| | | |
|---|---|---|
| **Code: CA-301** | **Paper: Introduction to Data Science** | **Credit: 4** |
| **Contacts Hours/Week: 4** | **Total Contact Hours: 40** | |

**Course Objectives:**

This course enables the students to:

| | |
|---|---|
| **1** | Provide knowledge and expertise to become a proficient data scientist. |
| **2** | Demonstrate an understanding of data collection and management techniques. |
| **3** | Apply statistical and machine learning concepts for data science. |
| **4** | Critically evaluate data visualizations to communicate insights. |
| **5** | Explore applications and recent trends in data science. |

**Course Outcome:**

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

| | | |
|---|---|---|
| **CO1** | Apply appropriate tools for data science applications. | **[BL3]** |
| **CO2** | Explain strategies of data collection, management, and storage. | **[BL2]** |
| **CO3** | Apply statistical concepts to analyze datasets. | **[BL3]** |
| **CO4** | Compare and apply data visualization techniques. | **[BL4]** |
| **CO5** | Analyze real-world problems using data science techniques. | **[BL5]** |

| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** | **PSO1** | **PSO2** | **PSO3** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | 2 | 3 | | | | 2 | | | 3 | 3 | 3 | |
| **CO2** | 3 | 2 | 2 | | 3 | | | | 2 | | | 3 | 3 | 3 | |
| **CO3** | 3 | 3 | 3 | 2 | 3 | | | | | | | 3 | 3 | 3 | |
| **CO4** | 3 | 3 | 3 | 3 | 3 | | | | 2 | 2 | | 3 | 3 | 3 | |
| **CO5** | 3 | 3 | 3 | 3 | 3 | 2 | 2 | | 3 | 2 | 2 | 3 | 3 | 3 | 3 |
| **CA-301** | 3.00 | 2.80 | 2.60 | 2.00 | 3.00 | 0.40 | 0.40 | 0 | 1.80 | 0.80 | 0.40 | 3.00 | 3.00 | 3.00 | 0.60 |

| **Module** | **COURSE CONTENT** |
|---|---|
| **1** | **Fundamentals of Data Science** **(4L)**<br>Introduction to Data Science: Objectives, Scope, and Applications; Data Analytics Lifecycle; Types of Data Analysis (Descriptive, Predictive, Prescriptive); Data Science Jobs and Roles; Overview of Data Science Tools; SQL and its role in Data Science. |
| **2** | **Data Collection and Pre-processing** **(6L)**<br>Sources of Data and APIs, Data Types and Formats, Common Data Errors and Pre-processing Operations, Handling Missing Data, Data Cleaning, and Feature Engineering, Data Transformation Techniques. |
| **3** | **Exploratory Data Analysis and Statistical Inference** **(8L)**<br>Descriptive Statistics: Measures of Central Tendency, Variability; Probability Theory and Distributions; Hypothesis Testing, Confidence Intervals, and p-values; Data Summarization and Outlier Detection; Introduction to Statistical Inference. |
| **4** | **Data Visualization and Analysis** **(8L)**<br>Fundamentals of Data Visualization and Visual Encoding; Data Visualization Tools: Matplotlib, Seaborn, Tableau, PowerBI; Creating Effective Data Representations (Histograms, Box Plots, Scatter Plots, etc.); Advanced Visualization: Geospatial Data, Time Series, Dashboards; Designing Visualization Applications. |
| **5** | **Machine Learning Basics** **(7L)**<br>Supervised Learning: Training-Validation-Test Split, Regression (Linear, Polynomial, Sparse Models), Classification (Support Vector Machines, Random Forest); Unsupervised Learning: Clustering (K-Means, Hierarchical, DBSCAN), Similarity Measures and Distance Metrics. |
| **6** | **Network Analysis & Applications** **(4L)**<br>Graph Theory and Social Networks, Centrality Measures and PageRank, Community Detection Algorithms, Case Study on Real-World Network Analysis. |
| **7** | **Applications and Trends in Data Science** **(3L)**<br>Emerging Trends in Data Science, Big Data and Cloud Computing in Data Science, AI, Deep Learning, and NLP in Data Science, Ethical Considerations and Bias in Data Science. |

**Reference Books:**


- Doing Data Science: Straight Talk from the Frontline, Cathy O'Neil & Rachel Schutt, 1st Edition, O'Reilly Media, 2013.
- Data Science from Scratch: First Principles with Python, Joel Grus, 2nd Edition, O'Reilly Media, 2019.
- Mining of Massive Datasets, Jure Leskovec, Anand Rajaraman & Jeffrey Ullman, 3rd Edition, Cambridge University Press, 2020.
- Introducing Data Science: Big Data, Machine Learning, and More, Using Python Tools, Davy Cielen, Arno D. B. Meysman, Mohamed Ali, 1st Edition, Dream Tech Press, 2016.
- Mining of Massive Datasets, Jure Leskovek, Anand Rajaraman & Jeffrey Ullman, 3rd Edition, Cambridge University Press, 2020.

| | |
|---|---|
| **Code: CA-302** | **Paper: Computer Networks** |
| **Contacts Hours / Week: 4** | **Total Contact Hours: 40** **Credit: 4** |

**Course Objectives:**

This course enables the students to:

| | |
|---|---|
| **1** | Understand the purpose of network layered models, network communication using the layered concept and able to compare and contrast OSI and TCP/IP model. |
| **2** | Differentiate among and discuss the four level of address (physical, logical, port and url) used by the internet TCP/IP protocols. |
| **3** | Understand the routing principals and algorithm such as distance vector routing and link state. |
| **4** | Judge the efficiency of the connection oriented and connectionless protocol. |
| **5** | Familiar with the routing techniques, protocols and quality of service. |
| **6** | Explain the concept of network security and cryptography. |

**Course Outcome:**

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

| | |
|---|---|
| **CO1** | Ability to understand the purpose of network layered models, network communication using the layered concept and able to compare and contrast OSI and TCP/IP model. |
| **CO2** | Differentiate among and discuss the four level of address (physical, logical, port and url) used by the internet TCP/IP protocols. |
| **CO3** | Ability to understand the routing principals and algorithm such as distance vector routing and link state. |
| **CO4** | Ability to analyze the efficiency of the connection oriented and connectionless protocol |
| **CO5** | Ability to understand and analyze the naming system, routing techniques, protocols and quality of service. |
| **CO6** | Ability to analyze and design network security and cryptography. |

| **Module** | **COURSE CONTENT** |
|---|---|
| **1** | **Introduction** **(4L)**<br>Direction of data flow (simplex, half duplex, full duplex), Network topology, categories of network (LAN, MAN, WAN), Techniques for Bandwidth utilization: Multiplexing - Frequency division, Time division and Wave division, Concepts on spread spectrum. |
| **2** | **Protocol and Standard** **(4)**<br>Layered Task, The OSI model, TCP/IP protocol suite, Addressing |
| **3** | **Internetworking** **(10)**<br>Internetworking concept, IPv4 and IPv6 Addressing, IPv4 protocol, IPv6 protocol, transition from IPV4 to IPV6, transition from IPv4 to IPv6, Address Mapping, Error Reporting, Multicasting, Unicast Routing Protocols, Distance Vector routing, Link state routing, Path vector routing, Multicasting Routing Protocols, NAT, Transmission Control Protocol (TCP), User Datagram Protocol(UDP). |
| **4** | **Quality of Service** **(6)**<br>Data traffic, Congestion, congestion control, Quality of service, Techniques to improve QoS, Integrated services, Differentiated service, QoS in Frame Relay, QoS in ATM |
| **5** | **DNS and Web** **(8)**<br>Name Space, Domain Name System, Distribution of Name Space, Remote Logging, Electronic Mail and File Transfer, WWW, Web document and HTTP, Network Management, Simple Network Management Protocol (SNMP) |
| **6** | **Network Security** **(8)**<br>Symmetric Key Cryptography, DES, AES, Asymmetric Key Cryptography, RSA, Diffie-Hellman, Security Services, Digital Signature, Key Management, IP Security, SSL/TLS, PGP, Firewalls |

**Reference Books:**


- Computer Networks, Andrew S. Tanenbaum, Pearson Education, Fourth edition.
- Data and Computer Communication, William Stallings, Prentice hall, Seventh edition.
- High speed Networks and Internets, William Stallings, Pearson education, Second edition.
- Behrouz A Forouzan, - Data communication & Networking , TMH
- Behrouz A Forouzan, - TCP/IP Protocol Suite , TMH
- Kelvin R Fall, W. Richard Stevens- TCP/IP Illustrated Volume 1, Addison Wesley

| | | |
|---|---|---|
| **Code:CA-303** | **Paper: Design and Analysis of Algorithm** | |
| **Contacts Hours/Week:4** | **Total Contact Hours:40** | **Credit:4** |

**Course Objectives:**

This course enables the students to:

| | |
|---|---|
| **1** | Analyze the performance of algorithms with respect to time and space complexity. |
| **2** | Learn the concepts divide and conquer greedy method to solve various problems. |
| **3** | Learn the different problems related to graph and dynamic algorithm to solve different problems. |
| **4** | Learn the concept of backtracking and branch bound techniques to solve the problems. |
| **5** | Be familiarizing with the concepts of deterministic and non-deterministic algorithms. |

**Course Outcome:**

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

| | | |
|---|---|---|
| **CO1** | Analyze the complexity of algorithms using asymptotic analysis and solve recurrence relations for recursive algorithms. | **(L4)** |
| **CO2** | Apply Divide-Conquer and Greedy techniques to solve real life problems. | **(L3)** |
| **CO3** | Apply Dynamic Programming concept to solve various problems. | **(L3)** |
| **CO4** | Apply Backtracking, Branch and Bound concept to solve various problems. | **(L3)** |
| **CO5** | Implement different performance analysis methods for non-deterministic algorithms and Apply graph algorithms to solve different problem. | **(L4)** |

| **Module** | **COURSECONTENT** |
|---|---|
| **1** | **Introduction:** **(6L)**<br>Characteristics of algorithm. Analysis of algorithm: Asymptotic analysis of complexity bounds – best, average and worst-case behavior; Performance measurements of Algorithm, Time and space trade-offs, Analysis of recursive algorithms through recurrence relations: Substitution method, Recursion tree method and Masters' theorem. |
| **2** | **Divide & Conquer:** **(6L)**<br>General Method, Merge sort, Quick sort, Binary Search, Strassen's matrix multiplication.<br>**Greedy Method:** **(6L)**<br>General Method, Fractional Knapsack problem, Activity Selection Problem, Job sequencing with Deadlines, Optimal Storage on Tapes, Minimal Spanning Trees and Single source shortest path problem. |
| **3** | **Graphs (Algorithm and Analysis):** **(4L)**<br>Breadth first search and traversal, Depth first search and traversal, Topological Sorting.<br>**Dynamic Programming:** **(5L)**<br>General Method: Optimal Binary Search Tree, 0/1 Knapsack Problem, All Pair Shortest Path Problem, Assembly-line programming, Matrix Chain Multiplication, Longest Common Subsequence. |
| **4** | **Back Tracking:** **(6L)**<br>General Method: 8-queens, Sum of subsets, Graph Coloring, Hamiltonian cycles.<br>**Branch & Bound:** **(2L)**<br>General Method: Traveling Salesperson problem. |
| **5** | **Lower Bound Theory:** **(5L)**<br>Basic concepts, non-deterministic algorithms, NP-HARD and NP-COMPLETE classes, COOKS theorem |

**Reference Books:**


- Fundamentals of Computer Algorithms, 2nd edition, Ellis Horowitz, Satraj Sahni, Rajasekharam, University Press, New Delhi.
- Data Structures and Algorithm Analysis in C++, 2nd edition, Allen Weiss, Pearson education, New Delhi.
- Design and Analysis of algorithms, 2nd edition, Aho, Ullman, Hopcroft, Pearson education, New Delhi.

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Code: CA-304** | | | **Paper: Software Engineering** | | | | | | | | | | | | |
| **Contacts Hours / Week: 4** | | | **Total Contact Hours: 40** | | | | | | | | | | | **Credit: 4** | |
| **Course Objectives:** This course enables the students to: | | | | | | | | | | | | | | | |
| **1** | Understand the foundational principles and methodologies of software engineering. | | | | | | | | | | | | | | |
| **2** | Analyze and apply different object-oriented software development life cycle models. | | | | | | | | | | | | | | |
| **3** | To learn software development life cycle for Object-Oriented solutions for Real-World Problems. | | | | | | | | | | | | | | |
| **4** | Ability to apply the concepts of object-oriented methodologies to analyze requirements and design to the point where it is ready for implementation. | | | | | | | | | | | | | | |
| **5** | Demonstrate the concept of Testing to measure quality of software. | | | | | | | | | | | | | | |
| **Course Outcome:** After the completion of this course, students will be able to: | | | | | | | | | | | | | | | |
| **CO1** | Ability to Understand the foundational principles and methodologies of software engineering. | | | | | | | | | | | | | | |
| **CO2** | Ability to demonstrate the conceptual modeling techniques of UML for solving Real-World problems. | | | | | | | | | | | | | | |
| **CO3** | Ability to learn software development life cycle for Object-Oriented solutions for Real-World Problems. | | | | | | | | | | | | | | |
| **CO4** | Ability to apply the concepts of object-oriented methodologies to analyze requirements and design to the point where it is ready for implementation. | | | | | | | | | | | | | | |
| **CO5** | Ability to Demonstrate the concept of Testing to measure quality of software. | | | | | | | | | | | | | | |
| | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO10** | **PO 1 1** | **PO12** | **PSO1** | **PSO2** | **PSO3** |
| **CO1** | | | | | | | | | | | | | | | |
| **CO2** | | | | | | | | | | | | | | | |
| **CO3** | | | | | | | | | | | | | | | |
| **CO4** | | | | | | | | | | | | | | | |
| **CA-E 305A** | | | | | | | | | | | | | | | |
| **Module** | **COURSE CONTENT** | | | | | | | | | | | | | | |
| **1** | **Introduction** **(4L)** What is Software Engineering? Software Engineering Concepts, Software Engineering Development Activities, Managing Software Development, SDLC and its Phases. | | | | | | | | | | | | | | |
| **2** | **Object Oriented Concept and Modeling:** **(6L)** **Object-Oriented Principals and Concepts:** Classes and Object, Modularity, Abstraction and Encapsulation; Object Relationship like Association, Aggregation and Composition; Inheritance, Polymorphism and Dynamic Binding Interfaces **Model:** Importance of Modeling, Object Oriented Modeling **Identifying the Elements of an Object Model:** Identifying classes and objects, Specifying the attributes Defining operations, Finalizing the object definition. | | | | | | | | | | | | | | |
| **3** | **Introduction to UML:** **(3L)** Overview of UML, Conceptual Model of UML, UML Architecture, | | | | | | | | | | | | | | |
| **4** | **Basic and advanced Structural Modeling:** **(6L)** Classes Relationship, Common mechanism, Diagrams, Class Diagram, Advanced classes, Advanced Relationship, Interface, Types and Roles, Packages, Object Diagram. | | | | | | | | | | | | | | |
| **5** | **Architectural Modeling:** **(4L)** Artifacts, Artifact Diagram, Implementation Diagram, Deployment Diagram. | | | | | | | | | | | | | | |
| **6** | **Object-Oriented Design:** **(5L)** Generic components of Object-Oriented Design model, System Design process, Partitioning the Analysis Model, Concurrency and subsystem Allocation, Task Management component, Data Management Component, Resource Management Component, Inter Sub-system Communication. | | | | | | | | | | | | | | |
| **7** | **Object Oriented Analysis:** **(4L)** Iterative Development, Unified process & its Phases: Inception, Elaboration, Construction, Transition, Understanding requirements. | | | | | | | | | | | | | | |
| **8** | **Object Oriented Testing:** **(4L)** Overview of Testing and object-oriented Testing, Types of Testing, Object oriented Testing strategies, Test case design for Object-Oriented software, Inter class test case design. | | | | | | | | | | | | | | |

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|---|---|
| **9** | **Emerging Trends in Software Engineering:** **(4L)**<br>Artificial Intelligence and Machine Learning in Software Engineering, Block chain Technology and its Impact on Software Development, Software Engineering for Mobile Applications and IoT, Augmented Reality (AR) and Virtual Reality (VR) Software Engineering. |

**Reference Books:**


- The Unified Modeling Language User Guide, Grady Booch, James Raumbaugh, Ivar Jacobson.
- Object Oriented Software Engineering, Ivar Jacobson, ACM Press
- Applying UML and Patterns, Craig LarmanMotilalUk Books Of India
- Object-Oriented Software Engineering: Using UML, Patterns, and Java, Bernd Bruegge, Allen Dutoit, Pearson.
- Software Engineering – A Practitione's Approach, Roger. S. Pressman and Bruce R. Maxim, McGraw Hill
- Software Engineering: A Practitioner's Approach by Roger S. Pressman
- Introduction to Software Engineering by Ian Sommerville

| | | |
|---|---|---|
| **Code: CA -305** | **Paper: Introduction to Cyber Security** | |
| **Contacts Hours/Week: 3** | **Total Contact Hours: 30** | **Credit:3** |

**Course Objectives:**

This course enables the students to:

| | |
|---|---|
| **1** | Learn about information systems, its types, threats, security issues related to it and also about cyber security and risk associated to it. |
| **2** | Learn about Application security, Data security and types of security Threats in network. |
| **3** | Understand the importance of secure information system and risk management issues indifferent applications. |
| **4** | Understand modern copyright, patent law, skills of ethics, cybercrime and IT ACT |

**Course Outcome:**

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

| | |
|---|---|
| **CO1** | Know Fundamental knowledge in Cyber Security |
| **CO2** | Understand the security challenges as well as the best practices that are essential to protect one from becoming the victims of cybercrimes. |
| **CO3** | Understand the current status of cyber world. |
| **CO4** | Understanding the idea of how to safe-guard the individual, society, organization and the government from the dangers of cyber frauds, scams, threats and attacks |

| | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO10** | **PO1 1** | **PO12** | **PSO1** | **PSO2** | **PSO3** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 3 | 3 | 2 |
| **CO2** | 3 | 3 | 3 | 2 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 3 | 3 | 2 |
| **CO3** | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 3 | 3 | 2 |
| **CO4** | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 3 | 3 | 2 |
| **CA-E 305A** | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 3 | 3 |

| **Module** | **COURSECONTENT** |
|---|---|
| **1** | **Introduction:** **(3L)**<br>Introduction to Cyber Space, Information Systems, Need for Cyber Security. |
| **2** | **Cyber Attacks:** **(3L)**<br>Introduction to Cyber Attacks, Classification of Cyber Attacks, Classification of Malware, Threats. |
| **3** | **Intrusion Detection and Prevention:** **(2L)**<br>Vulnerability Assessment, Intrusion Detection Systems, Intrusion Prevention Systems. |
| **4** | **Authentication Methods:** **(2L)**<br>Introduction to User Authentication Methods, Biometric Authentication Methods, Biometric Systems. |
| **5** | **Security Models:** **(3L)**<br>Different Security Models and Security Mechanisms, Information Security and Network Security Operating System Security. |
| **6** | **Online Security: (2L)**<br>Web Security Email Security Mobile Device Security, Cloud Security. |
| **7** | **IoT & Social Media Security: (3L)**<br>IoT Security, Cyber Physical System Security, Social Media Security. |
| **8** | **Security and Virtual Currency: (3L)**<br>Virtual Currency, Block Chain Technology, Security Auditing. |
| **9** | **Cyber Crimes: (4L)**<br>Introduction, Different Types of Cyber Crimes, Scams and Frauds, Analysis of Crimes, Human Behavior, Stylometry, Incident Handling, Investigation Methods, Criminal Profiling, Cyber Trails. |

| | |
|---|---|
| **10** | **Digital Forensics: (3L)**<br>Digital Forensics, History, Challenges, Branches of Digital Forensics, Digital Forensic Investigation Methods, Reporting, Management of Evidence. |
| **11** | **Cyber Law: (3L)**<br>Cyber laws, Cyber terrorism, Information Technology Act 2000 and Amendments, Evidentiary value of Email/SMS, Cybercrimes and Offenses dealt with IPC, RBI Act and IPR Act in India, Jurisdiction of Cyber Crime, Cyber Security Awareness Tips |

**Reference Books:**


- Fundamentals of Cyber Security by Mayank Bhushan, BPB Publications
- https://heimdalsecurity.com/pdf/cyber_security_for_beginners_ebook.pdf
- Information Security & Cyber Laws, Gupta & Gupta, Khanna Publishing House
- Certified Ethical Hacker Certification Exam by William Manning
- Data communication and Networking by Behrouz A. Forouzan, McGraw Hill Education (India) Pvt. Ltd.
- http://larose.staff.ub.ac.id/files/2011/12/Cyber-Criminology-Exploring-Internet-Crimes-and-Criminal-Behavior.pdf

| | | |
|---|---|---|
| **Code: CA-306** | **Paper: Introduction to IoT** | **Credit: 3** |
| **Hours/Week: 3** | **Total Contact Hours: 30** | |

**Course Objectives:**

This course enables the students to:

| | |
|---|---|
| **1** | Provide knowledge and expertise to become a proficient data scientist. |
| **2** | Demonstrate an understanding of data collection and management techniques. |
| **3** | Apply statistical and machine learning concepts for data science. |
| **4** | Critically evaluate data visualizations to communicate insights. |
| **5** | Explore applications and recent trends in data science. |

**Course Outcome:**

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

| | | |
|---|---|---|
| **CO1** | Understand the basics of Internet of things and protocols | **[BL2]** |
| **CO2** | Learn about the middleware for Internet of Things | **[BL1]** |
| **CO3** | Understand protocol and architecture of Internet of Things | **[BL2]** |
| **CO4** | Enumerate and overcome the challenges in Internet of Things | **[BL4]** |
| **CO5** | Design Internet of Things applications in different domain and be able to analyze | **[BL3]** |

| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** | **PSO1** | **PSO2** | **PSO3** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | 3 | 3 | 2 | 1 | 1 | 2 | 3 | 1 | 1 | 3 | 3 | 2 |
| **CO2** | 2 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 3 | 3 | 2 |
| **CO3** | 2 | 2 | 3 | 3 | 3 | 2 | 2 | 1 | 2 | 3 | 1 | 1 | 3 | 2 | 1 |
| **CO4** | 3 | 3 | 2 | 3 | 2 | 2 | 1 | 1 | 3 | 2 | 1 | 1 | 2 | 3 | 1 |
| **CO5** | 3 | 2 | 3 | 2 | 3 | 3 | 1 | 2 | 2 | 2 | 1 | 1 | 3 | 3 | 2 |
| **CA-E-305B** | 3 | 3 | 3 | 3 | 3 | 2 | 1 | 1 | 2 | 2 | 1 | 1 | 3 | 3 | 2 |

| **Module** | **COURSECONTENT** | |
|---|---|---|
| **1** | **Introduction to IoT:** Defining IoT, Characteristics of IoT, Physical Design of IoT, Logical Design of IoT, IoT Enabling Technologies, IoT Levels and Deployment Templates.<br>**IoT& M2M**: Machine to Machine, Difference between IoT and M2M, Software Defined Network, Network Function Virtualization. | **[10L]** |
| **2** | **IoT Protocols:** Protocol Standardization for IoT, Efforts, M2M and WSN Protocols, SCADA and RFID Protocols, Issues with IoT Standardization, Unified Data Standards, Protocols, IEEE802.15.4, BAC Net Protocol, Modbus, KNX, Zigbee, Network Layer, APS Layer Security.<br>**IoT Architecture:** IoT Open source architecture (OIC), OIC Architecture &Design Principles, IoT Devices and Deployment Models,<br>**IoTivity:** An Open source IoT Stack, Overview, IoTivity Stack Architecture, Resource Model and Abstraction. | **[10L]** |
| **3** | **Challenges in IoT:** Design Challenges, Development Challenges, Security Challenges, Other Challenges.<br>**Developing IoTs:** IoT Design Methodology, IoT Physical Devices and Endpoints, IoT Physical Servers and Cloud Offerings, Case Study on IoT Systems. | **[10L]** |
| **4** | **Domain Specific Applications of IoT:** Home Automation, Smart City Applications, Environment Applications, Healthcare Applications.<br>**Web of Things:** Web of Things versus Internet of Things, Two Pillars of the Web, Architecture Standardization for WoT, Platform Middleware for WoT, Unified Multitier WoT Architecture, WoT Portals and Business Intelligence. | **[10L]** |

**Text Books:**


1. Internet of Things: A Hands-On Approach - Vijay Madisetti, Arshdeep Bahga.
2. The Internet of Things in the Cloud: A Middleware Perspective - Honbo Zhou, CRC Press.


**Reference Books:**


1. Architectingthe Internet of Things- Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), Springer.
2. The Internet of Things – Key Applications and Protocols - Olivier Hersent, David Boswarthick, Omar Elloumi, Wiley.

| | | |
|---|---|---|
| **Code: CA-307** | **Course Title: Automata Theory and Formal Languages** | |
| **Hours/Week: 3** | **Total Contact Hours: 30** | **Credits: 3** |

**Prerequisites: Discrete Mathematics, Basic Programming Concepts**

**Course Objectives:**

| | |
|---|---|
| **1** | To understand the fundamental concepts of automata theory and formal languages. |
| **2** | To study different models of computation and their equivalence. |
| **3** | To analyze regular expressions, context-free grammars, and Turing machines. |
| **4** | To apply automata theory in compiler design, artificial intelligence, and language processing. |

**Course Outcomes (COs)**

Upon successful completion of this course, students will be able to:

| | |
|---|---|
| **1** | Understand the relationship between formal languages and automata. |
| **2** | Design and analyze finite automata (DFA and NFA) for given problems. |
| **3** | Construct and manipulate regular expressions and context-free grammars. |
| **4** | Explore the limitations of computational models using the Chomsky hierarchy. |
| **5** | Understand Turing machines and their role in computability theory. |
| **6** | Apply automata theory in real-world applications like lexical analysis and parsing. |

**Course Syllabus**

**UNIT 1: Introduction to Automata & Formal Languages (6 Hours)**

- Basic concepts of formal languages and automata
- Symbols, alphabets, strings, and languages
- Operations on languages
- Finite representation of languages

**UNIT 2: Finite Automata & Regular Expressions (9 Hours)**

- Deterministic Finite Automata (DFA): Definition, Design, and Properties
- Non-Deterministic Finite Automata (NFA): Definition and Equivalence with DFA
- ε-NFA and its Conversion to DFA
- Regular Expressions and Equivalence to Finite Automata
- Properties of Regular Languages: Closure and Decision Properties
- Pumping Lemma for Regular Languages

**UNIT 3: Context-Free Grammars & Pushdown Automata (9 Hours)**

- Context-Free Grammars (CFG): Definition, Derivations, and Parse Trees
- Normal Forms: Chomsky Normal Form (CNF) and Greibach Normal Form (GNF)
- Pushdown Automata (PDA): Definition and Acceptance by Final State and Empty Stack
- Equivalence of PDA and CFG
- Applications of CFG in Parsing

**UNIT 4: Turing Machines & Computability Theory (9 Hours)**

- Turing Machines (TM): Definition, Design, and Variants
- Universal Turing Machine and Church-Turing Thesis
- Decidability and Undecidability Problems
- Halting Problem and Rice's Theorem
- Recursive and Recursively Enumerable Languages

**UNIT 5: Applications of Automata Theory (6 Hours)**

- Automata in Compiler Design: Lexical Analysis and Syntax Analysis
- Applications in Artificial Intelligence and Machine Learning
- Role of Automata in Natural Language Processing (NLP)
- Introduction to DNA Computing and Quantum Computing Models

**Textbooks:**

1. K.L.P. Mishra, N. Chandrasekaran – Theory of Computer Science: Automata, Languages, and Computation, PHI Learning.
2. John E. Hopcroft, Rajeev Motwani, Jeffrey D. Ullman – Introduction to Automata Theory, Languages, and Computation (3rd Edition), Pearson.

**Reference Books:**

1. Peter Linz – An Introduction to Formal Languages and Automata (6th Edition), Jones & Bartlett.
2. Michael Sipser – Introduction to the Theory of Computation, Cengage Learning.
3. Daniel I.A. Cohen – Introduction to Computer Theory, Wiley.

| | | |
|---|---|---|
| **Code: CA-308** | **Paper: Fundamentals of Cryptography** | |
| **Contacts Hours/Week: 3** | **Total Contact Hours: 30** | **Credit:3** |

**Course Objectives:**
This course enables the students to:

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|---|---|
| **1** | Explain the objectives of information security |
| **2** | Explain the importance and application of each of confidentiality, integrity, authentication and availability |
| **3** | Understand various cryptographic algorithms. |
| **4** | Discuss the fundamental ideas of public-key cryptography. |

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

| | |
|---|---|
| **CO1** | Understand the classical and modern concepts related to cryptography and cryptanalysis. |
| **CO2** | Know the mathematical support for cryptography and learn methods for modern cryptography techniques under the category of stream and block cipher. |
| **CO3** | analyze and implement of some of the prominent techniques for symmetric-key encryption schemes like DES, AES etc. |
| **CO4** | describe and implement of some of the prominent techniques for public-key cryptosystems and digital signature schemes (e.g., Rabin, RSA, ElGamal, DSA) |

| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** | **PSO1** | **PSO2** | **PSO3** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 3 | 3 | 2 |
| **CO2** | 3 | 3 | 3 | 2 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 3 | 3 | 2 |
| **CO3** | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 3 | 3 | 2 |
| **CO4** | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 3 | 3 | 2 |
| **CA- E 305D** | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 3 | 3 |

| **Module** | **COURSECONTENT** |
|---|---|
| 1 | **Security Concepts:** **(12L)**<br>Introduction, The need for security, Security approaches, Principles of security, Types of Security attacks, Security services, Security Mechanisms.<br>**Cryptography Concepts and Techniques:** Introduction, plain text and cipher text, substitution techniques, transposition techniques, encryption and decryption, symmetric and asymmetric key cryptography, steganography, key range and key size, possible types of attacks. |
| 2 | **Mathematics of Cryptography:** **(6L)**<br>Algebraic structures, Modular arithmetic, Euclid's algorithm, Congruence and matrices, Groups, Rings, Fields- Finite fields. |
| 3 | **Symmetric key Ciphers:** **(11L)**<br>Block Cipher principles, DES, AES, Blowfish, RC5, IDEA, Block cipher operation, Stream ciphers, RC4.<br>**Asymmetric key Ciphers:** Principles of public key cryptosystems, RSA algorithm, ElGamal Cryptography, Diffie-Hellman Key Exchange, and Knapsack Algorithm. |
| 4 | **Cryptographic Hash Functions:** **(11L)**<br>Message Authentication, Secure Hash Algorithm (SHA-512), Message authentication codes: Authentication requirements, HMAC, CMAC, Digital signatures, ElGamal Digital Signature Scheme.<br>**Key Management and Distribution:**<br>Symmetric Key Distribution Using Symmetric & Asymmetric Encryption, Distribution of Public Keys, Kerberos, X.509 Authentication Service, Public – Key Infrastructure. |

**Reference Books:**


- B. S. Schneier: Applied Cryptography: Protocols, Algorithms, and Source Code in C.
- Behrouz A. Forouzan and Debdeep Mukhopadhyay, Cryptography and Network Security, Tata McGraw Hill
- Alfred J. Menezes, Paul C. van Oorschot, and Scott A. Vanstone, "Handbook of Applied Cryptography", CRC Press.
- Jonathan Katz and Yehuda Lindell, Introduction to Modern Cryptography, Chapman and Hall/CRC Press.
- Oded Goldreich, The Foundations of Cryptography, Volume 1 and Volume 2, Cambridge University Press

| Code: CA-391 | Paper: Data Science Lab with Python | |
|---|---|---|
| **Contacts Hours/Week: 4** | **Total Contact Hours: 40** | **Credit: 2** |

**Course Objectives:**

This course enables the students to:

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|---|---|
| **1** | Provide knowledge and expertise to become a proficient data scientist. |
| **2** | Demonstrate an understanding of data collection and management techniques. |
| **3** | Apply statistical and machine learning concepts for data science. |
| **4** | Critically evaluate data visualizations to communicate insights. |
| **5** | Explore applications and recent trends in data science. |

**Course Outcome:**

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

| | | |
|---|---|---|
| **CO1** | Apply appropriate tools for data science applications. | **[BL3]** |
| **CO2** | Explain strategies of data collection, management, and storage. | **[BL2]** |
| **CO3** | Apply statistical concepts to analyze datasets. | **[BL3]** |
| **CO4** | Compare and apply data visualization techniques. | **[BL4]** |
| **CO5** | Analyze real-world problems using data science techniques. | **[BL5]** |

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | 2 | 3 | | | | 2 | | | 3 | 3 | 3 | |
| **CO2** | 3 | 2 | 2 | | 3 | | | | 2 | | | 3 | 3 | 3 | |
| **CO3** | 3 | 3 | 3 | 2 | 3 | | | | | | | 3 | 3 | 3 | |
| **CO4** | 3 | 3 | 3 | 3 | 3 | | | | 2 | 2 | | 3 | 3 | 3 | |
| **CO5** | 3 | 3 | 3 | 3 | 3 | 2 | 2 | | 3 | 2 | 2 | 3 | 3 | 3 | 3 |
| **CA-391** | 3.00 | 2.80 | 2.60 | 2.00 | 3.00 | 0.40 | 0.40 | 0 | 1.80 | 0.80 | 0.40 | 3.00 | 3.00 | 3.00 | 0.60 |

| Module | COURSE CONTENT |
|---|---|
| **1** | **Fundamentals of Data Science** **(4L)**<br>– Setting up Python Environment (Jupyter Notebook, Google Colab, VS Code)<br>– Python basics for Data Science (data types, loops, functions, file handling) |
| **2** | **Data Collection and Pre-processing** **(6L)**<br>– Reading data from CSV, Excel, JSON, and APIs using Pandas<br>– Handling missing values, duplicates, and incorrect data types<br>– Feature scaling (Min Max, Standard Scaler, Normalization) |
| **3** | **Exploratory Data Analysis and Statistical Inference** **(8L)**<br>– Descriptive statistics using NumPy & Pandas (mean, median, variance, standard deviation)<br>– Visualizing data distributions using Seaborn & Matplotlib (Histograms, Boxplots, Violin plots)<br>– Outlier detection using Z-score & IQR |
| **4** | **Data Visualization and Analysis** **(8L)**<br>– Creating basic plots (line, bar, scatter) using Matplotlib<br>– Advanced visualization (heatmaps, geospatial plots, time-series graphs) using Seaborn & Plotly<br>– Dashboard creation using Plotly Dash |
| **5** | **Machine Learning Basics** **(6L)**<br>– Implementing simple Linear Regression using Scikit-learn<br>– Classification models (Support Vector Machines, Random Forest)<br>– Clustering models (K-means, DBSCAN) |
| **6** | **Network Analysis & Applications** **(4L)**<br>– Graph creation and analysis using NetworkX<br>– Centrality measures (Degree, Betweenness, PageRank)<br>– Community detection algorithms |
| **7** | **Applications and Trends in Data Science** **(4L)**<br>– Case study on real-world dataset (Customer segmentation, Fraud detection, Sentiment analysis)<br>– Introduction to AI/Deep Learning concepts using Tensor Flow/ PyTorch |

**Reference Books:**


- Doing Data Science: Straight Talk from the Frontline, Cathy O'Neil & Rachel Schutt, 1st Edition, O'Reilly Media, 2013.
- Data Science from Scratch: First Principles with Python, Joel Grus, 2nd Edition, O'Reilly Media, 2019.
- Mining of Massive Datasets, Jure Leskovec, Anand Rajaraman & Jeffrey Ullman, 3rd Edition, Cambridge University Press, 2020.
- Introducing Data Science: Big Data, Machine Learning, and More, Using Python Tools, Davy Cielen, Arno D. B. Meysman, Mohamed Ali, 1st Edition, Dream Tech Press, 2016.
- Mining of Massive Datasets, Jure Leskovek, Anand Rajaraman & Jeffrey Ullman, 3rd Edition, Cambridge University Press, 2020.