CMPE 101- COMPUTER ENGINEERING AS A DISCIPLINE

Module 5-

Overview of Integrated Circuits and Microcontrollers

Lesson Title: Overview of Integrated Circuits and Microcontrollers

Duration: 1 hour

Learning Objectives:

By the end of the lesson, students will:

1. Understand the basic concepts of Integrated Circuits (ICs) and Microcontrollers.

2. Differentiate between ICs and Microcontrollers.

3. Explore real-world applications of ICs and Microcontrollers.

I. Introduction to Integrated Circuits (ICs) (15 minutes)

1. **Definition of Integrated Circuits**:

   o **IC (Integrated Circuit)**: A miniaturized assembly of electronic components, such as transistors, diodes, and resistors, embedded on a semiconductor chip.

   o **Purpose**: Designed to perform various functions like amplification, oscillation, or digital signal processing.

   o **Types**:

      ▪ **Analog ICs**: Handle continuous signals (e.g., audio amplifiers).

      ▪ **Digital ICs**: Deal with discrete signals (e.g., logic gates, microprocessors).

      ▪ **Mixed-Signal ICs**: Combine both analog and digital functions (e.g., analog-to-digital converters).

2. **Key Example**:

   o **Microprocessors**: These are a type of digital IC and are the brain of computers, responsible for processing instructions.

3. **Reference**:

   o **Marwedel, P. (2021).** *Embedded System Design: Embedded Systems Foundations of Cyber-Physical Systems, and the Internet of Things* (3rd ed.). Springer.

II. Introduction to Microcontrollers (15 minutes)

1. **Definition of Microcontrollers**:

- o   A **Microcontroller** is a compact integrated circuit designed to govern a specific operation in an embedded system.
- o   It includes a **CPU**, **memory (RAM/ROM)**, and **I/O ports** on a single chip.

2. **Components**:

- o   **CPU**: Processes instructions.
- o   **Memory**: Stores programs and data (ROM for permanent storage, RAM for temporary data).
- o   **Input/Output Ports**: Interface with sensors, displays, and other peripherals.
- o   **Timers/ADC**: Perform time-based functions and convert analog signals to digital.

3. **Example**:

- o   **Arduino Uno**: Based on the AVR microcontroller, widely used for educational and prototyping purposes.

4. **Reference**:

- o   **Chattopadhyay, S., Banerjee, A., & Mall, R. (2022).** *Embedded Systems* (2nd ed.). Oxford University Press.

III. Comparison Between ICs and Microcontrollers (10 minutes)

1. **ICs**:

- o   General-purpose components performing specific electronic functions (e.g., logic gates, memory chips).
- o   Require external components to function as a complete system.

2. **Microcontrollers**:

- o   A self-contained system with a CPU, memory, and I/O.
- o   Specifically designed for embedded applications (e.g., home appliances, automotive systems).

3. **Reference**:

- o   **Wolf, W. (2020).** *Computers as Components: Principles of Embedded Computing System Design* (4th ed.). Morgan Kaufmann.

IV. Real-World Applications of ICs and Microcontrollers (10 minutes)

1. **Integrated Circuits**:

- o   **Computers**: Microprocessors and memory ICs form the foundation of computers.
- o   **Consumer Electronics**: Smartphones, laptops, and gaming consoles.

2. **Microcontrollers**:

   o **Automotive Systems**: Microcontrollers manage functions like engine control and anti-lock braking systems (ABS).

   o **IoT Devices**: Smart home devices such as thermostats, security cameras, and wearables.

3. **Reference**:

   o **Saponara, S., & De Gloria, A. (Eds.). (2021).** *Applications in Electronics Pervading Industry, Environment, and Society: APPLEPIES 2020*. Springer.

V. Summary and Q&A (10 minutes)

- **Recap Key Points**:

   o Definition and role of Integrated Circuits (ICs) and Microcontrollers.

   o Key differences between ICs and Microcontrollers.

   o Applications in modern industries.

- **Questions**: Open the floor for student queries and clarifications.

References (2019-2024):

1. **Marwedel, P. (2021).** *Embedded System Design: Embedded Systems Foundations of Cyber-Physical Systems, and the Internet of Things* (3rd ed.). Springer.

2. **Wolf, W. (2020).** *Computers as Components: Principles of Embedded Computing System Design* (4th ed.). Morgan Kaufmann.

3. **Chattopadhyay, S., Banerjee, A., & Mall, R. (2022).** *Embedded Systems* (2nd ed.). Oxford University Press.

4. **Saponara, S., & De Gloria, A. (Eds.). (2021).** *Applications in Electronics Pervading Industry, Environment, and Society: APPLEPIES 2020*. Springer.