Trial exam Software system engineering
2IW60, February 30, 2112, 9:00-12:00

It is neither allowed to use the study material nor a computer. The axioms formulated in the reader for the second part of the course are given as an appendix to this exam. The answers to the questions can be formulated in either English or Dutch. This exam consists of 9 questions. Good luck!

1. Describe 3 aspects which makes software problematic.

2. (a) What is a requirement?

   (b) Name 2 problems identified by Weber and Weisbrod with respect to requirements engineering in the automotive setting.

3. (a) Describe the difference between a subsystem and a component?

   (b) Describe 3 principles which lead to a good design.

4. (a) What are the 4 views in the "4+1" view model of software architecture proposed by Kruchten? Describe these views.

   (b) What is the architectural model used in SAR?

5. (a) Describe both "white-box" and "black-box" testing.

   (b) Conrad describes "equivalence classes" for test input partitioning, what is meant by "equivalence classes"?

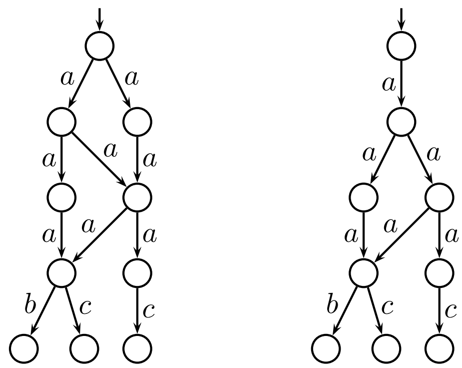
6. (a) Specify the datatype *Mode* with three elements *open*, *closed* and *stuck* using the datatypes of mCRL2.

   (b) Define a function that expresses that *open* and *close* are safe modes, and *stuck* is unsafe.

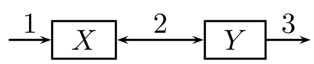
7. (a) Describe the behaviour of a simplified controller for an ABS system in mCRL2. The ABS system reads a detector which indicates how fast a wheel is turning. For this an action *turn* with a single parameter of type $\mathbb{N}$ is used that indicates the number of rotations of the wheel per minute. 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 and branching bisimilar? 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 read via channel 1 and 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	7				
2	2	5			
3	5	5			
4	7	5			
5	4	5			
6	3	3			
7	10	3			
8	8				
9	12	3	3		