Exercise 1 (5/20 Points)

Consider the Rhapsody example model of the automated rail cars system. The (composite) class \texttt{AutomatedRailCarsSystem} includes classes \texttt{Terminal} and \texttt{Car}.

Provide a signature which corresponds to the following part of the system:

- classes \texttt{Terminal} and \texttt{Car},
- the associations between the two classes,
- and for each of the two classes, about three interesting basic type attributes of your choice.

Hints:

- To use Rhapsody, connect to archithor.informatik.uni-freiburg.de with some RDP client.
- The model of the automated rail cars system is located in C:/Program Files/Telelogic/Rhapsody 7.4/Samples/CppSamples/Cars
- The host can (for limited number of licences) only run a limited number of parallel instances of Rhapsody. If you don’t get a license, please try again later. If the problem persists, tell me.
- In a Rhapsody model, classes and their structural relationships are specified by object model diagrams. For the purpose of the task, please disregard irrelevant “instance-related” information, i.e., the number and the object name in the first compartment in the boxes.

Exercise 2 (5+5/20 Points)

Consider the class diagram \(\mathcal{CD}\) in Figure 1.

(i) Assume that the intention of the class diagram is to model lists of terminals that are doubly linked and located on a two-way circular path.

Provide a brief but adequate (textual) explanation of this intention and use object diagrams of system states of \(\mathcal{CD}\) to reasonably illustrate the text. (3)

Hint: you decide, what a “reasonable illustration” is, e.g., whether you use one or more object diagrams, whether you announce that they’re partial or complete, etc.

(ii) Give an object diagram of \(\mathcal{CD}\) which illustrates a case that is not intended. (2)

(iii) Can you formalise this intention? (By any means provided by the lecture? By any means?) (+5)
Exercise 3  
(5/20 Points)  

Figure 2 shows an object diagram $G$ for a railway crossing system.  

(i) Provide a Rhapsody class diagram and a structure $\mathcal{D}$ such that $G$ becomes an object diagram wrt. $\mathcal{D}$ (as defined by the class diagram) and $\mathcal{D}$. 

Explain your proposal. (3)  

(ii) Consider the following OCL expression $expr$:  

$$  \text{context CrossingCtrl inv: occupied = false implies } n \rightarrow \text{forAll(it | it.angle > 80.0)}  $$  

Does $G$ satisfy $expr$? If yes, explain the reason; otherwise, provide a counterexample in form of a system state. (2)  

Exercise 4  
(5/20 Points)  

Consider the class diagram $\mathcal{CD}$ in Figure 3.  

(i) Show that $expr := self.p.x$ is well-typed, i.e. derive  

$$ A, C \vdash self.p.x > 0 : \tau $$  

with $A = self : \tau_C$ in the type-system from the lecture. (3)  

(ii) By the lecture’s convention, $x$ is public in $C$. Now assume $x$ is changed to be private in $C$, is $expr$ still well-typed after the change? (Briefly explain your answer.) (2)