

EMBEDDED SYSTEMS
(AEI3201)

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) Embedded systems are designed to-
 - (a) Change the state of a device
 - (b) Measure the state of a device
 - (c) Regulate a physical variable
 - (d) All of these
- (ii) Which of the following is used as system core in a 2nd generation ES?
 - (a) 8 bit Microprocessor
 - (b) 16 bit Microprocessor
 - (c) Multi-core processor
 - (d) SoC
- (iii) The instruction set of RISC processor is-
 - (a) Simple and lesser in number
 - (b) Complex and lesser in number
 - (c) Simple and larger in number
 - (d) Complex and larger in number
- (iv) The ATmega328 microcontroller has an inbuilt EEPROM of -
 - (a) 1 KB
 - (b) 2 KB
 - (c) 32 KB
 - (d) 64 KB
- (v) The ATmega328 microcontroller has an inbuilt SRAM of -
 - (a) 1 KB
 - (b) 2 KB
 - (c) 32 KB
 - (d) 64 KB
- (vi) In SPI protocol, which pin is used to enable Slave device?
 - (a) SCK
 - (b) SS
 - (c) MISO
 - (d) MOSI
- (vii) RTOS can be categorised in to
 - (a) 2
 - (b) 3
 - (c) 4
 - (d) 5
- (viii) ISR stands for
 - (a) Internal Service RTOS
 - (b) Internal Service Routines
 - (c) Interrupt Service Routines
 - (d) None of These

- (ix) What is the clock speed of the ATmega328P microcontroller on the Arduino Uno?
 (a) 8 MHz (b) 12 MHz
 (c) 16 MHz (d) 20 MHz
- (x) How many analog input pins does the Arduino Uno have?
 (a) 4 (b) 6
 (c) 8 (d) 10

Fill in the blanks with the correct word

- (xi) In FPGA, CLB stands for _____.
 (xii) ATmega328 is a ____ bit microcontroller.
 (xiii) The full form SPI protocol is _____.
 (xiv) Task is a Kernel controlled entity where _____ Process controlled entity.
 (xv) The Arduino Uno is based on the _____ microcontroller.

Group - B

2. (a) What is an embedded system? [[CO1] (Remember/LOCQ)]
 (b) Describe briefly the differences between an embedded system and a general computing system. [[CO1] (Remember/LOCQ)]
 (c) Compare general-purpose processors (GPPs) and single-purpose processors (SPPs), outlining their key features, advantages, and limitations. [[CO2] (Understand/LOCQ)]
2 + 4 + 6 = 12
3. (a) What are the primary elements of an embedded system? [[CO1] (Remember/LOCQ)]
 (b) Briefly discuss the DVS and Thermal Throttling techniques to improve the energy efficiency in an embedded system. [[CO2] (Understand/LOCQ)]
 (c) Why is RISC architecture preferred over CISC architecture in embedded systems? [[CO2] (Remember/LOCQ)]
2 + (4 + 3) + 3 = 12

Group - C

4. (a) Write down the main features of the ATmega328 microcontroller. [[CO3] (Remember/LOCQ)]
 (b) Draw the Status Register of ATmega328 microcontroller and briefly discuss the function all the flag bits. [[CO3] (Remember/LOCQ)]
 (c) In ATmega328 microcontroller, the CPU clock frequency is 16 MHz. From the following select the best possible pre-scalar value for the ADC module.
 i. ADPS2:0 = 010 ii. ADPS2:0 = 100 iii. ADPS2:0 = 111. [[CO4] (Apply/IOCQ)]
4 + (1 + 4) + 3 = 12
5. (a) Write the main features of SPI data communication protocol. [[CO3] (Remember/LOCQ)]
 (b) Draw and discuss the SPCR register of ATmega328 microcontroller. [[CO3] (Remember/LOCQ)]

- (c) Write a C program to initialize ATmega328 microcontroller as MASTER to transmit the data 'X' repeatedly using SPI data communication protocol, and display the received data on Port D. Use CLCK frequency of $F_{osc}/16$, and transmit LSB of the data first. 'X' is the first letter of your name. [[CO4] (Apply/IOCQ)]
4 + 4 + 4 = 12

Group - D

6. (a) Define: Thread and Process. Describe structure and purpose of a Process Control Block. [[CO5] (Remember/IOCQ)]
 (b) Write the Kernel services in an OS? [[CO5] (Remember/LOCQ)]
(1 + 1 + 6) + 4 = 12
7. (a) Explain the features of RTOS? [[CO5] (Remember/LOCQ)]
 (b) Explain different task scheduling models of an RTOS. [[CO5] (Explain/IOCQ)]
3 + 9 = 12

Group - E

8. (a) Design a circuit to interface one LM35 temperature sensor and one LED to Arduino Uno board. [[CO6] (Create/HOCQ)]
 (b) Write a program for the above circuit to check the current ambient temperature and turns on the LED when the temperature exceeds X0°C; otherwise, the LED is turned off.
 Where, X is the last digit of your autonomy roll number. If the last digit of your autonomy roll number is '0', then take X as 1. [[CO6] (Solve/IOCQ)]
 (c) What is the sensitivity and temperature measurement range of LM35 sensor? [[CO1] (Remember/LOCQ)]
4 + 6 + 2 = 12
9. (a) Design a circuit to interface an ultrasonic sensor (HC-SR04) and a buzzer with Arduino Uno. [[CO6] (Create/HOCQ)]
 (b) Write an Arduino program to activate the buzzer when an object is detected within 10 cm. [[CO6] (Solve/IOCQ)]
 (c) What is the operating voltage range of the HC-SR04 ultrasonic sensor? [[CO1] (Remember/LOCQ)]
4 + 6 + 2 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	54.16	37.51	8.33

