

# Introductory Course on IoT

## Course Curriculum:

### Theory:

**Module 1:** IoT-system introduction, fundamentals, benefits/challenges, architecture, applications, casestudy

**Module 2:** Sensors and actuator interfaces; signal conditioning, read-out circuits, signal processing

**Module 3:** Networking and cloud computing in IoT, IoT network protocols like MQTT/HTTP, wireless communication, IoT security, and privacy

**Module 4:** Data Analysis for IoT-specific use cases, computing, and data handling

**Module 5:** Industry expert session on recent advancements in IoT

**Lab Sessions:** Introduction to IoT-kit, interfacing sensor, ADC, connectivity of IoT-CPS system with cloud and control using dashboard, send/receive data to server, data Analysis. Labs will be conducted using hardware system consisting of 32-bit dual core/Arm cortex M4 microprocessor and Wi-Fi network processor.

### Batch 1: 13-18 June 2022

Hardware: Texas Instruments MSP432 Cortex M4, CC3100 WiFi module, Temperature sensor LM35, potentiometer, LEDs

Integrated Development Environment (IDE): TI Code Composer Studio, Energia IDE

Programming Language: Embedded C

Other Details: Node-Red IDE, Javascript programming and JSON

Introduction to lab sessions

Lunch

### **Lab 1: IoT Introduction**

- Orientation and familiarity with the hardware and course flow
- Installation of toolchain
- Writing the Hello world program
- API of Hello World and Explanation of the API

- Compiling the program and debugging the same
- What is the ADC and SAR Theory Module and ADC API explanation."

### **Lab 2: Sensors and Interfacing**

- Building the Hello World program on the MSP432 board
- Interfacing the Potentiometer to the board and writing the code for the same using the ADC API and code execution on the board.
- WiFi API explanation Code compilation and code execution on the board"

### **Lab 3: Network and Communication**

- Node-red programming on the personal machines
- Data points collection and linear regression
- Account creation on the FRED cloud "

### **Lab 4: Data Analysis for the IoT-system application**

- JSON and transfer function based potentiometer code on the board and sending raw data to the FRED cloud "

### **Lab 5: Prototype IoT system**

- Final dashboard creation and final embedded code running on the board, End-to-end connectivity in simple IoT applications

## **Batch 2: 20-25 June 2022**

Hardware: Xtensa L6 32-bit Dual core processor with built in network processor (Wi-Fi & BLE), Digital Temperature & Humidity Sensor, Op Amp AFE (I-V, PGA, Buffer, Comparator) OLED Graphics Display, 3x3 keypad matrix

Integrated Development Environment (IDE): Thonny Python , Arduino IDE with C, C++

Programming Language: Python, Arduino Using Embedded C , C++ API ( depending on participants level decide the depth up to Register level)

### **Lab 1: IoT Introduction:**

- Introductory session on hardware, IDE-platform,
- Handling GPIO, Blinking LEDs, Keypad, interrupts
- Working with Timers, ADC, DAC and PWM
- Communicating with serial interface
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### **Lab 2: Sensors and Interfacing**

- Sensors-Actuators and ADC interfacing
- Actuators: Stepper motor compilation
- Code execution on the board: Hands-on with onboard sensors and actuators

### **Lab 3: Network and Communication**

- Send data to cloud server using HTTP,
- Create own webserver inside the board
- Design web page using HTML
- Use mobile App (downloadable from playstore)
- Implementing IoT System using HTTP protocol and visualizing data through cloud
- Publish / Subscribe messages to other IoT clients using MQTT cloud broker

### **Lab 4: Data Analysis for the IoT-system application**

- Data analysis and data visualization using ThingSpeak
- How to create data visualization environment/ dashboard

### **Lab 5: Prototype IoT system**

- End-to-end connectivity in simple IoT applications like home automation, process automation, smart agriculture
- Send/receive data to cloud server using wireless network
- Controlling actuators from mobile App (Demo- if time permits coding of actuator)

### **Batch 3: 04-09 July, 2022**

Hardware: eYFi-Mega which has on board ATmega2560 and ESP32(WiFi + BLE) module, Digital temperature and humidity (DHT22) sensor, 12v LED, DC Fan, Relay, OLED, Potentiometer.

Integrated Development Environment (IDE): Visual Studio Code and Jupyter Notebook

Other details: Embedded C, Basic Electronics, JSON, Python, App Script

### **Lab 1: IoT Introduction:**

- Introduction to development board eYFi-Mega
- Overview of IoT Workshop - Modules planned
- Understanding the use of microcontrollers in IoT systems
- Overview ATmega2560 microcontroller architecture and importance of I/O ports
- Basic architecture of ESP32 with importance on wireless capabilities
- Getting familiar with VS Code and writing the first program to interface onboard LED and interfacing DHT22 to I/O pins

- Understanding Inter-Integrated Circuit (I2C) Protocol and interface OLED to display DHT values

### **Lab 2: Sensors and Interfacing**

- Interfacing potentiometer to regulate the intensity of LED light by using on-chip ADC and timers for PWM
- Understanding Universal Asynchronous Receiver Transmitter (UART) Protocol to use for communication between ATmega and ESP32. Writing a program to read sensor value on ATmega and sending it to ESP32.

### **Lab 3: Network and Communication**

- Introduction to MQTT and HTTP, writing programs to send sensor values to google sheets using both protocols

### **Lab 4: Data Analysis for the IoT-system application**

- Writing google app script to automate actuators based on patterns seen on sensor data
- Exploring visualization tools like Grafana for viewing data, and using python library to understand trends in data using time series analysis

### **Lab 5: Prototype IoT system**

- Capstone project: Building a smart home solution using the codes and knowledge gained so far.
- The project will use all the hardware used to learn concepts and programs written to actuate light and fan in a classroom environment.
- How to implement the capstone project with available development boards in the market?