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ताळगांव पठार,
गोंय - ४०३ २०६
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(Accredited by NAAC with Grade A+)

GU/Acad –PG/BoS -NEP/2026-27/239 Date: 27.07.2026

CIRCULAR

Ref. No.: GU/Acad –PG/BoS -NEP/2025/387 dated 09.09.2025

In supersession to the above referred Circular, the syllabus for the Courses offered under specialization **Internet of Things (IOT)** of **Bachelor of Engineering in Electronics and Computer Engineering/ Bachelor of Engineering in Electronics and Computer Science** Programme for Semester V & VI, approved by the Academic Council in its meeting held on 20th February 2026 and Semester VII approved by the Academic Council in its meeting held on 24th April, 12th & 13th May 2026, is attached.

The syllabus for Semester III & IV approved earlier by the Standing Committee of the Academic Council in its meeting held on 24th & 25th July 2025 is also attached.

The Dean, Faculty of Engineering and the Principals of the affiliated Engineering Colleges are requested to take note of the above and bring the contents of the Circular to the notice of all concerned.

ASHWIN V LAWANDE
Digitally signed by ASHWIN V LAWANDE
Date: 2026.07.27 17:20:01 +05'30'

(Ashwin V. Lawande)
Deputy Registrar – Academic

To,

1. The Dean, Faculty of Engineering, Goa University.
2. The Principals of Affiliated Engineering Colleges.

Copy to:

1. Chairperson, BoS in Electronics and Computer Engineering, Goa University.
2. Controller of Examinations, Goa University.
3. Assistant Registrar Examinations (Technical and Allied), Goa University
4. Directorate of Internal Quality Assurance, Goa University for uploading the Syllabus on the University website.

Electronics and Computer Engineering and Electronics and Computer Science

Specialization: Internet of Things (IOT)

Sr. No.	Semester	Course Code	Title of the Course	L	T	P	TCr
1	**III**	**ECS-281**	Fundamentals of IOT and Smart Systems	3	0	0	3
		ECS-282	Fundamentals of IOT and Smart Systems Lab	0	0	1	1
2	**IV**	**ECS-283**	IOT Sensing, Communication and Security	3	0	0	3
		ECS-284	IOT Sensing, Communication and Security Lab	0	0	1	1
3	**V**	**ECS-381**	Embedded Systems for IOT	3	0	0	3
		ECS-382	Embedded Systems for IOT lab	0	0	1	1
4	**VI**	**ECS-383**	IoT Hardware Platforms and Prototyping	2	0	0	2
		ECS-384	IoT Hardware Platforms and Prototyping Lab	0	0	2	2
5	**VII**	**ECS-481**	IOT Data Analytics and Edge Computing	3	0	0	3
		ECS-482	IOT Data Analytics and Edge Computing lab	0	0	1	1
			Total	**14**	**0**	**6**	**20**

Approved by: Standing Committee of the Academic Council on 24th & 25th July 2025

SEMESTER III

Name of the Programme : **Electronics and Computer Engineering/Electronics and Computer Science (Internet of Things)**
Course Code : **ECS-281**
Title of the Course : **Fundamentals of IoT and Smart Systems**
Number of Credits : **3 (T)**
Effective from AY : **2024-25**

Pre-requisites for the Course:	Nil	
Course Objectives:	This course will enable students to: 1. To understand the basic components of an IoT system. 2. To understand the technologies and current standards relating to each of the IOT layers. 3. To understand the importance of interoperability in IoT, and the concepts of Cloud computing and Fog computing via examples. 4. To appreciate and understand the appropriate use of various IoT technologies through real-life case studies and examples.	
Content		**No of hours**
Unit 1	**Basics of Networking:** Introduction, Connection types, OSI Model. **Emergence of IoT :** Introduction, Evolution of IoT, Enabling IoT and the Complex Interdependence of Technologies, IoT Networking Components. **Sensors and Actuators:** Sensors, Sensor Characteristics, Sensing Types, Sensor Considerations, Actuators, Actuator Types, Actuator Characteristics. **Introduction to Arduino Board:** Writing an Arduino Sketch, Hand's-on experiments with Arduino.	**11**
Unit 2	**IoT Processing Topologies and Types:** Data Format, Importance of Processing in IoT, Processing Topologies, Processing Offloading. **IoT Connectivity Technologies:** Introduction to connectivity technologies and standards, IEEE 802.15.4, Zigbee, RFID, NFC, LORA, Wi-Fi, Bluetooth. **IoT Communication Technologies:** Introduction to communication technologies, Infrastructure Protocols and Discovery Protocols, Introduction to Data Protocols - MQTT, CoAP, REST and Web Sockets.	**11**
Unit 3	**IoT Interoperability:** Introduction, Standards, Frameworks.	**11**

	Cloud Computing: Introduction, Virtualization, Cloud Models (Service & Deployment Models), Cloud Implementation, Sensor cloud: Sensors-as-a-service **Fog Computing and its application:** Introduction, View of a fog computing architecture, Fog Computing in IoT, Selected applications of FOG Computing.	
Unit 4	**IoT Smart Systems (Case studies):** **Agricultural IoT** – Components of an agricultural IoT, Advantages of IoT in agriculture, Case Studies - In-situ assessment of leaf area index using IoT-based agricultural system, Smart irrigation management system. **Vehicular IoT** – Introduction, Components of vehicular IoT, Advantages of vehicular IoT, Crime assistance in a smart IoT transportation system. **Healthcare IoT** – Introduction, Components of healthcare IoT, Advantages and risks of healthcare IoT. **Case Studies-** AmbuSens system. Evolution of New IoT Paradigms, Emerging Pillars of IoT.	**12**
Pedagogy:	Interactive, reflective, and inquiry-based methods, with a strong emphasis on critical thinking and problem-solving skills	
References/ Readings:	**TEXTBOOKS:** 1. Sudip Misra, Anandarup Mukherjee, Arijit Roy, Introduction to IoT, Cambridge University Press, 2020. 2. Nitesh Dhanjani, Abusing the Internet of Things, Shroff Publisher/O'Reilly Publisher, 2015 **REFERENCES:** 1. RMD Sundaram, Shriram K. Vasudevan, Abhishek S. Nagarajan, Internet of Things, John Wiley and Sons, 2019 2. Cuno Pfister, Getting Started with the Internet of Things, Shroff Publisher, 2011 3. Francis daCosta, Rethinking the Internet of Things: A Scalable Approach to Connecting Everything, Apress Publications, 1st Edition, 2014. 4. Massimo Banzi, Michael Shiloh, Getting Started with the Arduino, Maker Media Publishers/ O'Reilly, 3rd edition, 2015.	
Course Outcomes:	**Upon completion of the course, students will be able to:** CO 1. Explain the core concepts of networking, IoT architecture, sensor and actuator characteristics, and their roles in IoT systems. CO 2. Analyze IoT processing topologies, communication protocols and connectivity technologies CO 3. Evaluate the effectiveness of IoT systems in real-world domains such as agriculture, transportation, and healthcare through case studies	

	CO 4. Develop basic IoT applications using Arduino by interfacing sensors and actuators

Name of the Programme : **Electronics and Computer Engineering/Electronics and Computer Science (Internet of Things)**

Course Code : **ECS-282**

Title of the Course : **Fundamentals of IoT and Smart Systems Lab**

Number of Credits : **1 (P)**

Effective from AY : **2024-25**

Prerequisites for the Course:	Nil	
Course Objectives:	This course will enable students to: 1. Understand the fundamentals of IoT hardware, including sensors, actuators, and microcontrollers like Arduino. 2. Introduce interfacing techniques for common sensors (e.g., LDR, DHT, Ultrasonic) and actuators (e.g., LEDs, buzzers, servo motors). 3. Enable students to implement wireless communication using Bluetooth, Wi-Fi, and GPS modules in IoT applications 4. Develop practical skills in designing and testing real-time IoT systems for monitoring, control, and automation.	
Content:	**List of programs/ Experiments** ***(Following experiments should be conducted. A certified journal reporting the experiments conducted should be submitted at the end of the term)***	**No of Hours**
	1. Digital Control of LED and Buzzer 2. Ambient Light Monitoring Using an LDR-Based Analog Sensing Circuit 3. Environmental Sensing: Acquisition of Temperature and Humidity Using a DHT Sensor 4. Proximity and Distance Measurement Using an Ultrasonic Sensor 5. PIR-Based Motion Detection with Visual and Audio Alert System 6. Servo Motor Position Control via Push Button or Sensor Input 7. Bluetooth-Based Wireless Control of LED Using HC-05 Module 8. Sensor Data Transmission to Mobile Application via Bluetooth 9. Wi-Fi-Based IoT Application 10. GPS-Based Monitoring System	**30**
Pedagogy:	Integration of instructional learning, constructive thinking, inquiry-based, collaborative, experiential, and problem-solving approaches.	

References/ Readings:	**TEXTBOOKS:** 1. Sudip Misra, Anandarup Mukherjee, Arijit Roy, Introduction to IoT, Cambridge University Press, 2020. 2. Nitesh Dhanjani, Abusing the Internet of Things, Shroff Publisher/O'Reilly Publisher, 2015 **REFERENCES:** 1. RMD Sundaram, Shriram K. Vasudevan, Abhishek S. Nagarajan, Internet of Things, John Wiley and Sons, 2019 2. Cuno Pfister, Getting Started with the Internet of Things, Shroff Publisher, 2011 3. Francis daCosta, Rethinking the Internet of Things: A Scalable Approach to Connecting Everything, Apress Publications, 1st Edition, 2014. 4. Massimo Banzi, Michael Shiloh, Getting Started with the Arduino, Maker Media Publishers/ O'Reilly, 3rd edition, 2015
Course Outcomes:	**Upon completion of the course, students will be able to:** CO 1. Explain the role and functionality of various sensors, actuators, and communication modules used in IoT projects. CO 2. Interface and control devices such as LEDs, buzzers, motors, and sensors using Arduino-based systems. CO 3. Implement wireless communication for data exchange using Bluetooth, Wi-Fi, and GPS modules. CO 4. Design and demonstrate simple IoT systems that respond to user input, environmental conditions, or remote commands.

SEMESTER IV

Name of the Programme : **Electronics and Computer Engineering/Electronics and Computer Science (Internet of Things)**
Course Code : **ECS-283**
Title of the Course : **IOT Sensing, Communication and Security**
Number of Credits : **3 (T)**
Effective from AY : **2024-25**

Pre-requisites for the Course:	Fundamentals of IoT and Smart Systems	
Course Objectives:	The course aims to provide the student with 1. An understanding of IoT Sensing System and its applications 2. An ability to select a particular sensor for the desired application. 3. An understanding of various Ubiquitous Communication networks. 4. An understanding of security related issues in Communication networks.	
Content		**No of Hours**
Unit 1	**Introduction:** Overview, Sensing System, Conditioning System, Analog-to-digital Signal Conversion, Processor, **Example** : A Wireless Electrocardiogram. **Applications:** Civil Infrastructure Monitoring-Water Pipelines, Medical Diagnosis and Monitoring - Sleep Apnea and Medical Journalling, Water-quality Monitoring. **Conditioning Circuits:** Voltage and Current Sources, Transfer Function, Impedance Matching, Filters, Amplification, Closed-loop Amplifiers, Difference Amplifier. **Concepts of Sensing (Introduction only):** Electrical, Ultrasonic, Optical, Magnetic & Medical.	**11**
Unit 2	**Energy Harvesting:** Factors Affecting the Choice of an Energy Source, Architecture of an energy-harvesting system, Prototype - Microsolar Panel. **Sensor Selection and Integration:** Sensor Selection Parameters, Example: Temperature Sensor Selection, Sensor Integration Issues. **Estimation:** Sensor Error as a Random Variable, Zero-offset Error, Conversion Error, Accumulation of Error.	**11**
Unit 3	**Ubiquitous Communication:** Introduction, Audio Networks, Data Networks, Wireless Data Networks, Universal and Transparent Audio, Video and Alphanumeric Data Network Access, Ubiquitous Networks, Further Network Design Issues.	**11**

Unit 4	**Security:** Introduction, Security Protocols, Encryption, Security in Bluetooth, Authentication systems, Weaknesses and attack methods, Security on wireless channels.	**12**
Pedagogy:	Interactive, reflective, and inquiry-based methods, with a strong emphasis on critical thinking and problem-solving skills	
References/ Readings:	**TEXTBOOKS:** 1. Waltenegus Dargie, "Principles and Applications of Ubiquitous Sensing", A John Wiley and Sons, Ltd, Publication, 1st Edition, 2017. 2. Stefan Poslad, "Ubiquitous Computing: Smart Devices, Environments and Interactions", A John Wiley and Sons, Ltd Publication, 1st Edition, 2009. 3. Genco and S. Sorce, "Pervasive Systems and Ubiquitous Computing", WIT Press, 1st Edition, 2010. **REFERENCES:** 1. Athanasios Vasilakos, Witold Pedrycz, "Ambient Intelligence, Wireless Networking, and Ubiquitous Computing", Artech House, 1st Edition, 2006. 2. John Krumm, "Ubiquitous Computing Fundamentals", CRC Press, Taylor and Francis Group, LLC, 1st Edition, 2010.	
Course Outcomes:	**Upon completion of the course, students will be able to** CO 1. Explain the components and working principles of sensing and conditioning systems including filters, amplifiers, and ADCs. CO 2. Analyze the selection criteria and integration issues of sensors based on application-specific parameters CO 3. Evaluate error sources in sensor data and describe methods to estimate and manage those errors in real-time systems. CO 4. Demonstrate an understanding of communication networks and security protocols used in sensor-based and ubiquitous systems	

Name of the Programme : **Electronics and Computer Engineering/Electronics and Computer Science (Internet of Things)**

Course Code : **ECS-284**

Title of the Course : **IOT sensing, Communication and Security Lab**

Number of Credits : **1 (P)**

Effective from AY : **2024-25**

Prerequisites for the Course:	Nil	
Course Objectives:	This course will enable students : 1. To introduce students to the design and operation of basic analog signal conditioning circuits used in sensor systems. 2. To provide hands-on experience in interfacing and evaluating various sensors for real-world measurement applications. 3. To expose students to energy harvesting concepts and the implementation of wireless data transmission systems. 4. To familiarize students with basic encryption methods and the principles of securing wireless sensor communications.	
Content:	**List of programs/ Experiments**	**No of Hours**
	1. Analog-to-Digital Converter (ADC) 2. Basic Voltage Divider Circuit 3. Low-Pass and High-Pass Filter Design 4. Design and Analysis of a Difference Amplifier 5. Testing a Small Solar Panel's Output 6. Set up a wireless sensor network 7. Basic Wireless Data Transmission using Bluetooth 8. Basic Encryption Using Simple XOR Method Basic Signal Amplification using an Op-Amp 9. Basic Light Sensor (LDR) Experiment 10. Capacitor Charging Experiment in Energy Harvesting 11. Audio Signal Transmission Over a Wireless Network 12. Simple Temperature Measurement using LM35 Sensor 13. Implementation of Basic Data Encryption for Secure Communication 14. Demonstration of Sensor Offset Error 15. Analysis of Security Vulnerabilities in Bluetooth Communication	**30**
Pedagogy:	Learner centric teaching Integration of instructional learning, constructive thinking, inquiry-based, collaborative, experiential, and problem-solving approaches.	

References/ Readings:	**TEXTBOOKS:** 1. Waltenegus Dargie, "Principles and Applications of Ubiquitous Sensing", A John Wiley and Sons, Ltd, Publication, 1st Edition, 2017. 2. Stefan Poslad, "Ubiquitous Computing: Smart Devices, Environments and Interactions", A John Wiley and Sons, Ltd Publication, 1st Edition, 2009. 3. Genco and S. Sorce, "Pervasive Systems and Ubiquitous Computing", WIT Press, 1st Edition, 2010. **REFERENCES:** 1. Athanasios Vasilakos, Witold Pedrycz, "Ambient Intelligence, Wireless Networking, and Ubiquitous Computing", Artech House, 1st Edition, 2006. 2. John Krumm, "Ubiquitous Computing Fundamentals", CRC Press, Taylor and Francis Group, LLC, 1st Edition, 2010.
Course Outcomes:	Upon completion of the course, students will be able to: CO 1. Demonstrate the ability to design and analyze basic analog circuits including voltage dividers, filters, and amplifiers. CO 2. Implement sensor-based systems for measuring parameters such as temperature and light, and evaluate sensor performance and errors. CO 3. Construct functional energy harvesting setups and wireless sensor networks for real-time data transmission. CO 4. Develop secure communication mechanisms using basic encryption techniques and assess vulnerabilities in wireless communication.

SEMESTER V

Name of the Programme : **Electronics and Computer Engineering/Electronics and Computer Science (Internet of Things)**

Course Code : **ECS-381**

Title of the Course : **Embedded Systems for IOT**

Number of Credits : **3 (T)**

Effective from AY : **2024-25**

Pre-requisites for the Course:	Familiarity with C/C++ programming, Logic Design	
Course Objectives:	**This course will enable students to:** 1. Understand and apply IoT platform design methodologies for modeling and specifying embedded IoT systems. 2. Acquire hands-on experience with embedded IoT platforms, including digital and analog I/O, sensor interfacing, and peripheral integration. 3. Gain familiarity with IoT enabling technologies and communication protocols used in contemporary IoT solutions. 4. Develop a strong conceptual foundation in core IoT paradigms, including machine-to-machine communication, RFID, wireless sensor networks, SCADA, and IoT–cloud integration.	
Contents		**No of Hours**
UNIT- 1	**Embedded IoT Platform Design Methodology:** Purpose and requirement specification, Process specification, Domain Model Specification, Information Model Specification, Service Specification, IoT level specification, Functional view Specification, Operational view specification, Device and Component integration.	**11**
UNIT 2	Introduction to ARM® Mbed Platform, Overview of FRDM-K64F Board. **Digital and Analog I/O operations:** Digital Inputs, Digital Outputs, BusIn, BusOut, BusInOut, Analog Inputs, Analog Outputs. PWM (Pulse Width Modulation). Accelerometer, Magnetometer, SD Card, File System (LPC1768).	**11**
UNIT 3	**IoT Enabling Technologies** **Communications Technologies:** RFID and NFC (Near-Field Communication), Bluetooth Low Energy (BLE), LiFi, 6LowPAN, ZigBee, Z-Wave, LoRa. **IoT Protocol (MQTT) :** Architecture- Publisher, Subscriber, Broker Model; MQTT QoS levels (0, 1, 2) and when to use each; MQTT	**11**

	message structure and topics hierarchy; Security aspects: Username/password, certificates, TLS encryption.	
UNIT 4	**Four Pillars of IOT:** M2M, RFID, WSN, SCADA **The DNA of IOT:** Introduction to DCM: Device, Connect and Manage. Platform Middleware for Web of Things, Web of Things versus Internet of Things, The Internet of things and Cloud Computing	**12**
Pedagogy:	Interactive, reflective, and inquiry-based methods, with a strong emphasis on critical thinking and problem-solving skills	
References/ Readings:	**TEXTBOOKS:** 1. Arshdeep Bahga, Vijay Madisetti, Internet of Things – A Hands-on Approach, 1st Edition, VPT / Universities Press, 2014, ISBN: 9780996025515 2. Adrian McEwen, Hakim Cassimally, Designing the Internet of Things, 1st Edition, Wiley, 2013, ISBN: 9781118430620 3. Honbo Zhou, The Internet of Things in the Cloud – A Middleware Perspective, 1st Edition, CRC Press, 2013, ISBN: 9781466574771. 4. Perry Xiao, Designing Embedded Systems and the Internet of Things (IoT) with the ARM Mbed, 1st Edition, Wiley, 2018, ISBN: 9781119459838 **REFERENCES:** 1. Klaus Elk, Embedded Software for the IoT, 3rd Edition, DeG Press, 2018, ISBN: 9783110520264. 2. R. M. D. Sundaram, Shriram K. Vasudevan, Abhishek S. Nagarajan, Internet of Things, 2nd Edition, John Wiley & Sons, 2019, ISBN: 9788126580629.	
Course Outcomes:	**After going through this course, the students will be able to:** CO 1. Explain IoT platform design methodology, including requirement analysis, system modeling, and specification of embedded IoT systems. CO 2. Apply embedded system concepts to interface sensors, actuators, and peripherals in IoT-based applications. CO 3. Analyze IoT enabling technologies and communication protocols for reliable device connectivity and data exchange. CO 4. Design integrated IoT solutions incorporating middleware, device management, and cloud-based IoT architectures.	

Name of the Programme : **Electronics and Computer Engineering/Electronics and Computer Science (Internet of Things)**

Course Code : **ECS-382**

Title of the Course : **Embedded Systems for IOT lab**

Number of Credits : **1 (P)**

Effective from AY : **2024-25**

Prerequisites for the Course:	Knowledge of Logic Design, Basics of Programming	
Course Objectives:	**This course will enable students to:** 1. Understand and apply digital, analog, and communication interfaces for embedded systems using the Mbed platform. 2. Develop programs to interface sensors, actuators, and communication modules for real-time applications. 3. Implement wired and wireless communication protocols such as RFID, MQTT, and Zigbee for IoT-based systems. 4. Demonstrate data handling techniques including PWM control and file operations for embedded system applications.	
Content:	**List of programs/ Experiments**	**No. of Hours**
	1. Interface and Control Onboard digital inputs and outputs using the Mbed Simulator 2. Interface External LEDs and Control their operation using Push Buttons 3. Develop Programs using BusIn and BusOut classes for Parallel Input and Output Control 4. Implement Bidirectional Data Transfer using the BusInOut Class 5. Acquire Analog Sensor readings and display the Voltage values on a Serial Terminal 6. Control PWM Duty Cycle using a Potentiometer 7. Study and Implement RFID Module Interfacing using a Development Board 8. Implement MQTT Protocol for IoT Communication using a Development Board 9. Study and Implement Zigbee-Based Wireless Communication Using a Development 10. File Write and Read Operations Using the Local File System	**30**
Pedagogy:	Integration of instructional learning, constructive thinking, inquiry-based, collaborative, experiential, and problem-solving approaches.	

References/ Readings:	**TEXTBOOKS:** 1. Arshdeep Bahga & Vijay Madisetti, Internet of Things: A Hands-On Approach, 1st edition, Universities Press, 2014, ISBN: 9780996025515 2. Adrian McEwen and Hakim Cassimally, Designing the Internet of Things, 2nd edition, Wiley, 2013, ISBN: 9781118430620 3. Perry Xiao, Designing Embedded Systems and the Internet of Things (IoT) with the ARM Mbed, 1st Edition, Wiley, 2018, ISBN: 9781119459838 4. Peter Marwedel, Embedded System Design: Embedded Systems Foundations of Cyber-Physical Systems, 2nd edition, Springer, 2011, ISBN: 9789400715654 **REFERENCES:** 1. Olivier Hersent, David Boswarthick, Omar Elloumi, The Internet of Things: Key Applications and Protocols, 2nd edition, Wiley, 2012, ISBN: 9781119958348 2. RMD Sundaram, Shriram K. Vasudevan, Abhishek S. Nagarajan, Internet of Things, 2nd edition, John Wiley and Sons, 2019, ISBN: 9788126580629
Course Outcomes:	**After going through this course, the students will be able to:** CO 1. Interface and control digital and analog peripherals using the Mbed development environment. CO 2. Design and develop embedded applications involving BusIn, BusOut, BusInOut, PWM, and sensor acquisition techniques. CO 3. Integrate and test IoT communication protocols such as MQTT and Zigbee for device-to-device and cloud communication. CO 4. Implement persistent data storage techniques on embedded systems using local file system operations.

SEMESTER VI

Name of the Programme : **Electronics and Computer Engineering/Electronics and Computer Science (Internet of Things)**
Course Code : **ECS-383**
Title of the Course : **IoT Hardware Platforms and Prototyping**
Number of Credits : **2 (T)**
Effective from AY : **2024-25**

Pre-requisites for the Course:	Basics of C/C++ Programming and Python Programming.	
Course Objectives:	**This course will enable students to:** 1. Understand microcontroller architecture, GPIO features, and sensor interfacing. 2. Implement IoT communication protocols such as Wi-Fi, HTTP, and MQTT. 3. Understand single-board computer architecture and Linux-based sensor interfacing. 4. Implement cloud-based IoT applications using single-board computers.	
Content		**No. of Hours**
UNIT- 1	Overview of a basic IoT system and its applications, design considerations **ESP32 / ESP8266 based IoT Platform:** Overview of ESP8266/ESP32, Features and Capabilities, Architecture, Flash Memory Partition Tables, File systems: SPIFFS, FatFS, LittleFS, GPIO structure, Pin multiplexing: DAC, PWM, touch pins, ADC, Interrupts, Communication I/O – I2C, SPI, Wi-Fi, Bluetooth.	**7**
UNIT 2	**ESP32 / ESP8266 based IoT Platform:** Interfacing and programming with Arduino IDE, Programming with C/C++, HTTP webserver, HTTP requests, MQTT publish–subscribe, Interfacing high current **Case Study: Agriculture (AgriTech)**: IoT Based Agriculture System Using ESP32. Design of a Nutrient Spray System Using the ESP32 Microcontroller for Cultivation in an Aeroponic System	**8**
UNIT 3	**Raspberry Pi IoT Platform:** Introduction to Raspberry Pi Single Board Computer (SBC), Architecture, GPIO structure, Pi models and features: Pi 3, 4,	**6**

	Zero, Zero W, Pico), Using Raspberry Pi, Precautions, Hardware considerations, Raspberry Pi OS (Linux fundamentals),	
UNIT 4	**Raspberry Pi IoT Platform:** Raspberry Pi Headless Operation, Linux Commands, GPIO interfacing using Python, Interfacing sensors (DHT, PIR, Ultrasonic), IoT applications using Python and Cloud (AWS / Adafruit IO) **Other IoT Platforms:** STM32L475 Discovery IoT Node **Case Study:** IOT based home dashboard using Raspberry Pi, MQTT broker.	**9**
Pedagogy:	Interactive, reflective, and inquiry-based methods, with a strong emphasis on critical thinking and problem-solving skills	
References/ Readings:	**TEXTBOOKS:** 1. Iain Hendry, ESP32 Development using the Arduino IDE, Mohawk Valley Community College (eBook), 2019, 2. Rui Santos & Sara Santos, Build Web Servers with ESP32 and ESP8266,3rd Edition, 2023, ISBN: 9781731120137 3. Simon Monk, Raspberry Pi Cookbook: Software and Hardware Problems and Solutions,4th edition, O'Reilly Media, 2023, ISBN: 9781098130925 **REFERENCES:** 1. Arshdeep Bahga, Vijay Madisetti, Internet of Things – A Hands-on Approach, 1st edition, Universities Press ,2015, ISBN:9788173719547 2. John Soldatos, A 360-Degree View of IoT Technologies,1st edition, Artech House,2020, ISBN: 9781630817526 3. Neil Cameron, Electronics Projects with the ESP8266 and ESP32: Building Web Pages, Applications, and WiFi Enabled Devices, 1st edition, Apress, 2020, ISBN: 9781484256229 4. Simon Monk, Programming the Raspberry Pi: Getting Started with Python, 3rd edition, McGraw-Hill Education, 2015, ISBN: 9781259587405	
Course outcomes:	**After going through this course, the students will be able to:** CO 1. Describe IoT node architectures and their key features. CO 2. Design embedded data acquisition circuits using GPIO and multiplexing features. CO 3. Develop real-time remote monitoring systems using cloud-based IoT architectures. CO 4. Evaluate the effectiveness of IoT systems in real-world applications through case studies.	

Name of the Programme : **Electronics and Computer Engineering/Electronics and Computer Science (Internet of Things)**

Course Code : **ECS-384**

Title of the Course : **IoT Hardware Platforms and Prototyping Lab**

Number of Credits : **2 (P)**

Effective from AY : **2024-25**

Prerequisites for the Course:	Knowledge of C/C++, Python, fundamentals of web technologies.	
Course Objectives:	**This course will enable students to:** 1. Demonstrate the interfacing of analog and digital sensors and actuators with IoT controllers using GPIOs. 2. Understand serial communication protocols (I2C, SPI) for integrating complex modules such as OLED displays, RTCs, and accelerometers. 3. Implement Web Servers, Access Point modes, and MQTT protocols for remote device control. 4. Integrate cloud platforms for data logging, voice assistants, and basic image processing.	
Content:	List of Mini projects	**No. of Hours**
Instructions	The student shall apply knowledge of IoT hardware platforms and prototyping to any ONE of the topics listed below for the mini-project. The list is indicative only; students may also choose topics from related or allied areas.	
	1. IoT-Based Interfacing of Analog and Digital Sensors with ESP Controller/Raspberry Pi using GPIO Pins 2. IoT-Based Control of DC/Servo, and Stepper Motors and Relay/driver using ESP Controller/Raspberry Pi and MQTT Broker 3. Interfacing RTC/ OLED/ Accelerometer/ Gyroscope with ESP Controller via I^2C/SPI for IoT Applications 4. Cloud-Enabled Data Logging and Remote Monitoring Using an ESP Controller for IoT Applications 5. Building an IoT-Based Web Server Using an ESP Controller to Serve Dynamic Web Pages 6. IoT-Based Wi-Fi GPIO Control Using an ESP Controller in Access Point (AP) Mode 7. Remote Light Control Using MQTT with ESP controller/Rasp Pi 8. IoT-Based Interfacing of DHT and Ultrasonic Sensors with an ESP Microcontroller or Raspberry Pi for Temperature and Humidity Monitoring	**60**

	9. Voice-Based Home Automation Using ESP controller and Google Assistant / Amazon Alexa 10. Interfacing a Camera Module with Raspberry Pi for Basic Image Processing Applications.	
Pedagogy:	Integration of instructional learning, constructive thinking, inquiry-based, collaborative, experiential, and problem-solving approaches.	
References/ Readings:	**TEXTBOOKS:** 1. Iain Hendry, ESP32 Development Using the Arduino IDE, 1st Edition, Mohawk Valley Community College (eBook), 2019. 2. Rui Santos & Sara Santos, Build Web Servers with ESP32 and ESP8266, 3rd Edition, Independently Published, 2021, ISBN: 9781731120137 **REFERENCES:** 1. Derek Molloy, Exploring Raspberry Pi: Interfacing to the Real World with Embedded Linux, 1st edition, John Wiley & Sons, 2016, ISBN: 9781119188681 2. Neil Cameron, Electronics Projects with the ESP8266 and ESP32: Building Web Pages, Applications, and WiFi Enabled Devices,1st edition, Apress, 2020, ISBN: 9781484263365 3. Simon Monk, Programming the Raspberry Pi: Getting Started with Python,3rd edition, McGraw-Hill Education, 2015, ISBN: 9781259587405	
Course Outcomes:	**After going through this course, the students will be able to:** CO 1. Interface and control sensors, actuators, motors, and relays using microcontrollers or single-board computers. CO 2. Apply hardware communication protocols like GPIO, I²C, and SPI for data acquisition and display. CO 3. Design network-enabled IoT solutions using Wi-Fi, web servers, and MQTT for remote monitoring. CO 4. Integrate cloud services, voice assistants, and vision modules for intelligent and scalable IoT application	

SEMESTER VII

Name of the Programme : **Electronics and Computer Engineering/Electronics and Computer Science (Internet of Things)**
Course Code : **ECS-481**
Title of the Course : **IOT Data Analytics and Edge Computing**
Number of Credits : **3 (T)**
Effective from AY : **2024-25**

Pre-requisites for the Course:	Basic knowledge of IoT concepts, embedded systems, Data Structures and Algorithms, computer networks and communication protocols.	
Course Objectives:	**This course will enable students to:** 1. Build a foundation in IoT data analytics and machine learning techniques. 2. Explore big-data processing using Hadoop, NoSQL, and analytics frameworks. 3. Understand edge computing architectures and real-time analytics. 4. Gain awareness of blockchain-integrated edge systems and IoT applications.	
Content:		**No. of Hours**
UNIT 1	**Data Analytics for IoT:** Introduction, Structured Versus Unstructured Data, Data in Motion Versus Data at Rest, IoT Data Analytics Overview, IoT Data Analytics Challenges, Phases of data analytics, Types of Data Analytics. **Machine Learning (ML):** Basics, Advantages of ML, Challenges, Types. **Selected Algorithms in ML:** k-nearest neighbor, Decision Tree, Random forest, k-means clustering, Agglomerative clustering, Density-based spatial clustering of applications with noise.	**10**
UNIT 2	Machine Learning and Getting Intelligence from Big Data, Predictive Analytics, Big Data Analytics Tools and Technology, Massively Parallel Processing Databases, NoSQL Databases, Hadoop, YARN, The Hadoop Ecosystem, Lambda Architecture. **Edge Data Analytics:** Introduction, Benefits, Architecture, ML for edge devices, Case study. Edge Streaming Analytics, Comparing Big Data and Edge Analytics, Edge Analytics Core Functions.	**12**
UNIT 3	**Computing Paradigms:** Introduction, Impacts, Parallel Computing, Distributed Computing, Cluster Computing, Utility Computing, Grid Computing, Cloud Computing, Other Computing Paradigms.	**12**

	Edge Computing: Introduction, architecture, Background essentials – IoT Devices, Networking architecture, network management and control. **Edge computing state-of-the-art interfaces and devices:** Middleware, application interfaces. **Edge computing simulators:** PureEdgeSim, IoTSim-Edge, iFogSim, EdgeCloudSim.	
UNIT 4	**Blockchain & Edge Computing Systems:** Introduction, distributed ledger technology, P2P network in Blockchain, characteristics, benefits and limitations, blockchain types, blockchain architecture. **Edge Computing with Blockchain:** IoT & blockchain, system Design, case studies - Biometric System, Weapon Tracking. **Edge Computing high potential use cases:** Autonomous vehicles, Smart cities, Industrial automation, Network functions, Gaming, Content delivery, Financial sector, Augmented reality/virtual reality, Healthcare sector. **Case Study:** Pulse Oximeter to detect ARDS in edge server.	**11**
Pedagogy:	Interactive, reflective, and inquiry-based methods, with a strong emphasis on critical thinking and problem-solving skills	
References/ Readings:	**TEXTBOOKS:** 1. K. Anitha Kumari, G. Sudha Sadasivam, D. Dharani, M. Niranjanamurthy Edge Computing: Fundamentals, Advances and Applications, CRC Press, 2022. ISBN: 9781032214789 2. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things, Cisco Press, 2017. ISBN: 9781587144561 3. Sudip Misra, Anandarup Mukherjee, Arijit Roy Introduction to IoT, Cambridge University Press, 2020. ISBN: 9781108836548 **REFERENCES:** 1. Nitesh Dhanjani ,Abusing the Internet of Things, O'Reilly Media / Shroff Publishers, 2015. ISBN: 9781491902332 2. RMD Sundaram, Shriram K. Vasudevan, Abhishek S. Nagarajan 3. Internet of Things, John Wiley & Sons, 2019. ISBN: 9788126579385	
Course Outcomes:	**After going through this course, the students will be able to:** CO 1. Explain IoT data types, data analytics phases, and basic ML concepts. CO 2. Apply ML techniques and big-data tools (Hadoop, NoSQL) for IoT data analysis. CO 3. Analyze edge computing architectures and implement edge analytics pipelines.	

	CO 4. Evaluate blockchain-integrated edge systems and design solutions for IoT applications.

Name of the Programme : **Electronics and Computer Engineering/Electronics and Computer Science (Internet of Things)**

Course Code : **ECS--482**

Title of the Course : **IOT Data Analytics and Edge Computing lab**

Number of Credits : **1 (P)**

Effective from AY : **2024-25**

Prerequisites for the Course:	Basic Programming, knowledge of Sensors, Microcontrollers, Statistics.	
Course Objectives:	**This course will enable students to:** 1. Develop hands-on skills in IoT data handling, preprocessing, and basic analytics using Python. 2. Gain experience with machine learning models such as k-NN, decision trees, random forests, and clustering for IoT applications. 3. Acquire practical exposure to data streaming, NoSQL storage, and edge analytics using MQTT. 4. Understand edge–cloud performance, simulation tools, and basic blockchain concepts.	
Content:	List of Mini projects	**No. of Hours**
Instructions	The student shall apply knowledge of IoT Data Analytics and Edge Computing to any ONE of the topics listed below for the mini-project. The list is indicative only; students may also choose topics from related or allied areas.	
	1. Importing and visualizing IoT sensor data – Load CSV file (temperature/humidity), plot graphs, find min/max/avg. 2. Structured vs unstructured IoT data – Compare CSV data (structured) with text/log file data (unstructured). 3. Data preprocessing for IoT analytics – Handle missing values, normalize data, convert categorical values. 4. k-NN for basic classification – Use a small dataset (e.g., classifying temperature as normal/high). 5. Decision Tree & Random Forest – Predict whether a device should trigger ON/OFF based on sensor data. 6. Clustering on IoT data (k-means) – Group sensor readings into clusters (low/medium/high range).	**30**

	7. Storing IoT data in a simple NoSQL database – Use MongoDB Atlas (cloud free version) or local installation. 8. Map–Reduce demonstration using Python – Count readings above a threshold using map() and reduce() functions (no Hadoop needed). 9. Simulating data streaming using MQTT – Publish/subscribe temperature values using Mosquitto broker. 10. edge analytics task – Run a Python script on a laptop/Raspberry Pi to compute average temperature and trigger an alert locally (no cloud). 11. Compare latency: local vs cloud processing – Measure time taken to process a dataset locally vs using an online API or Google Colab. 12. Basic simulation using iFogSim (pre-built example only) – Run an existing example file and note results (latency, throughput). (No coding required.) 13. Blockchain chain creation (Python script) – Create blocks with hash linking (very basic, no smart contracts). 14. Mini case study: pulse oximeter signal analysis – Use sample SpO2 data → detect drop below threshold using Python → compare cloud vs edge execution time.	
Pedagogy:	Integration of instructional learning, constructive thinking, inquiry-based, collaborative, experiential, and problem-solving approaches.	
References/ Readings:	**TEXTBOOKS** 1. K. Anitha Kumari, G. Sudha Sadasivam, D. Dharani, M. Niranjanamurthy, Edge Computing: Fundamentals, Advances and Applications, CRC Press, 2022, ISBN: 9781032126081. 2. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things, Cisco Press, 2017, ISBN: 9781587144561. 3. Sudip Misra, Anandarup Mukherjee, Arijit Roy, Introduction to IoT, Cambridge University Press, 2020, ISBN: 9781108836548 **REFERENCES** 1. Nitesh Dhanjani, Abusing the Internet of Things, Shroff Publisher / O'Reilly Media, 2015, ISBN: 9781491902332.	

	2. RMD Sundaram, Shriram K. Vasudevan, Abhishek S. Nagarajan, Internet of Things, John Wiley & Sons, 2019, ISBN: 9788126579385.
Course Outcomes:	**After going through this course, the students will be able to:** CO 1. Analyze IoT sensor data using Python for meaningful insights. CO 2. Apply basic machine learning techniques for IoT data analysis and prediction. CO 3. Develop IoT data pipelines using MQTT, edge analytics, and NoSQL storage. CO 4. Demonstrate edge–cloud concepts through latency analysis and basic blockchain implementation.