Exercise 1  
(4/20 Points)

Consider a Rhapsody model of the automated rail cars system. Provide the signature which corresponds to the following part of the system: classes Terminal and Car, and the associations between the two classes, as shown in the (composite) class AutomatedRailCarsSystem. (2)

Hints:

- To use Rhapsody, you want to 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 $CD$ 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 $CD$ 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 $CD$ 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. a system state $\sigma$ from $\Sigma_{\mathcal{D}}$ as induced by $\mathcal{D}$ (defined by the class diagram) and $\mathcal{D}$.

Explain your proposal.  

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

\[
\text{context CrossingCtrl inv : occupied = false implies } n \rightarrow \forall (it \mid it.\text{angle} > 80.0)
\]

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

Exercise 4  
(6/20 Points)

Consider the class diagram $CD$ 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.

(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.)