AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING

Computer and Systems Engineering Department
Program of Mechatronics Engineering

Summer Semester 2019	**Course Code: *CSE 347***	***Time allowed: 3 Hrs.***

Embedded System Design

The Exam Consists of **Four** Questions in **two** Pages. ***Maximum Marks: 40 Marks*** **1 / 2**

تعليمات هامة

- حيازة التيلفون المحمول مفتوحا داخل لجنة الأمتحان يعتبر حالة غش تستوجب العقاب وإذا كان ضرورى الدخول بالمحمول فيوضع مغلق فى الحقائب.
- لا يسمح بدخول سماعة الأذن أو البلوتوث أو الأجهزة الإلكترونية.
- غير مسموح بدخول أي كتب أو ملازم أو أوراق داخل اللجنة.

Question 1: (10 Marks)

a. What is the worst response time for the background process in a foreground-background system in which the background requires 100 milliseconds to complete, foreground task F executes every 50 milliseconds and requires 25 milliseconds to complete, and context switching requires no more than 100 microseconds (recall that background task may be preempted)

b. Calculate processor utilization and hyper-period for the following task set:

Task#	E	P
1	3	7
2	5	16
3	3	15

Question 2: (10 Marks)

a. Verify the schedulability under earliest deadline first algorithm and construct the schedule of the following task set: $\tau1 \equiv \{1, 5, 4\}$, $\tau2 \equiv \{2, 8, 6\}$, and $\tau3 \equiv \{1, 4, 3\}$. Here, the notation $\tau i \equiv \{ ei , pi , Di \}$ gives the execution time, ei , period, pi , and relative deadline, Di , of task τi .

b. An I^2C system is built with 2 masters and 3 slaves, the addresses of the devices in hexadecimal are 1A, 1B, 05, 07 and 0C respectively. Consider the case where master 1A is writing to slave 05 and master 1B is reading from slave 0C:

   i. Draw a complete connectivity diagram showing the five devices.
   ii. How would the clock of the entire bus is synchronized?
   iii. Show which master will succeed to access the desired slave in a bit by bit fashion assuming the 2 masters sensed the bus idle at the same time

Question 3: (10 Marks)

a. Consider the following Free RTOS code snippet, identify how many tasks are scheduled, and identify the period of each task (assuming a rate monotonic processes). Draw a time diagram to show the scheduling of the tasks.

```
int main( void )
{
  xTaskCreate( vTaskFunction1, "Task 1", 240, NULL, 1, NULL );
  xTaskCreate( vTaskFunction1, "Task 2", 240, NULL, 2, NULL );
  xTaskCreate( vTaskFunction2, "Task 3", 240, NULL, 2, NULL );
  vTaskStartScheduler();
   for( ;; );
}
```

```
void vTaskFunction1( void *pvParameters )
{
  for( ;; )
  {
    //  Do Something
     vTaskDelay( 250 / portTICK_RATE_MS );
  }
}
void vTaskFunction2( void *pvParameters )
{
  for( ;; )
  {
    //  Do Something
     vTaskDelay( 350 / portTICK_RATE_MS );
  }
}
```

b. Consider a system that has 3 tasks with the same priorities and periods of 150, 200, and 200 ms. Use the free RTOS task scheduling to construct a program that performs the required tasks scheduling. Write down a skeleton for each task

Question 4: **(10 Marks)**

a. A system is designed to handle the following situation, A pipeline is used to prepare a certain type of food by a series of 5 heating operations. At the beginning of each operation a senor is used to measure the temperature, and a for each operation an electrical heater is turned on or off to control the temperature. Sensors are numbered 1 to 5. Each sensor is sampled on a period of 10 seconds and its value and sensor ID is pushed into a queue (assume there is some tasks that do so). A control task is executed every 15 seconds to check if any of the readings is lower than the desired set value, if sow the corresponding heater is turned ON, otherwise it is turned off. Assume an array holds the desired set temperatures for each stage, prepare a program using Free RTOS Queue and APIs to perform the described tasks. You need to define a suitable data structure for the data in the queue and you need only to define the queue size and write the control task logic. Assume for the heaters an 8 bits integer variable h is used to turn on and off the heater by setting (1) or resetting (0) a bit respectively. Fo example to turn heater 1 and 4 ON and the rest OFF, the variable h=should hold the value (000001001) in binary or 09 in hexadecimal.

b. Write a Free RTOS code that will respond to an interrupt on PORT B by differing the control to a task function called Task1. The necessary startup is done and the function void InterruptHx(void) is the corresponding ISR.

Good Luck