Internet of Things (GE)

Credits: Theory-03+ Practical-01 **Theory Lectures: 45h**

Course Learning Objectives

This course describes the Internet of Things (IoT), technology used to build these kinds of devices, how they communicate, how they store data, and the kinds of distributed systems needed to support them. Broad objectives are:

1. To introduce the IoT terminology, technology and its applications
2. To introduce the concept of M2M (machine to machine) with necessary protocols
3. To introduce the Arduino / Raspberry Pi platform and Programming Language widely used in IoT applications
4. To Familiarize the protocols, design requirements, suitable algorithms, and the state-of-the-art cloud platforms.
5. To introduce the implementation of web-based services on IoT devices.

Course Learning Outcomes

At the end of this course, students will be able to

CO1: Understand fundamentals and applications of Internet of Things, its hardware and software components

CO2: Understand the methodologies and tools involved (device, data, cloud) in the design of IoT Systems

CO3: Understand interfacing, technological challenges faced by IoT sensors and communication modules, with a focus on wireless, energy, power and sensing modules

CO4: Understand the working principle of the state-of-the-art cloud platforms to meet the industrial requirement for remote monitoring of data and control IoT based system.

Prerequisite: Basic knowledge of digital circuits and idea about microprocessors/ microcontrollers.

L-T-P: 3-0-1

Syllabus Contents

UNIT 1: Introduction to IoT **(11 Lectures)**

Introduction to IoT: Definition and Characteristics of IoT, Architectural Overview, Design principles and needed capabilities.

Physical design of IoT: IoT protocols in Link Layer, Network/Internet Layer, Transport Layer, Application Layer, Basics of Networking.

Logical design of IoT: Functional blocks, Communication Models and APIs, IoT levels and deployment templates.

M2M and IoT Technology Fundamentals, Software defined networks (SDN), network function virtualization (NFV), Basics of IoT System Management with SNMP, NETCONF - YANG.

UNIT 2 : Communication Protocols and IoT Components : **(11 Lectures)**

Communication Protocols - MQTT, Bluetooth, CoAP, TCP.

Hardware Components: Transducers, Sensors, Actuators and I/O interfaces – Concept, Characteristic and Classification of Sensors (Position, Velocity, Force, Temperature and Humidity, Motion Detection, ADC, Light, Bluetooth, etc.)

UNIT 3: Hardware Components - (Arduino/RaspberryPi) (12 Lectures)

Raspberry Pi: Communication with devices through the pins of the Raspberry Pi, RPi. GPIO library, Basics of Python programming and Python Functions, General purpose IO Pins, Protocol Pins, applying digital voltages, and generating Pulse Width Modulated signals, Tkinter Python library, accessing pins through a graphic user interface.

OR

Arduino: Arduino board - main components, inputs, and outputs. Arduino Integrated Development Environment (IDE), Basics of C programming. Composition of an Arduino programs, Arduino tool chain, basic structure of a sketch, including the use of the setup() and loop() functions. Accessing the pins from a sketch for input and output
Arduino/Raspberry Pi compatible shields together with their libraries.
Software components- Programming API‘s (using Python/Node.js/Arduino). UART, Serial libraries for communication with the serial monitor for Arduino/Raspberry Pi
Interfacing sensors and actuators with Arduino/Raspberry Pi.
**** It is optional to choose either Arduino or Raspberry Pi environment**

UNIT 4: IoT Applications (11 Lectures)

IoT Physical Devices and Endpoints, Domain specific IoTs, IoT Physical Servers and Cloud Offering Cloud Computing: Characteristics, Introduction to Cloud Service models (SaaS, PaaS, IaaS, XaaS etc.) Deployment models, Cloud storage APIs, IoT-Cloud convergence, Communication Enablers Webservices – Web server for IoT, Python-Web frameworks, RESTful Web API, ThingSpeak API, MQTT.
IoT Application Development - Solution framework for IoT applications- Implementation of Device integration, Data acquisition and integration, Device Data Storage - Unstructured data storage on cloud/local server, Authentication, authorization of devices.
IoT security, Basics of symmetric and non-symmetric encryption standards, IoT Case Studies.

References:

1. “A Internet of Things - A Hands-on Approach”, Arshdeep Bahga and Vijay Madisetti, Universities Press, 2015, ISBN: 9788173719547
2. “Designing Internet of Things”, Adrian McEwen and Hakim Cassimally, John Wiley and Sons, 2014.
3. “Introduction to Internet of Things: A practical Approach”, Dr. SRN Reddy, Rachit Thukral and Manasi Mishra, ETI Labs
4. “From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence”, Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, 1st Edition, Academic Press, 2014.
5. “Exploring Arduino: Tools and Techniques for Engineering Wizardr”, Jeremy Blum, Wiley & Sons, 2013, ISBN : 9781118549360
6. “Getting Started with Raspberry Pi”, Matt Richardson & Shawn Wallace, O'Reilly (SPD), 2014, ISBN: 9789350239759.
7. “Raspberry Pi Cookbook, Software and Hardware Problems and solutions”, Simon Monk, O'Reilly (SPD), 2016, ISBN 7989352133895

Internet of Things Lab

Credits: 01 **Lectures: 30h**

Course Learning Outcomes

At the end of this course, students will be able to

CO1: Execute programs on Arduino/Rasberry Pi boards.
CO2: Interface various I/O devices, sensors & actuators and implement them in various practical applications
CO3: Use various communication modules and protocols for data communication between devices, sensors and actuators for wired as well as wireless applications
CO4: Implement Wireless Control of Remote Devices and manage data through cloud based applications.

Syllabus Contents

1. Connect an LED and a Switch/Digital Sensor (IR/LDR, etc) and control the LED with the Switch/Digital Sensor.
2. To interface DHT11 sensor with Arduino/Raspberry Pi and write a program to print temperature and humidity readings.
3. To interface Bluetooth with Arduino/Raspberry Pi and write a program to send sensor (analog, digital) data to smartphone using Bluetooth.
4. To interface Bluetooth with Arduino/Raspberry Pi and write a program to turn on various options of RGB LED for different data received from smartphone using Bluetooth.
5. Create a traffic light signal with three colored lights (Red, Orange and Green) with an interval of 5-2-10 seconds.
6. Create an application that has three LEDs (Red, Green and white). The LEDs should follow the cycle (All Off, Red On, Green On, White On) for each clap (use sound sensor).
7. Write a program on Arduino/Raspberry Pi to upload/retrieve temperature and humidity data using ThingSpeak cloud.
8. Write a program on Arduino/Raspberry Pi to publish/subscribe temperature data using MQTT broker.
9. Write a program to create TCP server on Arduino/Raspberry Pi and respond with humidity data to TCP client when requested.
10. Create a web application as a project for any of the IoT Case Studies based on Smart Environment, Industrial automation, Transportation, Agriculture, Healthcare, Home Automation with functionalities to get input and send output.

Indicative Course Teaching-
Learning Processes and Assessment Methods are listed in section 7.3 and 7.4 respectively along with Table 1 on Suggestive Learning and Evaluation Strategies.