.E.3
Marks: 100
Credits: 4
Duration: 48 Hrs

Course Pre-Requisites: None

Course Objectives:

- To study important approaches in the field of Cloud Computing.

Course Outcomes:

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

- CO1:Define main concepts, key technologies, strengths, and limitations of cloud computing and the possible applications for cloud computing.
- CO2:Identify the architecture and infrastructure of cloud computing, including SaaS, PaaS, IaaS, public cloud, private cloud, hybrid cloud, etc.

- CO3:Explain the core issues of cloud computing such as security, privacy, and interoperability.
- CO4: Provide the appropriate cloud computing solutions and recommendations according to the applications used.
- CO5: Implement Virtualization

Syllabus:

Unit I: Introduction to cloud computing and Developing cloud services [12 Hrs]

How it all began, Grid computing, utility computing-automatic computing, dynamic data centre alliance-hosting/outsourcing, Cloud computing defined, the SPL frame work for cloud computing, traditional software model, virtualization, the cloud services delivery model, cloud deployment model, key drivers to adopting the cloud, the impact of cloud computing on users, governance in the cloud-the barrier to cloud computing adoption in the enterprise, Cloud infrastructure models-types of cloud service development, software as a service, platform as a service, infrastructure as a service-web services, on-demand computing, discovering cloud services deployment services and tools, amazon EC2, google app engine , Microsoft azure.

Unit II: Programming google app engine with python [12 Hrs]

The java runtime environment-the python runtime environment – the data store-development workflow-Setting up a google app engine account –setting development environment –starting to program in python with app engine. A first real cloud application –the basic example –chat application-the basics of HTTP – mapping chat into HTTP.

Unit III: Programming google app engine with java and Amazon cloud computing [12 Hrs]

Google app engine and java-managing server side data – building user interface in java – building the server side of java application. Amazon s3-amazon EC2-the simple storage service simple queuing services.

Unit IV: Window Azure Platform and Security [12 Hrs]

Windows azure-SQL azure-windows azure app fabric- additional online services. Data security – network security-host security –compromise –response.

References

Mandatory :

1. Hill, R., Hirsch, L., Lake, P., & Moshiri, S. (2012). *Guide to cloud computing: principles and practice*. Springer Science & Business Media.

Supplementary:

1. Buyya, R., Broberg, J., &Goscinski, A. M. (Eds.). (2010). *Cloud computing: Principles and paradigms* (Vol. 87). John Wiley & Sons.

Web References

1. https://www.geeksforgeeks.org/cloud-computing/
2. https://www.tutorialspoint.com/cloud_computing/index.htm
3. https://www.javatpoint.com/cloud-computing-tutorial

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Course Title: Advanced Database Management Systems
Course Code: PGM-IT.E.5
Marks: 100
Credits: 4
Duration: 48 Hrs

Course Prerequisites:

Fundamental knowledge of Database Management Systems

Course Objectives:

- Understand the concept of a database transaction and related database facilities.
- Introduce research development ability in databases through technical survey and Presentation.

Course Outcomes:
At the end of the course students will be able to:

CO1: Critically evaluate alternative designs and architectures for Databases and Data Warehouses.
CO2:Evaluate methods of storing, managing and interrogating complex data.
CO3: estimate the cost of executing an operator/query based on DB statistics
CO4: Analyze the background processes involved in optimizing queries and transactions.
CO5: Develop a high-level understanding of major DBMS components and their function.
CO6: Define, compare and use the two types of NoSQL Databases (Document-oriented, Graph).

Syllabus:

Unit I: [12 Hrs]
Database Design and Query Processing
Functional Dependencies, Decomposition of relational schemes, Normal forms for Relations, schemas, Multivalued and other forms of Dependencies. Basic algorithms for executing query operations, Basic optimization strategies, Algebraic manipulations, optimization of selections in system,.

Unit II: [15 Hrs]
Database Concurrency and Recovery Techniques
a simple transaction model, serializability, lock based protocols, Timestamp based protocol, Deadlock handling (Wait-die, wound-wait, no waiting, cautious waiting), optimistic concurrency control. NO-UNDO/REDO Recovery Based on deferred update, Recovery technique based on immediate update, shadow paging, ARIES,

Unit III: [10 Hrs]
Distributed Database
Principles of Distributed Databases, Framework for distribution, translation of global queries into fragment queries, query optimization and management of distributed transaction,

concurrency control and reliability in distributed databases,

Unit IV: Emerging Technologies [11 Hrs]

Emerging Technologies

XML Databases: XML-Related Technologies-XML Schema- XML Query Languages, Geographic Information Systems, Cloud Based Databases: Data Storage Systems on the Cloud , Introduction to Big Data-Storage-Analysis. Introduction of NoSQL databases: Document Database, GraphStores,

References:

Mandatory:
1. Elmasri&Navathe(2016), Fundamentals of Database Systems,(7th Ed),Pearson Arlington.
2. Abraham Silberschatz, Henry F. Korth(2016), Database System Concepts,(6th Ed), McGraw Hill Pennsylvania.

Supplementary:
1. RiniChakrabarti ,Shilbhadra Dasgupta(2011), Advanced Database Management System, 2 nd Ed) DreamtechPress,Kolkota India
2. S.Ceri and G.Relagatti(2017), Distributed Databases,(1st Ed),McGraw Hill Education India Private Limited New Delhi,

Web References:

1: https://link.springer.com/10.1007%2F978-0-387-39940-9_712
2: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.71.1311&rep=rep1&type=pdf
3: https://rubygarage.org/blog/neo4j-database-guide-with-use-cases
4: http://datasys.cs.iit.edu/events/ScienceCloud2013/p02.pdf
5: http://www.iitkgp.ac.in/research-areas/Big%20Data%20Analytics

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Course Title: Advanced Database Management Systems Lab
Course Code: PGM-IT.E.6
Marks: 50
Credits:2

Course Prerequisites:

Theoretical knowledge of Advanced Database Management Systems

Course Objectives:

- Understand the concept of a database transaction
- To understand Schema representation methods in Relational and NO SQL Databases

Course Outcomes:

At the end of the course students will be able to:
CO1: Populate and query a database using SQL,DML/DDL commands.
CO2: Perform PL/SQL programming using concept of Cursor Management, Error Handling, Package and Triggers
CO3: Execute various advance SQL queries related to Transaction Processing & Locking using

concept of Concurrency control.
CO4: Represent the database using XML and working on it.

List of suggested Assignments:

1: Advance SQL- Dynamic SQL, Triggers, Assertions	[09 Hrs]
2: Advance SQL- Stored Procedures	[06 Hrs]
3: Indexing	[01 Hr]
4: Views,Roles,Grants	[05 Hrs]
5: Design XML Schema and perform queries using Xquery and Xpath	[09 Hrs]
6: Introduction to NO SQL database	[01 Hr]
7: Creating Documents,Collection,insertingrecords,embedding documents	[03 Hrs]
8: Querying the documents	[03 Hrs]
9: Aggregation Framework	[03 Hrs]
10: Map Reduce	[07 Hrs]
10: Sharding	[01Hr]

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Course Title: Natural Language Processing
Course Code: PGM-IT.E.7
Marks: 100
Credits: 4
Duration: 48 Hrs

Course Prerequisites: None

Course Objectives:
To study fundamental concepts of Natural Language Processing and to introduce the basics of Language processing from an algorithmic viewpoint.

Course Outcomes:
At the end of the course students will be able to:
CO1: Compose key NLP elements to develop higher level processing chains.
CO2: Assess / Evaluate NLP based systems.
CO3: Choose appropriate solutions for solving typical NLP sub problems (tokenizing, tagging, parsing).
CO4: Perform Lexical and Semantic Analysis.

Syllabus

UNIT I: [10 Hrs]

Introduction to NLP, Stages of Processing, Regular Expressions, Text Normalization, Edit Distance: Regular Expressions, words, Corpora, Text Normalization, Minimum Edit Distance.
N-gram Language Models: N-Grams, Evaluating Language Models, Generalization and Zeros, Smoothing, Stupid Backoff, entropy, Naive Bayes.

UNIT II: [12 Hrs]

Vector Semantics and Embeddings: Lexical Semantics, Vector Semantics, Words and Vectors, Cosine for measuring similarity, TF-IDF: Weighing terms in the vector, Pointwise Mutual Information (PMI), Word2vec.
Neural Language Models: The XOR problem, Feed-Forward Neural Networks.

UNIT III: **[14Hrs]**

Sequence Labeling for Parts of Speech and Named Entities: English Word Classes, Part-of-Speech Tagging, Named Entities and Named Entity Tagging, HMM Part-of-Speech Tagging, Conditional Random Fields (CRFs).
Probabilistic Context free grammars, Dependency Grammars, Some Linguistically relevant concepts: Categories, Events, Representing time, Aspects, Representing beliefs, Pitfalls.Phonetics and phonology.

UNIT IV: **[12Hrs]**

Relation Extraction Algorithms, Extracting Events and their Times, Word Senses, WordNet: A Database of Lexical Relations, Word Sense Disambiguation, Machine Translation,Semantic Analysis, Using Thesauruses to Improve Embeddings, Semantic Roles, FrameNet.

Text Book:

1: Daniel Jurafsky, James H. Martin " Speech and Language Processing " edition 2, Prentice-Hall, Inc., 2013.
2: Hobson Lane, Cole Howard, Hannes Hapke "Natural Language Processing in Action" March 2019 ISBN 9781617294631

Supplementary Reading:

1: Steven Bird, Ewan Klein, Edward Loper, *Natural Language Processing with Python* 1st edition, O'Reilly, 2009.
2: Jacob Eisenstein, Natural Language Processing, The MIT Press, 2019.

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Course Title: Natural Language Processing Lab
Course Code: PGM-IT.E.8

Credits: 2
Duration: 48 Hrs

Course Prerequisites: Theoretical knowledge of Natural Language Processing

Course Objectives:
To study fundamental concepts of Natural Language Processing and to introduce the basics of Language processing from an algorithmic viewpoint.

Course Outcomes:
At the end of the course students will be able to:
CO1: Use NLP technologies to explore and gain a broad understanding of text data.
CO2: Use NLP methods to analyze sentiment of a text document.
CO3: Choose appropriate solutions for solving typical NLP sub problems (tokenizing, tagging, parsing).
CO4: Perform Lexical and Semantic Analysis.
CO5: Use NLP methods to perform topic modeling.

List of Experiments on the following topics:

1: Word Analysis	[2 Hrs]
2: Lexical analysis: Word and text tokenizer, Morphology,Text Summarization	[8 Hrs]
3: N-Grams, N-Grams Smoothing	[4 Hrs]
4: NLTK corpora, Na¨ıve Bayes classifier with NLTK	[6 Hrs]
5: Part-of-speech (POS) taggers: HMM and CRF,Tree model and Text chunker for capturing	[6 Hrs]
6: Named-entity recognition	[4 Hrs]
7: TF-IDF	[2 Hrs]
8: Word2Vec	[6 Hrs]
9: FrameNet	[5 Hrs]
10: Parsing	[5 Hrs]
11: Mini Project	

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Course Title: Data Mining
Course Code: PGM-IT.E.9
Marks: 100
Credits: 4
Duration: 48 Hrs.

Course Pre-Requisites:

- **Fundamental knowledge of Database Management System concepts**

Course Objectives:

- Identify the key processes of data mining, data warehousing and knowledge discovery process
- Describe the basic principles and algorithms used in practical data mining and understand their strengths and weaknesses
- Apply data mining methodologies with information systems and generate results which can be immediately used for decision making in well-defined business problems

Course Outcomes:

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

CO1: Identify appropriate data mining algorithms to solve real world problems

CO2: Apply various Association Rules Mining Algorithms.

CO3: Use Decision Trees, Bayesian Classification, Artificial Neural Networks and Fuzzy Set Theory while solving classification problems.

CO4: Apply various types of Clustering Algorithms, Web Mining Techniques and techniques of mining complex types of data.

Syllabus:

Unit I **[12 Hrs]**

Introduction

Introduction to data mining, Motivation and importance, Data Mining on various data types, Types of patterns to be mined, Interestingness of patterns, Classification of Data Mining systems, Major issues in Data Mining.

Data Warehouse and OLAP Technology

Introduction to a data warehouse, a multi-dimensional data model, Data warehouse architecture, Data warehouse implementation, Relationship between data warehouse and data mining

Data Preprocessing

Reasons for preprocessing data, Data cleaning, Data integration and transformation, Data reduction, Discretization and Concept-hierarchy generation

Unit II **[15 Hrs]**

Association Analysis

Problem definition, Frequent itemset generation, Rule generation, Compact representation of frequent itemsets, alternative methods for generating frequent itemsets, FP-Growth algorithm, Evaluation of Association patterns, Handling categorical and continuous attributes, Handling a concept hierarchy, Sequential patterns, Subgraph patterns, Infrequent patterns

Classification and Prediction

Introduction to classification and prediction, Decision Tree Induction, Bayesian classification, Neural network technique of Back Propagation, Fuzzy set theory and Genetic Algorithms, Linear, Multiple and Non-Linear Regression

Unit III **[12 Hrs]**

Cluster Analysis

Introduction to Cluster Analysis, Data types in ClusterAnalysis, Partitioning , Hierarchical and Density-based methods, Model based methods

Web Mining

Introduction to Web Mining, Web content mining, Web structure mining, Web usage mining

Unit IV **[09 Hrs]**

Mining other type of data

Data mining in Object oriented, Multimedia data bases, Time-series and text data bases

Data Mining Applications

Data Mining in Biomedical, Finance, Retail and Telecommunication industry

References:

Mandatory:

1. Han J &Kamber M (2011), *Data Mining Concepts and Techniques* (3rd Ed), New Delhi, India: Morgan Kaufmann Publishers.

Supplementary:

1. Kumar V & Dunham M (2006), *Data Mining: Introductory and Advanced Topics*(1st Ed), New Delhi, India: Prentice Hall (Pearson Publication).

2. Tan P, Steinbach M & Kumar V (2016), *Introduction to Data Mining* (1st Ed), New Delhi, India: Pearson Education.

Web References:

1. https://nptel.ac.in/courses/106/105/106105174/
2. https://www.coursera.org/specializations/data-mining
3. https://www.tutorialspoint.com/data_mining/

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Course Title: Machine Learning
Course Code: PGMIT.E.10
Marks: 100
Credits: 4
Duration: 48 Hrs

Course Pre-Requisites:

- Familiarity with Probability &Statistics.

Course Objectives:

- Provide a broad introduction to artificial intelligence and machine learningtechniques.

Course Outcomes:

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

CO1: Design and Implement Machine Learning solutions to real-world problems.

CO2: Evaluate and interpret the result of Machine Learning Algorithms.

CO3: Recognize various ways of selecting suitable model parameters for different machine learning techniques.

CO4: Perform experiments in Machine Learning using real-world data.

Syllabus:

UnitI Introduction **[09 Hrs]**

Decision Trees, Artificial Neural Networks.

Unit IISupervised Learning **[15Hrs]**

Supervised learning setup, LMS, Logistic regression, Perceptron, Back propagation neural network, Exponential family, Generative learning algorithms, Gaussian discriminant analysis. Naive Bayes, Support vector machines, Model selection and feature selection, Ensemble methods: Bagging, boosting, Evaluating and debugging learning algorithms.

Unit III Unsupervised Learning [12 Hrs]

Clustering.K-means, Hierarchical clustering, EM. Mixture of Gaussians, Factor analysis, Anomaly detection, PCA (Principal components analysis), ICA (Independent components analysis), Self-organizing map(SOM).

Unit IV ReinforcementLearning [12 Hrs]

MDPs. Bellman equations, Value iteration and policy iteration, Linear quadratic regulation (LQR), LQG, Q-learning, Value function approximation, Policy search, Reinforce, POMDPs.

References:

Introduction to Machine Learning, Examples of Machine learning applications, version space,

Mandatory:

1. Alpaydin E (2015), *Introduction to Machine Learning* (3rd Ed), New Delhi, India: PHI Learning Pvt. Ltd.

Supplementary:

1. Mitchell T (2017), *Machine Learning* (1st Ed), New Delhi, India: McGraw HillEducation.
2. Duda R, Hart P & Stork D (2012), *Pattern Classification* (2nd Ed), New Delhi, India:Wiley
3. Rich E, Knight K & Nair S (2017), *Artificial Intelligence* (3rd Ed), New Delhi, India: McGraw-HillEducation.

Web References:

1. https://nptel.ac.in/courses/106106139/
2. https://nptel.ac.in/courses/106/106/106106202/
3. https://nptel.ac.in/courses/106/106/106106198/
4. https://www.coursera.org/learn/machine-learning

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Course Title: Software Metrics & Project Management
Course Code: PGM-IT.E.11
Marks: 100
Credits: 4
Duration: 48 Hrs

Course Pre-Requisites: None

Course Objectives:
Provide a deeper understanding of various software metrics and project management concepts

Course Outcomes:
At the end of the course students will be able to:
•CO1: Identify and describe the key phases of project management.
•CO2: Apply Scope, Time and Cost Management process to Software Development.
•CO3: Define software metrics and quality standards.
•CO4: Plan a metrics measurement program
•CO5: Enforce Quality standards in projects

SYLLABUS:

Unit I: **[12 Hrs]**
Introduction Introduction to Project and Project management, Project phases and project life cycle, organizational structure, Qualities of Project Manager. Project Management Components Project Integration Management-Project plan development and execution, change controls, configuration management Scope and Time Management Strategic planning, scope planning, definition ,verification and control, Activity planning, schedule development and control.

Unit II: **[12 Hrs]**
Cost and Quality Management Cost estimation and Control, Quality planning and assurance Human Resource and Communication Management. Organizational planning, staff acquisition, Information distribution, reporting.

Unit III: **[12 Hrs]**
Risk Management Risk identification, Quantification and control. Procurement Management Solicitation, contract administration Software Metrics The scope of software metrics, software metrics data collection, analyzing software data, measuring size, structure, external attributes.

Unit IV: **[12 Hrs]**
Software Reliability Measurement and prediction, resource measurement, productivity, teams and tools. Planning a measurement program Metrics plan: Developing goals, questions and metrics. Where and When: Mapping measures to activities. How: Measurement tools. Who: Measurers , analyst, tools revision plans. Quality Standards – CMM, PSP/TSP.

References:
Mandatory:
1. Kathy S. Information Technology Project Management, Boston : Course Technology Press.

Supplementary:
1.Norman F., James B. (2014). Software Metrics A rigorous and practical approach(Third Edition), CRC Press.
2. Roger P. Software Engineering – A Practitioner's Approach, United States : McGraw Hill.

Web References:
1.www.tutorialspoint.com/software_engineering/software_project_management.htm
2.https://www.javatpoint.com/software-engineering-software-metrics
3.https://www.geeksforgeeks.org/software-measurement-and-metrics/

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Course Title: Compiler Design
Course Code: PGM-IT.E.12
Marks: 100
Credits: 4
Duration: 48 Hrs

Course Pre-Requisites: None

Course Objectives:

- To enable the student to understand compiler construction and equip them with skills to write a compiler for a programminglanguage.

Course Outcomes:

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

CO1: Convert a NFA to DFA and minimize the DFA.

CO2: Perform Lexical Analysis using tools such as Lex and YACC.

CO3: Apply the concepts of Register allocation.

CO4: Design and code a simple compiler for a programming language.

Syllabus:

Unit I. Introduction and ContextFreeGrammars [12 Hrs]

Lexical analysis, Regular Expressions, Finite automata. N.F.A., N.F.A. to D.F.A. conversion, D.F.A., minimization of D.F.A., Lex tool, Derivations & Parse trees, Syntax analysis: Parsing, Top Down Parser, Recursive descent Parser, Predictive parsing, LL(1) Parsing table, Bottom Up

Parsing, Shift Reduce parsing, Operator precedence parsing, LR Parsing methods, SLR, LRDL, LALR, YACC tool.

Unit II Syntax Directed Translation, Error DetectionandRecovery [12 Hrs]

Syntax directed translation schemes, Implementation of syntax directed translation schemes, Intermediate codes, Post fix notation parse trees &syntax trees, three address codes, quadruples, triples, Translation of assignment statements, Boolean expression, statements that after flow of control, Post fix translation, Translation with Up down parsing. Errors, lexical phase errors, Syntactic phase errors, semantic errors.

Unit III Code Optimization and DataFlowAnalysis [12 Hrs]

Loop optimization, DAG representation of basic block, value numbers & algebraic laws, Global data flow analysis, Dominators, Reducible flow graph, Depth first search, Loop invariant computation, Induction variable elimination, Reaching definition, Available Expression, copy propagation, Backward flow problems, Very busy, expression & code hoistingcode.

Unit IV Code Generation andRegisterAllocation [12 Hrs]

A simple code generation, code generation from DAG & labeled trees, Coloring by implication, coalescing, graph coloring implementation, Register allocation for Trees.

References:

Mandatory:

1. Aho A, Ullman J, Lam M &Sethi R (2006), *Compilers - Principles, Techniques, and Tools* (2nd Ed), New Delhi, India: Pearson Education.

Supplementary:

1. Tremblay J & Sorenson P (2014), Theory& Practice of Compiler Writing (4th Ed), New Delhi, India: B. S.Publication

Web References:

- https://nptel.ac.in/courses/106105190/
- https://www.tutorialspoint.com/compiler_design/index.htm
- https://www.geeksforgeeks.org/compiler-design-tutorials/
- https://www.javatpoint.com/compiler-tutorial

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Course Title: Software Testing
Course Code: PGM-IT.E.13
Marks: 100
Credits: 4
Duration: 48 Hrs

Course Pre-Requisites:
Knowledge of analysis, design and programming

Course Objectives:
To provide a detailed study of testing software and automated tools.

Course Outcomes:
At the end of the course students will be able to:
- CO1: Define Software Testing process for applications.
- CO2: Apply Software Testing process in relation to Software Development and Project Management.
- CO3: Create Test Strategies and plans, design test cases, prioritize and execute them.
- CO4: Identify various Software Testing problems and solve them.
- CO5: Identify the needs of software test automation, and define and develop a test tool to support test automation.
- CO6: Use software testing methods and modern software testing tools for their testing projects.

SYLLABUS:

Unit I: **[12 Hrs]**
Testing fundamentals Software testing, Levels of software testing, Test activities, Testing Life Cycle, Test Organization, White Box testing, Basis Path Testing, Control Structure testing, Black Box Testing,Equivalence Class Partitioning, Boundary Value Analysis, Cause-effect Graphing, Special cases.

Unit II: **[12 Hrs]**
Functional Testing Performance Testing, Stress testing, Configuration Testing, Security Testing, Recovery Testing, Integration Testing, Regression Testing, Acceptance Testing.
Object oriented testing methods
Testing Methods at Class level – Interclass test case design- Testing for Specific Environment, architecture, and application - Testing patterns

Unit III: **[12 Hrs]**
Testing Processes Comparison of different techniques- Test Plan – Test case Design Procedure Specification – Test Case Execution and Analysis - Test Documentation - Reporting test results - Final test report Test Driven Development & Refactoring.

Unit IV: **[12 Hrs]**
Testing Web Application Testing concepts for web apps, Content Testing, User Interface Testing , Component Level Testing, Navigation Testing, Configuration Testing , Security Testing – Performance Testing. Testing Tools Need for automated testing tools - Selection of testing tool – Tools used at various phases.

References

Mandatory: 1. Desikan S., Gopalswamy R. (2006). Software Testing : Principles and Practices, India: Pearson Education.

Supplementary:
1.Kit E. Software Testing in the Real World, United States: Addison-Wesley Publishing Co. 2.William E. Software Testing and Continuous Quality Improvement, Auerbach Publications.

Web References :
1. www.guru99.com/software-testing.html
2. 2. https://www.tutorialspoint.com/software_testing/index.htm
3. 3. https://www.javatpoint.com/software-testing-tutorial

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Course Title: Communication Skills Course Course
Code: PGM-IT.E.14
Marks: 100
Credits: 4
Duration: 48 Hrs

Course Pre-Requisites: None

Course Objectives:

- To understand the essential elements of Written Communication, and the process ofwriting.
- To learn various subgenres of workplace communication, including business & technical writing
- To learn the dynamics involved in oral communication, including non- verbalinteraction.
- To use language effectively in public oralcommunication.

Course Outcomes:

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

CO1: Apply creative thinking abilities necessary for effective communication at a modern workplace.

CO2: Demonstrate clarity, precision, conciseness and coherence in the use of language.

CO3: Learn to make one's writing better, faster and more successful.

CO4: Speak effectively while using non-verbal skills.

CO5: Design effective presentations that disseminate information, conduct negotiations and use persuasion.

Syllabus:

Unit I :Introduction,Theory of Written Communication and TheWritingprocess [12Hrs]

Process of Communication, Language as a Tool of Communication, Levels of Communication, Flow of Communication, Communication Networks, Barriers to Communication, Features of academic communication, Prewriting (Invention), Stasis Theory, Creating a Thesis Statement, Developing an Outline, Proofreading, Avoiding Plagiarism.

Unit II : Constituents of Effective Writing andBusinessWriting [12 Hrs]

Words & phrases, Sentence Construction, Paragraph Development, Précis Writing, Reading Comprehension Letters, Memos, Emails, Proposals, Reports, Analysis and Presentation of Data, Documentation and Document Design.

Unit III :Technical Writing, Oral Communication andPublicSpeaking. [12 Hrs]

Defining Technical Writing, Technical Description, Process Description, Instruction Manuals, User Manuals, Audience Awareness. Kinesics, Proxemics, Paralinguistics, Chronemics, Theory of Verbal Communication Features of Verbal Communication, Listening Skills.

Unit IV :Non-verbal communication, Meetings andgroupactivity [12 Hrs]

Preparation for Public Speaking, Speech Writing, Delivery of Speech, Anxiety Management, Interviews, Group Communication and Discussion, Team work, Leadership Skills.

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Course Title: Applied Probability and Statistics
Course Code: PGM-IT.E.15
Marks: 100
Credits:4
Duration: 48 Hrs

Course Pre-Requisites: None

Course Objectives:

- To provide the foundation of Probability theory and Statistical inference in order to apply statistical methods to various fields such as Statistical QualityControl.

Course Outcomes:

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

CO1: Apply knowledge about the probability theory to solve mathematical problems.

CO2: Solve problems containing Discrete and Continuous Random variables.

CO3: Apply the concepts of Statistical Inference to Mathematical problems.

CO4: Provide statistical quality control.

Syllabus:

Unit I: Introduction and DiscreteRandomVariables [12 Hrs]

Probability models, sample space events, algebra of events, graphical methods of representing events, probability axioms, combinational problems, conditional probability, independence of events, Baye's rule, Bernoulli trials, Introduction, random variables and their spaces, the probability mass function, distribution functions, special discrete distributions, analysis of program, the probability generating function, Discrete Random Vectors, independent random variables.

Unit II : Continuous Random Variablesand Expectation [12 Hrs]

Introductions, the exponential distribution, some important distribution, functions of a random variable, jointly distributed random variables, distributions of sums, functions of normal random variables. Introduction moments, expectation of functions of more than one random variable, moments and transforms of some important distributions, computations of mean time to failure, inequalities and limits theorems.

Unit III : Conditional Distribution andStatisticalInference. **[12Hrs]**

Conditional Expectation, Introduction, Parameter Estimation, Hypothesis testing: z, t, chi square, F test, Regression, correlation and 'analysis of variance: Introduction, least squares curve fitting, the coefficient of Determination, confidence Intervals in linear Regression, correlation analysis, simple nonlinear regression, Higher dimensional least-squares fit, Analysis of variance; Non parametric tests: sign test, u test, Rank test, Median test.

Unit IV : StatisticalQualityControl **[12Hrs]**

Control charts, Mean chart, R chart, sigma chart, C chart.

References:

Mandatory:

1. Gupta S.G. and Kapoor K. V, (2014), *Fundamentals of Mathematical Statistics* (10^{th} Ed), New Delhi, India: S Chand and Sons

Supplementary:

1. Ross S (2019), *A First Course in Probability* (Ninth Ed), New Delhi, India:Pearson

Web References:

1. https://www.tutorialspoint.com/statistics/index.htm
2. https://www.tutorialspoint.com/statistics/probability.htm

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Course Title: Middleware Technology
Marks: 100
Course Code: PGM-IT.E.16
Credits:4
Duration: 48 Hrs

Course Pre-Requisites:

- Fundamental knowledge of Distributed Systems and knowledge of Java

Course Objectives:

- Understanding the characteristics of distributed systems,Asynchronous communication and Event basedsystems.
- Understanding of J2EE and Webservices.

Course Outcomes:

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

CO1: Apply the concepts of distributed systems, asynchronous communication and event-based systems to real-world problems.

CO2: Develop Web programs using the Servlet technology and Enterprise Java beans.

CO3: Use web services and reflective middleware concepts for real-world problems.

CO4: Apply concepts that are learnt while working in live projects that involve Web Component and Business Component Programming.

Syllabus:

UNIT I: Foundation of Middleware [12Hrs]

Introduction to middleware, MW definition, styles of MW, key players.
Distributed systems characteristics System models-architectural and fundamental models. RPC, Distributed objects-RNI, .NET Remoting, Name services-DNS, Time and global states, synchronization, Coordination and agreement, distributed transactions and recovery, Consistency & Replication, Fault Tolerance, and Security.

UNIT II: Asynchronous communication and Eventbasedsystems [12 Hrs]

Notifications, message Queuing systems, peer to peer systems.

UNIT III: Enterprise servicesin J2EE **[12 Hrs]**
Servlets and EJBs.

UNIT IV: ReflectiveMiddleware **[12Hrs]**

SOA & Web services XML,SOAP, WSDL, UDDI & other protocols.
Reflective middleware Introduction to reflective middleware, Middleware oriented architectural patterns for enterprise systems.

Text Book:
1. Couloris G, Dollimore J &Kindberg T (2017), *Distributed Systems- Concepts and Design* (5th Edition), New Delhi, India:Pearson Education.

References:
1. ChrisBrittonandPeterEye(2004),*ITArchitecturesandMiddleware:StrategiesforBuilding Large, Integrated Systems* (2nd Ed), New Delhi, India: PearsonEducation

2. Qusay H. Mahmoud (2014), *Middleware for Communications* (2nd Ed), New Delhi, India: John Wiley andSons.

Web References

1. https://www.coursera.org/courses?query=distributed%20systems
2. https://online.stanford.edu/courses/cs244b-distributed-systems

3. https://www.globalonlinetrainings.com/courses/middleware-tools-training

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Course Title: Educational Technology

Course Code: PGM-IT.E.17

Marks: 100

Credits: 4

Duration: 48Hrs

Course Pre-Requisites: None

Course Objectives:

- To introduce the classroom applications of Educational Technologies.

Course Outcomes:

At the end of the course students will be able to:
CO1: Identify the role of educational technology in teaching.
CO2: Integrate technology in the classroom after determining technology requirements CO3: Perform research in the Educational Technology domain.
CO4: Use ICT tools in a particular course.

Syllabus:

Unit I Educational Technology in Instructional Planning [15 Hrs]

1) Technology in Education: Meaning, Evolution and Development,
2) Multiple Intelligence, Learning Metaphors: information acquisition, response strengthening, knowledge construction
3) Cognitive Information Processing, Peer Instruction
4) Learning Theories: Constructivist and situated theories of learning – social activism, stages of development, Constructionism, Inquiry based learning, Social constructivism, Discovery learning, Cognitive apprenticeship.Behaviorism & Symbolic Cognition(Skinner's defense of behaviorism, Watson's argument against introspection), Pavlov's classic physical conditioning, Operant conditioning, Miller's proposal on planning.
5) Role of Cognition in education: Distributed Cognition, Situated Cognition, Embodied Cognition.

Unit II ICT in Education, Educational Tools [14Hrs]

1) Computer, Internet, Multimedia/Hypermedia, Multimedia Principles, Animations, Simulations, Projected Materials, Audio Materials, Interactive Materials: LOGO, SCRATCH, LMS tools, Digital storytelling.
2) Type of contents: content types(fact, concept, process, procedure, principle) and graphic types(representational, organizational, transformational, interpretive).

Unit III Lesson planning and Instructional Design Models [12 Hrs]

1) Learning Objectives/Outcomes: LO (what why and how), Blooms Taxonomy, Learning outcomes and assessment(action verbs for Los).
2) Assessment: Diagnostic assessment, Formative assessment, Summative assessment, Rubrics (what, how when, benefits).
3) Instructional design models: theoretical frameworks and models i.e. ADDIE, LCM model; relevant tools for designing instructional material for online and blended mode.

Unit IV: Research Methods in Educational Technology [7Hrs]

1) Content of educational research: scientific method, planning educational research, ethics, identifying problem, variables, hypothesis. Strategies of data collection, Data analysis(distribution, statistical significance, statistical tests,SPSS.

References:

Mandatory:

1. Shelly G, Gunter G & Gunter R (2015), *Teachers Discovering Computers* (8th Ed), Kentucky, USA: Cengage Learning.

Supplementary:

1. Roblyer M &Doering A (2019), *Integrating Educational Technology into Teaching* (8th Ed), New Delhi, India:Pearson.

Web References:

1. https://nptel.ac.in/courses/121105010/
2. https://scratch.mit.edu/explore/projects/tutorials/
3. https://www.tutorialspoint.com/logo/index.htm
4. http://www.et.iitb.ac.in/ResearchResources.html

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Course Title: Network Security
Course Code:PGM-IT.E.18
Marks: 100
Credits: 4
Duration: 48 Hrs

Course Prerequisites: None

Course Objectives: To understand the concepts and theory of computer network security.

Course Outcomes:
At the end of the course students will be able to:
CO1: Classify the symmetric encryption techniques
CO2: Illustrate various Public key cryptographic techniques
CO3: Evaluate the authentication and hash algorithms.
CO4: Implement Cryptographic Algorithms in a programming language.

Syllabus:

Unit I: **[15 Hrs]**

Foundations of Cryptography and Security
Ciphers and Secret Messages, Security Attacks and Services. Classical encryption techniques. Substitutions and Permutations, Theory of Block ciphers, Feistel Cipher network Structures, DES and triple DES, Modes of Operation (ECB, CBC, OFB, CFB), Strength of DES., AES, Pseudo random sequences, Design of stream Ciphers, RC4.

Unit II: **[11 Hrs]**

Public Key Cryptography and Asymmetric Algorithm
Prime Numbers and testing for primality.RSA, Diffie-Hellman, ElGamal,, Key Management, Key exchange algorithms, Public Key Cryptography Standards.

Unit III: **[12Hrs]**

Message Digest and Digital Signature
Message Authentication, MD5, SHA-3, HMAC, Digital signature standards (DSS and DSA),

Public Key Infrastructures, Digital certificates and Basics of PKCS standards.

Unit IV: **[10 Hrs]**

Authentication and Security
Kerberos , X509 Authentication Service, IP Security, Transport Layer Security (TLS)., Wireless Security, Intrusion detection , Password management. Firewalls management

References:
Mandatory:
1. Stallings William(2019), " Cryptography and Network Security: Principles and Practises", (8th Ed), Pearson Education India Delhi

Supplementary:
1. KahateAtul(2013), "Cryptography and Network Security" (3rd Edition)Tata McGraw-Hill Education Pvt. Ltd Noida

Web References:
1: https://nptel.ac.in/courses/106/105/106105031/
2: https://engineering.purdue.edu/kak/compsec/NewLectures/Lecture8.pdf
3: https://www.us-cert.gov/ncas/tips/ST04-018
4: http://www.iet.unipi.it/g.dini/Teaching/sanna/lecturenotes/applied-cryptography-digital-signature.pdf
5: http://www.cs.man.ac.uk/~banach/COMP61411.Info/CourseSlides/Wk4.2.MAC.pdf

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Course Title: Image Processing
Course Code: PGM-IT.E.19
Marks: 100
Credits: 4
Duration: 48 Hrs

Course Prerequisites: None

Course Objectives:
To understand the basic image processing operations.

Course Outcomes:
At the end of the course students will be able to:
CO1:Comprehend how digital images are represented and manipulated in a computer, including reading and writing from storage, and display.
CO2: Analyze and implement image processing algorithms.CO3: Perform Image Compression.
CO4: Apply Morphological Image Processing.

Syllabus:

Unit I: **[12 Hrs]**

Image Formation and Enhancement
Introduction:Image formation model, representation, spatial and Gray Level resolution, Colour models-RGB, CMY and HIS models. Image Enhancement In Spatial Domain:Piecewise linear transformation, Histogram equalization, Histogram specification,

Unit II: **[12 Hrs]**

Image Enhancement In Frequency Domain
2D Discrete Fourier transform and its inverse, filtering in frequency domain, Ideal and Gaussian Low pass filters, high pass filtering, separability property 0f 2D Fourier transform, Fast Fourier Transform. Image Segmentation:Line detection, Edge detection, Edge linking and boundary detection,

UNIT III: **[12 Hrs]**

Morphological Image Processing
Logic operations involving binary images, Dilation and Erosion, Opening and closing, Applications to Boundary extraction, region filling, connected component extraction.
Image Compression:Coding redundancy- Huffman coding, LZW coding, run length coding, Lossy compression – Lossy predictive coding

UNIT IV: **[12 Hrs]**

Image Representation
Boundary description, Shape numbers, Fourier descriptors, Texture, principal Components based description. 3D Vision:Projective geometry, single perspective camera, stereopsis, the fundamental matrix –its estimation from image point correspondences, applications of epipolar geometry in vision,

References

Mandatory:
1. Gonzalez, R.C.& Woods, R.E. (2018) Digital Image Processing(4th ed), New Delhi, India: Pearson Education.Supplementary:
1. Sonka, M., Hlavac, V. & Roger Boyle, R. (2017).Image processing, analysis, and machine vision with MindTap(4th ed), Singapore: Cengage Learning
2. Jain, R.C., Kasturi, R. & Schunk, B. G. Introduction to Machine Vision McGraw Hill International Edition
3. Schalkoff, R. J. Digital Image Processing & Computer Vision, John Wiley and Sons

Web References:
1. https://nptel.ac.in/courses/117/105/117105079/
2. https://nptel.ac.in/courses/117/105/117105135/
3. https://www.udemy.com/course/image-processing-from-ground-uptm-in-c/

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