G.PULLA REDDY ENGINEERING COLLEGE (Autonomous): KURNOOL

Accredited by NBA of AICTE and NAAC of UGC with A Grade,

Affiliated to JNTUA ,Anantapuramu

Scheme–2023

Scheme and Syllabus for Minor Program in

Embedded Systems & IoT (EIoT)

Offered by

Department of Electronics and Communication Engineering

G.PULLA REDDY ENGINEERING COLLEGE (AUTONOMOUS): KURNOOL

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

MINOR IN EMBEDDED SYSTEMS &IoT (EIoT)

Scheme of Instruction and Examination

(Effective for the students admitted from the academic year 2023-2024 onwards)

S. No	Course Code	CourseTitle	Credits	Scheme of Instruction periods/week		Scheme of Examination Maximum Marks		
				L	T/P	End Exam Assessment	Internal Assessment	Total (100M)
1	MEI01	Embedded Systems Technology	3	3	0	70	30	100
2	MEI02	Principles of IoT	3	3	0	70	30	100
3	MEI03	Principles of IoT Lab	1.5	0	3	70	30	100
4	MEI04	Real Time Embedded Systems design and Analysis	3	3	0	70	30	100
5	MEI05	Industrial Internet of Things	3	3	0	70	30	100
6	MEI06	Industrial Internet of Things Lab	1.5	0	3	70	30	100
7	MEI07	Architectures of Wireless Sensor Networks	3	3	0	70	30	100
	Total		**18**					

EMBEDDED SYSTEMS TECHNOLOGY (EST)

Scheme:2023

Course Code	Category	Hours/Week		Credits	Maximum Marks		
		L	T/P	C	Continuous Internal Assessment	End Exam	TOTAL
MEI01	PC	3	0	3	30	70	100

Sessional Exam Duration:2Hrs **EndExamDuration:3 Hrs**

Course Outcomes:

At the end of the course the student will be able to

CO1: Understand the basics of embedded systems, including their history, classification, and processor selection.

CO2: Analyze different embedded processor architectures, including ARM, RISC, and application-specific processors.

CO3: Evaluate various communication interfaces and protocols, such as UART, USB, SPI, I2C, and Zigbee.

CO4: Implement rapid prototyping techniques using Arduino, sensors, and wearable system modules.

CO5: Develop and interface embedded GUI systems, including LCDs, touch screens, and VGA cameras, for real-world applications.

UNIT-I

Introduction to Embedded system: Introduction to Embedded Systems, Embedded Systems Vs General Computing Systems, History of Embedded Systems, Classification, Major Application Areas, Embedded Processor Requirements, Features, Types, RISC Processors, Harvard Architecture, Super Harvard Architecture, Selection of Processors &Microcontrollers

UNIT-II

Architecture of Embedded System Processor: Embedded processor models, ARM core processor, Application specific processor like network processors, multimedia processors, industrial processors, superscalar processor, Advanced RISC processors. Architecture of Embedded OS, Categories of Embedded OS, Application Software, Communication Software, Development and Testing Tools

UNIT-III

Communication Interfaces: Need for Communication Interfaces, OSI Reference Model, Basic of Networks, Network Topology, RS232/UART, RS422/RS485, USB, Infrared, Ethernet, IEEE 802.11,Bluetooth, SPI, I2C, CAN, Wifi, FlexRay, LIN Bus, Zigbee.

UNIT-IV

Rapid prototyping: Arduino platform, hardware and software, Sensor‘ modules, Robo Control modules, 3D printing module, ADC module, wearable systems. etc

UNIT-V

Embedded GUI interfacing: Arduino based graphic LCD, Touch screen, joy stick, VGA camera interfacing and programming in Python. Creative applications of Arduino Design Examples & Case Studies of Embedded System: Digital Thermometer, Navigation Systems, Smart Card, RF Tag.

TextBooks:

1.David Simon, ―An embedded Software Primer‖ PearsonPublication,2021.

2. Frank Vahid, ―Embedded system ― A unified Hardware Software Introduction‖ John Wiley and Sons,2005

ReferenceBooks:

1. Tammy Noergaard,‖ Embedded SystemArchitecture‖, Elsevier publication,2014.

Question Paper Pattern:

Sessional Exam:

The question paper for Sessional Examination shall be for 40 marks. The question paper shall consist of Four questions and all questions are compulsory. Question No.1 shall contain Five compulsory short answer questions for a total of Ten marks. Question No.2 to 4 shall be EITHER/OR Type for Ten marks each. Student shall Answer any one of them. Each of these questions may contain sub-questions.

End Examination:

The question paper for End Examination shall be for 70 marks. The Question paper shall contain Six Questions and all questions are compulsory. Question No.1 shall contain Ten compulsory short answer questions for a total of Twenty marks (with Two short answer questions from each unit). Question No.2 to 6 shall be EITHER/OR Type for Ten marks each and shall cover one Unit of the Syllabus for each question. Student shall Answer any one of them. Each of these questions may contain sub-questions.

PRINCIPLES OF IOT(PIOT)

Scheme:2023

Course Code	Category	Hours/Week		Credits	Maximum Marks		
		L	T/P	C	Continuous Internal Assessment	End Exam	TOTAL
MEI02	PC	3	0	3	30	70	100

Sessional Exam Duration:2Hrs | **EndExamDuration:3 Hrs**

Course Outcomes:

At the end of the course the student will be able to

CO1: Understand the fundamentals of IoT, including its architecture, characteristics, and challenges.

CO2: Analyze IoT communication protocols and networking techniques used in wireless sensor networks and M2M communication.

CO3: Design and manage IoT platforms, including device integration, service models, and application development.

CO4: Implement IoT networking and computing techniques, including cloud storage, APIs, and Python-based IoT programming.

CO5: Develop and evaluate IoT applications in real-world domains such as smart cities, connected vehicles, and industrial automation.

UNIT-I

Introduction & Basic of IoT :Definition, Characteristics, Physical and Logical Designs, challenges, Technological trends in IOT, IoT Examples, M2M.

UNIT-II

IoT Components, Communication and Networking: Introduction to Sensing and Networking: Sensing & actuation, Wireless Senor network, Senor nodes, Communication Protocols,M2M Communication, Networking Hardware, Networking Protocols.

UNIT-III

IoT System Management: Network Operator Requirements, IoT Platform Design Specification – Requirements, Process, Domain Model, Service, IoT Level, Function, Operational view, Device and Component Integration, Application development.

UNIT-IV

Networking and Computing: File Handling, Python Packages for IoT, IoT Physical Servers – Cloud Storage Models, Communication APIs.

UNIT-V

IoT Clouds and Data Analytics: RESTful Web API, Amazon Web Services for IoT, Apache Hadoop, Batch Data Analysis, Chef, Chef Case Studies, Puppet, NETCONF-YANG IoT Applications:Casestudies:smartcities,smarthome,connectedvehicles,Industrial IOT.

Text Books:

1. Kamal, R., Internet of Things – Architecture and Design Principles,‖ 1st Edition, Mc Graw Hill,2017.
2. Simone Cirani, Internet of Things-Architectures, Protocols and Standards‖, WILEY,2018.

Reference Books:

1. Alessandro Bassi,‖ Enabling Things to Talk- Designing IoT solutions with the IoT Architectural Reference Model‖, Springer,2013.

Question Paper Pattern:

Sessional Exam:

The question paper for Sessional Examination shall be for 40 marks. The question paper shall consist of Four questions and all questions are compulsory. Question No.1 shall contain Five compulsory short answer questions for a total of Ten marks. Question No.2 to 4 shall be EITHER/OR Type for Ten marks each. Student shall Answer any one of them. Each of these questions may contain sub-questions.

End Examination:

The question paper for End Examination shall be for 70 marks. The Question paper shall contain Six Questions and all questions are compulsory. Question No.1 shall contain Ten compulsory short answer questions for a total of Twenty marks (with Two short answer questions from each unit). Question No.2 to 6 shall be EITHER/OR Type for Ten marks each and shall cover one Unit of the Syllabus for each question. Student shall Answer any one of them. Each of these questions may contain sub-questions.

PRINCIPLES OF IOT LAB (PIOT (P))

Scheme: 2023

Course Code	Category	Hours/Week		Credits	Maximum Marks		
		L	T/P	C	Continuous Internal Assessment	End Exam	TOTAL
MEI03	PC	0	3	1.5	30	70	100
Sessional Exam Duration: 2Hrs				EndExamDuration:3Hrs			

Course Outcomes:

At the end of the course the student will be able to

CO1: Demonstrate the ability to control and monitor sensors and actuators using Microcontrollers & IoT platforms.

CO2: Implement IoT-based applications using cloud services like Thing Speak and mobile applications like Blynk.

CO3: Develop web-based IoT applications using HTTP and MQTT protocols for remote device management.

CO4: Apply IoT principles in real-world applications such as home automation, security systems, and industrial monitoring.

CO5: Integrate UAV/Drone technologies with IoT for automated navigation and data acquisition

List of Experiments

1. Serial Monitor, LED, Servo Motor - Controlling
2. Distance Measurement of an object
3. LDR Sensor, Alarm and temperature, humidity measurement
4. Experiments using Raspberry Pi
   - Controlling relay state based on input from IR sensors
   - Interfacing stepper motor with R-Pi
   - Advanced burglar alarm security system with the help of PIR sensor, buzzer and keypad. (Alarm gets disabled if correct keypad password is entered)
   - Automated LED light control based on input from PIR (to detect if people are present) and LDR(ambient light level)
5. IOT Framework
   - Upload humidity & temperature data to Thing Speak, periodically logging ambient light level to Thing Speak
6. Controlling LEDs, relay & buzzer using Blynk app
7. HTTP Based
   - Introduction to HTTP. Hosting a basic server from the ESP32 to control various digital based actuators (led, buzzer, relay) from a simple web page.
8. Displaying various sensor readings on a simple web page hosted on the ESP32.
9. MQTT Based
   - Controlling LEDs/Motors from an Android/Web app, Controlling AC Appliances from an android/web app with the help of relay.
10. Displaying humidity and temperature data on a web-based application
11. UAV/Drone:
    - Demonstration of UAV elements, Flight Controller
    - Mission Planner flight planning design
12. Python program to read GPS coordinates from Flight Controller

REAL TIME EMBEDDED SYSTEMS DESIGN AND ANALYSIS (RTESDA)

Scheme:2023

Course Code	Category	Hours/Week		Credits	Maximum Marks		
		L	T/P	C	Continuous Internal Assessment	End Exam	TOTAL
MEI04	PC	3	0	3	30	70	100

Sessional Exam Duration:2Hrs | **EndExamDuration:3 Hrs**

Course Outcomes:

At the end of the course the student will be able to

CO1: Explain the architecture of RTOS, task scheduling, and synchronization mechanisms such as semaphores, mutexes, and message queues.

CO2: Demonstrate proficiency in real-time embedded software development using Linux, RT Linux, and various RTOS platforms.

CO3: Apply real-time scheduling algorithms to optimize task execution and system performance.

CO4: Analyze real-time embedded hardware architectures and software stacks for efficient system integration.

CO5: Implement real-time communication protocols and perform validation and verification of embedded systems using case studies

UNIT-I

Introduction to RTOS: Overview Of RTOS, Architecture of Kernel, Task & Task Scheduler, ISR, Semaphore, Mutex, Mailbox, Message Queues, Event Registers, Pipes,Signals, Timers, Memory Management, Priority Inversion Problem.

UNIT-II

Real Time Embedded Software: Linux, RT Linux, multiprocessor software developments, data flow graph, Study and programming of RTOS like RTX51, Free RTOS etc. timingdiagram analysis for fixed and dynamic priority software services.

UNIT-III

Real time Scheduling: Scheduling Real-Time Tasks: Types of Schedulers Table-driven scheduling Cyclic schedulers EDF RMA, Priority Pre-emptive Scheduler State Machine for Linux and VxWorks, Comparison of Cyclic Executive, Introduction to Worst Case Analysis, Example of scheduling, Real-Time Scheduling and Rate Monotonic Least Upper Bound.

UNIT-IV

Overview of Real-time Hardware Architectures and Software Stacks: Embedded Linux on the Raspberry Pi ARM A-Series System-on-Chip processors, Tracing Linux kernel and network stack events. Best Practices for RTES Programming, System Integration Testing (Hardware, Firmware, and Software)

UNIT-V

Real Time Communication: RT Services Communication and Synchronization, Performance of two Real-Time communication Protocols, Real time communication over network, Real Time database.

Verification and Validation of RTES project:Using Point-to-point Serial and TCP/IP for Embedded Systems, Case Studyof Coding for Sending Application Layer Byte Streams on A TCP/IP Network Using RTOS. Building a simple Linux multi-service system using POSIX real- time extensions on Raspberry Pi 3b using sequencing and methods to log and verify agreement between theory and practice.

TextBooks:

1. Embedded Real time systems‖,Prasad DreamtechWileyPublication,2003.
2. "Real-Time Systems: Theory and Practice,"Rajib Mall Pearson,2008.

ReferenceBooks:

1. Real-TImeSystemsDesignandAnalysis‖,PhilipLaplante,2ndEdition,PrenticeHall, 2013.

Question Paper Pattern:

Sessional Exam:

The question paper for Sessional Examination shall be for 40 marks. The question paper shall consist of Four questions and all questions are compulsory. Question No.1 shall contain Five compulsory short answer questions for a total of Ten marks. Question No.2 to 4 shall be EITHER/OR Type for Ten marks each. Student shall Answer any one of them. Each of these questions may contain sub-questions.

End Examination:

The question paper for End Examination shall be for 70 marks. The Question paper shall contain Six Questions and all questions are compulsory. Question No.1 shall contain Ten compulsory short answer questions for a total of Twenty marks (with Two short answer questions from each unit). Question No.2 to 6 shall be EITHER/OR Type for Ten marks each and shall cover one Unit of the Syllabus for each question. Student shall Answer any one of them. Each of these questions may contain sub-questions.

INDUSTRIAL INTERNET OF THINGS (IIOT)

Scheme:2023

Course Code	Category	Hours/Week		Credits	Maximum Marks		
		L	T/P	C	Continuous Internal Assessment	End Exam	TOTAL
MEI05	PC	3	0	3	30	70	100

Sessional Exam Duration:2Hrs **EndExamDuration:3 Hrs**

Course Outcomes:

At the end of the course the student will be able to

CO1: Explain the key differences between IoT and IIoT, sensor calibration, placement, and the role of communication systems in IIoT applications.

CO2: Demonstrate knowledge of IIoT methodologies, including operating systems, networking protocols, and wireless sensor networks.

CO3: Apply data analytics techniques, including big data processing and machine learning, to industrial IoT applications.

CO4: Analyze and implement IP and non-IP communication protocols for efficient IIoT connectivity and data exchange.

CO5: Utilize IoT cloud platforms for device localization, tracking, and robotics applications in industrial environments

UNIT-I

Introduction IIoT: Market Size and Potential: Definition, IoT v IIoT, Next Generation Sensors, Sensor‘s calibration and validate sensor measurements, placement of IoT devices, sensors, low-cost communication system design, Top application areas include manufacturing, oil & gas, Embedded systems in the Automotive and Transportation market segment..

UNIT-II

IIoT Methodology :Top operating systems used in IIoT deployments, Networking and wireless communication protocols used in IIoT deployments. Smart Remote Monitoring Unit, components of monitoring system, control and management, Wireless Sensor Network(WSN)

UNIT-III

Data driven Analytics of IIoT: Implementing of industrial IoT Data flow, big data and how to prepare data for machine learning algorithms, Machine Learning algorithms, supervised learning & Un-supervised learning algorithms, Basics of neural network, activation functions, back- propagation.

UNIT-IV

IP and Non-IP Protocols for IoT: WPAN, IEEE 802.15.4, Bluetooth, NFC, 6LoWPAN; RFID, ZigbeeWireless HART Protocol, MQTT, IP and Non-IP Protocols, REST, CoAP.

UNIT-V

IoT Clouds and Data Analytics: Develops a physics-based and data-driven digital equipment model to monitor assets and systems, Introduction to device localization and tracking; different types of localization techniques, Radio-Frequency Identification (RFID) and fingerprinting, Device diversity/heterogeneity issue in IIoT networks. Internet of Robotic Things (IoRT):Introduction to stationary and mobile robots, Brief introduction to localization, mapping, planning, and control of robotic systems; Introduction to cloud-enabled robotics; Applications of IIoT in robotics; Architectures for IoRT, Examples and case studies: Open issues and challenges.

Text Books:

1. Industry4.0:The Industrial Internet of Things‖, Alasdair Gilchrist, Apress,2016—
2. Introduction to Industrial Internet of Things and Industry4.0,SudipMisra,ChandanaRoy,AnadarupMukherjee,CRCPress,2021

Reference Books:

1. Hands on Industrial Internet of Things‖, Giacomo Veneri, Antonio Capasso, Packt Press, 2018.

Question Paper Pattern:

Sessional Exam:

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End Examination:

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INDUSTRIAL INTERNET OF THINGS LAB (IIOT(P))

Scheme: 2023

Course Code	Category	Hours/Week		Credits	Maximum Marks		
		L	T/P	C	Continuous Internal Assessment	End Exam	TOTAL
MEI06	PC	0	3	1.5	30	70	100

Sessional Exam Duration: 2Hrs **EndExamDuration:3Hrs**

Course Outcomes:

At the end of the course the student will be able to

CO1: Explain the architecture, challenges, and fundamental concepts of IIoT and differentiate it from IoT.

CO2: Demonstrate the interfacing of sensors and actuators with microcontrollers like Raspberry Pi and NodeMCU for industrial automation.

CO3: Implement communication protocols such as MQTT, ZigBee, and Bluetooth to enable seamless IIoT connectivity.

CO4: Develop web-based dashboards for real-time visualization and control of IIoT devices.

CO5: Retrieve, analyze, and transmit industrial data using web-based interactions and M2M communication.

List of Experiments

MODULE 1: Introduction & Architecture

What is IIoT and connected world? The difference between IoT and IIoT, Architecture of IIoT, IOT node, Challenges of IIOT. Practice

1. Introduction to Arduino, Introduction to raspberry Pi.

MODULE 2: IIOT Components

Fundamentals of Control System, introductions, components, closed loop & open loop system. Introduction to Sensors (Description and Working principle): What is sensor? Types of sensors, working principle of basicSensors -Ultrasonic Sensor, IR sensor, MQ2, Temperature and Humidity Sensors (DHT-11).Digital switch, Electro Mechanical switches.

Practice

1. Measurement of temperature & pressure values of the process using raspberry pi/node mcu.
2. Modules and Sensors Interfacing (IR sensor, Ultrasonic sensors, Soil moisture sensor) using Raspberry pi/node mcu.
3. Modules and Actuators Interfacing (Relay, Motor, Buzzer) using Raspberry pi/node mcu.

MODULE 3: Communication Technologies of IIoT

Communication Protocols: IEEE 802.15.4, ZigBee, Bluetooth, BLE, NFC, RFIDIndustry standards communication technology (MQTT), wireless network communication.

Practice

1. Demonstration of MQTT communication.

MODULE 4: Visualization and Data Types of IIoT

Connecting an Arduino/Raspberry pi to the Web: Introduction, setting up the Arduino/Raspberry pi development environment, Options for Internet connectivity with Arduino, Configuring your Arduino/Raspberry pi board for the IoT.

Practice

1. Visualization of diverse sensor data using dashboard (part of IoT‘s _control panel‘)
2. Sending alert message to the user. ways to control and interact with your environment)

MODULE 5: Retrieving Data
Extraction from Web: Grabbing the content from a web page, Sending data on the web, Troubleshooting basic Arduino issues, Types of IoT interaction, Machine to Machine interaction (M2M).
Practice

1. Device control using mobile Apps or through Web pages.
2. Machine to Machine communication.

MODULE 6: Control & Supervisory Level of Automation
Programmable logic controller (PLC), Real-time control system, Supervisory Control & Data Acquisition (SCADA).

Practice

1. Digital logic gates programming using ladder diagram.
2. Implementation of Boolean expression using ladder diagram.
3. Simulation of PLC to understand the process control concept.

Projects:
IIoT based smart energy meter Smart Agriculture system
Automation using controller via Bluetooth Temperature controlled Fan/cooler using controller Automatic streetlight
Smart Baggage Tracker

ARCHITECTURES OF WIRELESS SENSOR NETWORKS (AWSN)

Scheme:2023

Course Code	Category	Hours/Week		Credits	Maximum Marks		
		L	T/P	C	Continuous Internal Assessment	End Exam	TOTAL
MEI07	PC	3	0	3	30	70	100

Sessional Exam Duration:2Hrs | **EndExamDuration:3 Hrs**

Course Outcomes:

At the end of the course the student will be able to

CO1: Learn the fundamental concepts and architecture of wireless sensor networks.

CO2: Explore various network architectures, optimization techniques, and design principles for wireless sensor networks.

CO3: Gain knowledge of MAC protocols, routing techniques, and addressing mechanisms for efficient sensor network communication.

CO4: Understand the infrastructure establishment of sensor networks, including topology control and synchronization.

CO5: Grasp the knowledge on sensor network platforms, programming challenges, and simulation tools.

UNIT-I

Overview of Wireless Sensor Networks: Single-Node Architecture - Hardware Components- Network Characteristics- unique constraints and challenges, Enabling Technologies for Wireless Sensor Networks- Types of wireless sensor networks.

UNIT-II

Architectures: Network Architecture- Sensor Networks-Scenarios- Design Principle, Physical Layer and Transceiver Design Considerations, Optimization Goals and Figures of Merit, Gateway Concepts.

UNIT-III

Networking Sensors: MAC Protocols for Wireless Sensor Networks, Low Duty Cycle Protocols and Wakeup Concepts - SMAC, - B-MAC Protocol, IEEE 802.15.4 standard and ZigBee, the Mediation Device Protocol, Wakeup Radio Concepts, Address and Name Management, Assignment of MAC Addresses, Routing Protocols Energy-Efficient Routing, Geographic Routing.

UNIT-IV

Infrastructure Establishment: Topology Control, Clustering, Time Synchronization, Localization and Positioning, Sensor Tasking and Control.

UNIT-V

Sensor Network Platforms and Tools :Sensor Node Hardware – Berkeley Motes, Programming Challenges, Node-level software platforms, Node level Simulators, State-centric programming

Text Books:

1.Holger Karl & Andreas Willig, "Protocols and Architectures for Wireless Sensor Networks‖, John Wiley, 2005.

2.Feng Zhao & Leonidas J.Guibas, ―Wireless Sensor Networks-An Information Processing Approach", Elsevier, 2007

Reference Books:

1. Waltenegus Dargie , Christian Poellabauer, ―Fundamentals Of Wireless Sensor Networks Theory And Practice‖, By John Wiley & Sons Publications, 2011
2. Kazem Sohraby, Daniel Minoli, &TaiebZnati, ―Wireless Sensor Networks-Technology, Protocols, and Applications‖, John Wiley, 2007.
3. Anna Hac, ―Wireless Sensor Network Designs‖, John Wiley, 2003

Question Paper Pattern:

Sessional Exam:

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