Midterm Exam – Spring 2023
CS 4380: Embedded Systems
CS 5331: Sp Problems in CS: Cyber Physical Systems

Department of Computer Science, Texas Tech University

Date: Mar. 09, 2023. Time: 5:00 PM – 6:20 PM. Room: Elec 101

Instructor: Dr. Morshed, Assoc. Prof. **Number of pages: 7**

Exam duration: 80 minutes **Marks: 15**

Name:	**R number:**
Signature:	**Date:**

EXAM RULES

1. **Before you begin the exam, complete the information section above.**
2. **Use this question paper to answer all your work (including rough work). Use of additional paper is not allowed. If needed, use the blank backside of this exam paper with appropriate indicators.**
3. **Show all your work in details. Partial marks will be awarded for proper procedure even if the result is incorrect.**
4. **In case of excess number of attempts, the EXTRA ATTEMPT AT THE END OF THAT SECTION WILL BE DISCARDED.**
5. **No clarification of questions will be provided during the exam. If a question requires you to make an assumption, state the assumption clearly with proper rationale.**
6. **This is a CLOSED BOOK exam. A NON-PROGRAMMABLE CALCULATOR is allowed.**
7. **ALL PHONES MUST BE COMPLETELY TURNED OFF. A clock display will be available during the exam.**

Section A: Answer any **5 (five)** out of 6 (six) questions:

5 X 3	=	15
Total Marks	**=**	**15**

Section A: Answer any FIVE (5) questions. (5x3 = 15 marks)

1. **a)** For an embedded system product with a market life of 60 months, compare the revenues for an on-time product and a delayed by 10 months product. Assume the revenue peak is $100K. Use the triangular approximation model for the market window. Also, determine the percentage loss of revenue for the delayed product.

b) If a product unit cost is $40, and NRE cost is $10,000, determine the minimum quantity of units to be produced to keep per-unit cost below $50.

2. **a)** Write 4 differences between microprocessor and microcontroller.
b) What is Arduino Uno? What is the model number of the microcontroller in Arduino Uno?
c) Compare and contrast: Cyber-physical system (CPS) vs Embedded System?

3. **a)** What is OS-less system? How it works? What are the advantages and disadvantages of this type of microcontroller system?

b) Write a complete C code for Arduino Uno (both setup() and loop() functions) to set the Pin 13 to blink an LED with ON time of 300 ms and OFF time of 200 ms.

4. **a)** What is DMA? Why DMA is useful?

b) Write an Arduino program for a night light, where a light sensor is connected to analog input pin A0, and a light (LED) is connected to a digital output pin 3. If the analog sensor value is below 500, the LED should be ON, otherwise OFF. Check the analog sensor once every 5 seconds. Also, the code should display the analog sensor value using the serial monitor (Baud rate = 9600) to a connected computer.

5. Write a complete Arduino Uno C code (both setup() and loop() functions) to read an analog temperature sensor once every second and connected to A2 pin. The temperature value is received as a digital reading between 0 to 255, where 0 corresponds to 30F and 255 corresponds to 150F. The code should turn ON pin 6 if temperature value is below 70°F and turn OFF if above 70°F. The code should also turn ON pin 7 if temperature value is above 75°F and turn OFF if below 75°F. Also, each temperature reading data must be send to computer via Serial port at 9600 Baud rate.

6. **a)** Draw a diagram of a ring buffer with detailed labeling, and briefly describe how it operates.
b) Explain the differences between polling and interrupt mechanism for an input port. What are the advantages and disadvantages? Provide two scenarios where one is preferred over the other.