Midterm 2

Q1: Compute the worst-case response time for the lowest-priority task in each of the task sets below. Assume deadline-monotonic scheduling. Note that, the symbols P, C, and D stand for period, computation time and relative deadline, respectively. If the relative deadline is omitted, assume that it is equal to the period. **(5 points)**

a) Task set #1:
P1=12, C1=6; D1=10
P2=20, C2=5, D2=8

Answer (a): 11

b) Task set #2:
P1=5, C1=1, D1=2
P2=10, C2=6, D2=9
P3=40, C3=3.5, D3=30

Answer (b): 19.5

c) Task set #3:
P1=7, C1=2
P2=18, C2=5.1

Answer (c): 9.1

d) Task set #4:
P1=10, C1=3
P2=10, C2=5
P3=20, C3=4

Answer (d): 20

e) Task set #5:
P1=12, C1=10
P2=27, C2=3, D2=24

Answer (e): 23

Q2: How many of the above task sets are schedulable using deadline monotonic scheduling? **(1 point)**

Answer: 4

Q3: Circle the best answer for each of the following questions: **(8 points)**

1. For some processor, the energy consumed in executing a task is given by $E = 8 f^3 + 1.5/f + 3$, where f is the normalized frequency (such that f=1 when the processor is running at maximum frequency). At what value of normalized frequency should the processor operate in order to be energy-optimal? **(5 points)**

a) f=1 **b) f=0.5** c) f=0.25 d) f=0.2 e) f=0.1

2) A processor consumes power at a rate of 15 W when active, and at a rate of 5 W when asleep. The wake-up cost is 3 Joules. If this processor goes to sleep, what is the shortest sleep interval such that dropping below it will actually waste more energy compared to not sleeping?

a) 10 ms b) 30 ms c) 100 ms **d) 300 ms** e) 3 s

3) To ensure a zero steady state error in a stable control loop, usually which of the following conditions needs to be true?

a) The loop gain must be equal to 0.5 b) The total phase lag must add up to -180
c) The loop should contains a delay element **d) The loop should contain an integrator**
e) None of the above; steady state error is always zero when the loop is stable!

4) In the ACPI standard, P-states stand for:

a) Processor states b) Power states **c) Performance states** d) Pending states e) Priority states

5) A control system measures actual power, P, consumed by a processor and adjusts its frequency, f, such that the actual consumed power approaches a desired value, P_{set}. In implementing the controller, when computing the error, e (which is the difference P_{set} - P), an incorrect value of power, P, was used. Specifically, rather than using the current value, the programmer inadvertently referenced the previous value, measured K seconds ago. What is the relation between K and stability of the resulting power control loop?

a) There is no relation. Loop stability is independent of the value of K
b) As K increases, system stability improves
c) As K increases, system stability may improve or worsen, depending system utilization
d) As K increases, system performance degrades, but the system always remains stable
e) As K increases, system stability is impaired, eventually possibly becoming unstable

6) Which of the following aperiodic task servers result in the lowest schedulability bound for periodic tasks?

a) Polling server b) Sporadic server **c) Deferrable server** d) Priority exchange server e) Slack stealing server

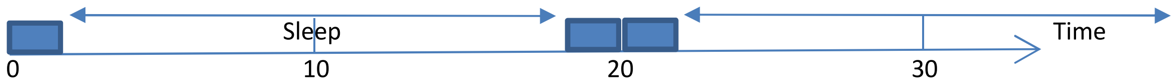
7) Which of the following aperiodic task servers behaves differently from a work-conserving periodic task?

a) Polling server b) Sporadic server **c) Deferrable server** d) Priority exchange server e) None of the above

8. Let f_c be the frequency at which a processor consumes the least energy in executing a task. Let f_s be the slowest frequency at which schedulability is guaranteed. If your goal is to minimize energy subject to a schedulability constraint, which frequency should you run the processor at?

a) f_c b) f_s c) min (f_c,f_s) **d) max (f_c,f_s)** e) (f_c+f_s)/2

Q4: A single periodic task of period = 10 seconds and computation time = 2 seconds runs on a processor with a zero-energy sleep-mode and a wake-up cost of 3 Jules. If the power consumed by the processor when awake is 10 Watt, draw on the timeline below an execution schedule that maximizes energy savings due to sleep. Indicate the intervals of task execution and processor sleep clearly. Assume that the first task execution starts at Time=0.
(1 point)


Sleep
Time
0
10
20
30