Internet of Things

Course Code: BECCS3C010
Course Title: Internet of Things
Semester: VI
Credits: 4 (L:3, P:1)

Rationale

The Internet of Things (IoT) has emerged as a transformative technology driving innovation across industries by connecting devices, enabling seamless communication, and fostering intelligent decision-making. This course introduces students to the foundational principles of IoT, including its architecture, protocols, hardware, and applications. It equips learners with the knowledge to design and analyze IoT systems while addressing critical aspects of data analytics and security. By the end of the course, students will be prepared to implement IoT solutions and contribute to the evolving IoT landscape.

Course Outlines

Contents	**No. of Lectures**
Unit I Introduction to IoT: Definition & Characteristics of IoT, Physical Design of IoT, Logical Design of IoT, IoT Enabling Technologies (WSN, Cloud Computing, Big Data Analytics, Communication Protocols, Embedded Systems), IoT challenges, Opportunities in IoT, Future Trends in IoT	8
Unit II IoT Architectures, Protocols, and Standards: Layered IoT architecture (Perception, Network, Application), Communication Models (Request-Response, Publish-Subscribe), Data Protocols (MQTT, AMQP, CoAP, REST HTTP, XMPP), Communication Protocols (Wi-FI, ZigBee, LoRA), IoT Levels and Deployment Templates	8
Unit III IoT Hardware, Platforms, and Computing Paradigms: Overview of IoT hardware (sensors, actuators, microcontrollers, gateways), Popular IoT platforms (Raspberry Pi, Arduino, ESP32), IoT hardware programming, IoT-specific operating systems, Computing Paradigms (Edge computing, Fog computing, Cloud computing, Comparative analysis of computing paradigms in IoT).	8

Unit IV IoT Applications, Design Methodology and Case Study: IoT Applications (Smart cities, Smart homes, Industrial IoT, Healthcare IoT, Agricultural IoT, Wearables, IoT in transportation, IoT-enabled supply chain), IoT Design Methodology (Various specification criteria), Case studies of IoT methodology implementation in real-world scenarios.	8
Unit V IoT Data Analytics and Security: Data acquisition and processing in IoT, IoT-specific data storage (NoSQL, Time-series databases), Data visualization techniques, Data analytics for IoT, IoT security challenges, Best practices for secure IoT deployment. AI for IoT Security: Centralized Learning, Decentralized Learning (Federated Learning)	8

Course Outcomes

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

- Understand the definition, characteristics, and enabling technologies of IoT.
- Analyze IoT architectures, protocols, and standards for effective communication and data management.
- Design IoT systems using appropriate hardware, platforms, and computing paradigms.
- Evaluate IoT applications, design methodologies, and case studies in diverse domains.
- Address challenges related to IoT data analytics and implement security measures for safe deployment.

List of Lab Experiments

1. Understand the programming environment of Arduino UNO and write a basic program to blink an LED.
2. Interface a DHT sensor with Arduino UNO to read temperature and humidity values and display them on the serial monitor.
3. Interface an ultrasonic sensor with Arduino UNO to measure the distance from an obstacle and display it on the serial monitor.
4. Familiarize with ESP8266/ESP32 and establish communication between it and Arduino UNO using serial communication.
5. Configure ESP8266/ESP32 to connect to a Wi-Fi hotspot and display its connection status on the serial monitor.
6. Configure ESP8266/ESP32 as a web server and control an LED connected to it via a web interface.

7. Interface DHT and ultrasonic sensors with ESP8266/ESP32 to display sensor data in real-time on a web interface.
8. Configure ESP8266/ESP32 to transmit DHT sensor readings to the ThingSpeak cloud for real-time monitoring.
9. To understand the working and programming of a 7-segment display and demonstrate its capability to display numeric values by interfacing it with Arduino UNO.
10. Set up Raspberry Pi with Raspbian OS and perform a basic GPIO operation by blinking an LED.
11. Interface a sensor with Raspberry Pi and log its data into a CSV file for analysis.
12. Use the Raspberry Pi camera module to capture images or stream live video and display it on a web interface in real time.
13. Perform edge computing by calculating average temperature and humidity locally on Raspberry Pi before sending data to the cloud.
14. Design a mobile or desktop application to control Raspberry Pi or ESP8266/ESP32 modules.
15. Design an IoT based air pollution control system which monitors the air pollution.

List of Books/References

8. Arshdeep Bahga, Vijay Madisetti, "Internet of Things: A Hands-On Approach", Universities Press, 2014.
9. Raj Kamal, "Internet of Things: Architecture and Design Principles", McGraw Hill Education, 2017.
10. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Jerome Henry, Rob Barton, "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", Cisco Press, 2017.
11. Greg Dunko, Joydeep Misra, Josh Robertson, Tom Snyder, “A Reference Guide to the Internet of Things”, Bridgera LLC, 2017.
12. Pethuru Raj, Anupama C. Raman, “The Internet of Things: Enabling Technologies, Platforms, and Use Cases”, CRC Press (Taylor & Francis Group), 2017.
13. Bassi Alessandro, Martin Bauer, Martin Fiedler, Thorsten Kramp, Rob Van Kranenburg, Sebastian Lange, Stefan Meissner, “Enabling Things to Talk: Designing IoT Solutions with TheIoT Architectural Reference Model”, Springer Nature, 2013.
14. Adeel Javed (2016), Building Arduino Projects for the Internet of Things: Experiments with Real-World Applications. Apress.
15. Dow, C. (2018). Internet of Things Programming Projects: Build Modern IoT Solutions with the Raspberry Pi 3 and Python. Germany: Packt Publishing.
16. Shovic, J. C. (2016). Raspberry Pi IoT Projects: Prototyping Experiments for Makers. United States: Apress.
17. 21 IOT EXPERIMENTS: Learn IoT, the ProgrammerÕs way. (2018). India: BPB Publications.