RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL

New Scheme Based On AICTE Flexible Curricula

CSE-IOT/IOT, VII-Semester

IO- 701 IOT Architecture & Protocol

Course Outcomes: On successful completion of this course the students will be able to
1. Understand the concepts of IoT Architecture
2. Apply knowledge of IoT Networking and its components to design IoT-based systems
3. Understand data link layer and network layer protocols ofIoT
4. Use the knowledge of IoT transport and session layer protocols in various applications of IoT 5. Design IoT-based systems for real-world problems

Unit I IoT definition, Characteristics, IoT conceptual and architectural framework, Physical and logical design of IoT, IoT enablers, Modern day IoT applications, M2M communications, IoT vs M2M, IoT vs WoT, IoT reference architecture, IoT Network configurations, IoT LAN, IoT WAN, IoT Node, IoT Gateway, IoT Proxy

Unit II Basics of IoT Networking, IoT Components, Functional components of IoT, IoT service oriented architecture, IoT challenges, 6LowPAN, IEEE 802.15.4, RFID Features, RFID working principle and applications, NFC (Near Field communication), Bluetooth, Wireless Sensor Networks and its Applications

Unit III IoT Data Link Layer & Network Layer Protocols: PHY/MAC Layer(3GPP MTC, IEEE 802.11, IEEE 802.15), Wireless HART,ZWave,Bluetooth Low Energy, Zigbee Smart Energy, DASH7 - Network Layer-IPv4,IPv6, 6LoWPAN, 6TiSCH,ND, DHCP, ICMP, RPL, CORPL, CARP

Unit IV IoT Transport & Session Layer Protocols: Transport Layer (TCP, MPTCP, UDP, DCCP, SCTP)-(TLS, DTLS) – Session Layer-HTTP, CoAP, CoAP message types, CoAP Request-Response model, XMPP, AMQP, MQTT, MQTT methods and components, MQTT communication, topics and applications, SMQTT

Unit V IoT Service Layer Protocols & Security Protocols: Service Layer -oneM2M, ETSI M2M, OMA, BBF – Security in IoT Protocols – MAC802.15.4 , 6LoWPAN, RPL, Application Layer IoT Platforms, Arduino, Raspberry Pi Board, Other IoT Platforms; Data Analytics for IoT, Cloud for IoT, Cloud storage models & communication APIs, IoT case studies

Reference Books:

1. Vijay Madisetti, ArshdeepBahga, “Ïnternet of Things, A Hands on Approach”, University Press
2. Dr. SRN Reddy, RachitThukral and Manasi Mishra, “Introduction to Internet of Things: A practical Approach”, ETI Labs
3. Pethuru Raj and Anupama C. Raman, “The Internet of Things: Enabling Technologies, Platforms, and Use Cases”, CRC Press
4. Jeeva Jose, “Internet of Things”, Khanna Publishing House, Delhi
5. Adrian McEwen, “Designing the Internet of Things”, Wiley
6. Raj Kamal, “Internet of Things: Architecture and Design”, McGraw Hill
7. CunoPfister, “Getting Started with the Internet of Things”, O Reilly Media
8. Daniel Minoli, “Building the Internet of Things with IPv6 and MIPv6: The EvolvingWorldof M2M Communications”, ISBN: 978-1-118-47347-4, Willy Publications ,2016

9. Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand,StamatisKarnouskos, David Boyle, “From Machineto-Machine to the Internet ofThings: Introduction to a New Age of Intelligence”, 1st Edition, Academic Press, 2015
10. Bernd Scholz-Reiter, Florian Michahelles, “Architecting the Internet of Things”,ISBN 978-3-642-19156-5 e-ISBN 978-3-642-19157-2, Springer, 2016

RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL

New Scheme Based On AICTE Flexible Curricula

CSE-IOT/IOT, VII-Semester

Departmental Elective IO- 702 (A) Mobile Application Development

Course Objectives: The objective of this course is to make students to understand basic concepts of mobile application development.

UNIT I

Overview of Mobile App Development: Mobile Applications, A formula for designing engaging applications, Unique challenges for development of engaging applications, Enterprise mobile development, Mobile App Development Lifecycle Overview

UNIT II

Importance of Design, App Design issues and considerations, Scope of Design in Mobile App Development, Design Principles and Guidelines, Some Design Methods, Factors for choosing mobile app, Mobile App Architectural Components, Mobile App Flow, Mobile App Deployment Considerations

UNIT III

Building Mobile Apps Powered by Enterprise Backend, Connecting the Mobile App with Enterprise IT Services and Data, Types of IT Backend to Integrate from Mobile Apps, Type of API Protocols, Security Integration, Mobile Devices Security Considerations, Secured Data Store and Synchronization, Enterprise Mobile Application Management and Device Management, Special Challenges in Managing Mobile Applications and Devices

UNIT IV

Quality, Cost of Quality, Automated versus Manual Testing, Preproduction versus Post release, Automated Mobile App Testing Considerations, Monetizing Apps, Publishing Apps

UNIT V

The Android Operating System, Working of Android Apps, Programming languages used for developing Android Apps, Android Studio, Emulators, General Procedure for developing an App

Reference Books:

1. Leigh Williamson, Roland Barcia, Omkar Chandgadkar, Ashish Mathur, Soma Ray, Darrell Schrag, Roger Snook, Jianjun Zhang, " Enterprise Class Mobile Application Development", IBM Press Pearson plc, 2016
2. Jakob Iversen Michael Eierman, "Learning Mobile App Development", Pearson Education, 2014
3. J. Paul Cardle, "Android App Development in Android Studio", Manchester Academic Publishers

Course Outcomes:

On successful completion of this course the students will be able to
1. Understand the entire lifecycle involved in mobile app development
2. Design a mobile app
3. Understand Security considerations in mobile app development
4. Know about the range of techniques available for testing of Mobile Apps and understand when one approach is better than the others.
5. Follow general procedure for developing an App

RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL

New Scheme Based On AICTE Flexible Curricula

CSE-IOT/IOT, VII-Semester

Departmental Elective IO 702 (B) Compiler Design

UnitI: Introduction to compiling & Lexical Analysis Introduction of Compiler, Major data Structure in compiler, types of Compiler, Front-end and Back-end of compiler, Compiler structure: analysis-synthesis model of compilation, various phases of a compiler, Lexical analysis: Input buffering, Specification & Recognition of Tokens,Design of a Lexical Analyzer Generator, LEX.

UnitII: Syntax Analysis &Syntax Directed Translation Syntax analysis: CFGs, Top down parsing, Brute force approach, recursive descent parsing, transformation on the grammars, predictive parsing, bottom up parsing, operator precedence parsing, LR parsers (SLR,LALR, LR),Parser generation. Syntax directed definitions: Construction of Syntax trees,Bottom up evaluation of S-attributed definition, L-attribute definition, Top down translation, Bottom Up evaluation of inherited attributes Recursive Evaluation, Analysis of Syntax directed definition.

UnitIII: Type Checking & Run Time Environment: Type checking: type system, specification of simple type checker, equivalence of expression, types, type conversion, overloading of functions and operations, polymorphic functions. Run time Environment: storage organization, Storage allocation strategies, parameter passing, dynamic storage allocation, Symbol table, Error Detection & Recovery, Ad-Hoc and Systematic Methods.

Unit IV: Code Generation: Intermediate code generation: Declarations, Assignment statements, Boolean expressions, Case statements, Back patching, Procedure calls Code Generation: Issues in the design of code generator, Basic block and flow graphs, Register allocation and assignment, DAG representation of basic blocks, peephole optimization, generating code from DAG.

Unit V: Code Optimization: Introduction to Code optimization: sources of optimization of basic blocks, loops in flow graphs, dead code elimination, loop optimization, Introduction to global data flow analysis, Code Improving transformations ,Data flow analysis of structure flow graph Symbolic debugging of optimized code.

References:

1. A. V. Aho, R. Sethi, and J. D. Ullman. Compilers: Principles, Techniques and Tools , Pearson Education

2. Raghavan, Compiler Design, TMH Pub.

3. Louden. Compiler Construction: Principles and Practice, Cengage Learning

4. A. C. Holub. Compiler Design in C , Prentice-Hall Inc., 1993.

5. Mak, writing compiler & Interpreters, Willey Pub.

RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL

New Scheme Based On AICTE Flexible Curricula

CSE-IOT/IOT, VII-Semester

Departmental Elective IO 702 (C) Cloud and Fog Computing

Course Objectives:

The objective of this course is to discuss cloud and fog computing as an increasingly viable means of achieving enhanced monitoring and control of industrial processes, differentiate between Cloud and edge-fog computing and what role the two technologies will increasingly play in process control and automation.

UNIT I

Cloud Computing Fundamentals: Motivation for Cloud Computing, Defining Cloud Computing, Principles of Cloud Computing , Five Essential Characteristics, Cloud Ecosystem, Requirements for Cloud Services, Cloud Applications, Benefits and Drawbacks, Cloud Architecture, Network Connectivity in Cloud Computing, Managing the Cloud, Migrating Application to Cloud

UNIT II

Cloud Deployment Models: Private Cloud, Public Cloud, Community Cloud, Hybrid Cloud; Cloud Service Models: Infrastructure as a Service, Platform as a Service, Software as a Service, Their characteristics, Suitability, Pros and Cons, Cloud Service Providers

UNIT III

Technological Drivers of Cloud Computing: Virtualization, Approaches in Virtualization, Hypervisor and Its Role, Types of Virtualization; Memory and Storage Technologies, Networking Technologies, Web 2.0 and Web 3.0, Agile SDLC for Cloud Computing, Programming Models for Cloud Computing

UNIT IV

Security in Cloud Computing: Security Aspects, Data Security, Virtualization Security, Network Security, Security Issues in Cloud Service Models, Audit and Compliance, Data Protection in the Cloud, Cloud Security as a Service; Advanced Concepts in Cloud Computing: Intercloud, Cloud Management, Mobile Cloud, Cloud Governance, Green Cloud, Cloud Analytics

UNIT V

Introduction to Fog Computing, Difference between cloud computing and fog computing, Fog Computing benefits and drawbacks, Applications of Fog computing, Role of Fog computing in Internet of Things, Need for Fog computation, Fog data processing layers.

Reference Books:

1. K. Chandrasekaran, “Essentials of Cloud Computing”, CRC Press, 2015

2. Arshdeep Bahga, Vijay Madisetti, “Cloud Computing: A Hands-on Approach”, 2013.

3. Rajkumar Buyya, James Broberg, Andrzej Goscinski, “Cloud Computing: Principles and Paradigms”, Wiley

4. Rajkumar Buyya, Satish Narayana Srirama, “ Fog and Edge Computing: Principles and Paradigms”, Wiley

5. Assad Abbas, Samee U. Khan, Albert Y. Zomaya “Fog Computing: Theory and Practice”, Wiley, 2020

Course Outcomes:

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

1. Articulate the main concepts, key technologies, strengths, and limitations of cloud computing
2. Identify the architecture and infrastructure of cloud computing, including SaaS, PaaS, IaaS, public cloud, private cloud, hybrid cloud, etc.
3. Have understanding of the Technological Drivers of Cloud Computing
4. Explain the core issues of cloud computing such as security, privacy, and interoperability and provide the appropriate cloud computing solutions and recommendations according to the applications used.
5. Attempt to generate new ideas and innovations in cloud computing and Fog computing.

RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL

New Scheme Based On AICTE Flexible Curricula

CSE-IOT/IOT, VII-Semester

Departmental Elective IO 702 (D) Machine Learning

COURSE OBJECTIVES: The objective of this course is to impart necessary knowledge of different machine learning techniques and develop programming skills required to build machine learning based applications**.**

COURSE OUTCOMES: After completing the course student should be able to:

1. Describe in-depth about theories, methods, and algorithms in machine learning.
2. Find and analyze the optimal hyper parameters of the machine learning algorithms.
3. Examine the nature of a problem at hand and determine whether machine learning can solve it efficiently.
4. Solve and implement real world problems using machine learning**.**

COURSE CONTENTS:

UNIT-I

Introduction to machine learning, Machine learning life cycle, Types of Machine Learning System (supervised and unsupervised learning, Batch and online learning, Instance-Based and Model based Learning), scope and limitations, Challenges of Machine learning, data visualization, hypothesis function and testing, data pre-processing, data augmentation, normalizing data sets, , Bias-Variance tradeoff, Relation between AI (Artificial Intelligence), ML (Machine Learning), DL (Deep Learning) and DS (Data Science).

UNIT-II

Clustering in Machine Learning: Types of Clustering Method: Partitioning Clustering, Distribution Model-Based Clustering, Hierarchical Clustering, Fuzzy Clustering. Birch Algorithm, CURE Algorithm. Gaussian Mixture Models and Expectation Maximization. Parameters estimations – MLE, MAP. Applications of Clustering.

UNIT-III Classification algorithm: - Logistic Regression, Decision Tree Classification, Neural Network, K-Nearest Neighbors (K-NN), Support Vector Machine, Naive Bayes (Gaussian, Multinomial, Bernoulli). Performance Measures: Confusion Matrix, Classification Accuracy, Classification Report: Precisions, Recall, F1 score and Support.

UNIT-IV Ensemble Learning and Random Forest: Introduction to Ensemble Learning, Basic Ensemble Techniques (Max Voting, Averaging, Weighted Average), Voting Classifiers, Bagging and Pasting, Out-of-Bag Evaluation, Random Patches and Random Subspaces, Random Forests (Extra-Trees, Feature Importance), Boosting (AdaBoost, Gradient Boosting), Stacking.

UNIT-V Dimensionality Reduction: The Curse of Dimensionality, Main Approaches for Dimensionality Reduction (Projection, Manifold Learning) PCA: Preserving the Variance, Principal Components, Projecting Down to d Dimensions, Explained Variance Ratio, Choosing the Right Number of Dimensions, PCA for Compression, Randomized PCA, Incremental PCA. Kernel PCA: Selecting a Kernel and Tuning Hyper parameters. Learning Theory: PAC and VC model.

REFERENCE BOOKS:

1. Tom M. Mitchell, “Machine Learning”, McGraw Hill Education, First edition, 2017.

2. Aurelien Geon, “Hands-On Machine Learning with Scikit-Learn and Tensorflow: Concepts, Tools, and Techniques to Build Intelligent Systems”, Shroff/O'Reilly; First edition (2017).

3. Andreas Muller, "Introduction to Machine Learning with Python: A Guide for Data Scientists", Shroff/O'Reilly; First edition (2016).

4. Leonard Kaufman and P. J. Rousseau. Finding groups in data: An introduction to cluster analysis, Wiley, 2005

5. NelloCristianini and John Shawe-Taylor, An Introduction to Support Vector Machines, Cambridge University Press, 2000.

PRACTICAL: Different problems to be framed to enable students to understand the concept learnt and get hands-on on various tools and software related to the subject. Such assignments are to be framed for ten to twelve lab sessions

RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL

New Scheme Based On AICTE Flexible Curricula

CSE-IOT/IOT, VII-Semester

Open Elective IO- 703(A) Block chain Technology

Course Objectives:

The objective of this course is to provide conceptual understanding of how block chain technology can be used to innovate and improve business processes.

Unit I

Introduction: Overview of Block chain, Public Ledgers, Bitcoin, Smart Contracts, Block in a Block chain, Transactions, Distributed Consensus, Public vs Private Block chain, Understanding Cryptocurrency to Block chain, Permissioned Model of Block chain, Overview of Security aspects of Block chain; Basic Crypto Primitives: Cryptographic Hash Function, Properties of a hash function, Hash pointer and Merkle tree, Digital Signature, Public Key Cryptography, A basic cryptocurrency

Unit II

Understanding Block chain with Crypto currency: Bitcoin and Block chain: Creation of coins, Payments and double spending, Bitcoin Scripts, Bitcoin P2P Network, Transaction in Bitcoin Network, Block Mining, Block propagation and block relay. Working with Consensus in Bitcoin: Distributed consensus in open environments, Consensus in a Bitcoin network, Proof of Work (PoW) – basic introduction, HashCash PoW, Bitcoin PoW, Attacks on PoW and the monopoly problem, Proof of Stake, Proof of Burn and Proof of Elapsed Time, The life of a Bitcoin Miner, Mining Difficulty, Mining Pool

Unit III

Understanding Block chain for Enterprises: Permissioned Block chain: Permissioned model and use cases, Design issues for Permissioned block chains, Execute contracts, State machine replication, Overview of Consensus models for permissioned block chain- Distributed consensus in closed environment, Paxos, RAFT Consensus, Byzantine general problem, Byzantine fault tolerant system, Lamport-Shostak-Pease BFT Algorithm, BFT over Asynchronous systems.

Unit IV

Enterprise application of Block chain: Cross border payments, Know Your Customer (KYC), Food Security, Mortgage over Block chain, Block chain enabled Trade, We Trade – Trade Finance Network, Supply Chain Financing, and Identity on Block chain

Unit V

Block chain application development: Hyperledger Fabric- Architecture, Identities and Policies, Membership and Access Control, Channels, Transaction Validation, Writing smart contract using Hyperledger Fabric, Writing smart contract using Ethereum, Overview of Ripple and Corda

References:

1. Melanie Swan, “Block Chain: Blueprint for a New Economy”, O’Reilly, 2015

2. Josh Thompsons, “Block Chain: The Block Chain for Beginners- Guide to Block chain Technology and Leveraging Block Chain Programming”

3. Daniel Drescher, “Block Chain Basics”, Apress; 1stedition, 2017

4. Anshul Kaushik, “Block Chain and Crypto Currencies”, Khanna Publishing House, Delhi.

5.Imran Bashir, “Mastering Block Chain: Distributed Ledger Technology, Decentralization and Smart Contracts Explained”, Packt Publishing

6. Ritesh Modi, “Solidity Programming Essentials: A Beginner’s Guide to Build Smart Contracts for Ethereum and Block Chain”, Packt Publishing

7. Salman Baset, Luc Desrosiers, Nitin Gaur, Petr Novotny, Anthony O’Dowd, Venkatraman Ramakrishna, “Hands-On Block Chain with Hyperledger: Building Decentralized Applications with Hyperledger Fabric and Composer”, Import, 2018

Course Outcomes:

After the completion of this course, the students will be able to:

1. Understand block chain technology

2. Acquire knowledge of cryptocurrencies

3. Develop block chain based solutions and write smart contract using Hyperledger Fabric and Ethereum frameworks

4. Build and deploy block chain application for on premise and cloud based architecture

5. Integrate ideas from various domains and implement them using block chain technology in different perspectives

RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL

New Scheme Based On AICTE Flexible Curricula

CSE-IOT/IOT, VII-Semester

Open Elective IO- 703(B) Security and Privacy in IoT

- Describe the basics of securing Internet of Things.
- Explain architecture and threats in IoT.
- Analyze various privacy schemes related to IoT
- Describe the authentication mechanisms for IoT security and privacy.
- Explain security issues for various applications using case studies

Unit I:Introduction: Securing the Internet of Things Introduction – Security Requirements in IoT architectures – Security in Enabling Technologies – IoT Security Life Cycle – Cryptographic Fundamentals for IoT Security Engineering - Security Concerns in IoT Applications – Basic Security Practices.

Unit II:security architecture in the Internet of Things Introduction – Security Requirements in IoT – Insufficient Authentication/Authorization – Insecure Access Control – Threads to Access Control, Privacy, and Availability – Attacks Specific to IoT – Malware Propagation and Control in Internet of Things.

Unit III:Privacy preservation Privacy Preservation Data Dissemination - Privacy Preservation for IoT used in Smart Building – Exploiting Mobility Social Features for Location Privacy Enhancement in Internet of Vehicles – Lightweight and Robust Schemes for Privacy Protection in Key personal IOT Applications: Mobile WBSN and Participatory Sensing.

UnitIV:Trust, Authentication and Data Security: Trust and Trust Models for IoT – Emerging Architecture Model for IoT Security and Privacy – preventing Unauthorized Access to Sensor Data – Authentication in IoT – ComputationalSecurity for the IoT – Secure Path Generation Scheme for real-Time Green IoT – Security Protocols for IoT Access Networks

UnitV:Social Awareness and Case StudiesUser Centric Decentralized Governance Framework for Privacy and Trust in IoT – Policy Based Approach for Informed Consent in IoT - Security and Impact of the IoT on Mobile Networks – Security Concerns in Social IoT – Security for IoT Based Healthcare – Smart cities.

TEXT BOOKS:

1. Shancang Li, Li Da Xu, “Securing the Internet of Things,” Syngress (Elsevier)publication, 2017, ISBN: 978-0-12-804458-2.

2. Fei Hu, “Security and Privacy in Internet of Things (IoTs): Models, Algorithms, andImplementations,” CRC Press (Taylor & Francis Group), 2016, ISBN:978-1-4987-23190.

3. Arshdeep Bahga, Vijay Madisetti, “Internet of Things – A Hands-on approach,” VPTPublishers, 2014, ISBN: 978-0996025515.

4. Alasdair Gilchris, “Iot Security Issues,” Walter de Gruyter GmbH & Co, 2017.

5. Sridipta Misra, Muthucumaru Maheswaran, Salman Hashmi, “Security Challenges andApproaches in Internet of Things,” Springer, 2016. 6. Brian Russell, Drew Van Duren,“Practical Internet of Things Security,” Packet Publishing Ltd, 2016.

RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL

New Scheme Based On AICTE Flexible Curricula

CSE-IOT/IOT, VII-Semester

Open Elective IO- 703 (C) Industrial IoT

Course Outcome:

Students are able to :

1. Understand the role of IIOT in manufacturing processes

2. Apply knowledge of IIoT design considerations and IIoT technologies to develop solutions for industries

3. Collect, communicate and leverage the IIoT data

4. Analyze the IIoT data by using various machine learning algorithms

5. Identify, formulate and solve engineering problems by using Industrial IoT.

Unit I: Introduction to Industrial Internet of Things and Industry 4.0: Basics of Industry 4.0, Basics of Industrial Internet of Things (IIoT), Evolution of IIoT – understanding the IT & OT (Operational Technology) convergence, OT components like Industrial control systems, PLC, SCADA, and DCS, Industrial Edge, Open loop and closed loop controls, Components of IIOT, Role of IIOT in Manufacturing Processes, Challenges & Benefits in implementing IIOT, Adoption of IIoT, Market trends and opportunities in IIoT

Unit II: Technological Aspects of Industry 4.0 and IIoT: Industrial processes, Industrial sensing and actuation, Industrial networks, Machine-to-machine networks, Business Models and Reference Architecture of IIoT, IIoT design considerations, Key Technologies: Off-site Technologies, On-site Technologies

Unit III: Enabling Technologies of IIoT: IIoT Layers, Sensing, Processing, Communication and Networking in IIoT, Sensors, Actuators, Industrial Data Transmission, Industrial Data Acquisition

Unit IV: IIoT Analytics: Big Data Analytics and Software Defined Networks, Machine Learning and Data Science in Industries, Security and Fog computing in IIoT

Unit V: Applications of IIoT and Case Studies: Healthcare Applications in Industries, Inventory Management and Quality Control, Plant Safety and Security, Oil, chemical and pharmaceutical industry, Integration of products, processes, and people, Smart factories and cyber-physical systems, Case Studies, IIoT Application Development, Protocols used in building IIoT applications

References:

1. “Introduction to Industrial Internet of Things and Industry 4.0”, By Sudip Misra Chandana Roy,Anandarup Mukherjee, CRC Press, 2020

2. “Industrial Internet of Things for Developers”, Ryane Bohm, Wiley

3. “Handbook of Industry 4.0 and Smart Systems”, Diego Galar Pascual, Pasquale Daponte, UdayKumar, CRC Press, 2019

RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA, BHOPAL

New Scheme Based On AICTE Flexible Curricula

CSE-IOT/IOT, VII-Semester

Open Elective IO- 703(D) Data Engineering

UNIT – I

Data Driven Organizations & Elements of Data:

Data-driven decisions, data pipeline infrastructure for data-driven decisions, role of the data engineer in data-driven organizations, Modern data strategies, Introduction to elements of Data, the five Vs of data – volume, velocity, variety, veracity, and value, Variety – data types & data sources, Activities to improve veracity and value.

UNIT – II

Design Principles and Patterns for Data Pipelines

The evolution of data architectures, Modern data architecture on various cloud platforms, Modern data architecture pipeline - Ingestion and storage, Modern data architecture pipeline - Processing and Consumption, Streaming analytics pipeline

Securing and Scaling the Data Pipeline:

Cloud security, Security of analytics workloads, ML security, Scaling Data Pipeline, creating a scalable infrastructure, creating scalable components.

UNIT – III

Ingesting and Preparing Data:

ETL and ELT comparison, Data wrangling, Data Discovery, Data structuring, Data Cleaning, Data enriching, Data validating, Data publishing

Ingesting by Batch or by Stream

Comparing batch and stream ingestion, Batch ingestion processing, Purpose-built data ingestion tools, Scaling considerations for batch processing, stream processing, Scaling considerations for stream processing, Ingesting IoT data by stream

UNIT – IV

Storing and Organizing Data

Storage in the modern data architecture, Data Lake storage, Data warehouse storage, Purpose-built databases, Storage in support of the pipeline, Securing storage.

Processing Big Data

Big data processing concepts, Apache Hadoop, Apache Spark, Amazon EMR

UNIT – V

Processing Data for ML & Automating the Pipeline:

ML Concepts, ML Lifecycle, Framing the ML problem to meet the business goal, Collecting data, Applying labels to training data with known targets, Pre-processing data, Feature engineering, Developing a model, Deploying a model, ML infrastructure on AWS, AWS SageMaker, Automating the Pipeline, Automating infrastructure deployment, CI/CD, Automating with Step Functions.

List of Experiments:

- 7 - 10 experiments to be framed as per the syllabus.

Recommended Books:

1. Designing Data-Intensive Applications: The Big Ideas Behind Reliable, Scalable, and Maintainable Systems, by Martin Kleppmann
2. T-SQL Querying (Developer Reference) by Itzik Ben-Gan
3. The Data Warehouse Toolkit: The Definitive Guide to Dimensional Modeling by Margy Ross
4. Spark: The Definitive Guide: Big Data Processing Made Simple by Bill Chambers
5. Data Pipelines with Apache Airflow by Bas P. Harenslak
6. Streaming Systems: The What, Where, When, and How of Large-Scale Data Processing by Tyler Akidau
7. Kubernetes in Action by Marko Luksa