ECE3849-D21

Exam 1 / Module 1

Question #	Grader	Total Points	Points Received	Comments
#1: Polling Strategies		35		
#2: Preemptive Scheduling		25		
#3 RMS Theory		40		
Total		100		

Name: _____

Instructions & Restrictions

Do's:

- Read the instruction on canvas before starting the test.
- Enter your name on page 1.
- This is an open book, open notes exam.
- If asked to write C code, you may use CCS as your editor to check your syntax.
- **Submit you test in pdf format to canvas by 10:15** or agreed to time if accommodations have been made.
  - Points may be deducted for lateness.
  - If you experience technical difficulties, contact the Professor immediately via zoom or by cell phone 508-523-0606.
- Make sure your answers are readable on your submitted version. Points cannot be given if the answers cannot be read.
- Review your pdf submission to verify all pages are present.
- All work must represent your knowledge and all code must be written by you.
- Read each question carefully, make sure you follow the specification when implementation details are given.
- You may ask questions of the instructor via zoom or by texting or calling 508-523-0606.

Don'ts

- You many not collaborate with or communicate with others during the exam. Not verbally or in writing. Not in-person or electronically.
- Do not lose track of time. It is more important to answer every question then to get one question 100% correct.

Question 1: Polling Strategies

A. The system has three tasks with the characteristics in the table below. It is using a **Round Robin Scheduling Strategy**. Determine the latency, response time, relative deadline and if it is schedulable. Provide answers in the table below. [12]

Task	Period	Execution Time	Latency	Response Time (latency + execution time)	Relative Deadline = Period	Schedulable? Response time <= Relative deadline
TaskA	15 ms	4 ms	3 +1 = 4ms, Worst case waits for A & B	4 + 4 = 8 ms	15	8 < 15 YES
TaskB	6 ms	3 ms	4 +1 = 5 ms Worst case waits for A & C	5 + 3 = 8 ms	6	8 > 6 NO
TaskC	5 ms	1 ms	4+3 = 7 ms Worst case wats for A & B	7+1 = 8 ms	5	8 > 5 NO

B. Explain how the worst-case latency for TaskC was determined in Round Robin Scheduling. [5]

There is no priority in round robin. TaskC may have to wait for TaskA to complete its execution and TaskB to complete its execution. The latency is the sum of TaskA + TaskB execution times.

C. For the system in part A, will switching to a Priority Polling Scheduling Strategy allow all the tasks to be scheduled? Explain. Specifically address how each task's response time is affected by the change in strategy. [10]
Use the table provided below if it is helpful, **but it is not required**.

Task	Period	Execution Time	Latency	Response Time	Relative Deadline	Schedulable?
TaskA	15 ms	4 ms	4 ms	8 ms	15 ms	8 < 15 YES
TaskB	6 ms	3 ms	5 ms	8 ms	6 ms	8 > 6 NO
TaskC	5 ms	1 ms	4 ms	5 ms	5 ms	5 == 5 YES

No. Priority Polling will not allow all tasks to be schedulable.

Only taskC's latency is reduced as it now only needs to wait for Task B OR Task A but not both. Its response time will drop to 5 ms making it schedule but just barely.

TaskB and TaskA have no reduction in response time by going to Priority Polling. Worst case they still need to wait for the other two tasks to execute completely before starting. TaskB is still not schedulable.

D. Under what conditions does starvation occur? Which scheduling strategy does not suffer from starvation. Explain. [8]

Starvation occurs when the scheduling strategy gives priority to one (or more) tasks. If the high priority task occurs frequently or has a long execution time. The lower priority tasks are not given a chance to execute.

Round Robin Polling treats all tasks with equal priority and does not suffer from starvation.

Question 2: Preemptive Scheduling

A. What is the roll of the interrupt controller? What happens to the foreground tasks when an interrupt occurs? [5]

The roll of the interrupt controller is to detect when an interrupt has occurred and call the Interrupt Service Route (ISR) associated with it.

Foreground tasks are preempted when the ISR is called. Lower priority tasks are preempted by the higher priority ISRs running in the background.

B. Name one advantage of using a preemptive strategy over a polling strategy. Name one disadvantage of using a preemptive strategy. [10]

Advantage:

Using a preemptive scheduling lowers the latency of higher priority tasks, reducing their response time. This makes tasks easier to schedule.

Disadvantage:

Using a preemptive scheduling requires an interrupt controller adding complexity to the hardware required.

OR

Calculating response times becomes more complicated making the system performance harder to analyze.

C. While using Preemptive Scheduling, why would we want to disable interrupts? Why is it important to minimize the time that interrupts are disabled for? [10]

When two tasks share data or resources, it may be required to disable interrupts such that only one task at a time can access the shared data / resource at a time.

It is very important to keep latencies low for real-time tasks. Disabling interrupts adds latency to every task in the system, which will cause reduction in system performance and possibly missed deadlines if not accounted for.

Question 3: Rate-Monotonic Scheduling Theory

A system is using Preemptive scheduling with interrupts enabled for the three periodic real-time tasks with the characteristics provided in the table below. The system satisfies all the RMS conditions.

Task	Period	Execution Time
TaskA	**15 ms**	**4 ms**
TaskB	**6 ms**	**3 ms**
TaskC	**5 ms**	**1 ms**

A. Calculate the CPU utilization for the system. Show your work. [6]

Utilization = 4/15 + 3/6 + 1/5 = 0.9667 or 96.67%

B. Using the RMS utilization upper bound, are the tasks guaranteed to meet all the deadlines? Explain.[5]

The RMS utilization upper bound for three tasks is 0.7798 or 77.98%. The calculated utilization is 96.67 is greater than 77.98%, therefore there is no guarantee that the tasks can be scheduled and further analysis is required.

C. Which task is the high, mid and low priority and provide answers in the table at the end of the question? Explain your answer, how did you set the priorities? [8]

RMS Theory requires that tasks with lower periods be given higher priority.

See next page for last part of problem and table

D. In the graph paper block provided below, draw **20 msec** of the worst-case RMS schedule using Graphical Model. Use the graph paper snippet below or your own graph paper. Be sure to label the time access and task names. [12]
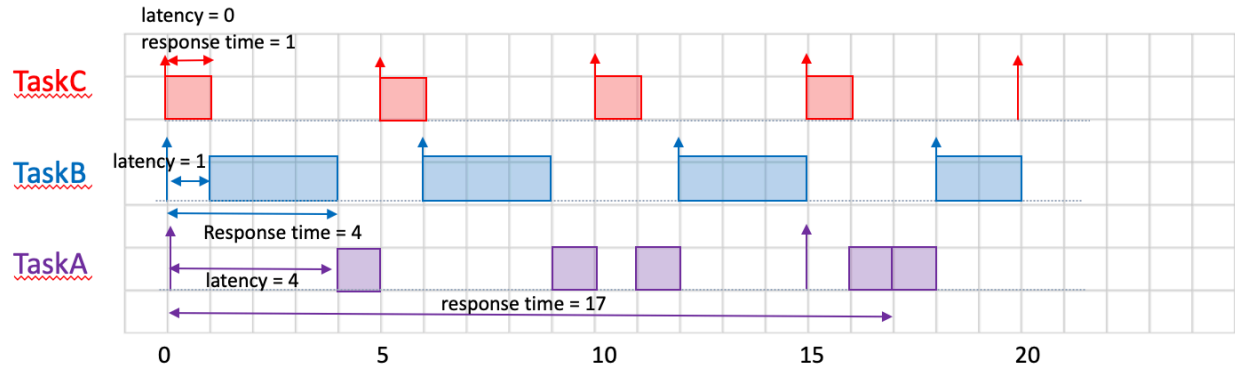
E. From the Graphical Model results determine the latency, response time and if it is schedulable. Enter the results in the table below. [9]

Task	Period	Execution Time	Priority	Latency	Response Time	Schedulable?
TaskA	15 ms	4 ms	low	4	17	17 > 15 NO
TaskB	6 ms	3 ms	mid	1	4	4 < 6 YES
TaskC	5 ms	1 ms	high	0	1	1 < 5 YES