jian-jia.chen [☺] tu-dortmund.de
ingo.korb [☺] tu-dortmund.de

Exercises for Lecture
Embedded Systems
Winter Semster 16/17

Written Exercise Sheet 1

(20 Punkte)

Hints: These assignments will be discussed at E23, from 10:15 am - 11:45 am on 02, Nov., 2016. You are not obligated to turn in the solutions. Exception! If you would like to turn in your answers regarding to Question 3, please hand in your solutions to the instructor after the lecture session on 02, Nov. 2016. We will organize to give you feedbacks.

1 Definition of Worst-Case Execution Time (2 Punkte)

For cyber-physical systems, it is important to know the maximum (worst-case) execution time of a program. How will you derive such an upper bound? Will there be some difficulties?

2 Power/Energy Consumption (3 Punkte)

You have at your disposal a battery with a capacity of 3600 mAh. Let us assume that its voltage is **constant** at 1.1 Volts until it is empty. Also, let us assume that we can ignore the power consumption of other electronic components.

Suppose that you have a CMOS system running with the capability of dynamic voltage frequency scaling. Assume that you can choose any frequency between 10 MHz and 200 MHz. The power consumption to operate at frequency f MHz is equal to $10^{-5}f^3 + 1$ mWatt. Suppose that you need to operate this system continuously with a constant frequency f^* until the battery gets empty. What is the maximum frequency f^* that can be chosen to ensure that the system can be operated consecutively for 360 hours?

3 Coffee Machines or Tea Machines (6 Punkte)

You are requested to design a coffee/tea machine for yourself. Let's only focus on the logics of the design (not to worry about the hardware components). Please write down

- plain text requirement and specifications of your coffee/tea machine
- use cases of your designed machine, and
- sequence charts of your designed machine to brew a cup of coffee/tea, and two cups of coffee/tea.

4 Time/Distance Diagrams (2 Punkte)

Draw a time/distance diagram to represent the cycles of H-Bahn Line 1 and Line 2. Please use the information from the figure, that is going to be valid for 2016. In this new program, the H-Bahn is extended to run from Emil-Figge-Str. to the Informatik-Gebäuden so that Informatikers do not need to walk for long distance to Mensa. Both directions of Line 1 (one starts from Informatik and ein starts from Eichlinghofen) start at 10:11 und stay in every station for one minute. The Line 2 starts at the same time from Nordcampus and stays in each station for *half a minute*.

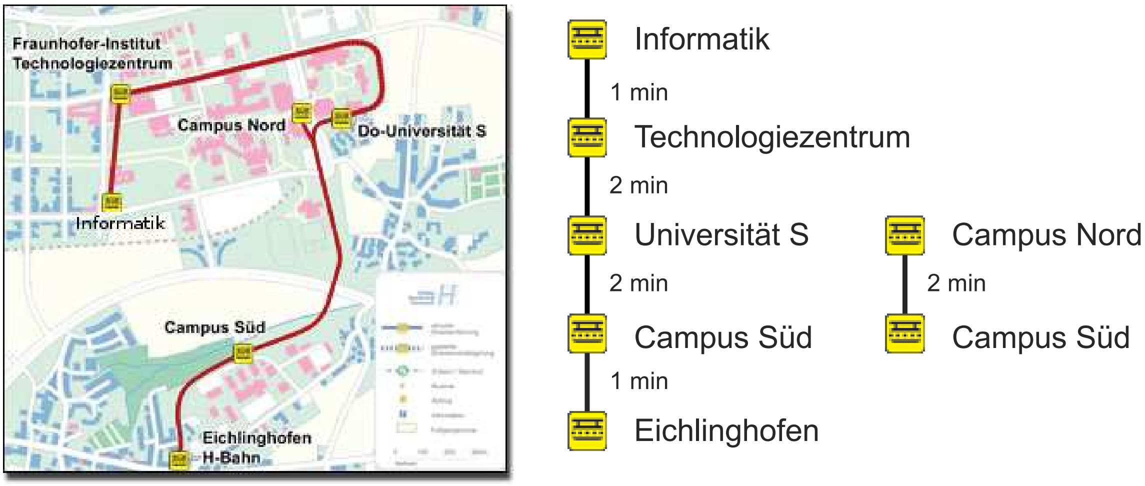
The departure plans are also found here:

Line 1 Nord-Süd **10:11** Informatik, **10:13** Technologiezentrum, **10:16** Universität S, **10:19** Campus Süd, **10:21** Eichlinghofen, **10:23** Campus Süd, . . .

Line 1 Süd-Nord **10:11** Eichlinghofen, **10:13** Campus Süd, **10:16** Universität S, **10:19** Technologiezentrum, **10:21** Informatik, **10:23** Technologiezentrum, . . .

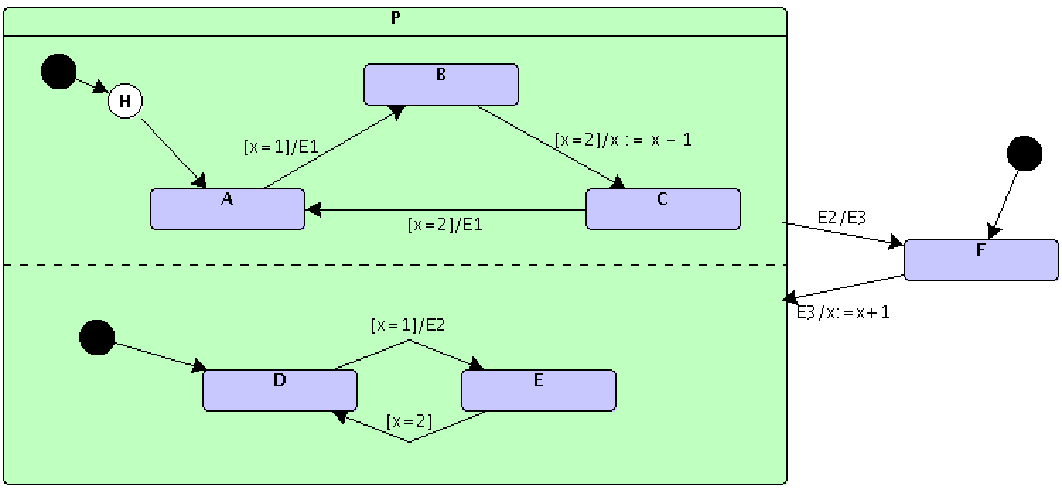
Line 2 **10:11:00** Campus Nord, **10:13:30** Campus Süd, **10:16:00** Campus Nord, **10:18:30** Campus Süd, . . .

Please draw the time/distance diagram.



5 StateCharts (2 Punkte)

Suppose that we have the following StateCharts Diagram:



Interpret the functions of the above StateCharts, when the event E3 generated at State F is $x = 0$. Please write down the configurations (active states, events, and the values of “x”) of the system after events are generated (till you can conclude the repetition.) Please also explain why the transition from E to D is not possible.

6 Multithreading (3 Punkte)

Suppose, the following code is given

```
semaphore S;
integer u;
```

```
thread a {
u = 3;              //op a1
if u<10             //op a2
   {u = u + 1; ..}  //op a3
else u=5;           //op a4
};
```

```
thread b {
u = 2;              //op b1
if u<4              //op b2
  {u = u + 4; ..}   //op b3
else u=10;          //op b4
};
```

- Each thread is supposed to be executed once on a microprocessor system.
- Threads can be executed in any sequence and the execution can switch between the two threads at any time.
- For the sake of simplicity, we assume that each operation is executed in an atomic manner, i.e. there is no switch (called context switch) during the execution of ax and by.
- Which values of u are possible at the completion of both tasks?

The figure at the end of this sheet shows a partial view of possible execution sequences. Each sequence corresponds to a path through the graph from the top to the bottom. Complete these them pages and add the values of u to the edges! Sequences which are infeasible due to the values of u can be either crossed out or left out right away.

7 Semaphores (2 Punkte)

Suppose that the code of the previous question is modified such that if-statements are protected by semaphores:

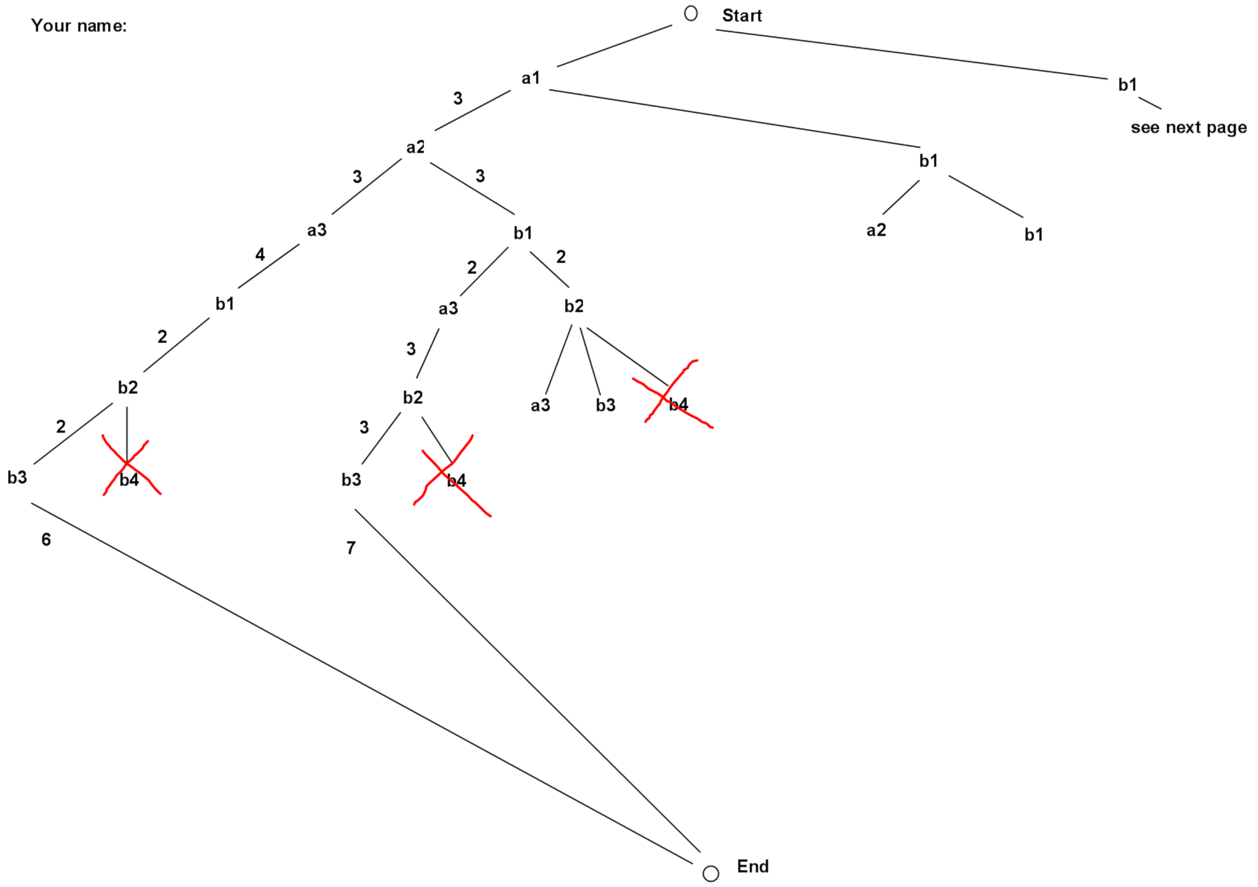
```
semaphore S;
integer u;
```

```
thread a {
u = 3;              //op a1
P(S);
if u<10             //op a2
   {u = u + 1; ..}  //op a3
else u=5;           //op a4
V(S);
};
```

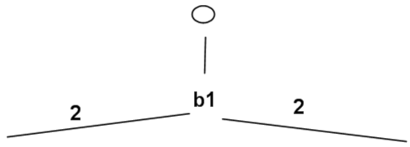
```
thread b {
u = 2;              //op b1
P(S);
if u<4              //op b2
  {u = u + 4; ..}   //op b3
else u=10;          //op b4
V(S);
};
```

Subject to the constraint imposed by the semaphore operations, threads can be executed in any sequence and the execution can switch between the two threads at any time. Generate a graph reflecting possible execution sequences of operations, similar to the one generated in the previous assignment. Add possible values of u to the edges. Sequences which are infeasible due to the values of u can be either crossed out or left out right away.

Your name:


Start
a1
b1
see next page
3
a2
b1
3
3
a3
b1
a2
b1
4
2
2
b1
a3
b2
2
3
b2
a3
b3
b4
2
b2
3
b3
b4
b3
b4
6
7
End

Your name



General Hints: