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Course Code: ECE201R01
Semester: V

MICROPROCESSOR & MICROCONTROLLER
(Common to ECE, EEE, EIE, ECE (CPS), Robotics & Artificial Intelligence, Electronics Engineering (VLSI Design & Technology)

Course Objective

To enable the learner to build small scale embedded systems for wide range of applications using Microprocessor/Microcontroller.

UNIT – I **15 Periods**

Introduction to Microprocessor

Functional units of a computing system - Processor architecture: General internal architecture – Address - Data and control bus - Register set: General Purpose Registers (GPRs) - Status and Control registers - Processor operation – Types of architecture: Von Neumann - Harvard - CISC – RISC.

8086 Microprocessor: Architecture overview – Registers - Memory segmentation - Addressing modes - Overview of assembly Instruction set - Instruction cycle - Timing diagram – Sample assembly programs on ALU operations.

Case study on indigenous processor based on RISC-V ISA.

UNIT – II **15 Periods**

Introduction to ARM & Cortex M3

Introduction to ARM: RISC design philosophy - ARM design philosophy – ARM nomenclature – ARM state registers – Features of ARM instruction set - ARM vs THUMB state.

Introduction to CORTEX series – Features of cortex-M3 – Architecture – Operational modes – Execution pipeline stages – Data types – Register set – Memory map – Bit banding – Power management – Overview of THUMB 2 instruction set – Sample assembly programs using THUMB 2 instruction set.

Unit – III **15 Periods**

STM32: ARM Cortex-M3 based Microcontroller Architecture

Device overview - System architecture block diagram – Bus architecture – Reset and clock control - Memory map – General-purpose and alternate-function I/Os – General purpose timers– DMA - ADC – USART – I2C – NVIC - External interrupt.

Unit – IV **15 Periods**

STM32: Application Programming and Interfacing

Embedded C programming on Cortex-M3: Digital & Analog interface – Counter – Delay generation – PWM generation – Event capturing – DMA – Serial I/O – External interrupt.

Real-world interfacing: Character LCD – Matrix keypad – Stepper motor.

TEXT BOOKS

1. STM32 Reference Manual: RM0008 Rev 21, February 2021. https://www.st.com/resource/en/reference_manual/cd00171190-stm32f101xx-stm32f102xx-stm32f103xx-stm32f105xx-and-stm32f107xx-advanced-arm-based-32-bit-mcus-stmicroelectronics.pdf
2. Muhammad Ali Mazidi, Sarmad Naimi, Sepehr Naimi, *The stm32f103 arm microcontroller and embedded systems: Using assembly and c*, Micro Digital Ed, 1st Edition, 2020.

3. Douglas V. Hall, SSSP Rao, *Microprocessors and Interfacing*, Tata McGraw-Hill, 3rd Edition, 2017.
4. Yiu, Joseph, *The Definitive Guide to ARM® Cortex®-M3 and Cortex®-M4 Processors,* Newnes, Elsevier Inc., 3rd Edition, 2013.

REFERENCES

1. STM32F103C8 Datasheet:DS5319 Rev 18, March 2022. https://www.st.com/en/microcontrollers-microprocessors/stm32f103c8.html
2. Barry B. Brey, *The Intel Microprocessors, 8086/8088, 80186/80188, 80286, 80386, 80486, Pentium, Pentium Pro Processor, Pentium II, Pentium III, Pentium IV, Architecture, Programming & Interfacing*, Prentice Hall, 8th Edition, 2009.
3. Andrew N. Sloss, Dominic Symes, Chris Wright, *ARM System Developer's Guide: Designing and Optimizing System Software*, Elsevier Inc., 2004.

ONLINE MATERIALS

1. NPTEL: Microprocessors and Interfacing: https://onlinecourses.nptel.ac.in/noc20_ee11/preview
2. NPTEL: Embedded System Design with ARM: https://nptel.ac.in/courses/106105193

UNIT-WISE LEARNING OUTCOMES

Upon successful completion of this course, the learner will be able to:

Unit I	• Compare the CPU architectures based on instruction set and bus model • Comprehend the architecture of 8086 microprocessor • Develop simple assembly codes using x86 instruction set
Unit II	• Summarize the architectural features of ARM Cortex M3 CPU core • Develop simple assembly codes using Thumb2 instruction set
Unit III	• Summarize the architectural features of STM32 based microcontroller
Unit IV	• Develop embedded C code for Cortex M3 based microcontrollers • Design small scale embedded systems using microcontroller