National Institute of Electronics and Information Technology, Calicut

COURSE SYLLABUS

Name of the Group: *Embedded System Group*

Name of the Course: Certificate course on *Internet of Things (IoT) Applications*
Course Code:*ED750*

Starting Date:*26 February 2018*

Duration:*12 Weeks*
Course Structure: *This course contains total four modules. After completing the first three modules, the students have to do a 2 weeks mini project using any of the topics studied to earn the certificate.*

ED750	***Module Name***	***Weeks***
ED751	Embedded System Design using ARM Cortex Microcontroller	*3*
ED752	*Embedded Linux*	*2*
ED753	*IoT Application Development*	*5*
ED754	*Mini Project Work*	*2*
	Total	*12*

a. **Course Contents :**
ED751: Embedded System Design using ARM Cortex Microcontroller

Module Duration: 15 days

Objective

This course covers the architecture of the popular 32-bit bit Microcontroller such as ARM. The ARM Cortex processor is the industry-leading 32-bit processor for highly deterministic real-time applications, specifically developed to enable partners to develop high-performance low-cost platforms for a broad range of devices including microcontrollers, automotive body systems, industrial control systems and wireless networking and sensors.

Course Description

Introduction to ARM Cortex Architecture
Introduction to 32-bit Processors, The ARM Architecture, Overview of ARM, Overview of Cortex Architecture, Cortex M3 Register Set and Modes, Cortex M3

Processor Core, Data Path and Instruction Decoding, ARM Cortex M3 Development Environment, Assembler and Compiler, Linkers and Debuggers, ARM, Thumb & Thumb2 instructions, Mixing ARM & Thumb Instructions, Memory hierarchy, Memory Mapping, Cache.

Cortex M3 Microcontrollers & Peripherals

Cortex M3 based controller architecture, Memory mapping, Cortex M3 Peripherals – RCC, GPIO, Timer, System timer, UARTs, LCD, ADC, Cortex M3 interrupt handling – NVIC. Application development with Cortex M3 controllers with standard peripheral libraries.

Learning Outcomes

After successful completion of the module, the students shall be able to:

- Use ARM Cortex M with Embedded C Programming for Application Development

Text Book:

1. The Definitive Guide to the ARM Cortex M3, Joseph Yiu, Newnes.

Reference Books:

1. Embedded Systems Architecture Programming and Design: Raj Kamal, Tata McGraw Hill.
2. Embedded Systems an Integrated Approach: Lyla B Das, Pearson
3. ARM System Developer's Guide - Designing and Optimizing System Software by: Andrew N Sloss, Dominic Symes, Chris Wright; 2004, Elseiver.
4. Cortex M3 Reference manual.
5. STM32Ldiscovery datasheets, reference manuals & Application notes.

ED752: Embedded Linux

Module Duration: 10 days

Objective

The objective of the course is to provide understanding of the techniques essential to the design and implementation of embedded systems with embedded operating systems.

Course Description

- **Introduction**
  Basic Operating System Concepts
  Linux as Embedded Operating System
  Comparison of Embedded OS

Embedded OS Tools and Development
Discussion on Embedded OS Applications and Products

- **System architecture of a Basic OS**
  Internals of Linux OS
  System Calls, Linux Compiler options, Make
  Process, Multithreading and Synchronization
  Serial port and Network programming with Embedded Linux
  Kernel module programming and Device drivers
- **Inter Process Communication**
  Pipe and FIFOs, Shared memory, Sockets
- **Getting Linux on a device**
  Linux boot sequence, Building Kernel, Building Boot image
- **Practical Sessions**
  Embedded Linux Applications

Learning Outcomes

After successful completion of the module, the students shall be able to:

- Understand the Embedded operating systems that is needed to run embedded systems
- Understand Embedded Linux and its internals
- Build embedded systems using Embedded Linux operating systems

Reading List

1. GNU/LINUX Application Programming, Jones, M Tims
2. Embedded Linux: Hardware, Software, and Interfacing, Hollabaugh, Craig,
3. Building Embedded Linux Systems: Yaghmour, Karim
4. Embedded Software Primer: Simon, David E.
5. Linux Kernel Internals: Beck, Michael At Al
6. UNIX Network Programming : Steven, Richard
7. Linux: The Complete Reference: Petersen, Richard
8. Linux Device Drivers: Rubini, Alessandro, Corbet, Jonathan
9. Linux Kernel Programming: Algorithms and Structures of version 2.4: Beck, Michael At Al
10. Linux Kernel Development: Love, Robert
11. Operating System Concepts, Peter B. Galvin, Abraham Silberschatz, Gerg Gagne, Wiley Publishers

ED753: IoT (Internet of Things) Application Development

Module Duration:25 days

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Objective

The Internet of Things (IoT) is a scenario in which objects, animals or people are provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction.The Internet of Things (IoT, sometimes Internet of Everything) is the network of physical objects or "things" embedded with electronics, software, sensors and connectivity to enable it to achieve greater value and service by exchanging data with the manufacturer, operator and/or other connected devices. Each thing is uniquely identifiable through its embedded computing system but is able to interoperate within the existing Internet infrastructure. Experts estimate that the IoT will consist of almost 50 billion objects by 2020.

The participants of this module will learn various software tools required for developing IoT Application.

Course Description

- **IoT Application Development using Embedded OS**
  - **Cotiki OS, mbedOS**
  - **Cooja Simulator**
- **Iot Database management**
  - Mysql
  - MongoDB
- **IoT platforms**
  - Rpi
  - Arduino - NodeMCU

- **IoT Graphical user interface**
  - Appache web servers
  - HTML, PHP
  - Scripting languages - Python, Bash
- **IoT application development for Android Mobile phones**
- **Advanced Application Development Concepts**
  - Security aspects for IoT applications
  - Data Analytics for IoT
  - IoT Physical Servers and Cloud offerings

Learning Outcomes

After successful completion of this module, students should be able to:

- Understand the IoT application development tools.
- Understand how to Implement IoT Applications.

Reading List

1. 6LoWPAN: The Wireless Embedded Internet, Zach Shelby, Carsten Bormann, Wiley
2. Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems, Dr. Ovidiu Vermesan, Dr. Peter Friess, River Publishers
3. Interconnecting Smart Objects with IP: The Next Internet, Jean-Philippe Vasseur, Adam Dunkels, Morgan Kuffmann
4. The Internet of Things: From RFID to the Next-Generation Pervasive Networked Lu Yan, Yan Zhang, Laurence T. Yang, Huansheng Ning
5. Internet of Things (A Hands-on-Approach) , Vijay Madisetti , Arshdeep Bahga
6. Designing the Internet of Things , Adrian McEwen (Author), Hakim Cassimally
7. Asoke K Talukder and Roopa R Yavagal, "Mobile Computing," Tata McGraw Hill, 2010.
8. Computer Networks; By:Tanenbaum, Andrew S; Pearson Education Pte. Ltd., Delhi, 4th Edition
9. Data and Computer Communications; By:Stallings, William; Pearson Education Pte. Ltd., Delhi, 6th Edition
10. F. Adelstein and S.K.S. Gupta, "Fundamentals of Mobile and Pervasive Computing," McGraw Hill, 2009.
11. Cloud Computing Bible, Barrie Sosinsky, Wiley-India, 2010
12. Cloud Security: A Comprehensive Guide to Secure Cloud Computing, Ronald L. Krutz, Russell Dean Vines, Wiley-India, 2010

ED754:Mini Project Work

Module Duration

- 10 Days

Course Description

The students can select hardware, software or system level projects related to IoT. The project can be implemented using **Microcontroller , WSN, Embedded OS** tools or its combination which students have studied and used during the course. A total product or project can be selected.