ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

Department of Computer Science and Engineering (CSE)

SEMESTER FINAL EXAMINATION **WINTER SEMESTER, 2021-2022**

DURATION: 3 HOURS **FULL MARKS: 150**

SWE 4739: Embedded Software Development

Answer all **6 (six)** questions. Marks of each question and corresponding CO and PO are written in the right margin with brackets.

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1. a) What is an Embedded Software? What are the development tools and software components that are used in developing Embedded Software? 7 (CO1) (PO1)

   b) Explain the design challenges of an Embedded System. How are these challenges different from a Desktop application? 8 (CO2) (PO1)

   c) Discuss the characteristics of an Embedded Software. What are the differences between an Embedded Software and an Embedded System? 7+3 (CO2) (PO1)

2. a) It is common to use a microprocessor or a microcontroller to develop an Embedded System. What factors do you consider to choose a microprocessor or a microcontroller? 5 (CO1) (PO1)

   b) Explain in detail the hypothetical design flow of an Embedded System. Briefly discuss Gajski's Y chart iterative design flow with an example. 10 (CO2) (PO1)

   c) Processors can be varied into three to develop Embedded Software in their customization of the problem. Discuss their pros and cons with an example. 10 (CO2) (PO1)

3. a) How do the linker and the loader work? Write five differences between the Linker and the Loader. 5+5 (CO2) (PO1)

   b) Design a combinational circuit using Read Only Memory (ROM) that takes 3-bit numbers as inputs and generates an output binary number equal to the square of the input number. 15 (CO2) (PO2)

4. You are given a pseudocode that calculates the Greatest Common Divisor (GCD) of two numbers shown in Figure 1.

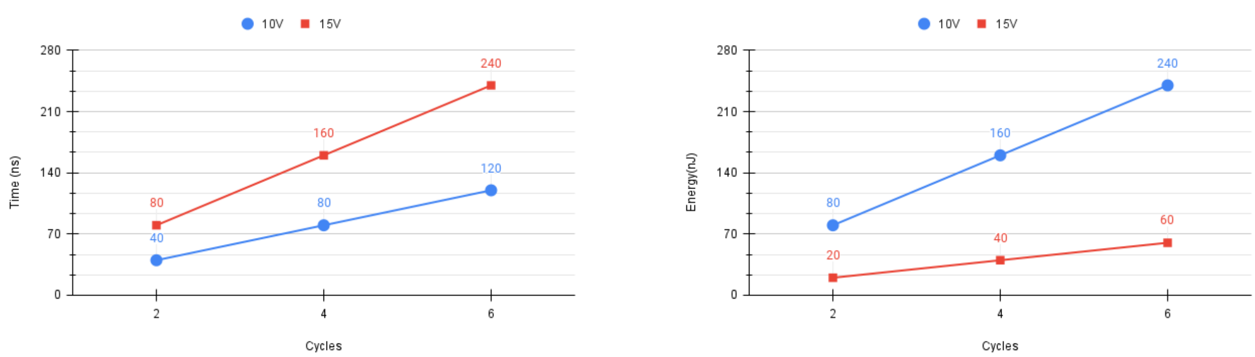
   a) Design a single-purpose processor with the following requirements- 5+5+5 (CO4) (PO3)
      i. Finite State Machine with Data (FSMD)
      ii. Datapath
      iii. FSM controller

```
int x, y;
while(1){
    while(!go_in);
    x = x_in;
    y = y_in;
    while(x!=y){
        if(x<y)
            y = y - x;
        else
            x = x - y;
    }
    d_out = x;
}
```

Figure 1: GCD of two numbers for Question 4

b) Optimize the implementation shown in Figure 1 and based on the modified code snippet, update the requirements mentioned in 4.a). 2+8 (CO3) (PO2)

5. Assume an Embedded System where two voltage sources (15V and 10V) and one microprocessor are attached. The microprocessor can use one of the voltage sources at a given time. For a specific task, the distributions of time and cost of energy over the number of cycles are given in Figure 2. **Specification of the task**: a basic home intruder detection system that consists of a PIR sensor, a Buzzer, and a red LED bulb. Whenever there is a movement of the given area that PIR is covered, the Buzzer will sound and the bulb will start blinking.



(a) Cycle time

(b) Energy per cycle

Figure 2: Distribution of time and energy over cycles

a) Analyze the above specification and write the *setup()* and *loop()* functions for Arduino. 5 (CO1) (PO1)

b) According to the above scenario, find the optimal combination where a task needs to execute 10^9 cycles within 25 seconds. To find the optimal combination, you can split the total time into 5 intervals. 10 (CO2) (PO2)

c) What are the things you consider for optimization? Explain with examples considering both hardware and software. 10 (CO2) (PO1)

6. Consider the following scheduling problem consisting of three tasks (assume that all tasks arrive at time 0). Here, Rate Monotonic Scheduling (RMS) and Earliest Deadline First (EDF) are applied to measure the performance of the scheduling problem.

Task	Period	Deadline	Execution Time (s)
A	10	10	4
B	15	15	4
C	18	18	6

Table 1: Data for Question 6

a) From an implementation perspective, what are the advantages/disadvantages of an RMS vs. an EDF scheduler? 5 (CO1) (PO1)

b) Compare the performance of RMS and EDF on the above task sets. 20 (CO3) (PO2)