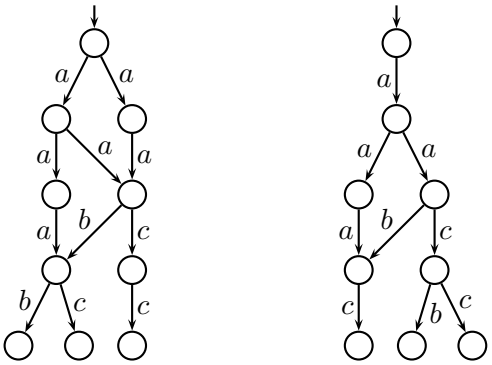
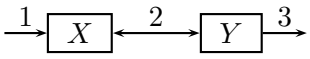
# Exam Software system engineering
# 2IW60, November 13, 2008, 9:00-12:00

It is neither allowed to use the study material nor a computer. The answers to the questions can be formulated in either English or Dutch. This exam consists of 9 questions. Good luck!

1. (a) Give a definition of software engineering.
   (b) Why is evolution crucial in automotive software engineering?
2. (a) Describe 2 problems identified by Weber and Weisbrod with respect to requirements engineering in the automotive setting.
   (b) What are the benefits of domain analysis?
   (c) Describe 3 techniques for gathering requirements.
3. (a) Describe the 'divide and conquer' design principle.
   (b) Decribe a component.
4. (a) Is the CTM/ES a black-box or white-box testing technique? Motivate your answer.
   (b) What is the difference between code inspection and testing?
5. AUTOSAR is a layered software architecture.
   (a) Give the definition of software architecture.
   (b) Describe the layers of AUTOSAR.
   (c) What are alternative architectural patterns?
6. (a) Specify a datatype *MotorStatus* with three elements *off*, *running*, *overheated* and *error* using the datatypes of mCRL2.
   (b) Define a function that expresses that only *running* and *overheated* are modes in which the motor can be used.
7. (a) Describe the behaviour of a simplified controller for an ABS system in mCRL2. The ABS system reads a detector which indicates how fast a wheel is turning. For this an action *turn* with a single parameter of type $\mathbb{N}$ is used that indicates the number of rotations of the wheel per minute. If the speed goes to zero, where it previously was more than $k$ rotations per minute, a message *unblock* must be sent to the braking unit.
   (b) Extend the system above with the option to switch the ABS system on and off, and to set the parameter $k$.
8. Are the following pairs of transition systems (strongly) bisimilar, trace equivalent? Explain your answers.




9. Data elements (from a set $D$) can be received by a one-place buffer $X$ via channel 1, in which case they are sent on to a one-place buffer $Y$ via channel 2. $Y$ either forwards an incoming datum via channel 2, or it returns this datum to $X$ via channel 2. In the latter case, $X$ returns the datum to $Y$ via channel 2.




$X$ and $Y$ are defined by the following recursive specification:

**act** $r_1, s_2, r_2, c_2, s_3{:}D$;
**proc** $X = \sum_{d:D}(r_1(d) + r_2(d))\cdot s_2(d)\cdot X$;
$Y = \sum_{d:D} r_2(d)\cdot(s_3(d) + s_2(d))\cdot Y$;

Let $S$ denote $\nabla_{\{r_1,c_2,s_3\}}(\Gamma_{\{s_2|r_2\to c_2\}}(X \parallel Y))$, and let $D$ consist of $\{d_1, d_2\}$.

(a) Draw the state space of $S$.

(b) Are data elements that are read via channel 1 sent in the same order via channel 3?

(c) Does $\tau_{\{c_2\}}(\nabla_{\{r_1,c_2\}}(S))$ contain a deadlock? If yes, then give an execution trace to a deadlock state.

Score: $(10 + n)/10$ where $n$ is the cumulative judgement given by the following table:

| question | (a) | (b) | (c) | (d) | (e) |
|---|---|---|---|---|---|
| 1 | 4 | 4 | | | |
| 2 | 3 | 3 | 4 | | |
| 3 | 4 | 4 | | | |
| 4 | 4 | 4 | | | |
| 5 | 3 | 4 | 3 | | |
| 6 | 3 | 3 | | | |
| 7 | 10 | 3 | | | |
| 8 | 8 | | | | |
| 9 | 12 | 3 | 4 | | |