EMBEDDED SYSTEMS
(AEIE 5201)

Time Allotted : 2½ hrs **Full Marks : 60**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 4 (four) from Group B to E, taking one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A

1. Answer any twelve: **12 × 1 = 12**

Choose the correct alternative for the following

(i) Which of the following is an example of a real-time embedded system?
(a) Smart TV (b) Digital Camera
(c) Pacemaker (d) Video Game Console

(ii) What type of OS is commonly used in embedded systems?
(a) General-purpose OS (b) Real-time OS (RTOS)
(c) Multi-user OS (d) Network OS

(iii) The internal EEPROM size in an ATmega328 Microcontroller is-
(a) 1KB (b) 2KB (c) 32KB (d) 1MB

(iv) What is the bit length of ATmega328 Microcontroller?
(a) 4 (b) 8 (c) 16 (d) 32

(v) The pin numbers in Port C of the ATmega328 is-
(a) PC0 to PC4 (b) PC0 to PC6
(c) PC0 to PC7 (d) PC0 to PC8

(vi) Which processor architecture is used in Raspberry Pi boards?
(a) x86 (b) ARM (c) MIPS (d) SPARC

(vii) Which GPIO library is commonly used for controlling hardware on a Raspberry Pi using Python?
(a) wiringPi (b) RPi.GPIO
(c) OpenCV (d) PySerial

(viii) What is the default user name in Raspberry Pi OS?
(a) root (b) admin
(c) pi (d) user

(ix) How many digital input/output (I/O) pins are available on the Arduino Uno?
(a) 10 (b) 12 (c) 14 (d) 16

(x) Which of the following wireless communication features are available on the Raspberry Pi 3 Model B?

(a) Bluetooth 4.1 and Wi-Fi (b) Zigbee and Wi-Fi
(c) NFC and Bluetooth (d) LoRa and Wi-Fi

Fill in the blanks with the correct word

(xi) In embedded system gated clock improves _____.

(xii) ATmega328 microcontroller has _____ number of instructions.

(xiii) In an embedded system, the communication protocol _____ is commonly used for interfacing Raspberry Pi with sensors and peripherals using serial communication.

(xiv) The function used to read an analog input in Arduino programming is _____.

(xv) The Arduino Uno operates at a clock speed of _____ MHz.

Group - B

2. (a) With block diagram explain the architecture of an embedded system, including its main components and their roles. *[(CO1)(Remember/LOCQ)]*

(b) Classify the embedded system based on deterministic behaviour. *[(CO1)(Remember/LOCQ)]*

(c) How does the constant folding optimization technique improve code performance? Provide a specific code example to illustrate its application. *[(CO2)(Analyze/IOCQ)]*

6 + 2 + 4 = 12

3. (a) What are the advantages of compiler optimization? *[(CO1)(Remember/LOCQ)]*

(b) With one suitable diagram explain the working of LUT in FPGA. *[(CO1)(Remember/LOCQ)]*

(c) Briefly discuss the gated clock and dynamic power management techniques to improve the energy efficiency of a processor. *[(CO1)(Remember/LOCQ)]*

2 + 4 + 6 = 12

Group - C

4. (a) Briefly discuss the function of DDRB and PORTB registers in ATmega328p-pu microcontroller. *[(CO1) (Remember/LOCQ)]*

(b) Discuss the SRAM memory organization in ATmega328p-pu microcontroller. *[(CO1) (Remember/LOCQ)]*

(c) Write an assembly level program to write 'XX' in EEPROM memory location 0100_H of ATmega328p-pu microcontroller. Where, 'X' is the last digit of your autonomy roll number. *[(CO1) (Apply/IOCQ)]*

(2 + 2) + 4 + 4 = 12

5. (a) Write the features of USART data communication protocol. *[(CO6) (Remember/LOCQ)]*

(b) Write an AVR program for ATmega328p-pu microcontroller to transmit the data 'A' repeatedly using USART data communication protocol. Use 9600 baud rate, 8 data bit, 1 stop bit and XTAL frequency of 8 MHz. *[(CO6) (Solve/IOCQ)]*

4 + 8 = 12

Group - D

6. (a) What is the function of a kernel? What is kernel space and user space? *[(CO4) (Remember/LOCQ)]*

(b) List the basic functions of real time kernel. *[(CO4) (Remember/LOCQ)]*

(c) Explain the structure of TCB. *[(CO4) (Remember/LOCQ)]*

(2 + 2) + 4 + 4 = 12

7. (a) Write a Python code to blink a LED for 50 times. *[(CO5) (Apply/IOCQ)]*

(b) Design a circuit to interface one temperature sensor (LM35) to Raspberry Pi board using MCP3002 ADC. *[(CO4) (Design/HOCQ)]*

(c) Write Python code for the above circuit to read data from temperature sensor and display it. *[(CO5) (Apply/IOCQ)]*

4 + 3 + 5 = 12

Group - E

8. (a) What is the purpose of the HDMI port on the Raspberry Pi 3 board? *[(CO2) (Remember/LOCQ)]*

(b) Design a circuit to interface an ultrasonic sensor (HC-SR04) and a buzzer with Arduino Uno. *[(CO4) (Design/HOCQ)]*

(c) Write an Arduino program to activate the buzzer when an object is detected within 10 cm. *[(CO4)(Solve/IOCQ)]*

2 + 4 + 6 = 12

9. (a) What type of storage is used by the Raspberry Pi 3 for the operating system and files? *[(CO2) (Remember/LOCQ)]*

(b) Design a circuit to interface a push button and a buzzer to an Arduino Uno board. *[(CO4) (Design/HOCQ)]*

(c) Write a program for the above circuit. When the button is pressed, the buzzer should sound for 2 seconds. If the button is held down for more than 5 seconds, the buzzer should emit a series of short beeps (e.g., 3 beeps). *[(CO4)(Solve/IOCQ)]*

2 + 4 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	50	36.46	13.54