MAHATMA GANDHI INSTITUTE OF TECHNOLOGY (Autonomous)

Kokapet (Village), Gandipet (Mandal), Hyderabad-500 075

B.Tech Minor in Internet of Things (IoT)
Scheme of Instructions and Examinations
Applicable for the batches admitted from the AY 2025-26
Minor Degree (4 Semesters)

S.No	Semester	Course Code	Course Title	Instruction Hours			Credits
				L	T	P	
1	IV Semester	M154AD	Introduction to IoT	3	0	0	3
2	V Semester	M155AD	Privacy and Security in IoT	3	0	0	3
3	V Semester	M15502	IoT Applications Laboratory	0	0	2	1
4	VI Semester	M156AE	Pattern Recognition and Machine Learning	3	0	0	3
5	VI Semester	M15604	Machine learning Lab	0	0	2	1
6	VII Semester	M157AP	Fog and Edge Computing	3	0	0	3
7	VII Semester	M15704	Project/ Experiential Learning	0	0	8	4
Total				12	0	12	18

Approved in the online BoS meeting held at 10.30am on 23/05/2026:

L	T	P	C
3	0	0	3

Minor Degree in Internet of Things (IoT)
IV Semester
Introduction to IOT

Course Objectives:

1. To provide information on the concepts of Internet of Things and applications.
2. To learn how to use of Arduino and Raspberry Pi boards.
3. To know about data handling in SDN.
4. To understand the integration of Cloud Computing and IoT.
5. To explore real-world applications in smart environments.

Course Outcomes: By the end of this course, students will be able to

1. Describe the physical and logical design of IoT and its functional blocks.
2. Compare IoT and M2M communication and understand the role of SDN in IoT.
3. Develop Python programs to interface sensors and actuators with Raspberry Pi.
4. Design and configure Arduino-based systems for real-world IoT data collection.
5. Analyze the impact of IoT in domains like Smart Grids and Healthcare.

Course Articulation Matrix:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	-	-	-	-	-	-	-	-	1	1
CO2	2	3	2	-	-	-	-	-	-	-	-	1	1
CO3	3	2	2	-	-	-	-	-	-	-	-	1	1
CO4	2	2	3	-	-	-	-	-	-	-	-	1	1
CO5	3	2	3	-	-	-	-	-	-	-	-	1	1

UNIT I: Introduction to Internet of Things, Characteristics of IoT, Physical design of IoT, Functional blocks of IoT, Sensing, Actuation, Basics of Networking, Communication Protocols, Sensor Networks.

UNIT II: Machine-to-Machine Communications, Difference between IoT and M2M, Interoperability in IoT, Introduction to Arduino Programming, Integration of Sensors and Actuators with Arduino.

UNIT III: Introduction to Python programming, Introduction to Raspberry Pi, Interfacing Raspberry Pi with basic peripherals, Implementation of IoT with Raspberry Pi.

UNIT IV: Introduction to Software Defined Network (SDN), SDN for IoT, Data Handling and Analytics, Cloud Computing.

UNIT V: Applications of IoT: Smart Cities and Smart Homes, Connected Vehicles, Smart Grid, Industrial IoT. Case Study: Agriculture, Healthcare, Activity Monitoring.

Text Books:

1. Pethuru Raj and Anupama C. Raman - The Internet of Things: Enabling Technologies, Platforms, and Use Cases, CRC Press.
2. Terokarvinen, Kemo, Karvinen and Villey Valtokari - Make Sensors, 1st Ed., Maker Media, 2014.

Reference Books:

1. Arshdeep Bahga and Vijay Madisetty - Internet of Things: A Hands-on Approach.
2. Waltenegus Dargie, Christian Poellabauer - Fundamentals of Wireless Sensor Networks: Theory and Practice.
3. Charles Bell - Beginning Sensor networks with Arduino and Raspberry Pi, Apress, 2013.

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Minor Degree in Internet of Things (IoT)
V Semester
Privacy and security in IOT

Course Objectives:

1. To understand the fundamental security architectures and the Security by Design principle.
2. To analyze cryptographic solutions and identity management for constrained devices.
3. To explore defensive strategies against evolving threats in cloud and edge IoT environments.

Course Outcomes: By the end of this course, students will be able to:

1. Identify vulnerabilities across the IoT stack, from physical sensors to cloud interfaces.
2. Implement lightweight cryptographic protocols suitable for resource-constrained IoT nodes.
3. Design robust Identity and Access Management (IAM) frameworks for Device-to-Cloud integration.
4. Analyze privacy risks in data virtualization and edge analytics platforms.
5. Evaluate the security of industrial and smart home use cases against attack vectors.

Course Articulation Matrix:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	-	-	-	-	-	-	-	-	1	1
CO2	2	3	2	-	-	-	-	-	-	-	-	1	1
CO3	3	2	2	-	-	-	-	-	-	-	-	1	1
CO4	2	2	3	-	-	-	-	-	-	-	-	1	1
CO5	3	2	3	-	-	-	-	-	-	-	-	1	1

UNIT I: Foundations of IoT Security: The "Security of Things"; Design Principles for Secure Connected Devices; Open Source vs. Closed Source security auditing; Prototyping secure firmware.

UNIT II: Secure Paradigms & Integration: Security as a strategic sound; M2M/D2D security challenges; Securing Device-to-Cloud (D2C) pathways; Trust boundaries in Cloud-to-Cloud (C2C) integration.

UNIT III: Wireless & Power Security: Architecture for secure mobile-IoT ecosystems; Security implications of Energy Harvesting; Secure Low Power Wide Area Networks (LPWAN); LoRaWAN join procedures.

UNIT IV: Protocol Security & Enablement Platforms: Security in IEEE 802.15.4, BLE, and ZigBee; IPv6 and Port security (TCP/UDP); Application layer security (CoAP, HTTPs); Secure Gateway design.

UNIT V: Robust Integration & Case Studies: MQTT, XMPP, and Data Distribution Bus; Case studies: Smart Homes, Smart Transportation, and protecting wearable data in Education Systems.

Text Books:

1. Brian Russell and Drew Van Duren - *Practical Internet of Things Security*, Packt Publishing.
2. Pethuru Raj and Anupama C. Raman - *The Internet of Things: Enabling Technologies, Platforms, and Applications*, CRC Press.

Reference Books:

1. Feifei Dai - *Security and Privacy in the Internet of Things,* CRC Press.
2. Adrain McEwen & Hakim Cassimally - *Designing the Internet of Things,* Wiley.

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Minor Degree in Internet of Things (IoT)
V Semester
IoT Applications Laboratory

Prerequisite: Microcontrollers and Interfacing, C/Python Programming.

Course Objectives:

1. To provide hands-on experience in interfacing sensors and actuators with microcontrollers like Arduino, NodeMCU, and Raspberry Pi.
2. To enable students to implement wired and wireless communication protocols (UART, MQTT, REST API) for IoT systems.
3. To develop skills in integrating local hardware setups with Cloud platforms for real-time data monitoring and control.

Course Outcomes: By the end of this course, students will be able to

1. Design and implement sensor-to-microcontroller interfaces for environmental and motion sensing.
2. Configure and utilize serial (UART) and wireless (NRF24L01, Wi-Fi) communication modules for data exchange.
3. Develop Cloud-integrated solutions using REST APIs and MQTT to log sensor data and remotely control hardware.
4. Implement smart automation systems using voice assistants and image processing tools on edge devices like Raspberry Pi.

Course Articulation Matrix:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	1	2	1	-	1	-	-	1	3	2
CO2	3	3	3	-	2	1	-	1	-	-	1	3	2
CO3	3	3	3	1	2	1	-	1	-	-	1	3	2
CO4	3	2	2	-	2	1	-	1	-	-	1	3	2

List of Experiments: *Note: A minimum of 12 experiments are to be completed.*

1. Arduino program to demonstrate UART communication protocol for serial data exchange.
2. Arduino program to demonstrate hardware interrupt handling.
3. OLED display interfacing with ESP8266 NodeMCU.
4. Motion detection using PIR sensor with ESP8266 NodeMCU.
5. Sound detection system using sound sensor interfaced with ESP8266 NodeMCU.
6. Obstacle detection and distance measurement using HC-SR04 ultrasonic sensor with NodeMCU.
7. Flex sensor interfacing and MPU-6050 accelerometer interfacing with ESP8266 NodeMCU.
8. Automatic irrigation system using soil moisture sensor and NodeMCU.
9. Wireless communication using NRF24L01 transceiver modules.
10. Interfacing DHT11 sensor with Raspberry Pi and uploading data to the cloud.

11. Interfacing NodeMCU/Raspberry Pi with Cloud platforms using REST API and MQTT protocol.
12. Remote switching of lights using Arduino/NodeMCU/Raspberry Pi through the Internet.
13. Voice-based Home Automation using Google Assistant, IFTTT, and MQTT.
14. Capturing images using a web camera with Raspberry Pi and applying image processing filters.
15. Accessing and controlling a remote computer from Raspberry Pi.

Hardware Requirements:

1. Arduino Uno / NodeMCU ESP8266 / Raspberry Pi 4
2. Sensors: PIR, Sound, Ultrasonic (HC-SR04), Flex, MPU-6050, Soil Moisture, DHT11
3. Actuators: LEDs, Relay Modules, OLED Display
4. Modules: NRF24L01 Transceiver, USB Web Camera
5. Breadboards, Jumper Wires, and Power Cables

Software Requirements:

1. Arduino IDE
2. Python 3.x
3. Cloud Platforms (Blynk, Thingspeak, or Adafruit IO)
4. MQTT Broker (Mosquitto or HiveMQ)
5. IFTTT and VNC Viewer

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Minor Degree in Internet of Things (IoT)
VI Semester
Pattern Recognition and Machine Learning

Course Objectives:

1. To understand the lifecycle of machine learning specifically for resource-constrained IoT data.
2. To learn supervised and unsupervised algorithms suitable for sensor data analytics.
3. To explore Neural Network architectures for Edge computing and sequence modeling.

Course Outcomes: By the end of this course, students will be able to

1. Apply statistical techniques and data cleaning methods to handle noisy, high-frequency sensor data, ensuring it is prepared for efficient model training.
2. Utilize Bayesian principles and Naïve Bayes classifiers to enable local decision-making and fault detection within constrained IoT devices.
3. Construct and evaluate supervised learning models (Classification/Regression) for real-world IoT use cases such as predictive maintenance and home automation.
4. Deploy clustering and association rule algorithms to identify behavioral patterns and anomalies in unlabeled multi-sensor datasets.
5. Design compact Neural Networks (CNNs/LSTMs) for real-time image recognition and time-series analysis directly on edge hardware.

Course Articulation Matrix:

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	2	1	-	2	-	-	-	-	-	-	1	1
CO2	2	3	2	-	-	-	-	-	-	-	-	1	1
CO3	3	2	2	-	2	-	-	-	-	-	-	1	1
CO4	2	2	3	-	2	-	-	-	-	-	-	1	1
CO5	2	2	3	-	3	-	-	-	-	-	-	1	1

UNIT-I: Introduction to Machine Learning: Types of learning (Supervised, Unsupervised, Reinforcement); Well-posed learning problems in IoT. Data Engineering for Sensors: Basic data types; Exploring numerical and categorical sensor data; Data issues (noise/missing values) and remediation; Data pre-processing (Scaling, Normalization). Evaluation: Bias-Variance tradeoff; Under-fitting vs. Over-fitting; K-fold cross-validation.

UNIT-II: Probability Essentials: Review of Gaussian and Bernoulli distributions (relevant to sensor noise). Bayesian Learning: Bayes Theorem; Naïve Bayes Classifier—Handling continuous numeric features in IoT; Bayesian Belief Networks: Conditional independence and its use in reducing computational complexity in IoT networks.

UNIT-III: Classification & Regression: k-Nearest Neighbour (kNN) for proximity sensing; Decision Trees and Random Forest; Simple and Polynomial Regression for trend prediction; Logistic Regression for binary alerts. Unsupervised Learning: Clustering for device grouping; K-Means and DBSCAN; Finding Patterns using Association Rules (Apriori Algorithm) for smart home automation logic.

UNIT-IV: Basics of ANN: Artificial Neuron (McCulloch-Pitts); Activation Functions (ReLU, Sigmoid, Tanh). Architectures: Single-layer and Multi-layer feed-forward networks; Backpropagation Algorithm. Learning Strategies: Instance-Based Learning (Radial Basis Function); Ensemble Learning (Boosting and Gradient Boosting Machines) for improving sensor accuracy.

UNIT-V: Deep Feed Forward Networks: Architecture design; Regularization (Dropout, Early Stopping). Convolutional Neural Networks (CNN): Convolution and Pooling operations; Applications in IoT-based Computer Vision. Sequence Modeling: Introduction to Recurrent Neural Networks (RNN); Long Short-Term Memory (LSTM) for time-series sensor data (e.g., weather/vibration monitoring).

Text Books:

1. Saikat Dutt, Subramanian Chandramouli, Amit K. Das - *Machine Learning*, Pearson Publishers, 2019.
2. Ian Goodfellow, Yoshua Bengio, Aaron Courville - *Deep Learning*, MIT Press, 2016.

Reference Books:

1. Mark E. Fenner - *Machine Learning with Python for Everyone*, Pearson Publishers, 2020.
2. S.N. Sivanandam - *Introduction to Neural Networks using MATLAB 6.0*, TMH, New Delhi.

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Minor Degree in Internet of Things (IoT)
VI Semester
Machine Learning Lab

Prerequisite: Probability Theory and Statistical Methods, Python Programming.

Course Objectives:

1. To introduce the practical implementation of fundamental machine learning algorithms using Python.
2. To provide experience in data preprocessing, visualization, and exploratory data analysis.
3. To develop skills in model selection, parameter tuning, and performance evaluation for predictive modeling.

Course Outcomes: By the end of this course, students will be able to

1. Utilize Python libraries like NumPy, SciPy, and Pandas for statistical computation and data manipulation.
2. Visualize data and identify underlying trends using Matplotlib to support model selection.
3. Implement and evaluate linear and multiple regression models for continuous variable prediction.
4. Develop classification models using Decision Trees, KNN, and Logistic Regression and analyze their strengths and weaknesses.
5. Apply unsupervised learning techniques like K-Means clustering and conduct comparative performance analysis on real-world datasets.

Course Articulation Matrix:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	1	2	1	-	1	-	-	1	3	2
CO2	3	3	3	-	2	1	-	1	-	-	1	3	2
CO3	3	3	3	1	2	1	-	1	-	-	1	3	2
CO4	3	2	2	-	2	1	-	1	-	-	1	3	2
CO5	3	2	3	1	2	1	-	1	-	-	1	3	2

List of Experiments: *Note: A minimum of 8 experiments are to be completed.*

1. Write a Python program to compute Central Tendency Measures (Mean, Median, Mode) and Measures of Dispersion (Variance, Standard Deviation).
2. Study and implementation of Python Basic Libraries such as Statistics, Math, NumPy, and SciPy.
3. Study and implementation of Python Libraries for ML applications such as Pandas and Matplotlib.
4. Write a Python program to implement Simple Linear Regression from scratch or using libraries.
5. Implementation of Multiple Linear Regression for House Price Prediction using the sklearn library.
6. Implementation of Decision Tree algorithms using sklearn including hyperparameter tuning.
7. Implementation of K-Nearest Neighbors (KNN) algorithm using sklearn.
8. Implementation of Logistic Regression for binary classification problems using sklearn.
9. Implementation of K-Means Clustering to identify patterns in unlabeled data.
10. Performance analysis of various Classification Algorithms on a specific dataset (Mini Project).

Text Books:

1. Tom M. Mitchell - *Machine Learning*, McGraw Hill (MGH).

Reference Books:

1. Stephen Marshland - *Machine Learning: An Algorithmic Perspective*, Taylor & Francis.
2. Sebastian Raschka & Vahid Mirjalili - *Python Machine Learning*, Packt Publishing.

Software Requirements:

1. Python 3.x
2. NumPy, Pandas, Matplotlib, Scikit-learn (sklearn), SciPy.
3. Jupyter Notebook, Google Colab, or VS Code.

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Minor Degree in Internet of Things (IoT)
VII Semester
Fog and Edge Computing

Course Objectives:

1. To understand the foundations of fog and edge computing networks and architectures.
2. To explore middleware issues and data management in fog computing.
3. To learn about machine learning for security and privacy in edge environments.
4. To analyze emerging trends like energy-efficiency and smart home integration.

Course Outcomes: By the end of this course, students will be able to

1. Understand the foundations of fog and edge computing networks and different architectures.
2. Design fog and edge computing-based systems using reference architectures.
3. Apply data collection, analysis, and learning methodologies over the edge.
4. Apply optimization techniques for edge and fog computing.
5. Address security, privacy, and energy-efficiency challenges in multi-tier IoT systems.

Course Articulation Matrix:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	-	-	-	-	-	-	-	-	1	1
CO2	2	3	2	-	-	-	-	-	-	-	-	1	1
CO3	3	2	2	-	-	-	-	-	-	-	-	1	1
CO4	2	2	3	-	-	-	-	-	-	-	-	1	1
CO5	3	2	3	-	-	-	-	-	-	-	-	1	1

UNIT I: Foundations: Introduction to IoT, Fog and Edge Computing, Edge computing architectures, OpenFog Reference Architecture, Case Study: Apache Edgent.

UNIT II: Middleware: Middleware for Fog and Edge Computing: Design Issues, Lightweight Container Middleware, Data Management in Fog Computing.

UNIT III: Security & Privacy: Machine Learning for Protecting Security; Anomaly Detection in Fog-based IoT; Federated Learning for Privacy-Preserving IoT Analytics.

UNIT IV: Applications: Applications in Big Data Analytics, health monitoring, smart surveillance. Modeling and Simulation using iFogSim Toolkit.

UNIT V: Emerging Trends: Security and Privacy Challenges in Multi-tier IoT, Energy-efficient Fog and Edge Computing, Role of Fog Computing in Smart Homes.

Text Books / References:

1. Rajkumar Buyya, Satish Narayana Srirama - *Fog and Edge Computing: Principles and Paradigms*, Wiley, 2019.
2. Javid Taheri, Shuiguang Deng - *Edge Computing: Models, technologies and applications*, IET, 2020.
3. Khaldoun Al Agha, Pauline Loygue, Guy Pujolle - *Edge Networking*, Wiley-ISTE, 2022.
4. Xin Sun and Amin Vahdat - *Edge Computing: A Primer*, CRC Press, 2019.
5. Industry IoT Consortium - *OpenFog Reference Architecture for Fog Computing*.
6. *"IEEE Standard for Adoption of Openfog Reference Architecture for Fog Computing," Aug. 201ti, standard No. 1934-201ti", [online] Available: i:ps://standards.ieee.org/standard/1934-201ti.html.*

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Minor Degree in Internet of Things (IoT)
VII Semester
Project / Experiential Learning

Prerequisite: IoT Applications Laboratory, Privacy and Security in IoT, Fog and Edge Computing.

Project General Objectives:

1. To build a system that connects physical sensors to a cloud/edge dashboard using standard IoT protocols (MQTT/CoAP).
2. To apply "Security by Design" principles by securing the communication channel and managing device identity.
3. To implement local data processing (Edge/Fog) to reduce latency and bandwidth consumption before sending data to the cloud.
4. To demonstrate a clear link between hardware selection, network protocol choice, and data privacy.

Course Outcomes: By the end of this course, students will be able to:

1. Design a functional IoT prototype using microcontrollers (ESP32/Raspberry Pi) and various sensors.
2. Configure wireless communication stacks (LoRa, BLE, or Wi-Fi) based on the application's range and power requirements.
3. Implement lightweight encryption or authentication to ensure data privacy and security.
4. Develop an Edge/Fog processing layer to perform real-time data filtering or anomaly detection.
5. Create a user interface (Web/Mobile) for real-time monitoring and control of the IoT system.