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Exercises for
Embedded Systems
Wintersemester 18/19

Exercise Sheet 11 (Theory)

(11 Points)

Please note: Solutions must be submitted (individually or in pairs) until 14.01.2019 at 10:00 AM (post box in OH16, ground floor, in front of room E16). Submitting solutions via mail is *not* possible. Discussion: 16.-18.01.2019..

1 RM Scheduling (2 Points)

Consider the given set of sporadic real-time tasks with implicit deadlines.

	τ_1	τ_2	τ_3
C_i	1	2	3
T_i	4	6	10

(a) Determine the priority of each task. Is a rate-monotonic (RM) schedule feasible? Explain why or why not.

(b) What happens, if the minimum inter-arrival time of task τ_3 is decreased to 8?

2 Resource Access Protocols (3 Points)

(a) What is Priority Inversion? Is it possible to completely avoid it under fixed-priority scheduling? If yes, what are the drawbacks? If no, why not?

(b) Explain why the Priority Ceiling Protocol (PCP) is deadlock-free.

(c) Mr. Smart wants to use PCP in his system, in which tasks are scheduled according to a dynamic-priority policy. Is this possible? Which problems may occur?

3 Resource Access Protocols (4 Points)

Consider the following tasks and semaphores. $S_j(\tau_i)$ denotes the worst-case execution time of a critical section of task τ_i, which is guarded by semaphore S_j. $S_j(\tau_i)$ is 0 if the semaphore S_j is not needed by τ_i.

	$S_1()$	$S_2()$	$S_3()$
τ_1	1	0	0
τ_2	0	0	9
τ_3	8	7	0
τ_1	6	5	4

	τ_1	τ_2	τ_3	τ_4
C_i	2	10	16	16
T_i	10	24	96	96
D_i	10	24	96	96

Assume that the critical sections are not nested. Moreover, regarding the computation of the worst-case execution time C_i of a task τ_i, the assumption is made that critical sections are always granted (no blocking).

(a) Assume that the above task set is scheduled according to the rate-monotonic algorithm (RM) and that the Priority Inheritance Protocol (PIP) is applied. Draw the scheduling diagram!

(b) Assume that the above task set is scheduled according to the rate-monotonic algorithm (RM) and that the Priority Ceiling Protocol (PCP) is applied. Draw the scheduling diagram!

4 Harmonic Task Systems (2 Points)

Consider the following periodic tasks with implicit deadlines:

	τ_1	τ_2	τ_3	τ_4	τ_5	τ_6	τ_7
C_i	0.2	2	2	1.5	1	14	28.8
T_i	2	6	12	24	24	72	288
D_i	2	6	12	24	24	72	288
U_i	0.1	$\frac{1}{3}$	$\frac{1}{6}$	0.0625	0.0417	0.195	0.1

Assume that the tasks are executed on a uniprocessor system.

(a) Determine formally if the rate-monotonic (RM) schedule is feasible.

(b) Determine formally if the earliest deadline first (EDF) schedule is feasible.