Program Elective-III

COURSE TITLE: Sensor Networks and Internet of Things									
Course Code:				**CSE-242041EIT**		**Examination Scheme**			
Total number of Lecture Hours: 56						**External**	**80**		
						Internal	**20**		
Lecture (L):	**4**	**Practicals(P):**	**-**	**Tutorial (T):**	**-**	**Total Credits**	**4**		

Course Objectives

- Explore the applications and research areas in smart systems, including smart cities, smart health, and big data.
- Understand IoT reference architecture and real-world design constraints for effective system development.
- Analyze industrial and commercial building automation using service-oriented architecture and case studies.
- Study hardware platforms, energy consumption, and networking protocols for IoT systems and their energy efficiency.

Course Content	TEACHING HOURS
UNIT 1: Introduction and Applications	**19 Hrs**
smart transportation, smart cities, smart living, smart energy, smart health, and smart learning. Examples of research areas include for instance: Self-Adaptive Systems, Cyber Physical Systems, Systems of Systems, Software Architectures and Connectors, Software Interoperability, Big Data and Big Data Mining, Privacy and Security	
UNIT 2: IoT Reference Architecture and Real-World Design Constraints	**14 Hrs**
Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views. Introduction, Technical Design constraintshardware, Data representation and visualization, Interaction and remote control.	
UNIT 3: Industrial Automation and Commercial Building Automation	**14 Hrs**
Service-oriented architecture-based device integration, SOCRADES: realizing the enterprise integrated Web of Things, IMC-AESOP: from the Web of Things to the Cloud of Things, Commercial Building Automation- Introduction, Case study: phase one-commercial building automation today, Case study: phase two-commercial building automation in the future.	
UNIT 4: Hardware Platforms and Energy Consumption	**14 Hrs**
Hardware Platforms and Energy Consumption, Operating Systems, Time Synchronization, Positioning and Localization, Medium Access Control, Topology and Coverage Control, Routing: Transport Protocols, Network Security, Middleware, Databases	

Textbooks

- Mandler, B., Barja, J., Mitre Campista, M.E., Cagáová, D., Chaouchi, H., Zeadally, S., Badra, M., Giordano, S., Fazio, M., Somov, A., Vieriu, R.-L., Internet of Things. IoT Infrastructures, Springer International Publishing

Reference Books

- Mandler, B., Barja, J., Mitre Campista, M.E., Cagáová, D., Chaouchi, H., Zeadally, S., Badra, M., Giordano, S., Fazio, M., Somov, A., Vieriu, R.-L., Internet of Things. IoT Infrastructures, Springer International Publishing

COURSE OUTCOMES (CO):

CO1: Identify and explain the applications of smart systems and related research areas.

CO2: Apply IoT reference architecture to design systems considering real-world constraints.

CO3: Design and evaluate industrial automation and commercial building systems using case studies.

CO4: Analyze hardware platforms, energy consumption, and networking protocols for optimizing IoT system performance.

LEVEL OF CO-PO MAPPING TABLE

	POs											
COs	1	2	3	4	5	6	7	8	9	10	11	12
1	3	3	3	3	2	2	2	1	1	2	2	3
2	2	2	2	1	1	1	3	3	3	-	2	3
3	3	3	3	3	2	2	2	2	1	1	1	2
4	3	2	2	2	3	3	3	1	1	1	3	3

COURSE TITLE: Data Visualization								
Course Code:				**CSE-242042EIT**		**Examination Scheme**		
Total number of Lecture Hours: 56						**External**	**80**	
						Internal	**20**	
Lecture (L):	**4**	**Practical (P):**	**-**	**Tutorial (T):**	**-**	**Total Credits**	**4**	

Course Objectives

- Introduce students to key principles of visual perception, Gestalt principles, and how they influence the design and interpretation of visualizations.
- Equip students with the skills to design, develop, and evaluate various types of data visualizations, focusing on effective visual mapping, interaction techniques, and addressing common issues like information overload and misleading representations.
- Provide students with the tools and knowledge necessary to visualize complex data types such as volumetric data, vector fields, and geographic information.
- Expose students to recent trends in data perception and visualization, emphasizing new techniques and technologies.

Course Content	TEACHING HOURS
UNIT 1: Introduction to Visual Perception and Data Representation	**13 Hrs**
Introduction of visual perception, visual representation of data, Gestalt principles, information overloads. Creating visual representations, visualization reference model, visual mapping, visual analytics, Design of visualization applications.	
UNIT 2: Classification of Visualization Systems and Interaction Techniques	**14 Hrs**
Classification of visualization systems, Interaction and visualization techniques misleading, Visualization of one, two and multi-dimensional data, text and text documents. Visualization of groups, trees, graphs, clusters, networks, software, Metaphorical visualization	
UNIT 3: Advanced Visualization Techniques for Specialized Data	**14 Hrs**
Visualization of volumetric data, vector fields, processes and simulations, Visualization of maps, geographic information, GIS systems, collaborative visualizations, Evaluating visualizations	
UNIT 4 : Emerging Trends and Data Structures in Visualization	**14 Hrs**
Recent trends in various perception techniques, various visualization techniques, data structures used in data visualization.	

Textbooks

1. WARD, GRINSTEIN, KEIM, .Interactive Data Visualization: Foundations, Techniques, and Applications. Natick : A K Peters, Ltd.

Reference Books

2. E. Tufte, The Visual Display of Quantitative Information, Graphics Press.

COURSE OUTCOMES (CO):

CO1: Apply Gestalt Principles and Visual Mapping to Create Effective Visual Representations: Students will be able to apply visual perception theories (such as Gestalt principles) and visual mapping techniques to create clear and intuitive visualizations for complex datasets.

CO2: Design, Develop, and Evaluate Visualization Applications: Students will develop interactive visualizations using appropriate techniques and tools, and critically evaluate the effectiveness of these visualizations in terms of clarity, accuracy, and user engagement.

CO3: Visualize Complex and Multi-dimensional Data Using Advanced Techniques: Students will be able to visualize multidimensional and specialized data types (such as 3D, geographic, and text data) using advanced techniques and tools like GIS, vector fields, and simulation data.

CO4: Identify and Apply Emerging Trends in Data Visualization and Evaluation: Students will recognize and apply emerging trends in data visualization, including new perception techniques and cutting-edge visualization methods. They will also be able to assess the usability and effectiveness of visualizations through evaluation metrics and real-world application.

LEVEL OF CO-PO MAPPING TABLE

	POs											
COs	1	2	3	4	5	6	7	8	9	10	11	12
1	2	2	3	1	3	2	-	2	3	3	2	2
2	3	3	3	-	3	3	1	2	3	3	2	1
3	3	2	3	3	3	2	1	2	3	2	-	1
4	2	2	2	3	2	-	1	2	2	3	3	3

COURSE TITLE: IT Applications and Communication Protocols							
Course Code:				**CSE-242043EIT**		**Examination Scheme**	
Total number of Lecture Hours: 48						**External**	**80**
						Internal	**20**
Lecture(L):	**4**	**Practicasls(P):**	**0**	**Tutorial(T):**	**0**	**Total Credits**	**4**

Course Objectives

- Basic introduction of all the elements of IoT-Mechanical, Electronics/sensor platform, Wireless and wireline protocols, Mobile to Electronics integration, Mobile to enterprise integration
- Open source/commercial electronics platform for IoT-Raspberry Pi, Arduino , ArmMbedLPC
- Open source /commercial enterprise cloud platform for IoT-Ayla, iO Bridge, Libellium, Axeda, Cisco fog cloud.

Course Content	TEACHING HOURS
UNIT 1:	**-Hrs**
Basic function and architecture of a sensor — sensor body, sensor mechanism, sensor calibration, sensor maintenance, cost and pricing structure, legacy and modern sensor network. Development of sensor electronics — IoT vs legacy, and open source vs traditional PCB design style Development of sensor communication protocols, Protocols: Modbus, relay, Zigbee, Zwave, X10,Bluetooth, ANT, etc. Business driver for sensor deployment — FDA/EPA regulation, fraud/tempering detection, supervision, quality control and process management Different kind of calibration Techniques: manual, automation, infield, primary and secondary calibration — and their implication in IoT Powering options for sensors: battery, solar, Witricity, Mobile and PoE	**12**
UNIT 2:	**- Hrs**
Zigbee and Zwave — advantage of low power mesh networking. Long distance Zigbee. Introduction to different Zigbee chips. Bluetooth/BLE: Low power vs high power, speed of detection, class of BLE. Introduction of Bluetooth vendors & their review. Wireless protocols such as Piconet and packet structure for BLE and Zigbee Other long distance RF communication link. LOS vs NLOS links, Capacity and throughput calculation Application issues in wireless protocols:power consumption, reliability, PER, QoS, LOS	**12**
UNIT 3:	**- Hrs**
PCB vs FPGA vs ASIC design Prototyping electronics vs Production electronics QA certificate for IoT- CE/CSA/UL/IEC/RoHS/IP65 Basic introduction of multi-layer PCB design and its workflow Electronics reliability-basic concept of FIT and early mortality rate Environmental and reliability testing-basic concepts Basic Open source platforms: Arduino, Raspberry Pi, Beaglebone	**12**
UNIT 4:	**- Hrs**

Introduction to Mobile app platform for IoT: Protocol stack of Mobile app for IoT, Mobile to server integration, iBeacon in IoS, Window Azure, Linkafy Mobile platform for IoT, Axeda, Xively	**12**

Textbooks

- Olivier Hersent, David Boswarthick, Omar Elloumi, The Internet of Things: Key Applications and Protocols, Wiley-Blackwell.

Reference Books

- Olivier Hersent, David Boswarthick, Omar Elloumi, The Internet of Things: Key Applications and Protocols, Wiley-Blackwell.

COURSE OUTCOMES(CO):

CO1: Understand the architecture, calibration, communication protocols, and power options for sensors in IoT and legacy systems.

CO2: Analyze and compare wireless communication protocols like Zigbee, Bluetooth, and RF links for IoT applications.

CO3: Differentiate between PCB, FPGA, and ASIC design processes and evaluate electronic reliability and environmental testing.

CO4: Develop insights into mobile app platforms for IoT, including protocol stacks, server integration, and popular frameworks.

LEVEL OF CO-PO MAPPING TABLE

	POs											
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1	3	3	2	2	2	2	1	1	2	2	1	2
2	3	3	2	3	3	2	1	1	2	2	2	3
3	3	3	3	3	3	2	1	1	2	3	2	3
4	2	2	2	2	3	1	1	1	3	3	2	2

Program Elective-IV

COURSE TITLE: Big Data Analytics

Course Code:	CSE-242051EIT	Examination Scheme	T	P
Total number of Lecture Hours:56 Total number of Practical Hours:-		External	80	
		Internal	20	

Lecture (L):	4	Practicals(P):	4	Tutorial (T):	-	Total Credits	6

Course Objectives:

- Understand the significance and applications of big data across various industries, including marketing, healthcare, and finance.
- Explore the fundamentals of NoSQL databases, including different data models and advanced concepts such as sharding and replication.
- Gain proficiency in data management and analysis using Hadoop, including its architecture, HDFS, and data processing techniques.
- Learn MapReduce workflows and integrate NoSQL databases, such as HBase and Cassandra, with Hadoop for effective data analytics

Course Content	TEACHING HOURS
UNIT 1: Introduction to Big Data and Its Applications Across Industries	**-14 Hrs**
What is big data, why big data, convergence of key trends, unstructured data, industry examples of big data, web analytics, big data and marketing, fraud and big data, risk and big data, credit risk management, big data and algorithmic trading, big data and healthcare, big data in medicine, advertising and big data, big data technologies, introduction to Hadoop, open source technologies, cloud and big data, mobile business intelligence, Crowd sourcing analytics, inter and trans firewall analytics.	
UNIT 2: NoSQL Databases and Data Processing Techniques	**- 14 Hrs**
Introduction to NoSQL, aggregate data models, aggregates, key-value and document data models, relationships, graph databases, schemaless databases, materialized views, distribution models, sharding, master-slave replication, peer peer replication, sharding and replication, consistency, relaxing consistency, version stamps, map-reduce, partitioning and combining, composing map-reduce calculations.	
UNIT 3: Data Management and Analysis with Hadoop	**-14 Hrs**
Data format, analyzing data with Hadoop, scaling out, Hadoop streaming, Hadoop pipes, design of Hadoop distributed file system (HDFS), HDFS concepts, Java interface, data flow, Hadoop I/O, data integrity, compression, serialization, Avro, file-based data structures	
UNIT 4: MapReduce Workflows and NoSQL Integration	**-14 Hrs**
MapReduce workflows, unit tests with MRUnit, test data and local tests, anatomy of MapReduce job run, classic Map-reduce, YARN, failures in classic Map-reduce and YARN, job scheduling, shuffle and sort, task execution, MapReduce types, input formats, output formats. Hbase, data model and implementations, Hbase clients, Hbase examples, praxis. Cassandra, Cassandra data model, Cassandra examples, Cassandra clients, Hadoop integration.	

Lab Manual

Lab should be covered on the following topics:

- Analyze datasets of varying size and structure (CSV, JSON, unstructured text). Identify volume, velocity, and variety characteristics.
- Use web analytics tools (e.g., Google Analytics) on sample data to perform customer segmentation and understand behavior patterns.
- Apply data mining techniques on a financial dataset to detect anomalies indicative of fraud (e.g., clustering for anomaly detection).
- Explore a healthcare dataset (e.g., patient records) to identify trends, assess risk factors, and understand applications in predictive analytics.
- Set up a Hadoop cluster on a local machine or cloud environment. Store and retrieve data on HDFS, exploring storage distribution.
- Use MongoDB or Redis to create and manipulate key-value pairs and document structures. Experiment with CRUD operations and indexing.
- Build a basic graph database with Neo4j. Load and query data with relationships (e.g., social network connections) to see graph traversal.
- Implement sharding and replication in MongoDB or Cassandra. Evaluate how sharding improves performance and replication enhances reliability.
- Run MapReduce tasks on NoSQL data, such as counting document types or aggregating values in a collection.
- Upload and retrieve files in HDFS. Experiment with replication factors, block sizes, and permissions to see their effect on storage and performance.
- Develop MapReduce workflows for a specific task (e.g., log parsing), set up unit tests with MRUnit, and perform local tests.
- Set up Hbase and Cassandra clients with Hadoop. Create data models and run queries, observing data distribution and access.

Textbooks

- **"Big Data: Principles and Best Practices of Scalable Real-Time Data Systems"**, Nathan Marz and James Warren, 1st Edition, 2015
- **Hadoop: The Definitive Guide"**, Tom White, 4th Edition, 2015, O'Reilly Media

Reference Books

- **"NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence"**, Pramod J. Sadalage and Martin Fowler, 1st Edition, 2012, Addison-Wesley
- **Data-Intensive Text Processing with MapReduce"**, Jimmy Lin and Chris Dyer, 1st Edition, 2010, Morgan & Claypool Publishers.
- **"HBase: The Definitive Guide"**, Lars George, 1st Edition, 2011, O'Reilly Media.
- **"Cassandra: The Definitive Guide"** Eben Hewitt, 2nd Edition, 2016, O'Reilly Media

COURSE OUTCOMES (CO):

CO1: Describe big data and use cases from selected business domains
CO2: Explain NoSQL big data management
CO3: Install, configure, and run Hadoop and HDFS
CO4: Perform map-reduce analytics using Hadoop, Use Hadoop related tools such as HBase, Cassandra

LEVEL OF CO-PO MAPPING TABLE

	POs											
COs	1	2	3	4	5	6	7	8	9	10	11	12
1	3	2	-	-	2	1	-	1	-	2	-	-
2	3	3	2	-	3	-	-	-	-	-	-	1
3	3	3	3	3	3	1	-	-	1	-	2	-
4	3	3	3	3	3	-	-	-	1	-	2	1

COURSE TITLE: Network Security

Course Code:			**CSE-242052EIT**			**Examination Scheme**	
Total number of Lecture Hours:						**External**	**80**
						Internal	**20**
Lecture (L):	**4**	**Practicals(P):**	**4**	**Tutorial (T):**	**-**	**Total Credits**	**6**

Course Objectives

To learn the basics of security and various types of security issues.
To study different cryptography techniques available and various security attacks.
Explore network security and how they are implemented in real world.
To get an insight of various issues of Web security and biometric authentication.

Course Content	**TEACHING HOURS**
UNIT 1:	**- 14 Hrs**
Data security: Review of cryptography. Examples RSA, DES, ECC. Authentication, non-repudiation and message integrity. Digital signatures and certificates. Protocols using cryptography (example Kerberos). Attacks on protocols.	
UNIT 2:	**- 14 Hrs**
Network security: Firewalls, Proxy-Servers, Network intrusion detection. Transport security: Mechanisms of TLS, SSL, IPSec.	
UNIT 3:	**-14 Hrs**
Web security – SQL injection, XSS, etc. Software security and buffer overflow. Malware types and case studies. Access Control, firewalls and host/network intrusion detection.	
UNIT 4:	**14 Hrs**
Biometric authentication, Secure E-Commerce (ex. SET), Smart Cards, Security in Wireless Communication. recent trends in IOT security, IDS and Biometric	

Textbooks

1. W. Stallings. Cryptography and Network Security. Prentice Hall, 1999.

Reference Books

1. W. R. Cheswick and S. M. Bellovin. Firewalls and Internet Security. Addison Wesley, 1994.
2. 3. B. Schneier. Applied Cryptography. Wiley, 1999.

COURSE OUTCOMES (CO):

CO1: To have an understanding of basics of security and issues related to it.
CO2: Understanding of biometric techniques available and how they are used in today's world.
CO3: Security issues in web and how to tackle them.
CO4: Learn mechanisms for transport and network security

LEVEL OF CO-PO MAPPING TABLE												
	POs											
COs	1	2	3	4	5	6	7	8	9	10	11	12
1	2	1	2	1	1	1	-	3	2	2	2	3
2	2	1	2	1	1	1	-	3	2	2	2	3
3	2	1	2	1	1	1	-	3	2	2	2	3
4	2	1	2	1	1	1	-	3	2	2	2	3

Lab Manuals

Lab should be covered on the following topics:

1. Implement Caesar Cipher, Playfair Cipher, and Vigenère Cipher.
2. Key generation, encryption, and decryption using RSA.
3. Encrypt and decrypt text using DES and AES.
4. Implement ECC-based encryption and decryption.
5. Generate and verify digital signatures using SHA and RSA.
6. Create and verify a self-signed digital certificate.
7. Perform a man-in-the-middle attack on an insecure protocol.
8. Configure basic and advanced rules for a firewall.
9. Set up and use a proxy server for secure communication.
10. Enable SSL/TLS on a web server and analyze traffic.
11. Secure communication between two networks using IPSec.
12. Perform and prevent SQL injection attacks on a web application.
13. Execute an XSS attack and implement mitigation techniques.
14. Write a simple program to demonstrate buffer overflow.
15. Analyze a malware sample using tools like IDA Pro or Wireshark.
16. Implement a basic fingerprint or facial recognition authentication.
17. Simulate Secure Electronic Transactions (SET) for online payments.
18. Demonstrate authentication using smart cards.
19. Analyze wireless security and demonstrate attacks.
20. Implement MQTT-based secure messaging using TLS.
21. Set up an IDS to monitor IoT network activity.

COURSE TITLE: Advanced Machine Learning									
Course Code:			**CSE-242053EIT**			**Examination**	**T**	**P**
Total number of Lecture Hours:56 **Total number of Practical Hours:-56**						**External**	**120**	
						Internal	**30**	
Lecture (L):	**4**	**Practicals(P):**	**4**	**Tutorial (T):**	**-**	**Total Credits**	**6**	

Course Objectives:

- To introduce key concepts in pattern recognition and machine learning; including specific algorithms for classification, regression, clustering and probabilistic modeling.
- To give a broad view of the general issues arising in the application of algorithms to analysing data, common terms used, and common errors made if applied incorrectly.
- To demonstrate a toolbox of techniques that can be immediately applied to real world problems, or used as a basis for future research into the topic.

Course Content	**TEACHING HOURS**
UNIT 1: Foundations of Machine Learning: Concepts, Methods, and Ensemble Techniques	**-14 Hrs**
Key concepts, Supervised/Unsupervised Learning, Loss functions and generalization, Probability Theory, Parametric vs Non-parametric methods, Elements of Computational Learning Theory Ensemble Learning, Bagging, Boosting, Random Forest.	
UNIT 2: Kernel Methods and Applications in Machine Learning	**- 14 Hrs**
Kernel Methods for non-linear data, Support Vector Machines, Kernel Ridge Regression, Structure Kernels, Kernel PCA,	
UNIT 3: Bayesian Methods and Probabilistic Modeling in Machine Learning	**-14 Hrs**
Bayesian methods for using prior knowledge and data, Bayesian inference, Bayesian Belief Networks and Graphical models, Probabilistic Latent Semantic Analysis, The Expectation-Maximization (EM) algorithm, Gaussian Processes	
UNIT 4: Dimensionality Reduction, Feature Selection, and Emerging Trends in Machine Learning	**-14 Hrs**
Dimensionality Reduction - LDA, ICA, Feature Selection Vs Feature Extraction, Filter Methods - Sub-space approaches - Embedded methods Low-Rank approaches - Recommender Systems . Application areas - Security - Business – Scientific Recent trends in supervised and unsupervised learning algorithm, dimensional reducibility, feature selection and extraction.	

Textbooks

4. Christopher Bishop, Pattern Recognition and Machine Learning, Springer, 2007.

Reference Books

1. John Shawe-Taylor and NelloCristianini, Kernel Methods for Pattern Analysis

COURSE OUTCOMES (CO):

CO1: Key concepts, tools and approaches for pattern recognition on complex data sets
CO2: Kernel methods for handling high dimensional and non-linear patterns
CO3: State-of-the-art algorithms such as Support Vector Machines and Bayesian networks
CO4: Solve real-world machine learning tasks: from data to inference
CO5: Theoretical concepts and the motivations behind different learning frameworks

Lab Manual:

Students are encouraged to perform hands-on lab exercises on the following topics:

- Hands-on practice with algorithms such as linear regression, k-means, and hierarchical clustering.
- Implement and visualize the effects of different loss functions (e.g., Mean Squared Error, Cross-Entropy) on model performance.
- Comparison of algorithms like Linear Regression (parametric) and k-Nearest Neighbors (non-parametric).
- Implement probability-based models such as Naive Bayes and Gaussian Mixture Models.
- Implement the bias-variance trade-off in supervised learning models to demonstrate generalization and overfitting.
- Train SVM models on linearly and non-linearly separable datasets using various kernels.
- Build a collaborative filtering recommender system using matrix factorization and evaluate its performance.
- Implement LDA for dimensionality reduction and classification tasks, and compare with PCA.
- Implement machine learning algorithms on application-specific datasets such as fraud detection (security), sales prediction (business), or bioinformatics (scientific applications).

LEVEL OF CO-PO MAPPING TABLE

	POs											
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1	3	3	2	3	3	-	2	1	2	2	2	3
2	3	2	2	3	3	2	-	1	2	2	3	2
3	3	3	3	3	3	-	-	2	2	2	3	3
4	3	3	3	3	3	2	2	2	3	3	2	3
5	3	3	3	2	3	--	-	1	2	2	2	3

Program Elective V

COURSE TITLE: Cloud Computing							
Course Code:				**CSE-243011EIT**		**Examination Scheme**	
Total number of Lecture Hours: 56						**External**	**80**
						Internal	**20**
Lecture (L):	**4**	**Practicals(P):**	**0**	**Tutorial (T):**	**0**	**Total Credits**	**4**

Course Objectives

- Understand core cloud computing concepts and service models.
- Gain practical skills in deploying and managing cloud applications.
- Understand how to manage cloud service performance, reliability, and security.
- Analyze the cost and benefits of different cloud platforms.

Course Content	TEACHING HOURS
UNIT 1: CLOUD COMPUTING FUNDAMENTALS	**14Hrs**
Introduction to Cloud Computing, Online Social Networks and Applications, Cloud introduction and, overview, Different clouds, Risks, Novel applications of cloud computing, Cloud Computing Architecture Requirements, Introduction Cloud computing architecture, On Demand Computing Virtualization at the infrastructure level, Security in Cloud computing environments, CPU Virtualization, A discussion on Hypervisors Storage Virtualization Cloud Computing Defined, The SPI Framework for Cloud Computing, The Traditional Software Model, The Cloud Services Delivery Model,	
UNIT 2: VIRTUALIZATION AND CLOUD APPLICATIONS	**14 Hrs**
Security Issues in Cloud Computing, Infrastructure Security, Infrastructure Security: The Network Level, The Host Level, The Application Level, Data Security and Storage, Aspects of Data Security, Data Security Mitigation Provider Data and Its Security, Identity and Access Management, Trust Boundaries and IAM, IAM Challenges, Relevant IAM Standards and Protocols for Cloud Services, IAM Practices in the Cloud, Cloud Authorization Management, Security Management in the Cloud, Security Management Standards, Security Management in the Cloud.	
UNIT 3: MANAGEMENT OF CLOUD SERVICES	**14Hrs**
Availability Management: SaaS, PaaS, IaaS, Privacy Issues, Privacy Issues, Data Life Cycle, Key Privacy Concerns in the Cloud, Protecting Privacy, Changes to Privacy Risk Management and Compliance, in Relation to Cloud Computing, Legal and Regulatory Implications, U.S. Laws and Regulations, International Laws and Regulations.	
UNIT 4: APPLICATION DEVELOPMENT	**14Hrs**
Recent devlopments in hybrid cloud and cloud security, Audit and Compliance, Internal Policy Compliance, Governance, Risk, and Compliance (GRC), Regulatory/External Compliance, Cloud Security Alliance, Auditing the Cloud, for Compliance, Security-as-a-Cloud, Recent devlopments in hybrid cloud and cloud security	

Textbooks

- Gautam Shroff, "Enterprise Cloud Computing: Technology, Architecture, Applications", Cambridge University Press; 2nd Edition [ISBN: 9780521137355], 2023.
- Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing: A Practical Approach" McGraw-Hill Education; 2nd Edition [ISBN: 9780071826400], 2022.
- Dimitris N. Chorafas, "Cloud Computing Strategies" CRC Press; 2nd Edition [ISBN: 9780367338611], 2021.

Reference Books

- Thomas Erl, "Cloud Computing: Concepts, Technology & Architecture" Prentice Hall; 3rd Edition [ISBN: 9780133994164], 2024.
- Rajkumar Buyya, Christian Vecchiola, and Selvi, S. Thamarai, "Mastering Cloud Computing: Foundations and Applications Programming" Morgan Kaufmann; 3rd Edition [ISBN: 9780128180747], 2022.

COURSE OUTCOMES (CO):

CO1: Explain cloud computing principles and service models.
CO2: Successfully deploy and manage cloud-based applications.
CO3: Apply best practices for cloud service management.
CO4: Assess the economic aspects of cloud computing platforms

LEVEL OF CO-PO MAPPING TABLE

	POs											
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1	3	2	1	2	3	1	2	-	1	2	-	3
2	2	3	2	3	3	2	1	1	2	2	1	2
3	1	2	3	2	2	3	3	1	3	1	2	3
4	2	1	2	3	1	2	1	3	1	3	3	2

COURSE TITLE: IT and Smart Cities

Course Code:				**CSE-243012EIT**		**Examination Scheme**			
Total number of Lecture Hours: 56						**External**		**80**	
						Internal		**20**	
Lecture (L):	**4**	**Practicals(P):**	**-**	**Tutorial (T):**	**-**	**Total Credits**		**4**	

Course Objectives

- To provide a foundational understanding of smart cities, including their components, objectives, and development drivers.
- To explore the key IT technologies (e.g., IoT, AI, big data, 5G) that enable smart city infrastructure and their applications in urban services.
- To analyze real-world examples of smart city projects and evaluate their impact on urban quality of life, sustainability, and efficiency.
- To discuss the challenges of implementing smart city solutions, including data privacy, cybersecurity, and governance issues, and explore future trends in smart city development.

Course Content	TEACHING HOURS
UNIT 1: Introduction to Smart Cities	**20 Hrs**
Concept of Smart Cities: Definition, importance, and key characteristics **Drivers of Smart City Development**: Technological advancements, urbanization, environmental sustainability **Key Components of Smart Cities**: Infrastructure, governance, economy, environment, and quality of life **Smart City Initiatives**: Overview of prominent smart city projects globally (e.g., Barcelona, Singapore, Amsterdam)	
UNIT 2: Technologies Enabling Smart Cities	**14 Hrs**
Internet of Things (IoT): Role of sensors and data collection in urban management. **Big Data and Data Analytics**: Data collection, storage, analysis, and usage in real-time decision-making. **Artificial Intelligence (AI)**: Predictive modeling, automation, and AI-driven solutions in smart cities. **5G and Connectivity**: The role of high-speed networks in enabling connected infrastructure. **Cloud Computing**: Importance of cloud infrastructure in data management and accessibility	
UNIT 3: Applications of IT in Urban Services	**14 Hrs**
Smart Transportation: Intelligent traffic systems, electric and autonomous vehicles, and smart parking. **Energy Management**: Renewable energy, smart grids, and energy-efficient buildings. **Waste Management**: Smart bins, recycling systems, and waste management analytics. **Public Safety and Security**: Surveillance, emergency response, and disaster management systems. **Healthcare and Education**: Telemedicine, e-learning, and digital health records	
UNIT 4: Challenges, Governance, and Future Trends	**14 Hrs**

Challenges: Data privacy, cybersecurity, and technological inequality **Governance and Policy**: Frameworks for smart city governance, data policy, and public-private partnerships **Citizen Engagement**: Role of citizens in smart cities and fostering inclusivity **Future Trends**: Evolution of technology in smart cities, the role of AI and machine learning, and sustainability	

Textbooks

- **Smart Cities: Big Data, Civic Hackers, and the Quest for a New Utopia (2013, 1st Edition)"** by Anthony M. Townsend
- **Smart Cities: A Spatialised Intelligence (2015, 1st Edition)"** by Antoine Picon

Reference Books

- **Smart Cities and Artificial Intelligence: Convergent Systems for Planning, Design, and Operations (2020, 1st Edition)"** by Christopher Grant Kirwan and Zhiyu Wan

COURSE OUTCOMES (CO):

CO1: Identify and explain the essential components and goals of a smart city and the key factors driving smart city adoption globally.
CO2: Apply knowledge of core IT technologies to understand how they support the functioning of smart city services, such as smart transportation, energy management, and healthcare.
CO3: Critically analyze and assess real-world smart city projects and propose improvements or solutions based on best practices.
CO4: Evaluate the challenges and policy implications of smart city implementation, including data privacy, cybersecurity, and citizen engagement, and propose recommendations for ethical and sustainable urban development.

LEVEL OF CO-PO MAPPING TABLE

	POs											
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1	3	2	2	-	2	-	1	-	-	2	-	1
2	3	3	3	2	3	2	2	1	-	-	2	1
3	2	3	3	3	3	3	2	2	2	2	2	1
4	2	2	3	2	2	3	3	3	2	2	-	2

COURSE TITLE: Emulation & Simulation Methodologies									
Course Code:				**CSE-243013EIT**		**Examination Scheme**			
Total number of Lecture Hours: 56						**External**	**80**		
						Internal	**20**		
Lecture (L):	**4**	**Practicals(P):**	**-**	**Tutorial (T):**	**-**	**Total Credits**	**4**		

Course Objectives

- This module teaches the fundamentals of simulation and emulation methodologies providing guidance on how to design a performance evaluation campaign.
- Set up a test scenario, select the appropriate models, level of granularity.
- Metrics for statistical correctness, and discuss the differences between simulation and emulation platforms and how to use them for accurate performance evaluation of communications.
- Critically evaluate the role of emerging technologies in simulation and emulation for IoT, including the impact of model-based and application-based granularity on system performance.

Course Content	TEACHING HOURS
UNIT 1: Fundamentals of Discrete Event Simulations (DES) and Model-Based Representation	**14 Hrs**
Fundamentals of Discrete Event Simulations (DES) , Model-based representationfor DES, from communication and networking, to mobility and data traffic.	
UNIT 2: Application-Based Granularity for Performance Evaluation	**14 Hrs**
Application-based Granularity Requirements: from bit-level, packet level, to system-level evaluation, and their appropriate selection as a function of the application requirements.	
UNIT 3: Statistical Tools and Case Studies in Simulation vs. Emulation	**14 Hrs**
Fundamentals on Random Numbers, Fundamentals on Statistical Tools for Performance Evaluation, Simulation vs. Emulations, Case study for the evaluation of communications for ITS.	
UNIT 4: Recent Trends in IoT Simulation and Emulation	**14 Hrs**
Recent trends in simulation and emulation for IOT, model based and application based granularity presentation.	

Textbooks

1. Banks, J., Carson, J. S., Nelson, B. L., & Nicol, D. M. (2010). *Discrete-event system simulation* (5th ed.). Pearson.

Reference Books

1. Jack L. Burbank, An Introduction to Network Simulator 3, Wiley

COURSE OUTCOMES (CO):

CO1: Key concepts, tools and approaches for pattern recognition on complex data sets
CO2: Kernel methods for handling high dimensional and non-linear patterns
CO3: State-of-the-art algorithms such as Support Vector Machines and Bayesian networks
CO4:Theoretical concepts and the motivations behind different learning frameworks
CO5: Be able to solve real-world machine learning tasks: from data to inference

LEVEL OF CO-PO MAPPING TABLE

	POs											
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1	3	3	2	2	3	-	2	-	2	2	1	2
2	3	3	3	2	3	-	-	-	2	2	-	2
3	3	3	2	3	3	-	2	-	2	2	-	3
4	3	3	2	3	2	2	-	1	1	3	1	1
5	3	3	3	3	3	2	3	2	3	3	3	3