Savitribai Phule Pune University
S.Y.B.Sc. (Computer Science) Sem-III
Course Type: Minor Code: CS-241-MN
Course Title: Embedded System with AVR Microcontroller

Teaching Scheme	No. of Credits	Examination Scheme
02 Hrs./Week	2	IE: 15 Marks UE: 35 Marks

Course Objective:

- To understand the fundamental concepts of embedded systems and microcontrollers.
- To explore the architecture and features of the AVR microcontroller family.
- To understand the memory organization of AVR microcontroller.
- To gain proficiency in programming AVR microcontrollers using the C language.
- To understand and implement peripheral interfacing with real-world applications.
- To develop embedded solutions using timers, interrupts, serial communication, and protocols like SPI and I2C.

Course Outcomes:

After completing this course, students will be able to:

- **CO1**: Explain the basic concepts of embedded systems and compare microcontrollers and microprocessors.
- **CO2**: Describe AVR microcontroller architecture, including memory structure, register file, and development tools.
- **CO4**: Implement AVR microcontroller-based applications using C, including timers, counters, I/O & serial operations.
- **CO5**: Interface AVR microcontrollers with external devices such as LCDs, sensors, motors, and ADC/DAC components.
- **CO6**: Design embedded applications involving serial communication and peripheral interfacing using standard protocols (SPI, I2C).

COURSE CONTENTS

Chapter-1	Introduction to Embedded System and Microcontroller	06 Hrs.

Introduction to Embedded Systems: Embedded systems: introduction, characteristics, elements and applications. Design metrics: NRE cost, unit cost, time to market, safety, maintenance, size, cost and power dissipation. Software development tools: editor, assembler, linker, compiler, IDE, ICE, programmer and simulator.

Microcontroller & Architectures: History, introduction, classification, applications. Differences between microcontroller and microprocessor, criteria for choosing a microcontroller. Architectures - Harvard and Von-Neumann architecture, RISC vs CISC. Concept of pipelining.

Chapter-2	Fundamentals of AVR & Its Programming in C	06 Hrs.

AVR Architecture: Overview of AVR, classification of AVR family, AVR (ATmega16/32) architecture, AVR processor memory map, CPU registers, ALU, I/O ports, peripherals in AVR.

Programming of AVR in C: basic structure, data types, operators, library files, delay functions and bitwise operation syntax. Simple C programs: Data transfer operation, arithmetic operation, decision making and code conversion**.**

Chapter-3	AVR Peripherals Programming in C	10 Hrs.

AVR Timer Programming: introduction, difference between timer and counter operation, Basic SFR Registers used – Timer 0, 1 & 2, C programs for delay generation, counter Programming.

AVR Serial Port Programming: Basics of serial communication (serial vs parallel, simplex vs duplex), difference between Asynchronous & synchronous communication, USART operation, SFR used, C programs for data transmission and reception.

I2C and SPI: introduction, specifications, bus signals, master-slave configuration, error handling and addressing. SFR used in AVR, C programs to transfer and receive information.

On-chip ADC: features, block diagram, operation, SFR used, C programs to convert the analog signal to digital.

Chapter-4	Real World Interfacing with AVR & Case Studies	08 Hrs.

I/O device interfacing: LED, push button, buzzer, seven segment display, Thumbwheel switch, DC and stepper motor, relay interfacing, 16*2 LCD interfacing, DAC interfacing (waveform generation using DAC).

Case studies: Traffic Light controller using AVR, Single digit event counter using opto-interrupter and SSD, Real time clock using IC DS1307 chip, temperature monitoring system using LM35 sensor, smart phone controlled devices using Bluetooth module HC05.

Reference Books:

1. The AVR Microcontroller and Embedded System using Assembly and C - By Muhammad Ali Mazidi, Sarmad Niami and Sepehr Naimi – Prentice Hall, Pearson.
2. Programming and customizing the AVR Microcontroller – By Dhananjay V. Gadre, McGraw Hill Publication.
3. Embedded System Design: A Unified Hardware/Software. Approach - Frank Vahid and Tony Givargis.

Savitribai Phule Pune University
S.Y.B.Sc. (Computer Science) Sem-III
Course Type: Minor **Code: CS-242-MNP**
Course Title: Lab course on Embedded System with AVR Microcontroller

Teaching Scheme	No. of Credits	Examination Scheme
04 Hrs./Week	2	IE: 15 Marks UE: 35 Marks

Course Objective:

- Understand the fundamental concepts of microcontrollers programming.
- Explore the Embedded C with the AVR microcontroller family.
- Learn and apply AVR programming techniques.
- Gain proficiency in programming AVR microcontrollers using the C language.
- Understand and implement peripheral interfacing with real-world applications.
- Develop embedded solutions using timers, interrupts, serial communication, and protocols like SPI and I2C.

Course Outcomes:

On successful completion of this course, students will be able to:

- **CO1**: Explain the basic concepts of embedded systems design.
- **CO2**: Describe AVR microcontroller architecture, including memory structure, register file, and development tools.
- **CO3**: Implement AVR microcontroller-based applications using C, including timers, counters, and I/O operations.
- **CO4**: Interface AVR microcontrollers with external devices such as LCDs, sensors, motors, and ADC/DAC components.
- **CO5**: Design embedded applications involving serial communication and peripheral interfacing using standard protocols (SPI, I2C).

COURSE CONTENTS

Part – A **Experiment (Any 12)**

1. To get familiarize with AVR target board, understand the use of software development tools (AVR Studio), perform necessary installation procedure and perform basic exercises like arithmetic, logical and data transfer operation.
2. Study of LED Array interfacing to AVR and program to display various patterns on LED array.
3. Study of Event Counter using opto-interrupter and SSD.
4. Study of Intrusion detection security system using IR / PIR sensor and Buzzer.
5. Study of SSD interfacing and write program for rolling display.
6. Study of Interfacing thumb wheel switch to AVR and display input data on SSD.
7. Study of 16*2 LCD interfacing and its programming.

8. Study of Traffic light controller using AVR.
9. Write a program to get the status of the switch and turn on / off LED / buzzer / AC appliances using relay.
10. Study to control devices using Smart phone & Bluetooth Module HC05.
11. Study of waveform generations using DAC and AVR.
12. Study of DC motor interfacing and write a program to vary speed of DC motor using PWM.
13. Study of Stepper Motor interfacing and write a program for clockwise and anticlockwise rotation of motor.
14. Study of interfacing LM35 sensor to on chip ADC of AVR and display temperature on LCD.
15. Study of Light intensity measurement using LDR sensor and AVR.
16. Study of blinking LED, generate a delay using AVR Timer.
17. Write a simple serial communication program to send message between the AVR and PC.
18. Study of interfacing EEPROM to AVR and write a program to read / write data from it.
19. Study of interfacing RTC chip DS1307 to AVR and display the Date & time on LCD.
20. Study to interface of DHT11 and programming using AVR.

Part – B	**Activity (Any One Equivalent to 3 Experiments)**

1. Survey/Case study/ Literature Review on "Latest Electronic Technologies"
2. Perform any one experiment from group-A using any simulation software (Give preference to the experiment from group-A which is not performed).

Reference Books:

1. The AVR Microcontroller and Embedded System using Assembly and C - By Muhammad Ali Mazidi, Sarmad Niami and Sepehr Naimi – Prentice Hall, Pearson.
2. Programming and customizing the AVR Microcontroller – By Dhananjay V. Gadre, McGraw Hill Publication.
3. AVR Datasheets and Application Notes – Atmel/Microchip.

Savitribai Phule Pune University
S.Y.B.Sc. (Computer Science) Sem-IV
Course Type: Minor Code: CS-291-MN
Course Title: Advance Communication

Teaching Scheme	No. of Credits	Examination Scheme
02 Hrs./Week	2	IE: 15 Marks UE: 35 Marks

Course Objective:

- To learn basics of communication system.
- To understand different digital modulation techniques.
- To understand multiplexing techniques and its requirement in communication.
- To understand the spread spectrum techniques.
- To Introduce cellular communication satellite communication.
- To Understand Wireless Sensor Network Technologies.

Course Outcomes:

- **CO1: -** Understand terminologies of wireless communication.
- **CO2: -** Understand the working of different modulation techniques.
- **CO3: -** Understanding the basic concept of error handling codes.
- **CO4: -** The idea behind the spread spectrum schemes and multiplexing scheme.
- **CO5: -** Understand cellular and satellite communication technology.
- **CO6: -** Understand basic idea of WSN.

COURSE CONTENTS

Chapter-1	Introduction to Communication System	06 Hrs.

Introduction to Communication System: Elements of digital Communication System (block diagram and explanation).

Characteristics of Communication Channel: Signal, Signal Types, Signal Bandwidth, Channel Bandwidth, Signal to noise ratio, Noise figure, data rate, baud rate, channel capacity, Shannon-Hartley theorem. (Definition only).

Signal encoding: Types of signal encoding formats, M-ary coding (Concept level),

Error Handling Codes: Necessity of error control codes, types of error handling codes, Hamming code (Error detection and correction).

Modulation and Demodulation: Definition of modulation and demodulation, need of modulation, classification of Modulation.

Chapter-2	Digital Modulation, Multiplexing and Spread Spectrum Techniques	08 Hrs.

Pulse Modulation: Nyquist Sampling theorem, PCM (Transmitter and receiver block diagram, Advantages, disadvantages and application), Concept of Delta modulation and Adaptive delta modulation.

Digital Modulation Techniques: ASK, PSK (concept, waveform and application), FSK, QPSK, (Transmitter end block diagram, working, waveforms, application), 4-QAM (Phaser Diagram, Constellation diagram and Application.)

Multiplexing Techniques: Necessity of signal multiplexing, FDM, TDM, CDM, OFDM (Conceptual diagram and working).

Spread Spectrum Techniques: Introduction to Spread Spectrum (SS), Frequency Hopping Spread Spectrum (FHSS) and Direct Sequence Spread Spectrum (DSSS), Pseudo-random (PN) sequence.

Chapter-3	Cellular and Satellite Communication	08 Hrs.

Cellular Communication: Cell and cellular telephony, frequency reuse and hand- off, LTE, UMTS, 4G, 5G architecture network, handovers in 5G, future generation 6G.

Types of Antennas: Working principle of dipole antenna and patch antenna.

Concept of Smart Antennas: Importance & block diagram of MIMO, concept of MU-MIMO and Massive MIMO.

Satellite Communication: Segments, orbits, uplink and downlink (block diagram and frequencies), and applications.

Chapter-4	Modern Communication Technology	08 Hrs.

Wireless Sensor Network: Sensing & Actuation (Concept only), WSN Architecture, WSN topologies, Types of nodes (Coordinator, Router and End Device).

Wireless Communication Protocols: Bluetooth, Wi-Fi & RFID.

Data Acquisition: Basic of Arduino platform (Pin Diagram and significance of each pin), I/O control and data acquisition using Arduino.

Introduction of IoT: Definition, Characteristics, Challenges and IoT applications.

Reference Books

1. Communication Electronics: Principles and Applications, Frenzel, Tata Mc Graw Hill publication, 5th edition.
2. Data Communication and Networking, Forouzan, Mc Graw Hill publication, 5th edition
3. Wireless Communications Principles and Practice, Theodore S. Rappaport, Pearson Publication, Second Edition
4. Lal Chand Godara, "SMART ANTENNAS" , CRC PR ESS, 2004
5. Leeladhar Malviya M.V. Kartikeyan and Rajib Kumar Panigrahi-MIMO Antennas for Wireless Communication-Theory and Design- CRC Press 2020
6. Wireless Sensor Networks Technology: Protocols and Applications - Kazem Sohraby, Daniel Minoli and Taieb Znati, John Wiley and Sons.
7. Arduino Made Simple with Interactive Projects by Ashwin Pajankar.
8. Kamal, R.,"Internet of Things – Architecture and Design Principles," 1st Edition, Mc-Graw Hill,2017.

Savitribai Phule Pune University

S.Y.B.Sc. (Computer Science) Sem-IV

Course Type: Minor Code: CS-292-MNP

Course Title: Lab Course Based on Advance Communication

Teaching Scheme	No. of Credits	Examination Scheme
04 Hrs./Week	2	IE: 15 Marks UE: 35 Marks

Course Objective:

- To understand basic modulation process.
- To understand sampling and quantization process.
- To understand error handling methods.
- To understand the shift keying techniques.
- To understand the concept of multiplexing and PN sequence generation.
- To understand about antenna basics and smart phone handset.
- To study sensing and acquisition process.

Course Outcomes:

- **CO1: -** Understand use of modulation and demodulation.
- **CO2:** - Understand use of sampling theorem.
- **CO3: -** Understand the error detection and correction techniques.
- **CO4:** - Understand the shift keying techniques.
- **CO5: -** Understand the concept of PN sequence and multiplexing.
- **CO6: -** Understand the different parts of smart mobile handset and Antenna working.
- **CO7: -** Understand how to acquire sensor signal and monitoring the data.

COURSE CONTENTS

Group-A Experiments (Any 12)

1.	Study of Amplitude Modulation.
2.	Study of Sample and Hold circuit.
3.	Study of Pulse Width Modulation (PWM).
4.	Study of 3- or 4-Bit Pulse code modulation (PCM) Technique.
5.	Study of Delta Modulation.
6.	Error Detection and Correction using Hamming code.
7.	Study of Frequency Shift Keying (FSK).
8.	Study of Binary Phase Shift Keying (BPSK).
9.	Study of Time Division Multiplexing (TDM).
10.	Study of PN sequence Generator circuit.
11.	Demonstration / Identification of different parts of smart mobile handset.
12.	Study of Radiation pattern of Antenna.
13.	To study Arduino based LED pattern generation.
14.	Ultrasonic sensor for motion detection using Arduino.
15.	Arduino based automatic Door control System Using Servomotor.
16.	Temperature and humidity sensing and monitoring using Arduino.
17.	Gas Leak Detection and controlling Using gas sensor using Arduino.

Group-B Activity (Any One Equivalent to 3 Experiment)

1. Electronics hobby Project.
2. Development of Wireless sensor node.
3. Visit to any electronics related Industry and prepare the report.

Reference Books:

1. Communication Electronics: Principles and Applications, Frenzel, Tata Mc Graw Hill publication, 5th edition.
2. Data Communication and Networking, Forouzan, Mc Graw Hill publication, 5th edition
3. Wireless Communications Principles and Practice, Theodore S. Rappaport, Pearson Publication, Second Edition
4. Lal Chand Godara, "SMART ANTENNAS", CRC PR ESS, 2004
5. Leeladhar Malviya M.V. Kartikeyan and Rajib Kumar Panigrahi-MIMO Antennas for Wireless Communication-Theory and Design- CRC Press 2020
6. Wireless Sensor Networks Technology: Protocols and Applications - Kazem Sohraby, Daniel Minoli and Taieb Znati, John Wiley and Sons.
7. Arduino Made Simple with Interactive Projects by Ashwin Pajankar.
8. Kamal, R.,"Internet of Things – Architecture and Design Principles," 1st Edition, Mc-Graw Hill,2017.