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Embedded Systems 2010/2011 – Assignment Sheet 2

Due: Tuesday, 9th November 2010, *before* the lecture (i.e., 10:10)
Please indicate your **name**, **matr. number**, **email address**, and which **tutorial** you are planning to attend on your submission. We encourage you to collaborate in **groups** of up to **three** students. Only one submission per group is necessary. However, in the tutorials every group member must be capable to present each solution.

Exercise 1: Getting Started with Petri Nets (10 pts.)

Draw the Petri net $N = (C, E, F)$ where:

$$C = \{c_1, c_2, c_3, c_4\},$$
$$E = \{e_1, e_2, e_3\},$$
$$F = \{(c_1, e_1), (c_1, e_2), (e_1, c_2), (e_1, c_3), (e_2, c_3), (e_2, c_4), (c_2, e_3), (c_3, e_3), (c_4, e_3), (e_3, c_1)\}.$$

Compute the preconditions of e_3 and the postconditions of e_1. Is N simple? Is N pure? Justify your answers.

Exercise 2: Modeling with Petri Nets (70 pts.)

Barbara and Franca are doctors in a hospital. As usual, they are working 12 hours a day. A typical day consists of treating patients who are waiting for their treatments. Of course, no treatment can be interrupted. In this exercise, we use Petri nets to come up with a schedule for the treatments.

(a) While Barbara is specialized in treatment *T1*, Franca is an expert for treatment *T2*. Only Barbara can do treatment *T3*. More precisely, Barbara and Franca require the following times for the treatments:

	Barbara	Franca
T1	$\frac{1}{2}$ hour	1 hour
T2	$1\frac{1}{2}$ hours	$\frac{1}{2}$ hour
T3	2 hours	∞

Under the assumption that Barbara and Franca are working independently, model the depicted scenario as a place/transition Petri net. Depending on the waiting patients, describe how you choose the initial marking. (15 pts.)

(b) Describe how you can use the reachability graph of the Petri net modeled in (a) to derive a schedule how the treatments should take place such that all patients are treated as soon as possible. (10 pts.)

(c) Describe a more efficient way (without using Petri nets and reachability graphs) for finding an optimal schedule for (a). Justify why your approach is correct. (20 pts.)

(d) Every Thursday, only patients for the special treatments *T4*, *T5*, and *T6* show up. While Barbara can do *T4* but not *T5*, Franca can only do *T5* but not *T4*. Both have to cooperate to do treatment *T6*. Due to room constraints, *T6* can only be done in the afternoon, i.e., in the last 6 working hours of Barbara and Franca. The precise times for the treatments are as follows:

	Barbara	Franca
T4	$1\frac{1}{2}$ hours	∞
T5	∞	1 hour
T6	2 hours	

Under the assumption that Barbara and Franca have to synchronize for doing *T6* (in the afternoon) together, model the depicted scenario as a place/transition Petri net. Depending on the waiting patients, describe how you choose the initial marking. Again, explain how can you use the reachability graph of the net to deduce a feasible schedule such that, at the end of the day, all patients are treated. (25 pts.)

Exercise 3: Aperiodic Scheduling (20 pts.)

Assume a uniprocessor architecture, where processes can *not* be interrupted at any time and later resumed. Consider the following set of asynchronous, aperiodic, and independent tasks:

Job	J_1	J_2	J_3	J_4
Arrival time a	0	4	2	6
Computation time C	6	2	4	2
Deadline d	16	10	9	12

Is the given task set schedulable? If it is, your task is to find the schedule.