SREE VIDYANIKETHAN ENGINEERING COLLEGE
(AUTONOMOUS)
Sree Sainath Nagar, Tirupati

Department of Computer Science and Engineering

Supporting Document for 1.1.3

Courses having focus on

Employability/ Entrepreneurship/ skill Development

Program: M.Tech.- Computer Science

Regulations : SVEC-19

The Courses (with course outcomes) under SVEC-19 Regulations which focus on ***employability/ entrepreneurship/ skill development*** are highlighted with the following colours.

Skill

Employability

Entrepreneurship

M. Tech. (CS) - I Semester

(19MT10501) ADVANCED ALGORITHMS

(Common to CS and CNIS)

Internal Marks	External Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES: A course on Design and Analysis of Algorithms.

COURSE DESCRIPTION:
Introduction to algorithm design techniques; Divide and conquer, greedy methods and dynamic programming; Backtracking, branch and bound techniques and NP-completeness; Methods of advanced graph theory; approximation algorithms and number theoretic algorithms; max flow and string matching algorithms and randomizing algorithms.

COURSE OUTCOMES:
On successful completion of the course, students will be able to:

CO1. Perceive and apply the concepts of different algorithmic techniques to find solutions for a specific problem.

CO2. Design solutions for societal problems by applying the concepts from dynamic programming, backtracking.

DETAILED SYLLABUS:

UNIT-I: The Role of Algorithms in Computing, Divide and Conquer, Greedy Methods (8 Hours)
The Role of Algorithms in Computing: Algorithms, Analyzing algorithms, Designing algorithms, Asymptotic notations.
Divide and Conquer: General method, Binary search, The maximum sub-array problem.
Greedy Method: General method, Job sequencing with deadlines, Knapsack problem, Huffman codes.

UNIT-II: Dynamic Programming, Back Tracking, Branch and Bound (10 Hours)
Dynamic Programming: Optimal binary search trees, 0/1 Knapsack problem, Traveling sales person problem.
Back Tracking: N–Queen's problem, Graph coloring, Sum of subsets problem, Hamiltonian cycles.
Branch and Bound: LC Search, LIFO and FIFO branch and bound solutions of 0/1 Knapsack problem.

UNIT-III: NP-Completeness and Approximation Algorithms (9 Hours)
NP-Completeness: Polynomial time, Polynomial time verification, NP-completeness and reducibility, NP-completeness proofs, NP-complete problems.
Approximation Algorithms: The vertex-cover problem, The traveling salesman problem, The set-covering problem, The subset-sum problem.

UNIT-IV: Max Flow and Number Theoretic Algorithms (9 Hours)
Max Flow: Flow networks, Ford-Fulkerson method, Maximum Bi-partite matching.
Number Theoretic Algorithms: Elementary number theoretic notions, Greatest common divisor, Modular arithmetic, Solving modular linear equations, The Chinese remainder theorem.

UNIT-V: String Matching Algorithms, Probabilistic and Randomized Algorithms (9 Hours)
String Matching: The Naive string-matching algorithm, The Rabin-Karp algorithm, String matching with finite automata, The Knuth-Morris-Pratt algorithm.
Randomizing Deterministic Algorithms: Monte Carlo and Las Vegas algorithms, Probabilistic numeric algorithms.

Total Hours: 45

TEXT BOOKS:
1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, *Introduction to Algorithms*, PHI Learning, 3rd Edition, 2009.
2. Ellis Horowitz, Sartaj Sahni, and S Rajasekaran, *Fundamentals of Computer Algorithms*, Universities Press, 2nd Edition, 2008.

REFERENCE BOOKS:
1. Michael T. Goodrich, Roberto Tomassia, *Algorithm Design: Foundations, Analysis and Internet Examples*, Wiley, 2002.
2. Adrian J., Bondy, U.S.R.Murty, *Graph Theory*, Springer, 2008.

M. Tech. (CS) – I Semester

(19MT10502) ADVANCED DATA STRUCTURES

(Common to CS and CNIS)

Internal Marks	External Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES: Courses on Computer Programming and Data Structures.

COURSE DESCRIPTION:
Introduction to elementary data structures including stacks, queues, and lists, analysis of algorithms and recurrences, Trees and Graphs, Skip lists, Computational Geometry, Heap and Hash tables.

COURSE OUTCOMES:
On successful completion of the course, students will be able to:

CO1. Develop appropriate data structures for efficient storage and retrieval of data.

CO2. Choose appropriate data structures, understand the ADT/libraries, and use it to solve a specific problem.

DETAILED SYLLABUS:

UNIT-I: Introduction to Data Structures **(9 Hours)**

Introduction to Data Structures: Types of data structures, time and space complexity, Asymptotic notations.

Recurrences: The substitution method, Recurrence tree method, Master's theorem for solving recursions.

Elementary data structures: Stacks and its applications, Queues - Circular Queue, Dequeue, applications; Linked lists implementations and its types.

UNIT-II: Trees **(10 Hours)**

Trees: Representation and applications of trees, Binary trees, Expression trees, Binary Search Trees, AVL Trees, Red Black Trees, B-Trees, Splay Trees, Sets and maps implementation.

UNIT-III: Graphs and Skip Lists **(10 Hours)**

Graphs: Basic terminologies of graphs, Representation and applications, Graph traversal techniques, Minimum spanning trees, Maximum Bipartite Matching, Minimum cost flow.

Skip Lists: Need for Randomizing data structures and algorithms, Search and update operations on skip lists, Probabilistic analysis of skip lists, Deterministic skip lists.

UNIT-IV: Heaps and Hash Tables **(9 Hours)**

Heaps: Definition, Heap Implementation, priority queues, Applications, Binomial heaps, operations on binomial heaps, Fibonacci heaps, Mergeable heap operations, decreasing a key and delete a node, Bounding a maximum degree.

Hashing: Definition, Hash functions and problems, Collision resolution techniques, Universal hashing, Applications**.**

UNIT-V: Computational Geometry **(7 Hours)**

One dimensional range searching, Two dimensional range searching, Constructing a priority search tree, Searching a priority search tree, Priority range trees, Quad trees, k-D Trees.

Total Hours: 45

TEXT BOOKS:

1. Mark Allen Weiss, *Data Structures and Algorithm Analysis in C++*, Pearson, 4th Edition, 2014.
2. Michael T. Goodrich, Roberto Tomassia, *Algorithm Design: Foundations, Analysis and Internet Examples*, Wiley, 2002.

REFERENCE BOOKS:

1. Sartaj Sahni, *Data Structures, Algorithms and Applications in C++*, Universities Press, 2nd Edition, 2005.
2. Richard F. Gilberg, Behrouz A. Forouzan, *Data Structures: A Pseudocode Approach with C*, Cengage, 2nd Edition, 2007.

M. Tech. (CS) - I Semester

(19MT10503) MATHEMATICAL FOUNDATIONS OF COMPUTER SCIENCE

(Common to CS and CNIS)

Internal Marks	External Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES: A course on Multivariable Calculus and Differential Equations.

COURSE DESCRIPTION:
Mathematical Logic, Predicate calculus, Set theory, Relations, functions, Algebraic Structures, Combinations and Permutations, Recurrence Relations, Graph Theory and its Applications.

COURSE OUTCOMES:
On successful completion of the course, students will be able to:

CO1. Understand and apply the fundamental concepts of mathematical logic to solve engineering problems.

CO2. Formulate problems and solve using recurrence relations and graph theory.

DETAILED SYLLABUS:

UNIT-I: Mathematical Logic and Predicate Calculus (9 Hours)

Mathematical Logic: Introduction, Statements and notations, Connectives, Truth tables, Tautology, Tautological implications, Well formed formulae, Other connectives, Normal forms, The theory of inference for the statement calculus, Automatic theorem proving.

Predicate Calculus: Predicates, Quantifiers, Predicate formulas, Free and bound variables, The universe of discourse, Theory of inference for the predicate calculus.

UNIT-II: Set Theory and Algebraic Structures (9 Hours)

Set Theory: Basic concepts of set theory, Relations, Properties of binary relation, Relation matrix and the graph of a relation, Equivalence relations, Compatibility relations, Partial ordering, Partially ordered set, Functions - Definition and introduction, Composition of function, Inverse function.

Algebraic Structures: Algebraic systems, Semigroups and monoids, Groups, Homomorphism and isomorphism, Cosets and Lagrange's theorem.

UNIT-III: Elementary Combinatorics (9 Hours)

Basics of counting, Combinations and permutations, Enumeration of combinations and permutations, Enumerating combinations and permutations with and without repetitions, The binomial and multinomial Theorems, The principle of inclusion exclusion, Pigeon hole principle.

UNIT-IV: Recurrence Relations (9 Hours)

Generating functions of sequences, Calculating coefficients of generating functions, Recurrence relations, Solving recurrence relations by substitution and generating functions, The method of characteristic roots, Solutions of inhomogeneous recurrence relations.

UNIT-V: Graph Theory and Its Applications (9 Hours)

Introduction, Isomorphism and sub graphs, Trees and their properties, Spanning trees, Planar graphs, Euler's formula, Multigraphs and Euler circuits, Hamiltonian graphs and circuits, Chromatic number, The four-color problem.

Total Hours: 45

TEXT BOOKS:

1. J. P. Tremblay, R. Manohar, *Discrete Mathematical Structures with Applications to Computer Science*, Mc Graw Hill, 2008.
2. Joe L. Mott, Abraham Kandel, Theodore P. Baker, *Discrete Mathematics for Computer Scientists and Mathematicians*, Pearson, 2nd Edition, 2008.

REFERENCE BOOKS:

1. John Vince, *Foundation Mathematics for Computer Science: A Visual Approach*, Springer, 2015.
2. K.H. Rosen, *Discrete Mathematics and its Applications*, McGraw Hill, 7th Edition, 2012.

M. Tech. (CS) – I Semester

(19MT26302) WIRELESS SENSOR NETWORKS

(Program Elective – 1)

Internal Marks	External Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES: A Course on Computer Networks.

COURSE DESCRIPTION:
Introduction to wireless sensor networks; Medium access control protocol design; Various routing protocols for wireless sensor networks; Security issues and requirements in wireless sensor Networks; Advanced concepts in wireless sensor networks.

COURSE OUTCOMES:
On successful completion of the course, students will be able to:

CO1. Analyze and apply the concepts of wireless sensor networks to evaluate network architectures for improving the performance of the networks.

CO2. Evaluate varying routing protocols for wireless sensor networks to overcome the problems of transmission.

DETAILED SYLLABUS:

UNIT-I: Introduction of Wireless Sensor Networks (9 Hours)
Basic concepts of wireless sensor networks, Motivations, Applications, Performance metrics, History and design factors, Architecture of a sensor node, Different sensing scenarios using WSN, Challenges in implementing WSNs.

UNIT-II: Medium Access Control Protocol Design (9 Hours)
Characteristics of WSN, MAC related properties, MAC performance issues, MAC protocols for WSNs - Schedule based protocols, Random access based protocols; WSN protocols - synchronized, duty cycled; Contention based and contention free MAC protocols.

UNIT-III: Routing Protocols for Wireless Sensor Networks (9 Hours)
Issues with the adoption of ad-hoc routing protocols, Data-centric routing, Position based Geographic routing, Clustering based routing algorithm, QoS based routing protocols, Analysis of opportunistic routing.

UNIT-IV: Security in Wireless Sensor Networks (9 Hours)
Security requirements in WSNs, Different types of attacks in WSNs, Security protocols for WSNs, Time synchronization, Requirements and challenges, Basic ideas, Various protocols, Coverage problem in WSNs, OGDC coverage algorithm, Placement problem.

UNIT-V: Advanced Concepts in Wireless Sensor Networks (9 Hours)
Overview, Types and challenges, Design of wireless sensor networks for emerging scenarios, Design analysis of transition from WSN to IoT, Real life deployment, Underwater sensor nodes vs Terrestrial sensor networks.

Total Hours: 45

TEXT BOOKS:

1. W. Dargie and C. Poellabauer, *Fundamentals of Wireless Sensor Networks: Theory and Practice*, Wiley, 2010.
2. K. Sohraby, D. Minoli and Taieb Znati, *Wireless Sensor Networks: Technology, Protocols, and Applications*, Wiley, 2007.

REFERENCE BOOKS:

1. Fei Hu and Xiaojun Cao, *Wireless Sensor Networks: Principles and Practice*, CRC Press, 2010.
2. Feng Zhao, Leonidas Guibas, *Wireless Sensor Networks: An Information Processing Approach*, Elsevier, 1st Edition, 2005.

M. Tech. (CS) - I Semester

(19MT10504) ARTIFICIAL INTELLIGENCE

(Program Elective -1)

(Common to CS and CNIS)

Internal Marks	External Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES: Courses on Mathematical Foundations of Computer Science and Data Structures.

COURSE DESCRIPTION:

Artificial intelligence concepts, Intelligent agents, Problem solving agents, Logical agents, Knowledge representation and processing, Probabilistic learning, Natural language processing.

COURSE OUTCOMES:

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

CO1. Apply knowledge of artificial intelligence techniques to develop an intelligent system for a given problem.

CO2. Design and develop solutions for natural language processing applications.

DETAILED SYLLABUS:

UNIT-I: Introduction **(9 Hours)**

AI Definition, Foundations of artificial intelligence, State of the art.

Intelligent Agents - Agents and environments, The concept of rationality, Nature of environments, Structure of agents.

UNIT-II: Problem Solving **(9 Hours)**

Problem solving agents, Searching for solutions, Uninformed search strategies, Informed search strategies, Heuristic functions, Local search algorithms and optimization problems.

UNIT-III: Logical Agents **(9 Hours)**

Knowledge based agents, The Wumpus World, Logic, Propositional logic, Propositional theorem proving.

First Order Logic - Syntax and semantics of first-order logic, Using first order logic, Knowledge engineering.

UNIT-IV: Knowledge Representation and Probabilistic Learning **(9 Hours)**

Ontological engineering, Categories and objects, Events, Mental events and mental objects, Reasoning systems for categories, Reasoning with default information, The Internet shopping world, Knowledge representation in uncertain domain, Bayesian networks, Independence, Bayes' rule.

UNIT-V: Probabilistic Reasoning over Time **(9 Hours)**

Time and uncertainty, Inference in temporal models, Hidden Markov models, Kalman filters, Dynamic Bayesian networks, Multi object tracking.

Natural Language Processing - Language models, Text classification, Information retrieval, Machine translation, Speech recognition.

Total Hours: 45

TEXT BOOK:

1. Stuart J. Russell and Peter Norvig, *Artificial Intelligence: A Modern Approach*, Pearson, 3rd Edition, 2010.

REFERENCE BOOKS:

1. Elaine Rich, Kevin Knight, B. Shivashankar B. Nair, *Artificial Intelligence*, McGraw Hill, 3rd Edition, 2017.
2. Saroj Kaushik, *Artificial Intelligence*, Cengage Learning, 1st Edition, 2011.

M. Tech. (CS) – I Semester

(19MT10505) DATA WAREHOUSING AND DATA MINING

(Program Elective – 1)

(Common to CS and CNIS)

Internal Marks	External Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES: A Course on Database Management Systems.

COURSE DESCRIPTION:

Introduction to Data warehousing and OLAP with its operations, Need for data pre-processing and pre-processing techniques, Functionalities of Data mining, Classification, Association pattern mining, Cluster analysis, Trends in Data mining.

COURSE OUTCOMES:

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

CO1. Identify the key concepts of data warehousing and design data warehouses to support OLAP applications.

CO2. Analyze and preprocess various datasets to improve the quality of data in the process of knowledge discovery.

CO3. Choose and apply appropriate data mining techniques for the given datasets to generate patterns, visualize and analyze patterns to discover actionable knowledge.

DETAILED SYLLABUS:

UNIT-I: Data Warehousing and Online Analytical Processing (9 Hours)

Data warehouse, Operational database systems versus data warehouses, A Multi-tiered architecture, A Multidimensional data model, Star, Snowflake and Fact Constellation schemas, Role of concept hierarchies, Measures, OLAP operations, From online analytical processing to multidimensional data mining, Indexing OLAP data.

UNIT-II: Data Mining and Data Preprocessing (8 Hours)

Introduction to data mining, Kinds of data, Kinds of patterns, Major issues in data mining, Data pre-processing, Data cleaning, Data integration, Data reduction, Data transformation and discretization.

UNIT-III: Associations and Classification (10 Hours)

Basic concepts, Frequent itemset mining methods, Pattern evaluation methods, From association mining to correlation analysis, Classification, Decision tree induction, Bayesian classification methods, Rule based classification, Prediction - linear regression.

UNIT-IV: Cluster Analysis (9 Hours)

Types of data in cluster analysis, A categorization of major clustering methods, Partitioning Methods - K-Means, K-Medoids; Hierarchical methods - Agglomerative method, Divisive method; Density based method - DBSCAN; Grid based method - STING; Outlier analysis.

UNIT-V: Data Mining Trends (9 Hours)

Mining sequence data, Mining graphs and networks, Spatial data mining, Text mining , Mining multimedia and web data, Statistical data mining, Privacy security and social impacts of data mining, Social network analysis.

Total Hours: 45

TEXT BOOK:

1. Jiawei Han, Micheline Kamber and Jian Pei, *Data Mining: Concepts and Techniques*, Elsevier, 3rd Edition, 2013.

REFERENCE BOOKS:

1. Mohammed J. Zaki, Wagner Meira Jr., *Data Mining and Analysis: Fundamental Concepts and Algorithms*, Cambridge University Press, 2014.
2. Pang-Ning Tan, Vipin Kumar, Michael Steinbach, *Introduction to Data Mining*, Pearson, 2nd Edition, 2019.

M. Tech. (CS) – I Semester

(19MT10506) IMAGE PROCESSING

(Program Elective – 1)

Internal Marks	External Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES: -NIL-

COURSE DESCRIPTION:

Fundamentals of image processing, Intensity transformation functions, Spatial filters, Filtering in the frequency domain, Image restoration, Filtering techniques for image restoration, Coding techniques for image compression , Image segmentation, color image processing methods, Feature extraction and image pattern classification.

COURSE OUTCOMES:

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

CO1. Select and apply appropriate digital image processing techniques to prepare digital images for processing.

CO2. Develop algorithms to process digital images in real-time applications and apply appropriate techniques to solve complex problems in the field of image processing.

DETAILED SYLLABUS:

UNIT-I: Image Fundamentals **(9 Hours)**

Evolution of digital image processing, Fundamental steps in digital image processing, Components of image processing system, Image sensing and acquisition, Image sampling and quantization, Basic relationships between pixels.

UNIT-II: Image Enhancement (**11 Hours)**

Intensity transformation and spatial filtering – Basic intensity transformation functions, Histogram processing, Fundamentals of spatial filtering, Smoothing spatial filters, Sharpening spatial filters, Combining spatial enhancement methods; Filtering in the frequency domain – Image smoothing using low-pass frequency domain filters, Image sharpening using high-pass filters.

UNIT-III: Image Restoration and Image Compression **(8 Hours)**

Image restoration: Image degradation/restoration process, Noise models, Restoration in the presence of Noise only-Spatial filtering, Estimating the degradation function, Inverse filtering, Weiner filtering, Constrained Least squares filtering, Image Reconstruction from Projections.

Image Compression: Arithmetic coding, Run length coding, Bit-plane coding, Image compression standards.

UNIT-IV: Image Segmentation and Color Image Processing **(8 Hours)**

Detection of discontinuities – Point, line and edge detection; Thresholding – Global thresholding, Adaptive thresholding; Region based segmentation, Color image fundamentals – RGB, HSI models, Pseudo color image processing, Color transformations, Color image smoothing and sharpening, Noise in color images.

UNIT-V: Feature Extraction and Image Pattern Classification **(9 Hours)**

Feature Extraction – Boundary preprocessing, Boundary feature descriptors, Region feature descriptors, Principal components as feature descriptors, Image features; Pattern classification – Patterns and pattern classes, Pattern classification by prototype matching, Bayes' classifiers, Neural networks and Deep learning, Convolution neural networks.

Total Hours: 45

TEXT BOOKS:

1. Rafael C. Gonzalez, Richard E. Woods, *Digital Image Processing*, Pearson, 4th Edition, 2018.
2. S. Sridhar, *Digital Image Processing*, Oxford University Press, 2nd Edition, 2016.

REFERENCE BOOKS:

1. Madhuri A. Joshi, *Digital Image Processing: An Algorithmic Approach,* PHI, 2nd Edition, 2018.
2. Anil K. Jain, *Fundamentals of Digital Image processing*, Prentice Hall, 2007.

M. Tech. (CS) – I Semester

(19MT16303) CLOUD COMPUTING

(Program Elective – 2)

(Common to CNIS, CS and SE)

Internal Marks	External Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES: Courses on Computer Networks and Operating Systems.

COURSE DESCRIPTION:

Characteristics and taxonomy of virtualization techniques, Cloud services, Cloud architecture - NIST and other models, communication protocols, and applications, Cloud programming concepts - concurrent programming, task programming, data intensive computing,; Trends and industrial platforms.

COURSE OUTCOMES:

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

CO1. Create virtual environments to deploy cloud services by using the concepts of virtualization and cloud computing.

CO2. Analyze and deploy cloud architectures for providing cloud services to cater needs of diverse applications.

DETAILED SYLLABUS:

UNIT-I: Introduction to Virtualization **(9 Hours)**

Characteristics of virtualized environments, Taxonomy of virtualization techniques, Virtualization and cloud computing, Pros and cons of virtualization, Technology examples - XEN, VMware, Microsoft Hyper-V.

UNIT-II: Fundamental Cloud Computing **(9 Hours)**

Understanding Cloud Computing - Origins and influences, Basic concepts and terminology, Goals and benefits, Risks and challenges; Fundamental concepts and models - Roles and boundaries, Cloud characteristics, Cloud delivery models, Cloud deployment models; Cloud enabling technology - Broadband networks and Internet architecture, Data center technology; Fundamental cloud security - Basic terms and concepts, Threat agents, Cloud security threats, Additional considerations.

UNIT-III: Defining Cloud Services **(9 Hours)**

Defining Infrastructure as a Service (IaaS) - IaaS workloads, Pods, Aggregation, and silos; Defining Platform as a Service (PaaS), Defining Software as a Service (SaaS) - SaaS characteristics, Open SaaS and SOA, Salesforce.com and CRM SaaS; Defining Identity as a Service (IDaaS) - Introduction to identity, Networked identity service classes, Identity system codes of conduct, IDaaS interoperability; Defining Compliance as a Service (CaaS).

UNIT-IV: Cloud Programming Concepts **(9 Hours)**

Concurrent programming - Introduction to parallelism for single machine computation, Programming applications with threads; High throughput computing - Task programming, Task based application models; Data intensive computing - Introduction to data intensive computing and technologies for data intensive computing.

UNIT-V: Industrial Platforms And Trending Developments **(9 Hours)**

Case Studies on Cloud Platforms: Software as a Service (SaaS) - Salesforce.com; Platform as a Service (PaaS) - Google App Engine, MS-Azure and IBM Bluemix; Infrastructure as a Service (IaaS) - Amazon EC2, Amazon S3 and Netflix; Enhancements in cloud - Energy efficiency in clouds, Market based management of clouds, Federated clouds / InterCloud, Third party cloud services.

Total Hours: 45

TEXT BOOKS:

1. Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi, *Mastering Cloud Computing: Foundations and Applications Programming*, Morgan Kaufmann, 1st Edition, 2013.
2. Thomas Erl, Zaigham Mahmood, Ricardo Puttini, *Cloud Computing: Concepts, Technology & Architecture*, PHI, 1st Edition, 2013.

REFERENCE BOOKS:

1. Anthony T. Velte, Toby J. Velte, Robert Elsenpeter, *Cloud Computing: A Practical Approach*, McGraw Hill, 1st Edition, 2010.
2. George Reese, *Cloud Application Architectures: Building Applications and Infrastructure in the Cloud*, O'Reilly, 1st Edition, 2009.

M. Tech. (CS) – I Semester

(19MT10507) BIG DATA ANALYTICS

(Program Elective – 2)

Internal Marks	External Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES: Courses on Data structures, Statistics.

COURSE DESCRIPTION:
Big Data Analytics, Architecture, Pre-processing, Hadoop Distributed File System, NoSQL Database, MongoDB, MapReduce, Hive, Spark, Stream mining, Graph analytics.

COURSE OUTCOMES:
On successful completion of the course, students will be able to:

CO1. Analyze the key issues in big data management and its associated applications using Hadoop Ecosystem.

CO2. Design and develop real world applications with data storage and retrieval using big data technologies like Hadoop, MapReduce and Hive.

DETAILED SYLLABUS:

UNIT-I: Introduction to Big Data Analytics **(9 Hours)**
Big data characteristics, Designing data architecture, Data sources, Preprocessing, Data storage and analysis, Big data analytics Applications.
Introduction to Hadoop: Hadoop and its Ecosystem, Hadoop Distributed File System, MapReduce Framework and programming model, Hadoop Yarn.

UNIT-II: NoSQL Database **(9 Hours)**
Data store, Data architecture patterns, Managing big data, Shared-nothing architecture for big data tasks, MongoDB Database - Features, Dynamic schema, Auto sharing, Query language and commands.

UNIT-III: Mapreduce, Hive And Spark **(9 Hours)**
Map tasks, Reduce tasks, Execution, Composing MapReduce for calculations, Matrix vector multiplication by MapReduce, Relational algebra operations, Matrix multiplication.
Hive: Architecture, Data types, Formats, Data model, Integration and workflow steps, Built-in functions, Data definition language, Data manipulation language, Aggregation, Join, Group by clause.
Spark: Spark SQL, Data analysis operations, Programming using RDDs, Data ETL process, Reporting and visualizing.

UNIT-IV: Data Stream Mining **(9 Hours)**
Data stream concepts, Model, Architecture, Data stream management system, stream queries, Stream processing issues, Stream computing, Sampling data, Filtering, Estimating moments, Decaying windows, Frequent Itemsets - Finding frequent itemsets, Limited passes algorithm, Counting frequent itemsets in a stream; Apache Sparkstreaming architecture.

UNIT-V: Graph Analytics **(9 Hours)**
Graph Model: Representing graph as triples, Resource description framework for graph databases, NaïveDB graph database, Property graph model, Probabilistic Graphical Network Organization - Bayesian and Markov networks.
Graph Analytics: Use cases, StatsModel and Probabilistic based analytics, Technical complexity in analyzing graphs; Spark GraphX platform – Features of graph analytics platform.

Total Hours: 45

TEXT BOOK:
1. Raj Kamal, Preeti Saxena, *Big Data Analytics: Introduction to Hadoop, Spark, and Machine Learning*, McGraw Hill, 1st Edition, 2019.

REFERENCE BOOKS:
1. Jeffrey Aven, *Data Analytics with SPARK using Python*, Pearson (Addison-Wesley Data & Analytics Series), 2018.
2. Tom White, *Hadoop: The Definitive Guide*, O'Reilly Publications, 4th Edition, 2014.

M. Tech. (CS) – I Semester

(19MT10508) HIGH PERFORMANCE COMPUTING

(Program Elective – 2)

Internal Marks	External Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES: Courses on Microprocessors and Computer Architecture.

COURSE DESCRIPTION:

Parallel computing, Parallel architectures, Message passing, Communication abstraction, Parallel programming - Principles, Decomposition techniques, Models, Communication operations; Design issues in HPC - Principles, Building blocks, Message passing interface; Synchronization and related algorithms, Advanced tools, techniques and applications.

COURSE OUTCOMES:

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

CO1. Demonstrate knowledge on parallel processing concepts and apply various parallel programming models to design a parallel processor.

CO2. Design large scale parallel programs on tightly coupled parallel systems using the message passing paradigm.

DETAILED SYLLABUS:

UNIT-I: Parallel Processing Concepts **(9 Hours)**

Introduction to parallel computing - Motivating parallelism, Scope of parallel computing; Convergence of parallel architectures - Communication architecture, Shared memory, Message passing, Convergence, Data parallel processing; Fundamental design issues - Communication abstraction, Naming, Ordering, Communication and replication, Performance.

UNIT-II: Parallel Programming **(9 Hours)**

Principles of parallel algorithm design - Preliminaries, Decomposition techniques, Characteristics of tasks and interactions, Mapping techniques for load balancing, Methods for containing interaction overheads, Parallel algorithm models; Basic communication operations - One-to-All broadcast and All-to-One reduction, All-to-All broadcast and reduction, All-Reduce and Prefix-Sum operations, Scatter and gather section, All-to-All personalized communication, Circular shift, Improving the speed of some communication operations.

UNIT-III: Design Issues in High Performance Computing **(9 Hours)**

Programming using the message passing paradigm - Principles of message passing programming; The building blocks - Send and receive operations; MPI - the message passing interface; Topology and embedding, Overlapping communication with computation, Collective communication and computation operations, One dimensional matrix vector multiplication, Single source shortest path, Sample sort, Groups and communicators, Two dimensional matrix vector multiplication.

UNIT-IV: Synchronization and Related Algorithms **(9 Hours)**

Synchronization - Components of synchronization event, Role of user, System software and hardware, Mutual exclusion, Point-to-point event synchronization; Thread Basics - Creation and termination, Controlling thread and synchronization attributes, Thread cancellation, Composite synchronization constructs; OpenMP - Standard for directive based parallel programming.

UNIT-V: Advanced Tools, Techniques and Applications **(9 Hours)**

Bandwidth scaling, Latency scaling, Physical scaling, Scaling in a generic parallel architecture, Dense matrix algorithms – Matrix vector multiplication, Matrix-matrix multiplication; Sorting - Issues in sorting on parallel computers, Sorting networks, Bubble sort and its variants, Quick sort, Bucket and sample sort, Single source shortest paths.

Total Hours: 45

TEXT BOOKS:

1. Ananth Grama, Anshul Gupta, George Karypis, Vipin Kumar, *An Introduction to Parallel Computing*, Addison-Wesley, 2nd Edition, 2003.
2. David E. Culler, Jaswinder Pal Singh, Anoop Gupta, *Parallel Computer Architecture: A Hardware/Software Approach*, Elsevier India, 1999.

REFERENCE BOOK:

1. Kai Hwang, Zhiwei Xu, *Scalable Parallel Computing: Technology, Architecture, Programming*, McGraw Hill, 1998.

M. Tech. (CS) – I Semester

(19MT10509) MACHINE LEARNING

(Program Elective – 2)

(Common to CS, CNIS and SE)

Internal Marks	External Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES: A course on statistics.

COURSE DESCRIPTION:

Concepts of supervised, unsupervised and reinforcement learning, Bayesian decision theory, Learning rules from data, Performance evaluation of classification algorithms, Ensemble learners, Elements of Reinforcement Learning.

COURSE OUTCOMES:

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

CO1. Understand, select and apply appropriate machine learning strategies of supervised, unsupervised and reinforcement learning for solving a given problem.

CO2. Evaluate the performance of machine learning algorithms and select optimal models to suit needs of a given problem.

CO3. Redesign existing machine learning algorithms to improve efficiency of classification models.

DETAILED SYLLABUS:

UNIT-I: Introduction **(9 Hours)**

Machine Learning, Applications, Supervised Learning - Learning a class from examples, Vapnik Chervonenkis (VC) dimension, Probably Approximately Correct (PAC) learning, Noise, Learning multiple classes, Regression, Model selection and generalization.

UNIT-II: Bayesian Decision Theory and Linear Discrimination **(9 Hours)**

Bayesian Decision Theory: Classification, Losses and risks, Discriminant functions, Utility theory, Value of information, Bayesian networks, Influence diagrams, Association rules.

Linear Discrimination: Generalizing linear model, Geometry of the linear discriminant, Pairwise separation, Parametric discrimination, Gradient descent, Support vector machines.

UNIT-III: Decision Trees and Clustering **(9 Hours)**

Decision trees: Univariate trees, Pruning, Rule extraction from trees, Learning rules from data, Multivariate trees.

Clustering: Mixture densities, K-Means clustering, EM algorithm, Supervised learning after clustering, Hierarchical clustering, Choosing the number of clusters.

UNIT-IV: Performance Evaluation of Classification Algorithms **(9 Hours)**

Cross validation and resampling methods, Measuring error, Interval estimation, Hypothesis testing, Assessing a classification algorithm's performance, Comparing two classification algorithms.

Combining Multiple Learners: Rationale, Voting, Bagging, Boosting, The mixture of experts revisited, Stacked generalization, Cascading.

UNIT-V: Reinforcement Learning **(9 Hours)**

Single state case - *K*-Armed Bandit; Elements of reinforcement learning, Model based learning, Temporal difference learning, Generalization, Partially observable states.

Total Hours: 45

TEXT BOOK:

1. Ethem Alpaydin, *Introduction to Machine Learning,* MIT Press (Adaptive Computation and Machine Learning Series), 3rd Edition, 2014.

REFERENCE BOOKS:

1. Stephen Marsland, *Machine Learning: An Algorithmic Perspective*, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2nd Edition, 2014.
2. Richard O. Duda, Peter E. Hart, David G. Stork, *Pattern Classification*, Wiley, 2nd Edition, 2012.

M. Tech. (CS) – I Semester
(19MT10708) RESEARCH METHODOLOGY AND IPR
(Common to all M. Tech. Programs)

Internal Marks	External Marks	Total Marks	L	T	P	C
40	60	100	2	-	-	2

PRE-REQUISITES: NIL

COURSE DESCRIPTION:
Overview of research, Research problem and design, Various research designs, Data collection methods, Statistical methods for research, Interpretation and drafting reports, Intellectual property rights.

COURSE OUTCOMES:
On successful completion of the course, students will be able to:

CO1. Apply the conceptual knowledge of research methodology to formulate the hypothesis, data collection and processing, analyzing the data using statistical methods, interpret the observations and communicating the novel findings through a research report.

CO2. Practice ethics and have responsibility towards society throughout the research process and indulge in continuous learning process.

CO3. Apply the conceptual knowledge of intellectual property rights for filing patents and trade mark registration process.

DETAILED SYLLABUS:

UNIT-I: Introduction to Research Methodology **(7 Hours)**
Objectives and motivation of research, Types of research, Defining and formulating the research problem, Features of research design, Different research designs, Different methods of data collection, Data preparation and processing.

UNIT-II: Data Analysis and Hypothesis Testing **(9 Hours)**
ANOVA, Principles of least squares - regression and correlation; Normal distribution - Properties of normal distribution; Testing of hypothesis – Hypothesis testing procedure, Types of errors, t-Distribution, Chi-Square test as a test of goodness of fit.

UNIT-III: Interpretation and Report Writing **(4 Hours)**
Interpretation – Need, Techniques and Precautions; Report writing – Significance, Different steps, Layout, Types of reports, Mechanics of writing a research report, Precautions in writing reports; Research ethics.

UNIT-IV: Introduction to Intellectual Property and Trade Marks **(7 Hours)**
Importance of intellectual property rights, Types of intellectual property, International organizations, Purpose and function of trademarks, acquisition of trademark rights, Protectable matter, Selecting and evaluating trademark, Trademark registration processes.

UNIT-V: Law of Copyrights **(8 Hours)**
Fundamental of copyright law, Originality of material, Rights of reproduction, Rights to perform the work publicly, Copyright ownership issues, Copyright registration, Notice of copyright, International copy right law.
Law of patents: Foundation of patent law, Patent searching process, Ownership rights and transfer.
New Developments in IPR: Administration of patent system.

Total Hours: 35

TEXT BOOKS:

1. C.R. Kothari, *Research Methodology: Methods and Techniques*, New Age International Publishers, New Delhi, 2nd Revised Edition, 2004.
2. Deborah E. Bouchoux, *Intellectual Property: The Law of Trademarks, Copyrights, Patents and Trade Secrets*, Cengage Learning, 5th Edition, 2017.

REFERENCE BOOKS:

1. R. Panneerselvam, *Research Methodology*, PHI learning Pvt. Ltd., 2009.
2. Prabuddha Ganguli, *Intellectual Property Rights - Unleashing the Knowledge Economy*, Tata McGraw Hill Publishing Company Ltd., 2001.

M. Tech. (CS) – I Semester

(19MT10531) ADVANCED ALGORITHMS LAB

(Common to CS and CNIS)

Internal Marks	External Marks	Total Marks	L	T	P	C
50	50	100	-	-	4	2

PRE-REQUISITES: A Course on Computer Programming.

COURSE DESCRIPTION:

Hands on practice on algorithmic design techniques - Divide and conquer, Greedy methods Dynamic programming, Backtracking, Sum of subset problem, Vertex cover problem, Flow networks, String matching algorithms and Randomized algorithms.

COURSE OUTCOMES:

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

CO1. Implement various algorithmic techniques greedy method, dynamic programming, backtracking, advanced graph theory and analyze the comparison of different techniques.

CO2. Design algorithms to solve real world computing problems and evaluate their efficiency.

CO3. Write, present technical report/document effectively.

CO4. Function effectively as an individual and as a member in team to implement mini-project.

LIST OF EXERCISES:

1. Write a program to implement Job sequencing with deadlines using greedy method.
2. Implement the 0/1 Knapsack problem using

   a) Dynamic Programming method b) Greedy method
3. Implement N-queen's problem using Backtracking. The N Queen is the problem of placing N chess queens on an N×N chessboard so that no two queens attack each other. The expected output is a binary matrix which has 1s for the blocks where queens are placed. For example following is the output matrix for above 4 queen problem's solution.

   {0, 1, 0, 0},{0, 0, 0, 1},{1, 0, 0, 0},{0, 0, 1, 0}
4. Find a subset of a given set S = {s1, s2,.....,Sn} of n positive integers whose sum is equal to a given positive integer d. For example, if S= {1, 2, 5, 6, 8} and d = 9 there are two solutions {1, 2, 6} and {1, 8}.A suitable message is to be displayed if the given problem instance doesn't have a solution.
5. Write a program to implement

   a) Vertex cover problem b) Maximum bipartite matching problem in the graph
6. Write a program to implement Ford-Fulkerson method for maximum flow networks.
7. Write a program to implement Chinese remainder theorem.
8. Write a program to solve string matching problem using Naïve approach and Knuth-Morris-Pratt algorithm.
9. Write a program to solve string matching problem and determine its performance.

   a) Finite Automata b) Rabin Karp algorithm
10. Write a program to implement a Monte Carlo algorithm to test the primarily of a given integer and determine its performance.
11. Mini Project

REFERENCE BOOKS:

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, *Introduction to Algorithms*, PHI Learning, 3rd Edition, 2009.
2. Ellis Horowitz, Sartaj Sahni, and S Rajasekaran, *Fundamentals of Computer Algorithms*, Universities Press, 2nd Edition, 2008.

M. Tech. (CS) – I Semester

(19MT10532) ADVANCED DATA STRUCTURES LAB

(Common to CS and CNIS)

Internal Marks	External Marks	Total Marks	L	T	P	C
50	50	100	-	-	4	2

PRE-REQUISITES: A Course on Computer Programming.

COURSE DESCRIPTION:
Hands on practice on Linked Lists, Stacks and Queues, Binary search tree, AVL tree, Red black tree, Splay tree, KD tree, Priority search tree and Hashing.

COURSE OUTCOMES:
On successful completion of the course, students will be able to:

CO1. Implement linear and non linear data structures like stacks, queues, linked lists, trees, graphs and hash functions to simulate by organizing the data in memory.
CO2. Design and develop appropriate algorithms to store and retrieve the data.
CO3. Write, present technical report/document effectively.
CO4. Function effectively as an individual and as a member in team to implement mini-project.

LIST OF EXERCISES:

1. Write program to implement the following Data structures:
   a) Single linked list
   b) Double linked list
   c) Circular linked list
2. Write a program to implement Stack and Queue
   a) Dequeue
   b) Circular queue
   c) Stack using two queues
   d) Queue using two stacks
3. Write a program to perform the following operations on binary search tree:
   a) Insertion b) Deletion c) Searching
4. Write a program to perform the following operations on AVL-tree:
   a) Insertion b) Deletion
5. Write a program to perform operations on Red Black tree.
6. Write a program to perform the following operations on splay-tree:
   a) Insertion b) Deletion
7. Write a program to implement Graph traversal techniques.
8. Implement the following functions of a dictionary using open addressing hashing techniques.
   a) Insertion b) Searching c) Deletion
9. Write a program to implement searching in Priority Search Tree.
10. Implement the following functions of K-D tree operations.
    a) Insert b) Update c) Delete
11. Mini Project

REFERENCE BOOKS:

1. Mark Allen Weiss, *Data Structures and Algorithm Analysis in C++*, Pearson, 4th Edition, 2014.
2. Michael T. Goodrich, Roberto Tomassia, *Algorithm Design: Foundations, Analysis and Internet Examples*, Wiley, 2002.

M. Tech. (CS) – I Semester

(19MT1AC01) TECHNICAL REPORT WRITING

(Audit Course)

(Common to all M. Tech. Programs)

Internal Marks	External Marks	Total Marks	L	T	P	C
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PRE-REQUISITES: NIL

COURSE DESCRIPTION:

Introduction, Process of writing, Style of writing, Referencing, Presentation.

COURSE OUTCOMES:

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

CO1. Demonstrate knowledge of Technical Report Writing by examining kinds of reports and structure with scientific attitude.

CO2. Apply the techniques in preparing effective reports by examining Techniques of Description, Describing Machines and Mechanisms and Describing Processes.

CO3. Communicate effectively through writing technical reports by demonstrating the knowledge of Industry Reports, Survey Reports, Interpretive Report and Letter Report.

DETAILED SYLLABUS:

UNIT-I: Introduction **(6 Hours)**

Introduction to Technical Report - Types of Reports - Planning Technical Report Writing - Components of a Technical Report - Report Writing in Science and Technology - Selecting and Preparing a 'Title' - Language Use in Report Writing

UNIT-II: Process of Writing **(6 Hours)**

Writing the 'Introduction' - Writing the 'Materials and Methods' - Writing the Findings/Results' - Writing the 'Discussion' - Preparing and using 'Tables'

UNIT-III: Style of Writing **(6 Hours)**

Preparing and using Effective 'Graphs' - Citing and Arranging References—I - Citing and Arranging References —II - Writing for Publication in a Scientific Journal

UNIT-IV: Referencing **(8 Hours)**

Literature citations - Introductory remarks on literature citations - Reasons for literature citations – Bibliographical data according to ISO - Citations in the text - Copyright and copyright laws - The text of the Technical Report - Using word processing and desktop publishing (DTP) systems - Document or page layout and hints on editing - Typographic details - Cross-references

UNIT-V: Presentation **(4 Hours)**

Giving the presentation - Appropriate pointing - Dealing with intermediate questions - Review and analysis of the presentation - Rhetoric tips from A to Z

***Total Hours:* 30**

TEXT BOOKS:

1. R C Sharma, Krishna Mohan, *Business Correspondence and Report Writing,* Tata McGraw-Hill Publishing Company Limited, New Delhi, 3rd edition, 2005 (reprint).
2. Patrick Forsyth*, How to Write Reports and Proposals,* The Sunday Times (Kogan Page), New Delhi, Revised 2nd edition, 2010.

REFERENCE BOOKS:

1. John Seely, *The Oxford Writing & Speaking*, Oxford University Press, Indian Edition.
2. Anne Eisenberg, *A Beginner's Guide to Technical Communication*, McGraw Hill Education (India) Private Limited, New Delhi, 2013.

M. Tech. (CS) – II Semester

(19MT20501) DATA SCIENCE

(Common to CS and SE)

Internal Marks	External Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES: Courses on Data Warehousing and Data Mining, Probability and Statistics.

COURSE DESCRIPTION:

Introduction to Data science, Using python for data science, Exploratory data analysis - Probability and distributions; Predictive modeling - Time series analysis; Data extraction - Feature selection, Single value decomposition, Principal component analysis; Data visualization - Using visualization for data science, Visualization tools.

COURSE OUTCOMES:

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

CO1. Analyze data by recognizing data science process and develop simple applications using relevant python libraries.

CO2. Investigate and evaluate various predictive models to contribute tools/techniques to applications of diverse domains.

CO3. Design and develop predictive models for a given problem to support forecasting.

DETAILED SYLLABUS:

UNIT-I: Introduction to Data Science **(9 Hours)**

Data science history, Data science project life cycle, Managing a data science project, Using python for data science - Understanding the basic concepts of python, Essential python libraries; Numpy, Pandas, Matplotlib, IPython, Scipy, Scikitlearn, StatsModels, Using python to analyze data.

UNIT-II: Statistical Thinking for Programmers **(11 Hours)**

Exploratory Data analysis: Distributions - Representing and plotting histograms, Outliers, Summarizing distributions, Variance, Reporting results; Probability mass function - Plotting PMFs, Other visualizations, The class size paradox Data frame indexing; Cumulative distribution functions - Limits of PMFs, Representing CDFs, Percentile based statistics, Random numbers, Comparing percentile ranks; Modeling distributions - Exponential distribution, Normal distribution, Lognormal distribution.

UNIT-III: Predictive Modeling **(9 Hours)**

Time series Analysis - Importing and cleaning, Plotting, Moving averages, Missing values, Serial correlation, Autocorrelation; Predictive modeling - Overview, Evaluating predictive models, Building predictive model solutions, Sentiment analysis.

UNIT-IV: Data Extraction **(9 Hours)**

Extracting meaning from data - Feature selection, User retention, Filters, Wrappers, Entropy, Decision tree algorithm; Random forests, The dimensionality problem, Single value decomposition, Principal component analysis.

UNIT-V: Data Visualization **(7 Hours)**

Need for data visualization, Creating visualizations - Comparison charts, Composition charts, Distribution charts, Relationship charts; Using visualization for data science – Popular visualization tools.

Total Hours: 45

TEXT BOOKS:

1. Ofer Mendelevitch, Casey Stella, Douglas Eadline, *Practical Data science with Hadoop and Spark: Designing and Building Effective Analytics at Scale*, Addison Wesley (Data & Analytics Series), 2017.
2. Alen B. Downey, *Think Stats: Exploratory Data Analysis*, O'Reilly Publications, 2nd Edition, 2014.

REFERENCE BOOKS:

1. Jacob T. VanderPlas, *Python Data Science Handbook: Essential Tools for Working with Data,* O'Reilly Publications, 2016.
2. Cathy O'Neil, Rachell Schutt, *Doing Data Science: Straight Talk from the Frontline*, O'Reilly Publications, 2013.

M. Tech. (CS) – II Semester
(19MT20502) WEB TECHNOLOGIES

Internal Marks	External Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES: A Course on Object Oriented Programming.

COURSE DESCRIPTION:
Concepts of HTML5 and CSS3 for web page creating and styling; JavaScript and JQuery for client-side scripting; PHP and MySQL; Node.js; AJAX.

COURSE OUTCOMES:
On successful completion of the course, students will be able to:
CO1. Design and develop dynamic and interactive web pages.
CO2. Create database connectivity from web applications to database to implement data definition and data manipulation operations.
CO3. Build web based applications to provide smart solutions to real-world problems.

DETAILED SYLLABUS:

UNIT-I: HTML5 and CSS3 **(9 Hours)**
HTML5: HTML5, Working with forms, HTML5 document structure, Creating editable content, Checking spelling mistakes, Exploring custom data attributes, Microdata, Client side storage, Drag and drop feature, Offline web applications, Web communications, Cross document messaging and Desktop notifications.
CSS3: Introduction, Features of CSS3, Syntax of CSS, Exploring CSS selectors, Inserting CSS in HTML Document, State of CSS3.

UNIT-II: Javascript AND JQuery **(8 Hours)**
JavaScript: Overview of Javascript, JavaScript functions, Events, Image maps and animations, JavaScript objects.
JQuery: Fundamentals of JQuery, JQuery selectors, JQuery methods to access HTML attributes and traversing, JQuery manipulators, Events and effects.

UNIT-III: PHP and MySQL **(9 Hours)**
Introduction, Data types, Control structures, Functions, Arrays, Embedding PHP code in web pages, Object Oriented PHP, PHP and web forms, Sending form data to a server, Authenticating users with PHP, Session handlers, PHP with MySQL, Interacting with the database, Database transactions.

UNIT-IV: Node.js **(11 Hours)**
Basics, Framework, Simple callbacks, HTTP responses, Variables, File access, MYSQL access.

UNIT-V: AJAX **(8 Hours)**
Exploring different web technologies, Exploring AJAX, Creating a sample AJAX Application, Displaying date and time using AJAX, Creating the XML HttpRequest object, Reading a file synchronously and asynchronously, Reading response headers, Loading list boxes dynamically using XML HttpRequest object, JQuery with AJAX, Validating a field using AJAX and PHP.

Total Hours: 45

TEXT BOOKS:

1. Kogent Learning Solutions Inc, *HTML 5 Black Book: Covers CSS3, JavaScript, XML, XHTML, AJAX, PHP and JQuery*, Dreamtech Press, 1st Edition, 2011.
2. Daniel Howard, *Node.js for PHP Developers*, O'Reilly, 1st Edition, 2012.

REFERENCE BOOKS:

1. Thomas A. Powell, *The Complete Reference: HTML and CSS*, Tata McGraw Hill, 5th Edition, 2010.
2. W. Jason Gilmore, *Beginning PHP and MySQL*, APress, 4th Edition, 2011.

M. Tech. (CS) – II Semester

(19MT26305) INTERNET OF THINGS

(Program Elective - 3)

(Common to CNIS, CS, SE, DECS and CMS)

Internal Marks	External Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES: Courses on Computer Networks, Python Programming.

COURSE DESCRIPTION:

Concepts of Domain Specific IoTs, M2M and system management with Netconf-Yang, IoT privacy and security, IoT physical devices, Amazon Web Services for IoT and case studies illustrating IoT design.

COURSE OUTCOMES:

CO1. Understand the concepts of IoT, IoT protocols, privacy and security issues in IoT applications to analyze domain specific IoT's.

CO2. Design solutions through implementing IoT applications on raspberry pi, AWS and develop security solutions to strengthen IoT environment.

DETAILED SYLLABUS:

UNIT-I: Concepts of IoT **(7 Hours)**

Definition and characteristics of IoT, Physical design of IoT – IoT protocols, Logical design of IoT, IoT enabling technologies, IoT levels and deployment templates.

UNIT-II: Domain Specific IoTs, IoT and M2M **(9 Hours)**

Domain Specific IoTs: Home automation, Cities, Environment, Energy, Logistics, Agriculture, Industry.

IoT and M2M: Introduction, M2M, Difference between IoT and M2M, SDN and NFV for IoT.

UNIT-III: IoT System Management with NETCONF-YANG and Developing IoTs **(9 Hours)**

Need for IoT systems management, Simple Network Management Protocol (SNMP), Network operator requirements, NETCONF-YANG, IoT systems management with NETCONF-YANG.

Developing Internet of Things: Introduction, IoT design methodology.

UNIT-IV: IoT Privacy, Security And Vulnerabilities Solutions and IoT Physical Devices **(11 Hours)**

Introduction, Vulnerabilities, Security requirements and treat analysis, Use cases and misuse cases, IoT security tomography and layered attacker model, Identity management and establishment, Access control and secure message communication, Security models, Profiles and protocols for IoT.

IoT Physical Devices and Endpoints: What is an IoT device, Exemplary device, About the board, Linux on Raspberry Pi, Raspberry Pi interfaces, Programming Raspberry Pi with Python and other IoT devices.

UNIT-V: Amazon Web Services for IoT and Case Studies Illustrating IoT Design **(9 Hours)**

Amazon Web Services for IoT: Amazon EC2, Amazon AutoScaling, Amazon S3, Amazon RDS, Amazon DynamoDB.

Case Studies Illustrating IoT Design: Home automation, Cities, Environment and Agriculture.

Total hours: 45

TEXT BOOKS:

1. Arshdeep Bahga, Vijay Madisetti, *Internet of Things: A Hands-on Approach*, Universities Press, 2015.
2. Raj Kamal, *Internet of Things: Architecture and Design Principles*", McGraw Hill, 1st Edition, 2017.

REFERENCE BOOKS:

1. Adrian McEwen, Hakim Cassimally, *Designing the Internet of Things*, Wiley, 2013.
2. Jeeva Jose, *Internet of Things*, Khanna Publishing, 1st Edition, 2018.

M. Tech. (CS) – II Semester

(19MT20503) ARTIFICIAL NEURAL NETWORKS AND DEEP LEARNING

(Program Elective – 3)

(Common to CS, CNIS and SE)

Internal Marks	External Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES: A course on Machine Learning.

COURSE DESCRIPTION:

Representation of neural network, Learning rule, Training algorithm, Activation functions, Convolution neural network and its variants, Long term dependencies in sequence-to-sequence classification, Regularization for deep learning, hyper parameter selection, Applications of deep learning.

COURSE OUTCOMES:

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

CO1. Apply conceptual knowledge to analyze various approaches for learning with deep neural networks.

CO2. Select appropriate libraries for using deep learning algorithms to implement various types of learning tasks in diverse domains.

CO3. Select optimal model parameters for different deep learning techniques using optimization techniques.

DETAILED SYLLABUS:

UNIT-I: Neural Networks **(9 Hours)**

Neural network representation, Topologies, Training, Activation functions, Perceptron learning, Rule and convergence Theorem, Adaline, Delta Rule, Exclusive OR problem, Multilayer perceptron.

UNIT-II: Training Feed-Forward Neural Networks **(9 Hours)**

Multilayer Feed Forward Backpropagation Algorithm, Delta rule and Learning rates, Other activation functions, Deficiencies of Backpropagation, Advanced algorithms, The effect of number of learning samples and number of hidden units, Stochastic and Minibatch gradient descent, Test sets, Validation sets, Overfitting - Preventing Overfitting.

UNIT-III: Convolutional Neural Networks **(9 Hours)**

The convolution operation, Parameter Sharing, Pooling, Variants of the basic convolution function, Data types, Efficient convolution algorithms, Random or Unsupervised features, Convolutional networks and the history of deep learning.

UNIT-IV: Recurrent Neural Networks **(9 Hours)**

Bidirectional RNNs, Encoder-Decoder Sequence-to-Sequence architectures, Deep recurrent networks, Recursive neural networks, The challenge of long-term dependencies, Echo state networks, Leaky units and other strategies for multiple time scales, The long short-term memory and other gated RNNs, Optimization for long-term dependencies, Explicit memory.

UNIT-V: Regularization for Deep Learning **(9 Hours)**

Parameter norm penalties, Dataset augmentation, Early stopping, Parameter tying and sharing, Dropout, Sparse representations, Bagging and other ensemble methods, Adversarial training, Performance metrics, Default baseline models, Selecting hyper parameters, Debugging strategies, Applications - Computer Vision, Speech Recognition, Natural Language Processing.

Total Hours: 45

TEXT BOOKS:

1. Ian Goodfellow I, Yoshua Bengio, Aaron Courville , *Deep Learning*, MIT Press, 2016.
2. Ben Krose, Patrick van der Smagt, *An Introduction to Neural Networks*, MIT Press, 8th Edition, 1996.

REFERENCE BOOK:

1. Yegnanarayana B., *Artificial Neural Networks*, PHI, 2012.

M. Tech. (CS) – II Semester

(19MT20504) COMPUTER VISION

(Program Elective – 3)

Internal Marks	External Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES: Courses on Image Processing, Machine Learning.

COURSE DESCRIPTION:

Fundamental of computer vision including filtering, image clustering, classification and scene understanding procedures; Practical integration of machine vision systems, and the related applications.

COURSE OUTCOMES:

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

CO1. Demonstrate knowledge on image processing techniques and analyze filtering, thresholding methods to solve segmentation techniques which elucidate the image segmentation, edge detection procedures.

CO2. Design solutions for image analysis problems by clustering and classification techniques to develop novel techniques and efficient algorithms for image classification.

DETAILED SYLLABUS:

UNIT-I: Introduction and Image Filtering **(9 Hours)**

Images and Imaging Operations: Gray scale versus color, Image processing operations, Basic operations on gray scale images, Basic operations on binary images, Sequential versus parallel operations.

Image Filtering Operations: Noise suppression using Gaussian smoothing, Median filters, Mode filters, Rank order Filters, Sharp-Unsharp masking, Color in image filtering.

UNIT-II: Thresholding Techniques **(9 Hours)**

Region growing methods, Thresholding - Finding suitable threshold, Bias in threshold selection, Finding the valley in the intensity distribution, Adaptive thresholding, Threshold selection - Variance based thresholding, Entropy based thresholding, Maximum likelihood thresholding.

UNIT-III: Edge Detection Methods **(10 Hours)**

Basic theory of edge detection, Template matching approach, 3×3 template operators, Hysteresis thresholding, Design of differential gradient operators, Canny operator, Laplacian operator, Active contours, Mathematical morphology **-** Dilation and erosion in binary images, Closing and opening.

UNIT-IV: Clustering and Classification **(9 Hours)**

Cluster Analysis: Supervised and unsupervised learning, Clustering procedures.

Classification: Principal component analysis, Support vector machine, Artificial neural networks, Backpropagation algorithm, MLP architectures, Over fitting to the training data.

UNIT-V: Texture Analysis and Applications of Computer Vision **(8 Hours)**

Texture Analysis: Basic approaches of texture analysis, Representing texture, Synthesizing Textures for Rendering Shape for Texture for Planes.

Case Studies: Face recognition, Location of dark contaminants in cereals, Location of insects, Inspection of cereal grains, In-vehicle vision systems, Location of road markings, Road signs, Vehicle guidance in agriculture.

Total Hours: 45

TEXT BOOK:

1. E. R. Davies, *Computer and Machine Vision: Theory, Algorithms, Practicalities*, Academic Press Elsevier, 4th Edition, 2012.

REFERENCE BOOKS:

1. David A. Forsyth and Jean Ponce, *Computer Vision: A Modern Approach*, Pearson, 2nd Edition, 2015.
2. Rafael C. Gonzalez, Richard E. Woods, *Digital Image Processing*, Pearson, 4th Edition, 2018.
3. Mark Nixon, Alberto Aguado, *Feature Extraction & Image Processing*, Elsevier, 2nd Edition, 2008.

M. Tech. (CS) – II Semester

(19MT20505) DATA PREPARATION AND ANALYSIS

(Program Elective - 3)

Internal Marks	External Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES: A Course on Probability and Statistics.

COURSE DESCRIPTION: Introduction, Sources of data, Types of variables, Hypothesis tests, Understanding relationships, Exploratory data mining and data cleaning - EDM in higher dimensions, Data driven approach; Partitions and piecewise models, Divide and conquer, Data cubes, Nonlinear partitions, Data quality techniques and algorithms.

COURSE OUTCOMES:

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

CO1. Prepare data and recognize the characteristics of data to perform business analytics in decision making process.

CO2. Use appropriate techniques including data profiling and normalization to improve the quality of data.

CO3. Interpret and recognize various patterns in data using visualization techniques.

DETAILED SYLLABUS:

UNIT-I: Introduction **(9 Hours)**

Sources of data, Process for making sense of data, Describing data - Observations and variables, Types of variables, Central tendency, Distribution of the data, Confidence intervals, Hypothesis tests; Preparing data tables - Cleaning the data, Normalization, New frequency distribution, Generating groups, Preparing unstructured data.

UNIT-II: Understanding Relationships **(9 Hours)**

Visualizing relationships between variables, Calculating metrics; Identifying and understanding groups – Clustering, Association rules, Learning decision trees from data; Building models from data - Linear regression, Logistic regression, K-Nearest Neighbors, Classification and regression trees.

UNIT-III: Exploratory Data Mining and Data Cleaning **(9 Hours)**

Cautionary tales, Taming the data, Challenges, EDM, End-to-End data quality (DQ), Exploratory Data Mining – Uncertainty, EDM, EDM summaries, Data driven approach-nonparametric analysis, EDM in higher dimensions, Rectilinear histograms, Depth and multivariate binning.

UNIT-IV: Partitions and Piecewise Models **(9 Hours)**

Divide and conquer, Data cubes, Nonlinear partitions, DataSpheres (DS), Set comparison using EDM summaries, Discovering complex structure in data, Piecewise linear regression, One-Pass classification, Data Quality **-** Meaning, Updating DQ metrics, DQ process.

UNIT-V: Data Quality: Techniques and Algorithms **(9 Hours)**

DQ tools based on statistical techniques, Database techniques for DQ, ETL, Approximate matching, Database profiling, Metadata and domain expertise, Measuring data quality, Data quality and its challenge.

Total Hours: 45

TEXT BOOKS:

1. Glenn J. Myatt, Wayne P. Johnson, *Making sense of Data: A practical Guide to Exploratory Data Analysis and Data Mining*, Wiley, 2nd Edition, 2014.
2. Tamraparni Dasu, Theodore Johnson, *Exploratory Data Mining and Data Cleaning*, Wiley Series in Probability and Statistics, 2003.

M. Tech. (CS) – II Semester

(19MT20506) CYBER SECURITY

(Program Elective – 4)

Internal Marks	External Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES: A course on Computer Networks.

COURSE DESCRIPTION: Cybercrime, Cyberoffenses, Tools and Methods used in Cybercrime, Cyber security vulnerabilities and safeguards, IT audit, Proxy servers and anonymizers, Phishing, Password cracking, Keyloggers and Spywares, Virus and Worms, Steganography, Cyber forensics.

COURSE OUTCOMES:

CO1. Apply the conceptual knowledge of cyber security to analyze the threats for protecting the computational assets.

CO2. Apply various standards and cyber laws to enhance cyber security in development process and infrastructure protection and design appropriate security solutions and policies to strengthen computers and digital information.

DETAILED SYLLABUS:

UNIT-I: Introduction to Cybercrime **(7 Hours)**

Definition and origins of the word, Cybercrime and information security, Classifications of cybercrimes, Cybercrime and the Indian ITA 2000, A global perspective on cybercrimes.

UNIT-II: Cyberoffenses and Cybercrime **(10 Hours)**

Cyberoffenses: How criminals plan the attacks, Social Engineering, Cyber stalking, Cybercafe and Cybercrimes, Botnets, Attack vector, Cloud computing.

Cybercrime: Proliferation of mobile and wireless devices, Trends in mobility, Credit card frauds in mobile and wireless computing era, Security challenges posed by mobile devices, Registry settings for mobile devices, Authentication service security, Attacks on mobile/cell phones, Mobile devices and security implications for organizations, Organizational measures for handling mobile devices related security issues, Organizational security policies and measures in mobile computing era, Physical security countermeasures for laptops.

UNIT-III: Tools and Methods used in Cybercrime **(9 Hours)**

Proxy servers and anonymizers, Phishing, Password cracking, Keyloggers and Spywares, Virus and Worms, Steganography, DoS and DDoS attacks, SQL injection, Buffer overflow, Attacks on wireless networks, Phishing, Identity theft (ID Theft).

UNIT-IV: Understanding Computer Forensics **(10 Hours)**

Historical background of cyber forensics, Digital forensics science, The need for computer forensics, Cyber forensics and digital evidence, Forensics analysis of email, Digital forensics lifecycle, Chain of custody concept, Network forensics, Approaching a computer forensics investigation, Setting of a computer forensics laboratory and understanding the requirements, Computer forensics and steganography, Relevance of the OSI 7 layer model to the computer forensics, Forensics and social networking sites, Forensics auditing, Antiforensics.

UNIT-V: Organizational Implications and Case Studies **(9 Hours)**

Organizational Implications: Cost of cybercrimes and IPR issues, Web threats for organizations, Security and Privacy Implications from Cloud Computing, Social media marketing, Social computing and the associated challenges for organizations, Protecting people's privacy in the organization, Organizational guidelines for Internet usage and safe computing guidelines and computer usage policy, Incident handling, Intellectual property in the cyberspace of cyber security.

Case Studies: The Indian case of online gambling, An Indian case of intellectual property crime

Total Hours: 45

TEXT BOOK:

1. Nina Godbole, Sunit Belapure, *Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives*, Wiley India, 2013.

REFERENCE BOOKS:

1. Dan Shoemaker, Kenneth Sigler, *Cybersecurity: Engineering a Secure Information Technology Organization*, Cengage India, 1st Edition, 2015.
2. Nancy R. Mead, Carol Woody, *Cyber Security Engineering: A Practical Approach for Systems and Software*, Pearson Education, 2017.
3. Nina Godbole, *Information System Security*, Wiley, 2009.

M. Tech. (CS) - II Semester

(19MT20507) RECOMMENDER SYSTEMS

(Program Elective - 4)

Internal Marks	External Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES: Courses on Data Warehousing and Data Mining, Machine Learning, Database Management Systems, Algorithm Design.

COURSE DESCRIPTION:

Recommender system overview, Overview of information retrieval models, Search and filtering techniques, Content based filtering, Similarity based and classification algorithms, Collaborative filtering, Evaluating recommender systems.

COURSE OUTCOMES:

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

CO1. Understand and analyze the need of recommender systems by comparing with classical decision support systems.

CO2. Evaluate and model recommender systems to apply appropriate recommender systems into real-world and simple web applications.

DETAILED SYLLABUS:

UNIT-I – Recommender System Overview and Functions **(9 Hours)**

Overview of information retrieval, Retrieval models, Search and filtering techniques, Relevance feedback, User profiles, Recommender system functions, Matrix operations, Covariance matrices, Understanding ratings, Applications of recommendation systems, Issues with recommender systems.

UNIT-II: Content Based Recommender Systems **(9 Hours)**

Content-based filtering - High level architecture of content-based systems, Advantages and drawbacks of content based filtering, Item profiles, Discovering features of documents, pre-processing and feature extraction, Obtaining item features from tags, Methods for learning user profiles, Similarity based retrieval, Classification algorithms.

UNIT-III: Models of Recommender Systems **(9 Hours)**

Collaborative filtering – User based recommendation, Item based recommendation, Model based approaches, Matrix factorization, Attacks on collaborative recommender systems; Hybrid approaches - Opportunities for hybridization; Monolithic hybridization design - Feature combination, Feature augmentation; Parallelized hybridization design - Weighted, Switching, Mixed; Pipelined hybridization design - Cascade meta-level; Limitations of hybridization strategies.

UNIT-IV: Evaluating Recommender Systems **(9 Hours)**

Introduction, General properties of evaluation research, Evaluation designs - Accuracy, Coverage, Confidence, Novelty, Diversity, Scalability, Serendipity, Evaluation on historical datasets, Offline evaluations.

UNIT-V: Recommender System Types **(9 Hours)**

Recommender systems in personalized web search, Knowledge based recommender systems, Social tagging recommender systems, Trust centric recommendations, Group recommender systems.

Total Hours: 45

TEXT BOOKS:

1. Charu C. Aggarwal, *Recommender Systems: The Textbook*, Springer, 2016.
2. Jannach D., Zanker M., Felfernig A. Gerhard F., *Recommender Systems: An Introduction*, Cambridge University Press, 2011.

REFERENCE BOOKS:

1. Ricci F., Rokach L., Shapira B., *Recommender Systems Handbook*, Springer, 2011.
2. Manouselis N., Drachsler H., Verbert K., Duval E., *Recommender Systems for Learning*, Springer, 2013.

M. Tech. (CS) – II Semester

(19MT20508) SOFT COMPUTING

(Program Elective - 4)

(Common to CS and CNIS)

Internal Marks	External Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES: Courses on Mathematical Foundations of Computer Science, Machine Learning.

COURSE DESCRIPTION:

Introduction to neural networks, Applications and scope of neural networks, Basic models of artificial neural networks, Supervised and unsupervised learning networks, Associative memory networks, Fuzzy logic and fuzzy sets, Genetic algorithms, Hybrid soft computing techniques and its applications.

COURSE OUTCOMES:

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

CO1. Review the feasibility of applying a soft computing methodology for a particular problem.

CO2. Analyze architectures of neural networks, genetic algorithms, hop field networks, and hybrid soft computing techniques to solve combinatorial optimization problems using genetic algorithms.

CO3. Develop hybrid algorithms using soft computing techniques by integrating ANN and genetic algorithms.

DETAILED SYLLABUS:

UNIT-I: Introduction **(9 Hours)**

Neural networks, Application and scope of neural network, Fuzzy logic, Genetic algorithm, Hybrid systems, Basic models of artificial neural network, Linear separability.

UNIT-II: Supervised and Unsupervised Learning Networks **(9 Hours)**

Supervised Learning Networks: Perceptron networks, Adaptive linear neuron, Multiple adaptive linear neuron, Radial basis function network, Backpropagation network.

Unsupervised Learning Networks: Kohonen self-organizing feature maps, Learning vector quantization.

UNIT-III: Associative Memory Networks **(9 Hours)**

Training algorithms for pattern association, Autoassociative memory network, Heteroassociative memory network, Bidirectional associative memory, Hop field networks.

UNIT-IV: Fuzzy Logic and Genetic Algorithms **(9 Hours)**

Fuzzy Logic: Classical sets, Fuzzy sets, Fuzzy relations, Cartesian product of relation, Tolerance and equivalence relation, Fuzzy decision making.

Genetic Algorithms: Biological background, Traditional optimization and search techniques, Genetic algorithm and search space, Terminologies, General genetic algorithm, Operators, Stopping condition, Constraints, Schema theorem.

UNIT-V: Hybrid Soft Computing Techniques **(9 Hours)**

Genetic neuro-hybrid system, Properties, Genetic algorithm based back-propagation network (BPN).

Applications: Flood area analysis, Optimization of travelling salesman problem, Internet search engines.

Total Hours: 45

TEXT BOOKS:

1. S.N. Sivanandam and S.N. Deepa, *Principles of Soft Computing,* Wiley, 2nd Edition, 2011.

REFERENCE BOOKS:

1. J. –S. R. Jang, C. –T. Sun, E. Mizutani, *Neuro-Fuzzy and Soft Computing: A Computational Approach to Learning and Machine Intelligence*, Pearson, 2015.
2. S. Rajasekaran and G. A. Vijayalakshmi Pai, *Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis and Applications*, PHI, 2011.

M. Tech. (CS) – II Semester

(19MT20509) VIRTUAL REALITY AND AUGMENTED REALITY

(Program Elective - 4)

Internal Marks	External Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES: Courses on Artificial Intelligence, Image Processing.

COURSE DESCRIPTION:
Virtual Reality - Devices, Interfaces, Architectures, Rendering Principles, Modeling and Management; Augmented Reality – Environment, Devices, Communication techniques; Applications of Virtual Reality and Augmented Reality.

COURSE OUTCOMES:
On successful completion of the course, students will be able to:

CO1. Acquire the knowledge in the basic concepts of virtual reality and augmented reality and understand the contemporary applications.
CO2. Analyze various virtual reality architectures for developing virtual reality based applications.
CO3. Explore the augmented reality environment essentials to evaluate and select appropriate augmented reality based user-machine communication techniques.

DETAILED SYLLABUS:

UNIT-I: Virtual Reality **(10 Hours)**
Definition, Three I's of virtual reality, Virtual reality Vs 3D computer graphics, Benefits of virtual reality, Components of VR system, Input devices, 3D position trackers, Performance parameters, Types of trackers, Navigation and manipulation interfaces, Gesture interfaces, Types of gesture input devices, Output devices, Graphics display, Human visual system, Personal graphics displays, Large volume displays, Sound displays, Human auditory system.

UNIT-II: Virtual Reality Architecture **(10 Hours)**
Computing architectures of VR, Rendering principle, Graphics and Haptics rendering, PC graphics architecture, Graphics accelerators, Graphics benchmarks, Workstation based architectures, Sun Blade 1000 architecture, SGI infinite reality architecture, Distributed VR architectures, Multipipeline synchronization, Collocated rendering pipelines, Distributed virtual environments.

UNIT-III: Virtual Reality Modeling **(9 Hours)**
Modeling, Geometric modeling, Virtual object shape, Object visual appearance, Kinematics modeling, Transformation matrices, Object position, Transformation invariants, Object hierarchies, Viewing the 3D world, Physical modeling, Collision detection, Surface deformation, Force computation, Force smoothing and mapping, Behavior modeling, Model management.

UNIT-IV: Augmented Reality **(8 Hours)**
Augmented reality, How is AR evolving, AR environment, Tactile sensations, Haptics and touch screens, Deformable screens, Adding a sense touch behind the screens, Haptics as a method of communication.

UNIT-V: Applications of Virtual Reality and Augmented Reality **(8 Hours)**
VR applications - Medical applications of VR, Education, Arts and entertainment, Military VR applications, VR applications in manufacturing, Applications of VR in robotics, Information visualization.
AR applications - Story telling conventions, Ghosts, Living pictures, 3-D drawing, Objects Telling stories, Embedding technology inside the body.

Total Hours: 45

TEXT BOOKS:

1. Grigore C. Burdea, Philippe Coiffet, *Virtual Reality Technology*, Wiley India, 2nd Edition, 2006.
2. Helen Papagiannis, *Augmented Human: How Technology is Shaping the New Reality*, O'Reilly, 1st Edition, 2017.

REFERENCE BOOKS:

1. John Vince, *Introduction to Virtual Reality*, Springer, 2004.
2. William R. Sherman, Alan B. Craig, *Understanding Virtual Reality: Interface, Application, Design*, Elsevier, Morgan Kaufmann, 2nd Edition, 2018.

M. Tech. (CS) – II Semester
(19MT20531) DATA SCIENCE LAB

Internal Marks	External Marks	Total Marks	L	T	P	C
50	50	100	-	-	4	2

PRE-REQUISITES: Courses on Data Warehousing and Data Mining, Probability and Statistics.

COURSE DESCRIPTION:
Hands on experience on applications of data science using Python - Linear regression, Logistic regression, Gaussian Distribution, Naïve Bayes' classification, Support vector machine, Principal component analysis, Decision Tree, Time series analysis, Data visualization.

COURSE OUTCOMES:
On successful completion of the course, students will be able to:

CO1. Design and develop probability and statistical models to interpret data using relevant python libraries such as SciPy and StatsModel.
CO2. Apply dimensionality reduction techniques on appropriate online dataset and perform time series analysis importing Scikitlearn.
CO3. Build data visualization using charts, plots and histograms to identify trends, patterns and outliers in data importing Matplotlib.
CO4. Write, present technical report/document effectively.
CO5. Function effectively as an individual and as a member in teams to implement mini-project.

LIST OF EXERCISES:

1. Construct a model to perform one day ahead prediction of stock market using rolling linear regression, ARIMA, and neural networks. Consider stock market dataset from Kaggle.
2. Consider dataset provided by Google Inc. Size of dataset is 50M records. Perform data cleaning, construct new features, visualize the pre-processed dataset and construct a multi-linear regression model. Consider NYC taxi fare prediction dataset from Kaggle.
3. Implement Gaussian distribution to detect anomalies of credit card transaction. Consider credit card fraud detection data from Kaggle.
4. Construct a binary classifier using Naïve Bayes algorithm to detect spam Emails. Consider spambase dataset from UCI machine learning repository.
5. Design logistic regression based model for credit risk assessment by detecting outliers. Consider credit risk assessment dataset from Kaggle.
6. Predict whether or not a patient is having heart disease using support vector machine and also handle the missing values in the dataset. Consider heart disease dataset from UCI machine learning repository.
7. Use principal component analysis to reduce the dimensionality of the given Glass dataset and perform classification on the reduced and as well as the raw data to evaluate the performance of the classifier. Consider glass identification dataset from UCI machine learning repository.
8. Implement decision tree and random forest for multiclass classification using Iris dataset. Consider iris dataset from UCI machine learning repository.
9. Using time series analysis predict the web traffic based on the historical traffic data to a specific web page. Consider web traffic time series forecasting data from Kaggle.
10. Perform data visualization considering online dataset from UCI machine learning repository.
    a) Plot the Pearson correlation between a set of variables.
    b) Plot the word cloud after performing processing on a given text data.
    c) Visualize the hierarchical data using tree map plot (Use SQUARIFY package)
11. Perform sentiment data analysis using Hadoop to build a predictive model. Consider Twitter data from Kaggle for processing.
12. Mini Project

REFERENCE BOOKS:

1. Ofer Mendelevitch, Casey Stella, Douglas Eadline, *Practical Data science with Hadoop and Spark: Designing and Building Effective Analytics at Scale*, Addison Wesley (Data & Analytics Series), 2017.
2. Alen B. Downey, *Think Stats: Exploratory Data Analysis*, O'Reilly Publications, 2nd Edition, 2014.

M. Tech. (CS) – II Semester
(19MT20532) WEB TECHNOLOGIES LAB

Internal Marks	External Marks	Total Marks	L	T	P	C
50	50	100	-	-	4	2

PRE-REQUISITES: A course on Object Oriented Programming.

COURSE DESCRIPTION:
Hands on practice on development of web applications using HTML tags, CSS Selectors, Java Script, JQuery, XML, PHP and MYSQL, node.js, AJAX.

COURSE OUTCOMES:
On successful completion of the course, students will be able to:

CO1. Design interactive web applications using HTML, CSS, JavaScript, JQuery, XML, AJAX, node.js, PHP and MySQL.
CO2. Develop dynamic web applications based using AJAX, Node.js and JavaScript programming language.
CO3. Write, present technical report/document effectively.
CO4. Function effectively as an individual and as a member in teams to implement mini-project.

LIST OF EXERCISES:

1. Create an HTML web page with the following features:
    a. Title, Page formattingincludes a background color andpicture, a non-default text color, and non-default text and link colors.
    b. A horizontal rule includes with three levels of headers.
    c. Text formatting includes text alignment, three-level bulleted list and a two-level numbered list, two external links, with one a text link and one an image link, three internal "bookmark" links –that is, a link to further down on the current page, A relative link to an image in a different directory than the directory in which your current HTML page resides.
    d. An image should appear off to the right side of the page.
    e. An image map with at least three links.
    f. A table that includes at least three rows, two cells in each row, two colspan attributes, and one rowspan attribute. Put a background color on the entire table, a different background color on one cell, and a background image on one entire row of the table.

2. Apply the following styles to above web page.
    a. Fonts and Styles: font-family, font-style, font-weight and font-size
    b. Backgrounds and colors: color, background-color,background-image and background-repeat
    c. Text: text-decoration, text-transformation, text-align and text-indentation, text-align
    d. Borders: border, border-width, border-color and border-style
    e. Styles for links: A: link, A: visited, A:active, A:hover

3. Create an HTML web page with JavaScript for the following problem:
   Get two input numbers from an HTML form. On submit, call a function to edit them to make sure that they are within the range of 1-100. If not, display an error message and set focus to the field in error. If the entered numbers are valid, add the two numbers together and display the total in an alert box. Pop up a prompt box to get a third number and edit it to make sure it's in the range of 1 to 5. Multiply the original total (from the two input boxes) by this third number. Store the result in a cookie and then automatically open a second page to display the cookie that you saved on the prior page.
4. Design a web page with the following features using HTML5, JavaScript and JQuery:
    a. Displaying of images with Custom animated effects
    b. Playing of selected video from the list of videos
    c. Showing the animated text in increasing and decreasing font size
    d. Changing the size of the area in a web page using DIV tag
    e. Hiding and Showing elements in a web page.
5. Write a program to perform the following operations on the database called College stored on client's machine.
    a. Create table Emp.
    b. Insert records into Emp table.
    c. Display records of Emp table.
    d. Delete record(s) from Emp table.
    e. Drop Emp table.

6. Write PHP Script that takes user input data (Personal Information like registration to a website) in a form and validates it and write the data into the database.
7. Design a web page to reload some portion of the web page content using XMLHttpRequest object.
8. Write a node.js code for storing books details like Name of the book, author, publisher, edition, price, etc into MySQL database and retrieve books details from the database.
9. Write a node.js program to read contents from one file and write to another file.
10. Write a AJAX program to retrieve the data from the database without refreshing the page.
11. Mini Project

REFERENCE BOOKS:

1. Kogent Learning Solutions Inc, *HTML 5 Black Book: Covers CSS3, JavaScript, XML, XHTML, AJAX, PHP and JQuery*, Dreamtech Press, 1st Edition, 2011.
2. Daniel Howard, *Node.js for PHP Developers*, O'Reilly, 1st Edition, 2012.

M. Tech. (CS) – II Semester

(19MT2AC01) STATISTICS WITH R

(Audit Course)

(Common to All M. Tech. Programs)

Internal Marks	External Marks	Total Marks	L	T	P	C
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PRE-REQUISITES: A course on Statistics.

COURSE DESCRIPTION:
Concepts of R programming basics, Bivariate and multivariate data, Confidence intervals, Goodness of fit, Analysis of variance.

COURSE OUTCOMES:
On successful completion of the course, students will be able to:

CO1. Import, manage, manipulate, and structure data files using R programming.

CO2. Implement models for statistical analysis of a given dataset and visualize the results to identify trends, patterns and outliers in data.

DETAILED SYLLABUS:

UNIT-I: Introduction **(5 Hours)**
Data, R's command line, Variables, Functions, The workspace, External packages, Data sets, Data vectors, Functions, Numeric summaries, Categorical data.

Unit II - Bivariate and Multivariate Data **(7 Hours)**
Lists, Data frames, Paired data, Correlation, Trends, Transformations, Bivariate categorical data, Measures of association, Two-way tables, Marginal distributions, Conditional distributions, Graphical summaries, Multivariate data - Data frames, Applying a function over a collection, Using external data, Lattice graphics, Grouping, Statistical transformations.

UNIT-III: Populations **(6 Hours)**
Populations, Discrete random variables, Random values generation, Sampling, Families of distributions, Central limit theorem, Statistical Inference - Significance tests, Estimation, Confidence intervals, Bayesian analysis.

UNIT-IV: Confidence Intervals **(6 Hours)**
Confidence intervals for a population proportion, *p* - population mean, Other confidence intervals, Confidence intervals for differences, Confidence intervals for the median, Significance test - Significance test for a population proportion, Significance test for the mean (t-tests), Significance tests and confidence intervals, Significance tests for the median.

UNIT-V: Goodness of Fit **(6 Hours)**
The chi-squared goodness-of-fit test, The multinomial distribution, Pearson's χ^2-statistic, chi-squared test of independence and homogeneity, Goodness-of-fit tests for continuous distributions, ANOVA - One-way ANOVA, Using *lm* for ANOVA.

Total Hours: 30

TEXT BOOKS:

1. John Verzani, *Using R for Introductory Statistics*, CRC Press, 2nd Edition, 2014.
2. Sudha G Purohit, Sharad D Gore, Shailaja R Deshmukh, *Statistics Using R*, Narosa Publishing house, 2nd Edition, 2015.

REFERENCE BOOKS:

1. Francisco Juretig, *R Statistics Cookbook*, Packt Publishing, 1st Edition, 2019.
2. Prabhanjan N. Tattar, Suresh Ramaiah, B. G. Manjunath, *A Course in Statistics with R*, Wiley, 2018.

M. Tech. (CS) - III Semester
(19MT30531) INTERNSHIP

Internal Marks	External Marks	Total Marks	L	T	P	C
--	100	100	-	-	-	2

PRE-REQUISITES: --

COURSE DESCRIPTION:

Expose students to the industrial environment, Create competent professionals for the industry, Gain professional experience, Develop communication skills and understand engineer's responsibilities and ethics.

COURSE OUTCOMES:

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

CO1. Discern various challenges in developing solutions for complex problems, utilize appropriate modern tools and techniques to provide solutions for the chosen engineering problems.

CO2. Develop problem solving skills, critical thinking skills through designing and developing solutions for complex problems.

CO3. Discern various challenges in developing solutions for complex problems, design and conduct experiments to evaluate alternative solutions for the chosen engineering problems.

CO4. Develop communication, enrich professional and interpersonal skills pertaining to the internship experience.

CO5. Function effectively as an individual and participate well as a team member to build professional network for growth in career.

CO6. Utilize real work experiences to explore their interests, career alternatives that will help with future education or employment through and develop professional skills and competencies to engage in lifelong learning.

M. Tech. (CS) - III Semester
(19MT30532) PROJECT WORK PHASE – I

Internal Marks	External Marks	Total Marks	L	T	P	C
50	50	100	-	-	-	10

PRE-REQUISITES: --

COURSE DESCRIPTION:

Identify of a domain of interest and a specific problem, Conduct literature review, Collect preliminary data, Conduct a critical study and analysis of the chosen problem, Identify appropriate modern tools/techniques, Write thesis and present.

COURSE OUTCOMES:

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

CO1. Apply contextual knowledge to identify a domain of interest and a specific problem in core and allied areas of discipline and discern various issues, challenges to identify alternative methodologies, tools for implementing a solution for the chosen problem.

CO2. Conduct a systematic literature review, analyze, cognize and comprehend the extracted information for recognizing the current status of research pertinent to the chosen problem.

CO3. Write and present technical report/document to report the findings on the chosen problem.

CO4. Function effectively as an individual to recognize the opportunities in the chosen domain of interest and engage in independent learning.

CO5. Recognize the need to engage in lifelong learning for development of technical competence in the advanced fields of computer science to contribute to the development of scientific/ technological knowledge.

M. Tech. (CS) - IV Semester

(19MT40531) PROJECT WORK PHASE – II

Internal Marks	External Marks	Total Marks	L	T	P	C
150	150	300	-	-	-	16

PRE-REQUISITES: --

COURSE DESCRIPTION:

Design and develop solutions for the proposed system, Use appropriate modern tools/techniques, Implement the proposed system, Execute practical investigations, Conduct critical analysis and interpretation of results, Test and evaluate the proposed system, Write thesis and present.

COURSE OUTCOMES:

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

CO1. Investigate, conceptualize and design optimal solution for the chosen problem.

CO2. Utilize appropriate modern tools/techniques to implement the proposed system.

CO3. Design and conduct investigations and experiments to test and evaluate the proposed system.

CO4. Write and present technical report/document to report the findings on the chosen problem.

CO5. Function effectively as an individual to recognize the opportunities in the chosen domain of interest and engage in independent learning.

CO6. Recognize the need to engage in lifelong learning for development of technical competence in the advanced fields of computer science to contribute to the development of scientific/ technological knowledge.