Exam for Real Time Systems

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Important Instructions:

1. No course material or computer/calculator are allowed, only a pen and a dictionary.
2. Please mark which course you are registered for:

○ **5hp** (1DT063)	○ **10hp** (1DT004)
You need to solve problems 1–6 only.	You need to solve *all* problems.

3. For each problem, a number of choices/statements are given, that may be correct or wrong.

   You are asked to mark only the **correct** ones.

   If you mark all correct choices for each problem, it will give you all points of the problem; otherwise each wrong choice (marked) will result in "negative points" proportionally.

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Problem 1

1. *(5p) Why is it so difficult to predict the timing behaviour of a computer system?*
   - ( ) *it may run software with too many lines of code*
   - ( ) *it may have shared resources*
   - ( ) *it is impossible to decide whether a program terminates or not*
   - ( ) *it may consume too much energy*
   - ( ) *it may have cache memory*
   - ( ) *it may support direct memory access (DMA)*
   - ( ) *it may have a multicore processor*
2. *(5p) The characteristics of RTOS are:*
   - ( ) *typical footprints: 100MB to 1GB*
   - ( ) *typical footprints: 0.2 to 10MB*
   - ( ) *deterministic and fast responsiveness*
   - ( ) *it supports multi-tasking*
   - ( ) *fast and time-sharing*
   - ( ) *possible to change scheduling policies*
   - ( ) *tasks are scheduled using EDF*
3. *(5p) Resource servers can be useful for*
   - ( ) *isolating applications of different types*
   - ( ) *hierarchically designing systems that may have many sub-systems*

( ) *improving the average response times of soft real-time tasks*

( ) *guaranteeing the deadlines of event-driven hard real-time tasks*

4. *(5p) When RMS is used, what is the maximal resource utilization you may achieve by selecting proper task parameters while the schedulability is still ensured?*

   ( ) 100%

   ( ) 99%

   ( ) $n * (2^{1/n} - 1)$ *where n is the number of tasks*

   ( ) 69.3%

5. *(5p) The advantages of static scheduling include:*

   ( ) *it is flexible and easy to change*

   ( ) *it can be used to implement predictable and deterministic systems*

   ( ) *it can be used to implement complex systems with large task sets*

   ( ) *it can be used to implement safety-critical systems*

6. *(5p) We know that the bandwidth is 1Mbps for a CAN bus of around 50 meters. What is the bandwidth for a bus of 100 meters?*

   ( ) *3-4Mbps*

   ( ) *2-3Mbps*

   ( ) *0.2-0.5 Mbps*

   ( ) *0.1-0.15 Mbps*

7. *(5p) A system with periodic tasks may contain dependent tasks with input/output relations, which causes release jitters. Assume that the dependent tasks have the same period and task B depending on task A is defined as follows: the computed result of a job of task A is used as the input of a job of task B (and thus task B suffers a release jitter due to the varying response times of task A).*

   Is it possible to avoid this and thus avoid release jitters?

   ( ) *this is not possible at all*

   ( ) *yes, deliver the result of a job as soon as possible*

   ( ) *yes, deliver the result of a job as late as possible*

   ( ) *yes, deliver the result of a job at the end of each period*

8. *(5p) Which statements are correct?*

   ( ) *EDF and DMS are non stable*

   ( ) *EDF is non stable; DMS is stable*

   ( ) *DMS uses fixed priorities*

   ( ) *EDF uses dynamic priorities*

   ( ) *EDF is optimal, DMS is not*

   ( ) *EDF is optimal*

   ( ) *DMS is optimal*

9. *(5p) Assume that a set of periodic tasks with deadlines equal to periods is schedulable on a single processor system using Shortest Job First Scheduling Algorithm. Then the task set is also schedulable using*

   ( ) *RMS*

   ( ) *Non-Preemptive EDF*

   ( ) *EDF*

   ( ) *FIFO*

( ) *DMS*

10. *(5p) When you use CAN to implement a distributed system, you should*

    ( ) *make sure that messages sent from different nodes have different priorities*

    ( ) *know that sending messages with the same identity by different nodes may lead to errors*

    ( ) *assign the priorities of messages according to the periods of the sending tasks*

    ( ) *make sure that the priority ordering of messages is given according to their id's with the lower id number, the higher priority for each message*

    ( ) *send messages without receiver's explicit address*

Problem 2 *(10p) For a set of periodic tasks with utilization 1, what would be the worst case response time of a task if EDF is used for scheduling?*

( ) *its period*

( ) *its worst case execution time*

( ) *any number larger than its worst case execution time*

( ) *it could be larger than its period*

( ) *any number strictly less than its period*

( ) *any number between its worst case execution time and its period*

Problem 3 *(10p) Assume a set of sporadic sets* (C_i, D_i, T_i) *where deadline* $D_i \leq T_i$.

( ) *if the task set is feasible then* $\sum C_i/T_i \leq 1$

( ) *if* $\sum C_i/T_i \leq 1$, *the task set is feasible*

( ) *if the task set is feasible then* $\sum C_i/D_i \leq 1$

( ) *if* $\sum C_i/D_i \leq 1$, *the task set is feasible*

( ) *if* $\sum C_i/D_i \leq 0.693$, *the task set is schedulable with DMS*

( ) *if the task set is schedulable then* $\sum C_i/D_i \leq 0.693$

( ) *if* $\sum C_i/T_i \leq 0.693$, *the task set is schedulable with DMS*

( ) *if the task set is schedulable then* $\sum C_i/T_i \leq 0.693$

Problem 4 *(10p) Assume a set of* 12 *non-preemptive sporadic tasks whose computation times are all* $0.20ms$ *and whose periods are* $1ms, 2ms, 2ms, 7ms, 8ms, 10ms, 18ms, 20ms, 30ms, 31ms, 43ms$ *and* $50ms$ *respectively. Assume that RMS is used for scheduling, there are no jitters and no context-switch overheads.*

The worst-case response time for the task with period 1ms is bounded by:

( ) $0.20ms$

( ) $0.40ms$

( ) $0.60ms$

( ) $0.80ms$

( ) $1ms$

( ) $1.20ms$

The worst-case response time for the task with period 10ms is bounded by:

( ) $2ms$

( ) $4ms$

( ) $6ms$

( ) $8ms$

( ) $10ms$

( ) $10.20ms$

Problem 5 *(10p) What are the differences between BIP (Basic Priority Inheritance Protocol) and HLP (also known as Immediate Priority Inheritance Protocol)?*

( ) *BIP can avoid deadlocks, HLP can not*

( ) *HLP can avoid deadlocks, BIP can not*

( ) *BIP lets a task run with a higher priority whenever it locks a semaphore*

( ) *HLP lets a task run with a higher priority whenever it locks a semaphore*

( ) *HLP is easier to implement than BIP*

( ) *Using BIP, the blocking time a higher-priority task may suffer is the sum of the worst case execution times of lower-priority tasks sharing a semahore with the higher-priority task.*

( ) *Using BIP, the blocking time a higher-priority task may suffer is the max of the worst case execution times of lower-priority tasks sharing a semaphore with the higher-priority task.*

( ) *Using HLP, the blocking time a higher-priority task may suffer is the sum of the worst case execution times of lower-priority tasks sharing a semahore with the higher-priority task.*

( ) *Using HLP, the blocking time a higher-priority task may suffer is the max of the worst case execution times of lower-priority tasks sharing a semaphore with the higher-priority task.*

Problem 6 *(10p) Assume a set of event-driven tasks with computing times C_i and deadlines D_i (assume $C_i \leq D_i$). The jobs of a task may arrive sporadically but the minimal distance between two jobs is $T_i > D_i$. Design a polling server for the tasks with period T and capacity C such that no deadline is violated when RMS is used for scheduling. Assume $C \leq T$ and R is the response time estimated using RMS analysis when the server is considered as a periodic task. Identify correct statements:*

( ) $T \leq D_i$ *is necessary*

( ) $T + T \leq D_i$ *is necessary*

( ) $T + R \leq D_i$ *is necessary and sufficient*

( ) $T + C \leq D_i$ *is necessary*

( ) $\sum C_i \leq C$ *is necessary*

( ) $\sum C_i \leq C$ *and* $T + T \leq D_i$ *is sufficient*

Problem 7 *(10p) Assume 10 synchronous periodic tasks each with execution time 2 and period 100. Assume a "large" task with execution time 100 and period 101. These 11 tasks will be scheduled on a multicore platform with 10 cores.*

( ) *the task set is schedulable with global RMS*

( ) *the task set is schedulable with global EDF*

( ) *the task set is schedulable with partitioned RMS*

( ) *the task set is schedulable with partitioned EDF*

What is the minimal number of cores to ensure schedulability for partitioned scheduling?

( ) *2 cores*

( ) *10 cores*

( ) *11 cores*

Problem 8 *(10p) Assume a system with a set of DRT tasks described by digraphs whose workload are $dbf_i(t)$ (demand bound functions). Identify the correct ones out of the following statements:*

( ) *The system is feasible on a single-core platform if for all $t \geq 0, \sum dbf_i(t) \leq t$*

( ) *If the system is feasible on a single-core platform then for all $t \geq 0, \sum dbf_i(t) \leq t$*

( ) *The system is feasible on a two-core platform if for all $t \geq 0, \sum dbf_i(t) \leq 2t$*

( ) *If the system is feasible on a two-core platform then for all $t \geq 0, \sum dbf_i(t) \leq 2t$*

Problem 9 *(10p) Assume a set of periodic tasks with periods as deadlines and utilizations as follows:* $0.96, 0.99, 0.5, 0.1, 0.6, 0.7, 0.5, 0.2, 0.4, 0.3, 0.2, 0.1$

If you partition the tasks onto a multiprocessor platform and then run the respective scheduling policy, what is the least number of processors you need?

( ) *8-10 with EDF*

( ) *5-7 with EDF*

( ) *2-4 with EDF*

( ) *9-11 with RMS*

( ) *6-8 with RMS*

( ) *3-5 with RMS*

Problem 10 *(10p)*

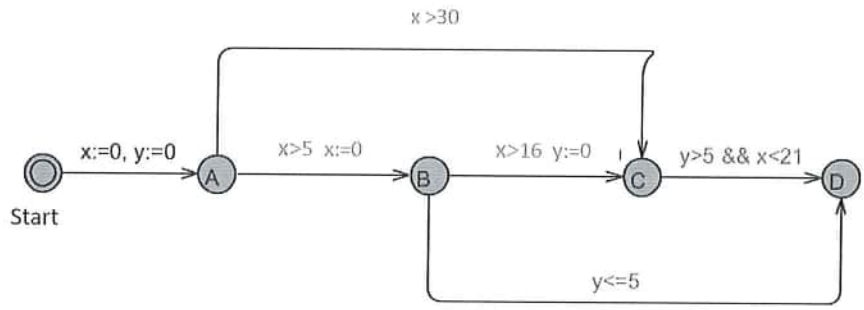

Figure 1. An Example of Timed Automaton where x and y are clocks and Start is the initial node.

Study the automaton in Figure 1. Identify the correct statements in the follwoing:

( ) *B is reachable and at B, it is always the case* $y > 5$

( ) *C is not reachable*

( ) *C is reachable and at C, it is always the case* $x > 3$

( ) *C is reachable and at C, it is possible* $x > 100$

( ) *C is reachable and at C, y can take any value larger than* 0

( ) *D is reachable*

( ) *D is reachable and at D, it is possible* $x < 21$ *and* $y > 5$

( ) *D is not reachable*