Fall 2015 Mid-Exam（答案卷） RTS

Name:_____ Score:_____

ID:_____

Read each question over carefully several times. Answer all questions in the space provided. The exam is 150minutes long. The total score is 109.

(1). Please define the following terminologies (15pts):

a. Timer Drifting

Because of timer setting, the time of a computer system begins falling behind, due to the rounding off of timer intervals to integer multiples.

b. Even Driven Software Architecture

Tasks are triggered by I/O completion and timer events.

c. Static Scheduling

The scheduling operates on a fixed set of processes and produces a single schedule that is fixed at all time.

d. Least Slack Time Algorithm (LST)

LST assigns processes priorities inversely proportional to their slack times.

e. Priority Inheritance

If a process τ_i blocks higher priority processes, τ_i inherits the highest priority of the process blocked by τ_i

(2) Please give me an example task set in which the task set is schedulable by the Global EDF but not schedulable by Partitioned EDF for multiprocessor systems. (Hint: Global and partitioned fixed job-priority (FJP) scheduling) 10pts.

Ans: $t_1=(c_1=2,d_1=2,p_1=3)$, $t_2=(3, 3, 4)$, $t_3=(5, 12, 12)$ on 2 processors

(3) Consider the scheduling of N independent real-time periodic tasks by Round-Robing Scheduling with Time Quantum being equal to ε, where ε is a very small number and approaches zero nearly infinitely. Suppose the context switch cost is zero. Please answer the following questions (20pts)

(a) When N = 1 (i.e., one task), what is the least upper bound of the utilization factor? You must prove it to receive any credits (5pts)

(b) When N = 2, if the two tasks have the same period P (and become ready at time 0), what is the least upper bound of the utilization factor? You must prove it to receive any credits (10pts)

(c) Consider any N and every task has the same period P (and becomes ready at time 0). Suppose the tasks are scheduled by the Rate Monotonic Scheduling algorithm (RMS). What is the least upper bound of the utilization factor? You must prove it to receive any credits (5pts)

Ans: (a) It is 100% because the task receives all of the computing time. (b) It is 100%. Suppose the ratio of the computation times of the two tasks is M (for any M). For the first 2P/(M+1) time interval in a period, each task receives P/(M+1) computation time, and the larger task receives all of the computation time for the remaining (M1-)*P/(M+1) time interval. (c) It is 100% because every task has the same period, and the RMS turns into a FIFO scheduling algorithm. If the total computation time is not over P, the task set is schedulable.

(4) Please explain why Piping could save energy. Please explain why VLIW can save energy. (10pts)

Ans: (a) It is because we can overlap the execution of subtasks of different tasks in a pipe, and the energy consumption function and the supply voltage has the following relationship:

$E \propto V_{dd}^2 (\#\text{cycles})$

$E_2 = \frac{1}{4} E_1$

(b) VLIW has a large degree of parallelism.

(5) For energy-efficient real-time scheduling, we might need to do both voltage scaling and dynamic power management. Why the optimal uniprocessor DVS scheduling algorithm presented in the class[1] could not provide good schedules for dynamic workloads? Please give me one reason why dynamic power management is difficult? (12pts).

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Ans: (a) It is because the computing and the selection of the best intensity function do not consider the future arrivals of tasks. (b) We don't know the arrivals of tasks/workloads or the length of idle periods.

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(6) Please show us the similarity and difference between the Highest Locker's Priority Protocol and Priority Ceiling Protocol, with respect to how "Priority Ceiling" is used. Please explain why there is no chain blocking for the Highest Locker's Priority Protocol. (12pts)

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Ans: (a) The Highest Locker's Priority Protocol lets a task runs at the priority equal to the Priority Ceiling of a semaphore if the task locks the semaphore, regardless of whether any tasks is blocked because of the semaphore. (b) It is because there is no hold and wait.

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(7) Why the Deadline Modification technology to EDF can not be used in an on-line fashion (in other words, what it is not a polynomial-time approach)? (5pts)

Ans: It is because we need to consider all of the computations performed in the interval $[0, L]$, where L is the LCM of all task periods.

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[1] Frances Yao, Alan Demers, and Scott Shenker, "A Scheduling Model for Reduce CPU Energy", FOCS, 1995

(8) Total Bandwidth Servers (TBS) and Constant Utilization Servers (CUS) are servers designed for dynamic-priority scheduling. Suppose that we have one TBS and one CUS running together. Suppose that the CUS keeps busy because of coming requests between time interval (0, t), but the TBS is idle because of no requests. Please comment on the fairness in request services for the TBS and CUS when lots of requests come in to both the CUS and TBS between the time interval (t, 2t). (10pts)

Ans: CUS will still have good service because CUS will not use the unused time too much. Students could comment on the behavior of CUS and TBS to receive good credits…

(9). RMA: Consider the following process set with the assigned priorities (Max:1, Min:4): (hint: use schedulability bound tests, completion time test, or schedulability point test. All critical sections are NESTED.) (15pts)

	T1	T2	T3	T4
Pi	60 (periodic)	100 (periodic)	220 (periodic)	310 (periodic)
Ci	20	25	40	50
Semaphores	S1(5)	S2(20)	S1(12),S2(10)	S1(20)
deadline	50	90	190	300
priority	2	1	3	4

(a) Consider periodic process set {T1, T2, T3, T4} without semaphore sharing and without pre-period deadlines. Show me which process is schedulable or unschedulable.

(b) Consider periodic process set {T1, T2, T3, T4} without semaphore sharing but with pre-period deadline. Show me which process is schedulable or unschedulable.

(c) Consider periodic process set {T1, T2, T3, T4} with semaphore sharing and pre-period deadline. Show me which process is schedulable or unschedulable under the No Preemption Protocol..