# DEPARTMENT OF ARTIFICIAL INTELLIGENCE AND DATA SCIENCE ENGINEERING

## COURSE OUTCOMES OF ALL COURSES OF FIFTH SEMESTER & SIXTH SEMESTER BE AI(Artificial Intelligence & Data Science Engineering)

## FIFTH SEMESTER

### 5AD01 DATA SCIENCE (L-4, T-0, P-0, C-4)

**Course Prerequisite:** Database, Basic Knowledge of programming

**Course Objectives:** Throughout the course, students will be expected to demonstrate their understanding of Data Science by being able to do each of the following:

1. To understand the basic terminology used in data science
2. To Understand data management and data models
3. To understand basic terminology and concept of data analysis.
4. To understand and apply data visualization.

**Course Outcomes (Expected Outcome):** After Successful completion of this course, the student will be able to:

1. Identify the basic concepts and technologies involved in dealing with Data science process.
2. Apply data management for exploring and fixing data.
3. Understand different types of statistical data analysis.
4. Apply and use different technologies for data visualization.
5. Demonstrate data science techniques on real time applications
6. Describe recent trends in Data Science

**Unit I: Introduction** **Hours-07**

Data Science, Terminology Related with Data Science, Methods of Data Repository, Personnel involved with Data Science, Types of Data, The Data Science Process, Popular Data Science toolkits.

**Unit II: Data Management** **Hours-06**

Data Management Planning, Data Management Plan, Data Collection and Management, Application Programming Interface, Exploring Data, Building Models, Storage Management, Importing Data.

**Unit III: Data Analysis Using R** **Hours-07**

Introduction to Applied statistical Techniques, Types of Statistical Data, Types of Big Data Analytics, Collecting data for Sampling and Distribution, Probability, Frequency Distribution, Population and Parameters, Central Tendency or Central Value, Measures of Central Tendency, Different types of Statistical Means.

**Unit IV: Data Visualization** **Hours-07**

Data Visualization, Importance of Data Visualization, Conventional Data Visualization Methods, Retinal Variables, Mapping Variables to Encodings, Case Study.

**Unit V: Applications of Data Science** **Hours-06**

Applications of Data Science Technologies for Visualization, Introduction to Python, Basic Numeric Operations, Data Types in Python, Modules, Libraries.

**Unit VI: Recent Trends in Data Science** **Hours-06**

Recent Trends in various data collection and analysis Techniques, Various Big Data Visualization Tools, Visualizing Big Data, Pre attentive Attributes, Challenges of Big Data Visualization, Future progress of Big Data Visualization.

**Text Book:** V. K. Jain; "Data Science and Analytics" Khanna Publication 2018.

**Reference Books:**

1. Cathy O'Neil and Rachel Schutt, " Doing Data Science, Straight Talk From The Frontline", O'Reilly, 2014.
2. Mohammed J. Zaki and Wagner MieraJr, "Data Mining and Analysis: Fundamental Concepts and Algorithms", Cambridge University Press, 2014.
3. Joel Grus, "Data Science from Scratch: First Principles with Python", O'Reilly Media, 2015.

### 5AD02 MACHINE LEARNING TECHNIQUES (L-3, T-0, P-2, C-3)

**Course Prerequisite:** Artificial Intelligence

**Course Objectives:** Throughout the course, students will be expected to demonstrate their understanding of Machine Learning Techniques by being able to do each of the following:

1. To understand various key paradigms for machine learning approaches
2. To familiarize with the mathematical and statistical techniques used in machine learning.
3. To understand and differentiate among various machine learning techniques

**Course Outcomes (Expected Outcome):** After Successful completion of this course, the student will be able to:

1. Understand fundamentals of machine learning
2. Describe mathematic techniques required for machine learning
3. Perform optimization techniques for predicting

4. Apply regression model to perform specific task
5. Demonstrate classification techniques
6. Design prediction model using clustering techniques

**Unit I: Introduction** **Hours-06**

What is Machine learning, why machine learning, History of Machine Learning, Fundamentals of Machine Learning, Data needed, ML Techniques overview, Validation Techniques (Cross-Validations), Supervised Learning, unsupervised learning, reinforcement learning.

**Unit II : Mathematics for ML** **Hours-06**

Linear Algebra, matrix decomposition algorithm- SVD: Properties and applications, low rank Approximations, Feature Reduction/Dimensionality reduction, Principal components analysis (Eigen values, Eigen vectors, Orthogonality.

**Unit III: Optimization** **Hours-06**

Unconstrained and Constrained optimization, Numerical optimization techniques for constrained and unconstrained optimization: Newton's method, Steepest descent method, Penalty function method.

**Unit IV: Regression** **Hours-06**

Introduction to Regression, Linear Regression with one variable, Relationship between attributes using Covariance and Correlation, Model Evaluation in Regression, Evaluation Metrics in Regression Models, Gradient decent for Linear regression, Multiple Linear Regression, Non-Linear Regression, Hypothesis testing of Regression Model.

**Unit V: Classification** **Hours-06**

Classification Naïve Bayes Classifier, Classifier K-Nearest Neighbors, K-Nearest Neighbor algorithm; SVM for classification and regression problems. Decision Trees, Building Decision Trees, Ensembles methods, introduction to Support Vector Machine, Measure of performance, Error analysis, Confusion matrix, ROC.

**Unit VI: Clustering** **Hours-06**

Clustering, Distance measures, Different clustering methods (Distance, Density, Hierarchical), Iterative distancebased clustering; Dealing with continuous, categorical values in K-Means, Constructing a hierarchical cluster, Gaussian mixer model. EM-algorithm for mixture of Gaussians.

**Text Book:** Mitchell Tom, Machine Learning. McGraw Hill, 1997.

**Reference Books:**

1. R. O. Duda, P. E. Hart, D. G. Stork (2000), Pattern Classification, Wiley-Blackwell, 2nd Edition.
2. Shalev-Shwartz,S., Ben-David,S., (2014), Understanding Machine Learning: From Theory to Algorithms, Cambridge University Press.
3. C. M. BISHOP (2006), Pattern Recognition and Machine Learning, Springer-Verlag New York, 1st Edition.
4. Ethem Alpaydin, Introduction to Machine Learning, PHI.

**5AD03 COMPUTER NETWORKS (L-3,T-0,C-3)**

**Course Prerequisite:** Fundamentals of Computer, C/C++ programming.

**Course Objectives:** Throughout the course, students will be expected to demonstrate their understanding of Computer Networks by being able to do each of the following:

1. Understand the importance of Computer Network and its usage.
2. Study error control and flow control techniques.
3. Solve real-world problems in the context of today's internet (TCP/IP and UDP/IP).
4. Distinguish and relate various physical Medias, interfacing standards and adapters.
5. Implement mathematically and logically the working of computer protocols in abstract.

**Course Outcomes (Expected Outcome):** After Successful completion of this course, the student will be able to:

1. Understand the layered architecture of computer networks
2. Describe data link layer and its protocols
3. Explain medium access control with its protocol.
4. Demonstrate the ability to setup a small network and properly configure network Components including switches, routers and services.
5. Discuss transport layer protocol
6. Describe various network applications, and network security considerations.

**Unit I: Introduction and Physical Layer** **Hours:6**

Introduction to computer network, LAN, MAN, WAN, PAN, Ad-hoc Networks, Network Architectures- Client-Server, Peer To Peer, Network Topologies- Bus, ring, tree, star, mesh, hybrid. Communication Models- OSI Model, TCP/IP Model, Design issues for layers. Transmission media- Guided media, unguided media. Transmission Modes- Simplex, Half-Duplex and Full-Duplex. Network Devices- Hub, Repeater, Bridge, Switch, Router, Gateways and Brouter.

**Unit II: Data Link Layer** **Hours:6**

Logical Link Layer- Services to Network Layer, Framing, Error Control and Flow Control. Framing in LLCframing challenges, types of framing. Error Control in LLC- error detection, error correction, Parity Bits, Hamming Codes (11/12-bits) and CRC. Flow Control Protocols- Unrestricted Simplex, Stop and Wait, Sliding Window Protocol. WAN Connectivity- PPP and HDLC.

**Unit III: Medium Access Control** **Hours:06**

Channel Allocation-Static and Dynamic, Multiple Access Protocols- Pure and Slotted ALOHA, CSMA, WDMA, IEEE 802.3 Standards and Frame Formats, CSMA/CD, Fast Ethernet, Gigabit Ethernet, IEEE 802.11a/b/g/n and IEEE 802.15 and IEEE 802.16 Standards, Frame formats, CSMA/CA.

**Unit IV: Network Layer** **Hours:06**

Switching techniques, IP Protocol, IPv4 and IPv6 addressing schemes, Subnetting, NAT, CIDR, ICMP, Routing Protocols- Distance Vector, Link State, Path Vector, Routing in Internet- RIP,OSPF, BGP, Congestion control and QoS, MPLS, Mobile IP, Routing in MANETAODV, DSR.

**Unit V: Transport Layer** **Hours:06**

Services, Berkley Sockets, Addressing, Connection establishment, Connection release, Flow control and buffering, Multiplexing, TCP, TCP Timer management, TCP Congestion Control, Real Time Transport protocol (RTP), Stream Control Transmission Protocol (SCTP), Quality of Service (QoS), Differentiated services, TCP and UDP for Wireless.

**Unit VI: Application Layer** **Hours:06**

Domain Name System (DNS), Hyper Text Transfer Protocol (HTTP), Email: SMTP, MIME, POP3, Webmail, FTP, TELNET, Dynamic Host Control Protocol (DHCP), Simple Network Management Protocol (SNMP).

**Text Book:** Behrouz A. Forouzan: Data Communication and Networking, (5/e) (TMH)

**Reference Books:**

1. R. O. Duda, P. E. Hart, D. G. Stork (2000), Pattern Classification, Wiley-Blackwell, 2nd Edition.
2. Shalev-Shwartz,S., Ben-David, S., (2014), Understanding Machine Learning: From Theory to Algorithms, Cambridge University Press.
3. C. M. BISHOP (2006), Pattern Recognition and Machine Learning, Springer-Verlag New York, 1st Edition.
4. Ethem Alpaydin, Introduction to Machine Learning, PHI.

**5AD04 PROFESSIONAL ELECTIVE-I (i) INTERNET OF THINGS (L-3, T-0, C-3)**

**Course Prerequisite:** Basic knowledge of Internet and Microprocessor & Assembly Language Programming

**Course Objectives:** Throughout the course, students will be expected to demonstrate their understanding of Internet of Things by being able to do each of the following:

1. To learn and understand fundamental of IoT
2. To study the design methodology and different IoT platform
3. To understand usefulness of IoT for society
4. To design and implement application of IoT using various sensor

**Course Outcomes (Expected Outcome):** On completion of the course, the students will be able to:

1. Understand the basics of IoT ·
2. Explain design methodology and platforms involved in IoT
3. Apply the knowledge to interface various sensors with IoT development
4. Design and Implement IoT system for real time application.

**Unit I:** **Hours: 6**

Introduction to Internet of Things, Definition & Characteristics of IoT, Physical Design of IoT Logical Design of IoT, IoT Enabled Technologies like Wireless Sensor Networks, Cloud Computing, Big data analytics, Communication protocols, Embedded Systems, IoT Levels & Deployment Templates, Domain Specific IoTs: Home, Cities, Environment, Energy systems, Logistics, Agriculture, Health & Lifestyle.

**Unit II:** **Hours: 7**

IOT & M2M: Introduction, M2M, Difference between IoT and M2M, SDN and NFV for IoT, Software defined networks, network function virtualization, IoT Systems Management, Simple Network Management Protocol (SNMP), Limitations of SNMP, Network Operator Requirements, NETCONF, YANG, IoT Systems Management with NETCONF-YANG, NETOPEER.

**Unit III:** **Hours: 7**

IoT Platforms Design Methodology, Case Study on IoT System for Weather Monitoring, Motivation for Using Python, IoT Systems - Logical Design using Python, Installing Python, Python Data Types & Data Structures, Control Flow, Functions, Modules, Packages, File Handling l, Date/Time Operations, Classes, Python Packages of Interest for IoT.

**Unit IV:** **Hours: 7**

IoT Physical Devices & Endpoints, Raspberry Pi, About the Board, Linux on Raspberry Pi, Raspberry Pi Interfaces serial, SPI, I2C, Programming Raspberry Pi with Python, Controlling LED with Raspberry Pi, interfacing an LED and switch with Raspberry Pi, Interfacing Light Sensor with Raspberry Pi Other IoT Devices, pcDuino, BeagleBone Black, Cubieboard.

**Unit V:** **Hours: 7**

IoT Physical Servers & Cloud Offerings, Introduction to Cloud Storage Models & Communication APIs, WAMP - AutoBahn for IoT , Xively Cloud for IoT , Python Web Application Framework - Django , Designing a RESTful Web API , Amazon Web Services for ,SkyNet IoT Messaging Platform.

**Unit VI:** **Hours: 7**

Case Studies Illustrating IoT Design, Introduction, Home Automation: Smart Lighting, Home Intrusion detection, Cities: Smart parking, Environment: Weather Monitoring System, Weather reporting Bot, Air pollution monitoring, Forest fire detection, Agriculture: Smart Irrigation, Productivity Applications: IoT printer.

**Text Book:** Arshdeep Bahga, Vijay Madisetti, “Internet of Things – A hands-on approach”, Universities Press, ISBN:0: 0996025510, 13: 978-0996025515.

**Reference Books:**

1. Fundamentals of Python, K.A.Lambert and B.L.Juneja, Cengage Learning, 2012.
2. David Hanes, IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things, Cisco Press, ISBN-13: 978-1-58714-456-1, ISBN-10: 1-58714-456-5, 2017
3. Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, “From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence”, 1st Edition, Academic Press, 2014

**5AD04 PROFESSIONAL ELECTIVE-I (ii) CYBER SECURITY (L-3,T-0,C-3)**

**Course Prerequisite:** Computer Programming, Data Structure, Data Communication & Networking.

Course Objectives: Throughout the course, students will be expected to demonstrate their understanding of Cyber Security by being able to do each of the following:

1. Understand basics of Cybercrime and Information Security.
2. To familiarize various cyber threats, attacks, Cyber offenses.
3. Understand Cybercrime on Mobile and Wireless devices.
4. Understand tools and methods used in Cybercrime.
5. Understand Access Control and Authentication.
6. Understand Intrusion Detection and Prevention.

**Course Outcomes (Expected Outcome):** After completion of this course, the students should be able to:

1. Understand fundamentals of Cybercrimes
2. Describe cyber offences and attacks
3. Illustrate and solve the Cyber threats, attacks and Vulnerabilities with respect to mobiles devices.
4. Explore the industry practices and tools.
5. Comprehend the Access Control and Authentication Process.
6. Implement Intrusion Detection and Prevention.

**Unit I:** **Hours:6**

Introduction to Cybercrime: Introduction, Cybercrime, Cybercrime and Information Security, Classifications of Cybercrimes, Cybercrime: The Legal Perspectives, Cybercrimes: An Indian Perspective, Cyber-crime and the Indian ITA 2000, A Global Perspective on Cybercrimes, Cybercrime Era.

**Unit II:** **Hours:6**

Cyber offenses: Introduction, Attacks, Social Engineering, Cyberstalking, Cybercafe and Cybercrime, Botnets, Attack Vector, Cloud Computing.

**Unit III:** **Hours:6**

Cybercrime: Mobile and Wireless Devices Introduction, Proliferation of Mobile and Wireless Devices , Trends in Mobility, Credit Cards Frauds in Mobile and Wireless Computing, Security Challenges posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication Service Security, Attacks on Mobile/ Cell Phones, Mobile Devices: Security Implementations for Organizations, Organizational Measures for Handling Mobile, Devices Related Security Issues Organizational Security Policies and Measures in Mobile Computing, Laptops.

**Unit IV:** **Hours:6**

Tools and Methods Used in Cybercrime: Introduction, Proxy Servers and Anonymizers, Phishing, Password Cracking, Key loggers and Spywares, Virus and Worms, Trojan Horses and Backdoors, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Overflow, Attacks on Wireless Networks.

**Unit V:** **Hours:6**

Access Control and Authorization: Definitions, Access Rights, Access Control Systems, Authorization, Types of Authorization Systems, Authorization Principles, Authorization Granularity, Web Access and Authorization. Authentication: Definition, Multiple Factors and Effectiveness of Authentication, Authentication Elements, Types of Authentication, Authentication Methods.

**Unit VI:** **Hours:6**

System Intrusion Detection and Prevention: Definition, Intrusion Detection, Intrusion Detection Systems (IDSs), Types of Intrusion Detection Systems, The Changing Nature of IDS Tools, Response to System Intrusion, Challenges to Intrusion Detection Systems, Implementing an Intrusion Detection System, Intrusion Prevention Systems (IPSs), Intrusion Detection Tools Disaster Management: Introduction, Disaster Prevention, Disaster Response, Disaster Recovery, Make your Business Disaster Ready, Resources for Disaster Planning and Recovery.

**Text Books:**

1. Nina Godbole, SunitBelapure, “Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives”, Wiley India Pvt Ltd, ISBN: 978-81- 265-21791,2013
2. Joseph Migga Kizza, “A Guide to Computer Network Security”, Springer 2009.

**Reference Books:**

1. V.K. Pachghare, “Cryptography and information Security”, PHI Learning Private Limited, Delhi India.
2. Nina Godbole, “Information Systems Security”, Wiley India, New Delhi
3. Kennetch J. Knapp, “Cyber Security & Global Information Assurance”, Information Science Publishing.
4. James Graham, Richard Howard, Ryan Olson, “Cyber Security Essentials” CRC Press.
5. Jeetendra Pande, “Introduction to Cyber Security” Uttarakhand Open University, 2017.

**5AD04 PROFESSIONAL ELECTIVE-I (iii) CLOUD COMPUTING (L-3, T-0, C-3)**

**Course Prerequisite:** Data Communication and Networks

**Course Objectives:** Throughout the course, students will be expected to demonstrate their understanding of Cloud Computing by being able to do each of the following:

· To provide students with the fundamentals and essentials of Cloud Computing.
· To provide students a foundation of Cloud Computing, Cloud Computing services and tools in real life scenarios.
· To enable student to explore some important Cloud Computing driven commercial systems and applications.
· To provide students with essentials of Cloud Computing architecture, Virtualization, Storage and Network concepts.

**Course Outcomes (Expected Outcomes):** On completion of the course, the students will be able to

1. Describe the fundamental concept, architecture and applications of Cloud Computing.
2. Discuss the problems related to cloud deployment model.
3. Examine the concept of virtualization.
4. Identify the role of network connectivity in the cloud.
5. Assess different Cloud service providers.
6. Inspect the security issues in cloud service models.

**Unit I: Cloud Computing Fundamental, Architecture and Management** **Hours: 8**

Computing Paradigm and various computing types, Cloud Computing Fundamentals: Motivation for Cloud Computing, The need for Cloud Computing, Defining Cloud Computing, Principles of Cloud Computing, Requirements of Cloud Services, Cloud Applications, Benefits and Drawbacks. Cloud Computing Architecture and Management: Introduction, Cloud Architecture, Network connectivity in Cloud Computing, Applications on the cloud, Managing Cloud, Migrating Application to cloud.

**Unit II: Cloud Deployment and Service Models** **Hours: 8**

Cloud Deployment Models: Introduction, Private Cloud, Public Cloud, Community Cloud, Hybrid Cloud. Cloud Service Models: Introduction, Infrastructure as a Service, Platform as a Service, Software as a Service, Other Cloud Service Models.

**Unit III: Operating System and Virtualization** **Hours: 8**

Types of Operating Systems, Role of OS in Cloud Computing, Features of Cloud OS. Application Environment: Need for Effective ADE, Application Development Methodologies, Cloud Application Development Platforms and Cloud Computing API's. Virtualization: Introduction, Virtualization Opportunities, Approaches to Virtualization, Hypervisors, Virtualization to Cloud Computing.

**Unit IV: Software Development in Cloud and Networking for Cloud Computing:** **Hours: 8**

Introduction, Different Perspectives on SaaS Development, New Challenges, Cloud-Aware Software Development Using PaaS Technology. Networking for Cloud Computing: Introduction, Overview of Data Center Environment, Networking Issues in Data Centers, Transport Layer Issues in DCNs.

**Unit V: Cloud Service Providers** **Hours: 8**

Introduction, EMC: IT, and captive cloud toolkit, Google: Platform, Storage, Cloud connects, Cloud Print and App Engine, Amazon Web Services: Elastic Compute Cloud, Simple storage, Simple Queue Service, Microsoft: Windows Azure, IBM Cloud models and IBM Smart Cloud, SAP Labs: SAP HANA Cloud Platform, Virtualization Services Salesforce: Sales Cloud and Service Cloud, Rackspace and VMware.

**Unit VI: Open-Source Support for Cloud and Security in Cloud Computing** **Hours: 8**

Open-Source Support for Cloud: Introduction, Open Source Tools for IaaS, Open Source Tools for PaaS, Open Source Tools for SaaS, Open Source Tools for Research, Distributed Computing Tools for Management of Distributed Systems. Security in Cloud Computing: Introduction, Security Aspects: Data, Virtualization and Network Security, Platform-Related Security: Security issues in Cloud Service Models, SaaS, PaaS, IaaS security issues, Audit and Compliance: Disaster Recovery, Privacy and Integrity.

**Text Book:** K. Chandrasekaran: Essentials of Cloud Computing, Edition, CRC Press Taylor & Francis Group.

**Reference Books:**

1. A. Shrinivasan, J. Suresh: Cloud computing a practical approach for learning and implementation, Pearson publication.
2. M. N. Rao: Cloud Computing, PHI Learning Pvt. Ltd, 2015.
3. Dr. Kumar Saurabh: Cloud computing, 2nd Edition, Wiley India 2012.
4. Rajkumar Buyya, James Broberg and Andrzej M. Goscinski: Cloud Computing: Principles and Paradigms, John Wiley & Sons, Inc. 2011.
5. Anthony T. Velte , Toby J. Velte and Robert Elsenpeter, Cloud computing a practical approach, Tata McGraw- Hill , New Delhi – 2010.
6. Judith Hurwitz, Robin Bloor, Marcia Kaufman and Fern Halper, "Cloud computing for dummies" Wiley Publishing, Inc, 2010.

**5AD05 OPEN ELECTIVE- I (i) DATA STRUCTURE AND ALGORITHM (L-3, T-0, C-3)**

**Course Prerequisite:** Fundamentals of programming Language & Logic Building Skills.

**Course Objectives:** Throughout the course, students will be expected to demonstrate their understanding of Data Structure by being able to do each of the following:

1. To understand the linear and nonlinear data Structures and its memory representations.
2. To perform different operations on data structures such as insertion, deletion, searching and traversing.
3. To understand various data searching and sorting methods with its complexity.
4. To introduce various techniques for representation of the data in the real world.

**Course Outcomes (Expected Outcome):** On completion of the course, the students will be able to

1. Understand the fundamentals of Data Structures
2. Apply various linear and nonlinear data structures
3. Demonstrate operations like insertion, deletion, searching and traversing on various data structures
4. Examine the usage of various structures in approaching the problem solution.
5. Choose appropriate data structure for specified problem domain.

**Unit I: Introduction to Data Structures** **Hours: 8**

Introduction to Data structures, Data Structure Operations, Algorithmic Notation, Complexity of algorithms. String processing: storing strings, character data type, string operations, word processing, and pattern matching algorithms.

**Unit II: Array & Record Structure** **Hours: 8**

Linear arrays: Memory Representation of arrays, traversing linear arrays, insertion & deletion operations, Bubble sort, Linear search and Binary search algorithms. Multi-dimensional arrays, Pointer arrays. Record structures and Matrices.

**Unit III: Linked lists** **Hours: 8**

Linked lists: Memory Representation of Linked List, traversing a linked list, searching a linked list. Memory allocation & garbage collection. Insertion & deletion operations on linked lists. Header linked lists, Two- way linked lists.

**Unit IV: Stack & Queue** **Hours: 8**

Stacks: Sequential Memory Representation of Stack, Arithmetic expressions: Polish notation. Quick sort, Recursion, Tower of Hanoi. Queues: Sequential Memory Representation of Queue, DeQueue, Priority queues.

**Unit V: Trees** **Hours: 8**

Introduction to Trees, Binary trees, Memory Representation of Binary Tree, Traversing binary trees, Header nodes, Binary Search Tree, Heap and heapsort, Path length & Huffman‟s algorithm.

**Unit VI: Graphs & Sorting Algorithms** **Hours: 8**

Introduction to Graphs, Memory representation of graphs, Warshalls‟ algorithm, operations on Graphs, Breadth First Search, Depth First Search Sorting: Insertion Sort, Selection Sort, Radix sort, Merge Sort.

**Text Books:**

1. Seymour Lipschutz: Data Structures, Schaum's Outline Series, McGraw-Hill, International Editions.
2. Trembley, Sorenson: An Introduction to Data Structures with Applications, McGraw Hill.

**Reference Books:**

1. Ellis Horowitz, Sartaj Sahni: Fundamentals of Data Structures, CBS Publications.
2. Data Structure Using C, Balagurusamy.
3. Standish: Data Structures in Java, Pearson Education.

**5AD05 OPEN ELECTIVE-I (ii) DATABASE MANAGEMENT SYSTEMS (L-3, T-0, C-3)**

**Course Prerequisite:** Discrete Mathematics, Data Structures and Algorithm.

**Course Objectives:** Throughout the course, students will be expected to demonstrate their understanding of Database Management Systems by being able to do each of the following:

1. To understand the fundamental concepts of database management system.
2. To learn database query languages.
3. To give systematic database design approaches covering conceptual design, logical design and an overview of physical design.
4. To understand the query processing and optimization.
5. To learn basics of transaction management and concurrency control.

**Course Outcomes (Expected Outcome):** On completion of the course, the students will be able to

1. Understand and distinguish file system with database system.
2. Create Database applications using Query Languages like SQL.
3. Model, design and normalize databases for real life applications.
4. Break down query to optimize overall cost.
5. Design & develop transaction processing approach for relational databases.
6. Understand validation framework like integrity constraints, triggers and assertions.

**Unit I: Introduction to DBMS** **Hours:8**

Database System Applications, Purpose of database systems, View of Data, Database Languages Database Architecture, Database Users and Administrators, Entity- Relationship Model, Constraints, removing redundant attributes in Entity sets, E-R diagrams, Reduction to Relational Schemas, E-R design issues, Extended E-R Features.

**Unit II: Relational Algebra, SQL** **Hours:8**

Relational Model: Structure of Relational Databases, Database schema, keys, schema diagram, relational query languages, relational operators, The Relational Algebra, Overview of SQL query language, SQL data definition, Basic Structure of SQL queries, Additional basic operations, Set Operations, Null Values, Aggregate Functions, Nested Subqueries, Modification of the Database Operations, Null Values, Aggregate Functions, Nested Subqueries, Modification of the Database, Join expressions, Views.

**Unit III: Relational Database Design** **Hours:8**

Integrity Constraints, SQL data types and schemas, Authorization, Triggers, Features of good relational designs, atomic domains and First Normal Form, decomposition using functional dependencies, Functional dependency theory, Algorithms for decomposition, Decomposition using multivalued dependencies, More Normal Forms, Database Design Process.

**Unit IV: Query Processing and Query Optimization** **Hours:8**

Query Processing: Overview, Measures of Query Cost, Selection Operation, Sorting, Join Operation, Other Operations, Evaluation of Expressions, Query Optimization: Overview, Transformation of Relational Expressions, Estimating Statistics of Expression Results, , Choice of Evaluation Plans, Materialized Views.

**Unit V: Transaction Management** **Hours:8**

Transaction Concept, Simple transaction model, Storage structure, Transaction Atomicity and Durability, transaction isolation, Serializability, transaction isolation and atomicity, transaction isolation levels, Implementation of Isolation levels, Transactions as SQL statements.

**Unit VI: Concurrency Control and recovery system Hours:**8

Lock-Based Protocols, Deadlock Handling, Multiple Granularities, Timestamp- Based Protocols, Validation-Based Protocols, Multiversion schemes, Recovery system: Failure classification, Storage, Recovery & Atomicity, Recovery algorithm, buffer management, Failure with loss of nonvolatile storage, early lock release and logical undo operations, , Remote Backup Systems.

**Text Book:** Abraham Silberschatz, Henry F. Korth, S. Sudarshan, DATABASE SYSTEM CONCEPTS, Sixth Edition, McGraw Hill.

**Reference Books:**

1. Raghu Ramakrishnan and Johannes Gehrke, Database Management Systems, McGraw-Hill
2. Shamkant B. Navathe, RamezElmasri, Database Systems, Pearson Higher Education
3. Garcia-Molina, Ullman, Widom: Database System Implementation, Pearson education.
4. S. K. Singh: Database Systems, Concepts, Design and Applications, Pearson Education.
5. G.K. Gupta: Database Management Systems, McGraw Hill.
6. Toledo and Cushman: Database Management Systems, (Schaum's Outlines)

**5AD05 OPEN ELECTIVE-I (iii) SOFTWARE TESTING AND QUALITY ASSURANCE (L-3, T-0, C-3)**

**Course Prerequisites**: Software Engineering.

**Course Objectives:** Throughout the course, students will be expected to demonstrate their understanding of

Software Testing and Quality Assurance by being able to do each of the following:
1. Learn to apply the testing strategies and methodologies in projects.
2. To understand test management strategies and tools for testing.
3. A keen awareness of the open problems in software testing and maintenance. 4. To explain quality assurance and various tools used in quality management.
4. To learn in detail about various quality assurance models.
5. To understand the audit and assessment procedures to achieve quality.

**Course Outcomes:** By the end of the course, students should be able to:
1. Test the software by applying testing techniques to deliver a product free from bugs.
2. Investigate the scenario and to select the proper testing technique.
3. Explore the test automation concepts and tools and estimation of cost, schedule based on standard metrics.
4. Understand how to detect, classify, prevent and remove defects.
5. Choose appropriate quality assurance models and develop quality.
6. Ability to conduct formal inspections, record and evaluate results of inspections.

**Unit I: Software Testing Basics** **Hours-07**

Testing as an engineering activity, Role of process in software quality, Testing as a process, Basic definitions, Software testing principles, The tester's role in a software development organization, Origins of defects, Defect classes, The defect repository and test design, Defect examples, Developer / Tester support for developing a defect repository.

**Unit II: TESTING TECHNIQUES AND LEVELS OF TESTING** **Hours-07**

Using White Box Approach to Test design - Static Testing Vs. Structural Testing, Code Functional Testing, Coverage and Control Flow Graphs, Using Black Box Approaches to Test Case Design, Random Testing, Requirements based testing, Decision tables, State-based testing, Cause-effect graphing, Error guessing, Compatibility testing, Levels of Testing -Unit Testing, Integration Testing, Defect Bash Elimination. System Testing - Usability and Accessibility Testing, Configuration Testing, Compatibility Testing.

**Unit III: SOFTWARE TEST AUTOMATION AND QUALITY METRICS** **Hours-07**

Software Test Automation, Skills needed for Automation, Scope of Automation, Design and Architecture for Automation, Requirements for a Test Tool, Challenges in Automation Tracking the Bug, Debugging. Testing Software System Security - Six-Sigma, TQM - Complexity Metrics and Models, Quality Management Metrics, Availability Metrics, Defect Removal Effectiveness, FMEA, Quality Function Deployment, Taguchi Quality Loss Function, Cost of Quality.

**Unit IV: FUNDAMENTALS OF SOFTWARE QUALITY ASSURANCE** **Hours-07**

SQA basics, Components of the Software Quality Assurance System, software quality in business context, planning for software quality assurance, product quality and process quality, software process models, 7 QC Tools and Modern Tools.

**Unit V: QUALITY ASSURANCE MODELS** **Hours-07**

Models for Quality Assurance, ISO-9000 series, CMM, CMMI, Test Maturity Models, SPICE, Malcolm Baldrige Model- P-CMM.

**Unit VI: SOFTWARE QUALITY ASSURANCE TRENDS** **Hours-07**

Software Process- PSP and TSP, OO Methodology, Clean-room software engineering, Defect Injection and prevention, Internal Auditing and Assessments, Inspections & Walkthroughs, Case Tools and their Effect on Software Quality.

**Text Books:**

1. Srinivasan Desikan, Gopalaswamy Ramesh, Software Testing: Principles and Practices Pearson.
2. Daniel Galin, Software Quality Assurance: From Theory to Implementation, Pearson Addison Wesley.

**Reference Books:**

1. Aditya P. Mathur, Foundations of Software Testing, Pearson.
2. Paul Ammann, Jeff Offutt, Introduction to Software Testing, Cambridge University Press.
3. Paul C. Jorgensen, Software Testing: A Craftsman's Approach, Auerbach Publications.
4. William Perry, Effective Methods of Software Testing, Wiley Publishing, Third Edition.
5. Renu Rajani, Pradeep Oak, Software Testing – Effective Methods, Tools and Techniques, Tata McGraw Hill.
6. Stephen Kan, Metrics and Models in Software Quality, Addison – Wesley, Second Edition.
7. S.A.Kelkar, Software quality and Testing, PHI Learing, Pvt, Ltd.
8. Watts S Humphrey, Managing the Software Process ,Pearson Education Inc.

**5AD06: Machine Learning Techniques Lab:** Minimum Eight experiments/ programming assignments must be completed based on the respective syllabus (5AD02) covering each of the units.

**5AD07: Computer Network Lab:** Minimum Eight experiments/ programming assignments must be completed based on the respective syllabus(5AD03) covering each of the units.

**5AD08: Professional Elective- I Lab:** Minimum Eight experiments/programming assignments must be completed based on the respective syllabus (5AD04) covering each of the units.

**5AD09: C Skill Lab III:** Minimum Eight experiments/programming assignments must be completed based on the respective syllabus covering each of the units. (Given List of Experiment may be used as given below)

**5AD09 C-SKILL LAB. - III (P-2, C-1)**

**Course Prerequisite:** Basic knowledge of Web Development, HTML, CSS, JavaScript and IDE.

**Course Objectives:** Throughout the course, students will be expected to demonstrate their understanding of C-Skill Lab - III by being able to do each of the following:
1. To develop an ability to set up a local JS Library/Framework development Environment.
2. To be able to install and implement different JS Libraries and Frameworks
3. To be able to develop single-page/multi-page static and dynamic Web Applications.

**Course Outcomes (Expected Outcome):** On completion of the course, the students will be able to:

1. Explain the various tools, packages and modules required for Web Development.
2. Discuss the workings of web server, cookies, routes, etc.
3. Develop a mobile application using JS Framework.
4. Design GUI using JS framework and/or Libraries.
5. Create applications using Angular, React, Node and Express.

**List of Experiments:** This is the sample list of Experiments; minimum 8 experiments are to be performed covering the entire syllabus. At least two experiments should be beyond syllabi based on learning of syllabi (Apply)

**List of Experiments based on Syllabus:**

1. Introduction to the Node.js and its installation to print Hello World
2. To study built-in modules and implement the user defined built-in modules in the Node.js
3. To study HTTP module and implement Node.js as a web server
4. To study and implement Node.js File system module to read, write, create, update, delete and rename the file
5. To study the URL module of the Node.js and write a program that opens the requested fileand returns the content of the file to the client. If anything goes wrong, throw a 404 error.
6. To convert the output "Hello World!" into upper-case letters by installing the “upper-case” package of NPM.
7. To study event handling in Node.js and demonstrate it using event module and Event Emitter object.
8. To study and implement the Formidable module of Node.js to upload the file on the server.
9. To study and implement the Nodemailer module of Node.js to send emails from your server.
10. To install MySQL and its driver and create connection with it using Node.js.
11. To demonstrate the creation database and table in MySQL using Node.js
12. To demonstrate the insertion of single and multiple records in the MySQL using “INSERT” statement and Node.js
13. To demonstrate the display of records from the MySQL database using “SELECT” statement and display it using Node.js
14. To demonstrate the display the records based on condition from the MySQL database using “WHERE” statement using Node.js
15. To demonstrate deletion of records from database using “DELETE” statement and Node.js
16. To demonstrate updating existing records in a table by using the "UPDATE" statement and Node.js
17. To demonstrate combining rows from two or more tables, based on a related column between them, by using a JOIN statement using Node.js

**List of Experiments beyond Syllabus:**

1. Create an Email sender app using Node.js
2. Create a Basic User database: Site in which User can Sign up/Login and can see other User’s Profile Information.
3. Create a user model covering Registration, Email verification (send an email), login (with remember me, display user details and allow to save/update user details (DOB, Location, Hobbies etc or anything)
4. A random number generator web application.

**Text Books:**

1. Simon Holmes: Getting Mean with Mongo, Express, Angular, and Node, 2nd Edition, Manning.
2. Alex Banks and Eve Porcello: Learning React: Functional Web Development with React and Redux, O’Reilly.

**Reference Books:**

1. Shyam Seshadri: Angular Up and Running, O’Reilly
2. Akshat Paul and Abhishek Nalwaya: React Native for Mobile development, Apress.
3. Jos Dirksen: Learn Three.js, 3rd Edition, Packt Publishing.
4. Patrick Mulder and Kelsey Breseman: Node.js for Embedded Systems, O’Reilly

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## SEMESTER : SIXTH

### 6AD01 DATA ANALYTICS

**Prerequisite:** Data Mining, Knowledge of probability theory, statistics, and programming.

**Course Objectives:** Throughout the course, students will be expected to demonstrate their understanding of Data Analytics by being able to do each of the following:

· To understand Data Analytics Life Cycle and Business Challenges
· To understand Analytical Techniques and Statically Models
· To understand Statically Modelling Language.

**Course Outcomes:** On completion of the course, student will be able to–

1. Understand the basics of business intelligence with respect to big data
2. Describe the need of analyze big data
3. Explain various phases of Data analytic lifecycle
4. Apply appropriate analytic techniques and tools to analyze big data, create statistical models, and identify insights that can lead to actionable results
5. Understand the problem and apply suitable algorithm for concerned task.
6. Select appropriate data visualizations to clearly communicate analytic insights to business sponsors and analytic audiences.

**Unit I: Introduction to Big Data** **06 Hours**

Business Intelligence, Decision Support Systems, Data Warehousing; Definition of Big Data, Big data characteristics & considerations, Introduction to Hadoop.

**Unit II: Big Data Analytics** **06 Hours**

Big data analytics, Drivers of Big data analytics, Big Data Stack, Typical analytical architecture, Virtualization & Big Data, Virtualization Approaches, Business Intelligence Vs Data science, Applications of Big data analytics.

**Unit III: Data Analytics Lifecycle 06 Hours**

Need of Data analytic lifecycle, Key roles for successful analytic projects, various phases of Data analytic lifecycle: Discovery, Data Preparation, Model Planning, Model Building, Communicating Results, Operationalization.

**Unit IV: Machine Learning: Supervised Learning 08 Hours**

What is Machine Learning? Applications of Machine Learning; Supervised Learning: Structure of Regression Model, Linear Regression, Logistics Regression, Time series analysis, Support Vector Machine.

**Unit V: Classification & Unsupervised Learning 08 Hours**

Classification: Classification Problem, Classification Models, Classification Trees, Bayesian Method; Association Rule: Structure of Association Rule, Apriori Algorithm, General Association; Clustering: Clustering Methods, Partition Methods, Hierarchical Methods.

**Unit VI: Exploring Data in R 06 Hours**

Basic features of R, Exploring R GUI, Data Frames & Lists, Handling Data in R Workspace, Reading Data Sets & Exporting Data from R, Manipulating & Processing Data in R.

**Text Books:**

1. David Dietrich, Barry Hiller, "Data Science & Big Data Analytics", EMC education services, Wiley publications, 2012
2. Trevor Hastie, Robert Tibshirani, Jerome Friedman, "The Elements of Statistical Learning", Springer, Second Edition, 2011.

**Reference Books:**

1. Business Intelligence – Data Mining and Optimization for Decision Making – Carlo Vercellis – Wiley Publications.
2. Big Data & Analytics – Seema Acharya & Subhashini Chellappan – Wiley Publications
3. Big Data (Black Book) – DT Editorial Services – Dreamtech Press.
4. Data Mining: Concepts and Techniques Second Edition – Jiawei Han and Micheline Kamber – Morgan KaufMan Publisher
5. Beginning R: The Statistical Programming Language – Mark Gardner – Wrox Publication.

**6AD02 ARTIFICIAL NEURAL NETWORKS AND FUZZY LOGIC L-4, T-0,C-4**

**Course Prerequisite:** Artificial Intelligence

**Course Objectives:** Throughout the course, students will be expected to demonstrate their understanding of Artificial Neural Networks and Fuzzy Logic by being able to do each of the following:

1. To get insight into Artificial Neural networks and Fuzzy Logic
2. To familiarize various neural network architectures
3. To perform classification of linear separable problems.
4. To learn how to train feed forward network using back propagation algorithm.
5. To decide difference between crips and fuzzy sets,
6. To recognize fuzzy logic membership's function.

**Course Outcomes (Expected Outcome):** On completion of the course, student will be able to–

1. Outline fundamental of neural network
2. Train and Test Feed Forward Network using back propagation algorithm.
3. Describe associative memory
4. Explain Adaptive Resonance theory with respect to ANN
5. Relate fuzziness involved in various systems and fuzzy set theory.
6. Create applications on Fuzzy logic membership function.

**Unit I: Fundamental of Neural Network Hours: 06**

Basic concepts of Neural Network, Human Brain, Model of artificial neurons, Mcculloch Pitts model, Neural Network architecture, Characteristics of Neural Network, Learning methods, taxonomy of Neural Network architecture, early neural network architecture, Perceptron model, Perceptron learning algorithm, error correction and Gradient descent rules.

**Unit II: Backpropagation Networks Hours: 08**

Supervised Learning with Neural Networks, Architecture of Backpropagation Network, The perceptron model, Single layer Artificial Neural Network, Multilayer Perceptron, Back propagation algorithm, Back Propagation learning, training of network, calculation of error, Method of steepest descent algorithm, effect of learning rate, adding momentum term.

**Unit III: Associative Memory Hours: 06**

Autocorrelation, Hetro correlation, multiple training encoding strategy, Hopfield Network, error performance of Hopfield network, Exponential BAM, Associative memory for real coded pattern pairs, character recognition application.

**Unit IV: Adaptive Resonance Theory Hours: 06**

Cluster structure, vector quantization, classical ART network, simplifier ART architecture, ART1: architecture, Special features and algorithm, ART2: architecture, Special features and algorithm, character recognition using ART1

**Unit V: Fuzzy Set Theory Hours: 06**

Fuzzy vs crisp, operations and properties of crisp sets, Fuzzy sets, Memberships functions, Basic fuzzy set operations, Properties of Fuzzy sets, Cartesian product, operations on relations, Fuzzy relations, Fuzzy Cartesian product, operations of Fuzzy relations.

**Unit VI: Fuzzy systems Hours: 08**

Laws of Propositional logic, inference in propositional logic, predicate logic, interpretations of predicate, logic formula, inference in predicate logic, fuzzy logic, Fuzzy quatifiers and inference, Fuzzy rule based system, defuzzification methods, application.

**Text Book:**

S. Rajesekaran, G. A. VijayalakshmiPai: "Neural Network, Fuzzy logic, and Genetic algorithms Synthesis and

Applications" PHI.

**Reference Books**:

1. S. Hykin: " Neural Networks" Pearson Education.
2. Jang,Sun and Mezutani: " Neuro Fuzzy and Soft Computing" .
3. Zurada: " Artificial Neural Neworks".
4. N.P.Pahey: "Artificial Intelligence and Intelligent Systems", Oxford University Press

**6AD03 DATABASE MANAGEMENT SYSTEM FOR DATA SCIENCE (L-3, T-0, P-0, C-3)**

**Course Prerequisite:** Data Structure

**Course Objectives:** Throughout the course, students will be expected to demonstrate their understanding of Database Management System for Data Science by being able to do each of the following:

1. To understand the role of a database management system in an organization.
2. To Understand difference of SQL and NoSQL Database
3. To construct simple and advanced database queries using a data language.
4. To understand and apply logical database design principles and database normalization.
5. To recognize the need for transaction management and query processing.

**Course Outcomes (Expected Outcome):** On completion of the course, student will be able to:

1. Understand and distinguish file system with database system.
2. Create Database applications using Query Languages like SQL.
3. Model, design and normalize databases for real life applications.
4. Apply indexing and hashing for proper database management
5. Break down query to optimize overall cost.
6. Design & develop transaction processing approach for relational databases.

**Unit I: Introduction** **Hours: 8**

Databases and Database Users, Characteristics of the Database Approach, Advantages of Using the DBMS Approach, When Not to Use a DBMS, Data Models, Schemas, and Instances, Three-Schema Architecture and Data Independence, Database Languages and Interfaces, The Database System Environment.

**Unit II: Relational Model and NoSQL** **Hours: 8**

Relational Model Concepts, Relational Model Constraints and Relational Database Schemas, Update Operations, Transactions, and Dealing with Constraint Violations, SQL Data Definition, Data Types and Constraints, Data Management in SQL, Transforming ER Model into Relational Model. Introduction to NoSQL databases, Key-Value and Document Data Models.

**Unit III: Normalization** **Hours: 8**

Database Design and Normalization Functional Dependencies, Inference Rules, Equivalence, and Minimal Cover, Properties of Relational Decomposition, Normal Forms Based on Primary Keys, General Definitions of Second and Third Normal Forms, Boyce-Codd Normal Form, Other Dependencies and Normal Forms.

**Unit IV: Indexing and Hashing** **Hours: 8**

Indexing and Hashing Ordered Indices, B+-Tree Index Files and its Extensions, Static Hashing and Dynamic Hashing, Comparison of Ordered Indexing and Hashing, Bitmap Indices, Some General Issues Concerning Indexing.

**Unit V : Query Processing and Optimization** **Hours: 8**

Query Processing and Optimization Measures of Query Cost, Query Operation: Selection, Sorting and Join Operation, Transformation of Relational Expressions, Estimating Statistics of Expression Results, Choice of Evaluation Plans.

**Unit VI: Transaction Processing and Concurrency Control** **Hours: 8**

Transaction Processing, Concurrency Control and Recovery Introduction to Transaction Processing, Characterizing Schedules Based on Recoverability, Characterizing Schedules Based on Serializability, Two-Phase Locking Techniques for Concurrency Control, Deadlock Handling and Multiple Granularity, Database Recovery Techniques.

**Text Books:**

1. Abraham Silberschatz, Henry F. Korth and S. Sudarshan; "Database System Concepts"; Sixth Edition, Tata McGraw Hill, 2011.
2. Sadalage, P. & Fowler, NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence, Wiley Publications, 1st Edition ,2019.

**Reference Books:**

1. Ramez Elmasri and Shamkant Navathe; "Fundamentals of Database Systems"; Sixth Edition, Addison Wesley 2011.
2. Raghu Ramakrishnan and Johannes Gehrke; "Database Management Systems"; Third Edition, Tata McGraw Hill Publication, 2003.
3. C. J. Date; "Database in Depth – Relational Theory for Practitioners"; O`Reilly Media, 2005.

**6AD04 PROFESSIONAL ELECTIVE- II (i) DATA WAREHOUSING**

**Prerequisite:** Database Management System

**Course Objectives:** Throughout the course, students will be expected to demonstrate their understanding of Data Warehousing being able to do each of the following:

1. Understand the role of data warehouses in decision support
2. Explain data integration and the extraction, transformation, and load (ETL) processes

**Course Outcomes:** On completion of the course, student will be able to:

1. Describe the role of data warehouses in decision support
2. Explain data warehousing operations with view of conceptual design
3. Discuss data warehousing logical design architectures
4. Select query for data warehousing
5. Differentiate different data warehousing design

6. Demonstrate competency in data modeling, including dimensional modeling.

**Unit I: Introduction:** A Historical Overview of Data Warehousing, Spatial and Spatiotemporal Data Warehouses, New Domains and Challenges, **Data Warehouse Concepts:** Multidimensional Model, Hierarchies, Measures, OLAP Operations, Data Warehouses, Data Warehouse Architecture, Back-End Tier, Data Warehouse Tier, OLAP Tier, Front-End Tier, Variations of the Architecture, Data Warehouse Design, Business Intelligence Tools., Overview of Microsoft SQL Server Tools, Overview of Pentaho Business Analytics.

**Unit II: Conceptual Data Warehouse Design:** Conceptual Modeling of Data Warehouses, Hierarchies, Balanced Hierarchies, Unbalanced Hierarchies, Generalized Hierarchies, Alternative Hierarchies, Parallel Hierarchies, Nonstrict Hierarchies, Advanced Modeling Aspects, Facts with Multiple Granularities, Many-to-Many Dimensions, Querying the Northwind Cube Using the OLAP Operations.

**Unit III: Logical Data Warehouse Design:** Logical Modeling of Data Warehouses, Relational Data Warehouse Design, Relational Implementation of the Conceptual Model, Time Dimension, Logical Representation of Hierarchies, Balanced Hierarchies, Unbalanced Hierarchies, Generalized Hierarchies, Alternative Hierarchies, Parallel Hierarchies, Nonstrict Hierarchies, Advanced Modeling Aspects, Facts with Multiple Granularities, Manyto-Many Dimensions, Slowly Changing Dimensions, SQL/OLAP Operations, Data Cube, ROLLUP, CUBE, and GROUPING SETS, Window Functions, Definition of the Northwind Cube in Analysis Services, Data Sources, Data Source Views, Dimensions, Hierarchies, Cubes, Definition of the Northwind Cube in Mondrian, Schemas and Physical Schemas, Cubes, Dimensions, Attributes, and Hierarchies, Measures.

**Unit IV: Querying Data Warehouses:** Introduction to MDX, Tuples and Sets, Basic Queries, Slicing, Navigation, Cross Join, Subqueries, Calculated Members and Named Sets, Relative Navigation, Time Series Functions, Filtering, Sorting, Top and Bottom Analysis, Aggregation Functions, Querying the Northwind Cube in MDX, Querying the Northwind Data Warehouse in SQL, Comparison of MDX and SQL.

**Unit V: Physical Data Warehouse Design:** Physical Modeling of Data Warehouses, Materialized Views, Algorithms Using Full Information, Algorithms Using Partial Information, Data Cube Maintenance, Computation of a Data Cube, PipeSort Algorithm, Cube Size Estimation, Partial Computation of a Data Cube, Indexes for Data Warehouses, Bitmap Indexes, Bitmap Compression, Join Indexes, Evaluation of Star Queries, Data Warehouse Partitioning, Queries in Partitioned Databases, Managing Partitioned Databases, Partitioning Strategies, Physical Design in SQL Server and Analysis Services, Indexed Views, Partition-Aligned Indexed Views, Column-Store Indexes, Partitions in Analysis Services, Query Performance in Analysis Services, Query Performance in Mondrian, Aggregate Tables, Caching.

**Unit VI: A Method for Data Warehouse Design:** Approaches to Data Warehouse Design, General Overview of the Method, Requirements Specification, Analysis-Driven Requirements Specification, Analysis-Driven Requirements for the Northwind Case Study, Source-Driven Requirements Specification, Source-Driven Requirements for the Northwind Case Study, Analysis/Source-Driven Requirements Specification, Conceptual Design, Analysis-Driven Conceptual Design, Analysis-Driven Conceptual Design for the Northwind Case Study, Source-Driven Conceptual Design, Source-Driven Conceptual Design for the Northwind Case Study, Analysis/Source-Driven Conceptual Design, Logical Design, Logical Schemas, ETL Processes, Physical Design, Characterization of the Various Approaches, Analysis-Driven Approach, Source-Driven Approach, Analysis/Source-Driven Approach .

**Text Book:**

Alejandro Vaisman and Esteban Zimanyi - Data Warehouse Systems, Design and Implementation- © Springer-Verlag Berlin Heidelberg 2014.

**Reference Books:**

1. Parteek Bhatia- Data Mining and Data Warehousing, Principles and Practical Techniques- Cambridge University Press.
2. Paulraj Ponniah- Data Warehousing Fundamentals for IT Professionals, Second Edition, John Wiley & Sons, Inc., 2010
3. Krish Krishanan- Data Warehousing in the Age of Big Data, Morgan Kaufmann.
4. K.P. Soman, Shyam Diwakar and V. Ajay, ―Insight into Data Mining Theory and Practice‖, Eastern Economy Edition, Prentice Hall of India, 2006.
5. Ian H.Witten and Eibe Frank, ―Data Mining: Practical Machine Learning Tools and Techniques‖, Elsevier, Second Edition.
6. Alex Berson and Stephen J.Smith, ―Data Warehousing, Data Mining & OLAP‖, Tata McGraw – Hill Edition, 35th Reprint 2016.
7. Jiawei Han and Micheline Kamber, ―Data Mining Concepts and Techniques‖, Third Edition, Elsevier, 2012.

**6AD04 PROFESSIONAL ELECTIVE- II (ii) CRYPTOGRAPHY (L-3,T-0,C-3)**

**Course Prerequisite:** Discrete Structure & Graph Theory, Data Communication and Networking, Introduction to Cyber security

**Course Objectives:** Throughout the course, students will be expected to demonstrate their understanding of Cryptography by being able to do each of the following:

1. Understand Security Concepts.
2. Know about various encryption techniques.
3. Understand the concept of public key cryptography.
4. Study about message authentication and hash functions.
5. Impart knowledge on Network security, Internet Security Protocols.

**Course Outcomes (Expected Outcome):** On completion of the course, the students will be able to

1. Classify the symmetric encryption techniques
2. Illustrate various public key cryptographic techniques
3. Evaluate the authentication and hash algorithms.

4. Discuss authentication applications
5. Summarize the intrusion detection and its solutions to overcome the attacks.
6. Understand basic concepts of system level security.

**Unit I:** **Hours: 6**

Attacks on Computers and Computer Security: Introduction, Need for Security, Security Approaches, Principles of Security, Types of Attacks.

Cryptography: Concepts and Techniques Introduction, PlainText and CipherText, Substitution and Transposition Techniques, Encryption and Decryption, Symmetric and Asymmetric Key Cryptography, Stenography, Key Range and Key Size, Possible Types of Attacks

**Unit II:** **Hours: 6**

Symmetric Key Algorithms and AES: Introduction, Algorithm Types and Modes, An Overview of Symmetric Key Cryptography, Data Encryption Standard(DES), International Data Encryption Algorithm (IDEA), RC4, RC5, Blowfish, Advanced Encryption Standard(AES).

**Unit III:** **Hours: 6**

Asymmetric Key Algorithms, Digital Signatures and RSA: Introduction, History and Overview of Asymmetric Key Cryptography, The RSA Algorithm, Symmetric and Asymmetric Cryptography, Digital Signatures, Knapsack and other Algorithms.

**Unit IV:** **Hours: 6**

Digital Certificates and Public Key Infrastructure (PKI): Introduction, Digital Certificates, Private Key Management, The PKIX Model, Public Key Cryptography Standards (PKCS), XML,PKI and Security, Creating Digital Certificate.

**Unit V:** **Hours: 6**

Internet Security Protocols: Introduction, Concepts, Secure Socket Layer(SSL), Transport Layer Security(TLS), Secure Hypertext Transport Protocol(SHTTP), Time Stamping Protocol(TSP), Secure Electronic Transaction (SET), SSL Versus SET, 3-D Secure Protocol, Electronic Money, Email Security, Wireless Application Protocol(WAP)Security, Security in GSM, Security in 3G.

**Unit VI:** **Hours: 6**

User Authentication and Kerberos: Introduction, Authentication Basics, Passwords, Authentication Tokens, Certificate-based-authentication, Biometric Authentication, Kerberos, Key Distribution Center (KDC), Security Handshake Pitfalls, Single Sign On (SSO) Approaches.

**Text Book:** Atul Kahate,"Cryptography and Network Security", Mc-GrawHill, Second Edition.

**Reference Books:**

1. William Stallings," Cryptography and Network Security, Principles and Practice", PHI Fourth Edition.
2. Behrouz A. Forouzan and Debdeep Mukhopadhyay, "Cryptography and Network Security", McGraw Hill, Second Edition.
3. Matt Bishop, "Computer Security Arts and Science", Pearson Education.
4. Douglas R Stinson, "Cryptography, Theory and Practice" CRC Press.
5. Keith M Martin, "Everyday Cryptography, Fundamental Principles and Applications", Oxford University Press, Second Edition.

**6AD04 PROFESSIONAL ELECTIVE –II (iii) ROBOTICS (L-3, T-0, C-3)**

**Course Prerequisite:** Mathematics.

**Course Objectives:** Throughout the course, students will be expected to demonstrate their understanding of Robotics by being able to do each of the following:

· To introduce the functional elements of Robotics
· To impart knowledge on the direct and inverse kinematics
· To introduce the manipulator differential motion and control
· To educate on various path planning techniques
· To introduce the dynamics and control of manipulators
.

**Course Outcomes (Expected Outcome):** On completion of the course, the students will be able to:

1. Describe basic concept of robotics.
2. Explain Components of a Robot System & Mechanical Systems
3. Illustrate Control of Actuators in Robotic Mechanisms
4. Compare and contrast Robotic Sensory Devices
5. Recommend Robotics Hardware &Software Considerations in Computer Vision
6. Design Robotic system by taking real time considerations.

**Unit I** **Hours: 7**

Introduction to Robotics: Objectives, Motivation, Historical Perspective of Robots, Classification of Robots, Classification by Control Method, Continuous-path servo-controlled robots, Major Components of a Robot, Fixed versus Flexible Automation.

**Unit II:** **Hours: 7**

Components of a Robot System & Mechanical Systems: Basic Components of a Robot System, Functions of a Robot System Specifications of Robot Systems, Kinematic Chains the Manipulator End Effectors, Resolution, Forces Encountered in Moving Coordinate Systems Lagangian Analysis of a Manipulator.

**Unit III:** **Hours: 7**

Control of Actuators in Robotic Mechanisms: Closed-Loop Control in a Position Servo, The Effect of Friction and Gravity, Frequency-Domain Considerations, Control of a Robotic Joint Brushless DC Motors, Direct-Drive Actuator, Hydraulic Actuators.

**Unit IV:** **Hours: 7**

Robotic Sensory Devices: Non-Optical-Position Sensors, Optical Position Sensors, Robot Calibration Using an Optical Incremental Encoder, Instability Resulting from Using an Incremental Encoder, Velocity Sensors, Accelerometers.

**Unit V:** **Hours: 7**

Computer Vision for Robotics Systems: A Functional Approach: Imaging Components, Image Representation, Hardware Considerations, Picture Coding, Object Recognition and Categorization, Software Considerations, Need for Vision Training and Adaptations.

**Unit VI:** **Hours: 7**

Computer Considerations for Robotic Systems: Architectural Considerations, Hardware Considerations, Computational Elements in Robotic Applications Real-Time Considerations, Robot Programming, Path Planning, The Robot's Computer System.

**Text Books:**

1. Richard D.Klafter Thomas , Achmielewski and Michael Negin Robotic Engineering- An Integrated Approach Prentice Hall India – New Delhi.
2. Saeed B Nikku Introduction to Robotics , analysis control and applications Wiley-India 2nd Edition-2011.

**Reference Book:**

B.K.Ghosh, Control in Robotics and Automation: Sensor Based Integration, Allied Publishers, Chennai, 1998.

**6AD05 OPEN ELECTIVE- II (i) SOFTWARE PROJECT MANAGEMENT (L-3, T-0, C-3)**

**Course Prerequisite:** Fundamentals of programming Language

**Course Objectives:** Throughout the course, students will be expected to demonstrate their understanding of Software Project Management by being able to do each of the following:

1. To learn and understand the principles of Software Engineering
2. To be acquainted with methods of capturing, specifying, visualizing and analyzing software requirements.
3. To apply Design and Testing principles to S/W project development.
4. To understand project management through life cycle of the project.
5. To understand software quality attributes.
6. To understand of the role of project management including planning, scheduling, risk management.

**Course Outcomes (Expected Outcome):** On completion of the course, student will be able to:

1. Decide on a process model for a developing a software project
2. Classify software applications and identify unique features of various domains
3. Design test cases of a software system.
4. Understand basics of Project management.
5. Plan, schedule and execute a project considering the risk management.
6. Apply quality attributes in software development life cycle.

**Unit I: Introduction to Software Engineering, Software Process Models** **Hours: 6**

Introduction to Software Engineering, Software Process Models Evolving role of Software, Software crises & myths, Software engineering, Software process & process models, Linear sequential, prototyping ,RAD ,Evolutionary Product & Process, Project management concepts, People, Product, Process, Project W5HH principles, critical practice.

**Unit II: Project Management: Process, Metrics, And Estimations & Risks** **Hours: 6**

Project Management: Process, Metrics, And Estimations & Risks Measures, Metrics & Indicators. Metrics in process & project domains-software measurement, Metrics for software quality, small organization. Software projects Planning: Scope, resources, estimation, decomposition technique, Tools. Software risks: identification, risk projection, refinement & RMMM plan.

**Unit III: Project Scheduling & Quality Management** **Hours: 6**

Project Scheduling & Quality Management Project Scheduling: Concepts. Peoples Efforts. Task set, Task network. Scheduling. EV analysis, Project Plan.

Software quality concepts. SQ Assurance, Software reviews, technical reviews, software reliability, ISO 900 L,SQA Plan. SCM process. Version control. SCM standard.

**Unit IV: Requirement Engineering & System Engineering** **Hours: 6**

Requirement Engineering & System Engineering System engineering: Hierarchy, Business Process & Product engineering: Overviews. Requirement engineering, System modeling. Requirement analysis. Analysis principles. Software prototyping. Specification. Design Process. Design Principles & Concepts. Effective modular design. Design model & documentation.

**Unit V: Software architecture & User interface design** **Hours: 6**

Software architecture & User interface design Software architecture, Data Design, Architectural styles, Requirement mapping. Transform & Transaction mappings. User interface design: Golden Rule. UTD, Task analysis &modeling, ID activities, Tools, design evaluation. Component level design: Structure programming, Comparison of design notation.

**Unit VI: Software Testing Hours: 6**

Software testing fundamentals; test case design, White box testing. Basis path, control structure-, Black box-Testing, & for specialized environments. Strategic approach to S/W testing. Unit testing, integration testing, validation testing, and system testing. Debugging. Technical metrics for software.

**Text Book:** Pressman Roger. S: Software Engineering, A Practitioner’s Approach, TMH.

**Reference Books:**

1. Somerville: Software Engineering (Addison-Wesley) (5/e)
2. Fairly R: Software Engineering (McGraw Hill)
3. Davis A: Principles of Software Development (McGraw Hill)
4. Shooman, M.L: Software Engineering (McGraw-Hill)

**6AD05 OPEN ELECTIVE –II (ii) E COMMERCE (L-3, T-0, C-3)**

**Course Prerequisite:** Fundamentals of programming Language

**Course Objectives:** Throughout the course, students will be expected to demonstrate their understanding of E Commerce by being able to do each of the following:

1. Analyze the impact of E-commerce on business models and strategy.
2. Describe the major types of E-commerce.
3. Explain the process that should be followed in building an E-commerce presence.
4. Identify the key security threats in the E-commerce environment.

**Course Outcomes (Expected Outcome):** On completion of the course, student will be able to:

1. Understand the basic concepts and technologies used in the field of management information systems;
2. Describe the different types of management information systems;
3. Explain the processes of developing and implementing information systems;
4. Distinguish the ethical, social, and security issues of information systems;

**Unit I: E Commerce** **Hours: 6**

The difference between E-commerce and E business, Why study E-commerce? Eight unique features of ECommerce Technology, Types of E-Commerce, Growth of the INternet and the WEb, Origins and Growth of Ecommerce, E-Commerce - A brief History.

**Unit II: E-commerce Business Models and Concepts** **Hours: 6**

E-Commerce business Model-eigh Key elements of a Business Model, Major Business-to-Consumer (B2C) Business Models, Major Busiess to -Business (B2B) Business Models: Businss Models emerging in E-Commerce areas, How the Internet and the WEB change Business; Strategy, Structure and Process.

**Unit III: E-Commerce Infrastructure** **Hours: 6**

The Internet: Technology Background, The Internet Today, Intenet II; The future infrastructure, The World Wide Web, The Internet and the Web Features.

**Unit IV: Building an E-Commerce Web Site** **Hours: 6**

Building and E-Commerce Wet Site- A strategic approach, Choosing Server Software, Choosing the Hardware for an E-Commerce site, Other E-Commerce Site Tools.

**Unit V: Online Security and payment systems** **Hours: 6**

The E-Commerce Security Environment, Security threads in the E-commerce environment, Technology solutions, Management Policies, business procedures and public laws, payment systems.

**Unit VI: E-Commerce Marketing Concepts** **Hours: 6**

Consumer online; The Internet Audience and Consumer behavior, Basic Marketing Concepts, Internet Marketing Technologies, B2C and B2C E=Commerce marketing and Branding strategies.

**Text Book:** Keneth C. Laudon, Carol Gurcio Trave" e-commerce, business, technology, society" (Pearson)

**Reference Books:**

1. Dave Chaffley "E-Business and E-commerce management"(3rd Edition) Pearson.
2. Kalkakofa Whirttoton, "Frontiers of E-Commerce" Pearson.

**6AD05 Professional Elective – II (iii) INTRODUCTION TO DATA SCIENCE (L-3, T-0, P-0, C-3)**

**Course Prerequisite:** Database, Basic Knowledge of programming.

**Course Objectives:**

1. To understand the basic terminology used in data science
2. To Understand data management and data models
3. To understand basic terminology and concept of data analysis.
4. To understand and apply data visualization.

**Course Outcomes (Expected Outcome):**

1. Identify the basic concepts and technologies involved in dealing with Data science process.
2. Apply data management for exploring and fixing data.
3. Understand different types of statistical data analysis.
4. Apply and use different technologies for data visualization.

**Unit I Introduction 7 Hrs**

Data Science, Terminology Related with Data Science, Methods of Data Repository, Personnel involved with Data Science, Types of Data, The Data Science Process, Popular Data Science toolkits.

**Unit II Data Management 6 Hrs**

Data Management Planning, Data Management Plan, Data Collection and Management, Application Programming Interface, Exploring Data, Building Models, Storage Management, Importing Data.

**Unit III: Data Analysis Using R 7 Hrs**

Introduction to Applied statistical Techniques, Types of Statistical Data, Types of Big Data Analytics, Collecting data for Sampling and Distribution, Probability, Frequency Distribution, Population and Parameters, Central Tendency or Central Value, Measures of Central Tendency, Different types of Statistical Means.

**Unit IV: Data Visualization 7 Hrs**

Data Visualization, Importance of Data Visualization, Conventional Data Visualization Methods, Retinal Variables, Mapping Variables to Encodings, Case Study.

**Unit V : Applications of Data Science 6 Hrs**

Applications of Data Science Technologies for Visualization, Introduction to Python, Basic Numeric Operations, Data Types in Python, Modules, Libraries.

**Unit VI: Recent Trends in Data Science 6 Hrs**

Recent Trends in various data collection and analysis Techniques, Various Big Data Visualization Tools, Visualizing Big Data, Pre-attentive Attributes, Challenges of Big Data Visualization, Future progress of Big Data Visualization.

**Text Book:** V. K. Jain; "Data Science and Analytics" Khanna Publication 2018.

**Reference Books:**

1. Cathy O'Neil and Rachel Schutt, "Doing Data Science, Straight Talk From The Frontline", O'Reilly, 2014.
2. Mohammed J. Zaki and Wagner MieraJr, "Data Mining and Analysis: Fundamental Concepts and Algorithms", Cambridge University Press, 2014.
3. Joel Grus, "Data Science from Scratch: First Principles with Python", O'Reilly Media, 2015.

**6AD06 Data Analytics Lab:** Minimum Eight experiments/ programming assignments must be completed based on the respective syllabus (6AD01) covering each of the units.

**6AD07 Database Management System for Data Science Lab:** Minimum Eight experiments/ programming assignments must be completed based on the respective syllabus (6AD03) covering each of the units.

**6AD08 Professional Elective- I Lab:** Minimum Eight experiments/programming assignments must be completed based on the respective syllabus (6AD04) covering each of the units.

**6AD09 C Skill Lab IV:** Minimum Eight experiments/programming assignments must be completed based on the respective syllabus covering each of the units. C Skill Lab Iv is based on technology like DevOp to be decided by Individual Department of Respective College.

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