INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal - 500 043, Hyderabad, Telangana

COURSE CONTENT

EMBEDDED HARDWARE PLATFORMS AND PROGRAMMING

II Semester: ES

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
BESE06	Elective	3	-	-	3	40	60	100

Contact Classes: 45	Tutorial Classes: Nil	Practical Classes: Nil	Total Classes: 45

Prerequisite: Digital Electronics.

I. COURSE OVERVIEW:

This course deals with a variety of applications including converters that translate between RS-232, RS-485, and 3V/5V logic. Designs with fail-safe features, high noise immunity, and low power consumption are included. USB is the most successful personal-computer interface ever. PCs, tablets, phones, and other devices have USB ports that can connect to everything from keyboards, mice, and game controllers to cameras, printers, drives, audio and video devices, and more.

II. COURSES OBJECTIVES:

The students will try to learn

I.   Using wireless technologies to transmit serial data by selecting suitable buses for different applications.
II. Familiarity with USB peripherals such as mice, keyboards, drives, printers, speakers, and cameras for data acquisition.
III. Implementation of multicast-based communication protocols like Controller Area Network (CAN).
IV. Overview and fundamentals of Peripheral Component Interconnect (PCI) architecture at a high level

III. COURSE OUTCOMES:

At the end of the course students should be able to:

CO 1   Select appropriate low-speed serial buses (RS-232, I²C, SPI, etc.) for various embedded applications.
CO 2   Configure and implement low-speed serial buses for asynchronous communication in embedded systems.
CO 3   Analyze and design communication systems based on the Controller Area Network (CAN) standard.
CO 4   Compare and contrast the architectural perspectives of PCI and PCI Express (PCIe) technologies.
CO 5   Organize and manage different types of USB transfers (control, bulk, interrupt, isochronous) using USB descriptors.
CO 6   Understand the fundamental concepts of communication buses, interfaces, and embedded hardware platforms.

IV. COURSE CONTENT:

MODULE – I: INTRODUCTION TO EMBEDDED SYSTEMS (9)

Embedded systems Overview, Characteristics of embedded computing applications. Design Challenges, Common Design Metrics, Embedded systems Design flow. Processor Technology, IC Technology, Trade-offs. Unified Modeling Language (UML), Activity, diagram, class diagram, component diagram,

use-case diagram, sequence diagram. UML specification examples.

MODULE –II: INTRODUCTION TO ARM PROCESSORS (9)

Introduction to ARM processors, Evolution of ARM processors, pipeline organization, ARM Processor cores and CPU cores. Introduction to ARM Cortex-M Processors, ARM Cortex M4 processor 's architecture, Programmer's model, Special registers, Operation Modes, Memory map, Memory access attributes and overview of Interrupts and exceptions. Keil Microcontroller Development Kit for ARM, Typical program compilation flow, Sample arithmetic and logical assembly language programs

MODULE –III: EMBEDDED SYSTEMS INTERFACING: (9)

Serial Peripheral Interface (SPI), Inter-Integrated Circuit (I2C), RS-232, USB, CAN, IrDA, Bluetooth, Zigbee, AMBA bus protocols.

MODULE –IV: EMBEDDED HARDWARE PLATFORMS (9)

Introduction and specifications of hardware SBC platforms for AI and ML applications: Raspberry Pi 4, Jetson Nano, Jetson Xavier NX, Jetson AGX Xavier, Google Coral, Rock Pi, Beagle Bone AI and PYNQ boards.

MODULE –V: PROGRAMMING ON EMBEDDED HARDWARE PLATFORMS: (9)

Board setup, installation of libraries, and application code development in Python, C and C++ on different embedded hardware platforms.

V. TEXT BOOKS:

1. Joseph Yiu, The Definitive Guide to ARM Cortex-M3 and Cortex-M4 Processors, Newnes Publications; 2013, 3rd Edition.
2. Ata Elahi-Trever Arjeski, ―ARM Assembly language with hardware experiment‖, Springer Int. Publishing, 2015.
3. Santanu Chattopadhya, ―Embedded System Design‖, PHI, 2023,2nd Edition.
4. Articles on Embedded hardware platforms and programming.

VI. REFERENCE BOOKS:

1. Wrox, ― Professional Embedded ARM Development‖
2. William hohl and Christoper Hinds, ―ARM assembly language fundamentals and Techniques‖CRC,2nd Edition,2015.

VII. MATERIALS ONLINE

1. Course template
2. Tutorial question bank
3. Assignments
4. Model question paper - I
5. Model question paper - II
6. Lecture notes
7. Power point presentations
8. Early Lecture Readiness Videos