

Embedded Systems and Internet of Things

Course Objectives:

- To understand fundamentals of IoT and embedded system including essence, basic design strategy and process modeling.
- To introduce students a set of advanced topics in embedded IoT and lead them to understand research in network.
- To develop comprehensive approach towards building small low cost embedded IoT system.
- To understand fundamentals of security in IoT,
- To learn to implement secure infrastructure for IoT
- To learn real world application scenarios of IoT along with its societal and economic impact using case studies

Course Outcomes:

- On completion of the course, student will be able to
- Implement an architectural design for IoT for specified requirement
- Solve the given societal challenge using IoT
- Choose between available technologies and devices for stated IoT challenge

Syllabus

- **Introduction to Embedded System and Internet of Things**
 - *Embedded Systems:*
 - Application Domain and Characteristic of Embedded System,
 - Real time systems and Real-time scheduling,
 - Processor basics and System-On-Chip,
 - Introduction to ARM processor and its architecture.
 - *IoT:*
 - Definition and characteristics of IoT,
 - Internet of Things: Vision, Emerging Trends, Economic Significance,
 - Technical Building Blocks, Physical design of IoT, Things of IoT, IoT Protocols, Logical design of IoT, IoT functional blocks,
 - IoT communication models, IoT Communication APIs,
 - IoT enabling technologies,
 - IoT levels and deployment templates,
 - IoT Issues and Challenges, Applications
- **Embedded IoT Platform Design Methodology**
 - Purpose and requirement specification, Process specification, Domain model specification, information model specification, Service specifications, IoT level specification, Functional view specification, Operational view specification,
 - Device and component integration,
 - Application development

Impetus IT Services Pvt.Ltd.

B-16, First floor, Sant Tukaram Vyapar Sankul, Sector - 24, Nigdi, Pune, Maharashtra. India. Pin – 411044.

Mobile 9970600774, 9730012775 | Board 91-20-27640406 | Fax 91-20-27641703

Email : hreshikesh@impetusitservices.com | Website <http://impetusits.in>

- **Pillars of Embedded IoT and Physical Devices**

- Horizontal, verticals and four pillars of IoT,
- M2M: The internet of devices,
- RFID: The internet of objects,
- WSN: The internet of transducer,
- SCADA: The internet of controllers,
- DCM: Device, Connect and Manage,
- Device: Things that talk, Connect: Pervasive Network,
- IoT Physical Devices and Endpoints: Basic building blocks of and IoT device,
- Exemplary device:
 - Raspberry Pi, Raspberry Pi interfaces,
 - Programming Raspberry Pi with Python,
 - Beagle board and Other IoT Devices.

- **IoT Protocols and Security**

- Protocol Standardization for IoT,
- M2M and WSN Protocols,
- SCADA and RFID Protocols,
- Issues with IoT Standardization,
- Unified Data Standards,
- Protocols – IEEE 802.15.4,
- BACNet Protocol, Modbus, KNX, Zigbee Architecture,
- Network layer, APS layer.
- IoT Security:
 - Vulnerabilities of IoT, Security Requirements,
 - Challenges for Secure IoT, Threat Modeling,
 - Key elements of IoT Security: Identity establishment, Access control, Data and message security, Non-repudiation and availability,
 - Security model for IoT.

- **Web of Things and Cloud of Things**

- Web of Things versus Internet of Things, Two Pillars of the Web,
- Architecture Standardization for WoT, Platform Middleware for WoT, Unified Multitier WoT Architecture, WoT Portals and Business Intelligence.
- Cloud of Things: Grid/SOA and Cloud Computing, Cloud Middleware, Cloud Standards – Cloud Providers and Systems, Mobile Cloud Computing,
- The Cloud of Things Architecture.

- **IoT Physical Servers, Cloud Offerings and IoT Case Studies**

- Introduction to Cloud Storage Models, Communication API,
- WAMP: Autobahn for IoT, Xively Cloud for IoT, Python Web Application Framework: Django, Amazon Web Services for IoT, Skynet IoT Messaging Platform. Case Studies: Home Intrusion Detection, Weather Monitoring System, Air Pollution Monitoring, Smart Irrigation.

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Embedded Systems & Internet of Things Lab

Group A

1. Study of Raspberry-Pi, Beagle board, Arduino and other micro controller (History & Elevation)
2. Study of different operating systems for Raspberry-Pi /Beagle board. Understanding the process of OS installation on Raspberry-Pi /Beagle board
3. Study of Connectivity and configuration of Raspberry-Pi /Beagle board circuit with basic peripherals, LEDS. Understanding GPIO and its use in program.
4. Understanding the connectivity of Raspberry-Pi /Beagle board circuit with temperature sensor. Write an application to read the environment temperature. If temperature crosses a threshold value, the application indicated user using LEDSS

Group B

5. Understanding the connectivity of Raspberry-Pi /Beagle board circuit with IR sensor. Write an application to detect obstacle and notify user using LEDs.
6. Understanding and connectivity of Raspberry-Pi /Beagle board with camera. Write an application to capture and store the image.
7. Understanding and connectivity of Raspberry-Pi /Beagle board with a Zigbee module. Write a network application for communication between two devices using Zigbee.
8. Study of different CPU frequency governors. Write an application to change CPU frequency of Raspberry-Pi /Beagle board

Group C

9. Write an application using Raspberry-Pi /Beagle board to control the operation of stepper motor.
10. Write an application using Raspberry-Pi /Beagle board to control the operation of a hardware simulated traffic signal.
11. Write an application using Raspberry-Pi /Beagle board to control the operation of a hardware simulated lift elevator

Group D

12. Write a server application to be deployed on Raspberry-Pi /Beagle board. Write client applications to get services from the server application.
13. Create a small dashboard application to be deployed on cloud. Different publisher devices can publish their information and interested application can subscribe.
14. Create a simple web interface for Raspberry-Pi/Beagle board to control the connected LEDs remotely through the interface.

Group E

15. Develop a Real-time application like smart home with following requirements: When user enters into house the required appliances like fan, light should be switched ON. Appliances should also get controlled remotely by a suitable web interface. The objective of this application is student should construct complete Smart application in group.
16. Develop a Real-time application like a smart home with following requirements: If anyone comes at door the camera module automatically captures his image send it to the email account of user or send notification to the user. Door will open only after user's approval.

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