Prof. Dr. Ir. Joost-Pieter Katoen

Falak Sher, Sabrina von Styp

Exam Theoretical Foundations of UML WS 2012/13

First Name: _____

Second Name: _____

Matriculation Number: _____

Degree Programme (please mark):

- ○ CS Master
- ○ SSE Master
- ○ Other: _____

	Σ **Points**	**Points obtained**
Exercise 1	**10**	
Exercise 2	**10**	
Exercise 3	**10**	
Exercise 4	**10**	
Exercise 5	**10**	
Σ	**50**	

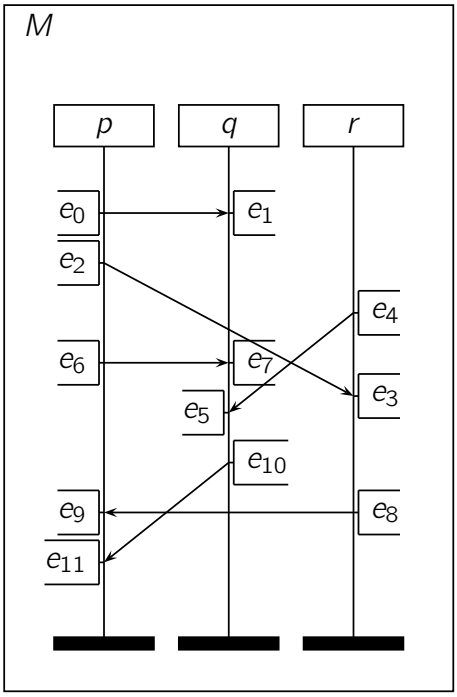
Notes:

- Mark every sheet with your **matriculation number**.
- Check that your copy of the exam consists of **16 sheets**.
- Duration of exam: **120 minutes**.
- Give your solution on the respective sheet. Also use the backside if necessary. If you need more paper, ask the assistants.
- Write with blue or black ink; do **not** use a pencil or red ink.
- Make sure all electronic devices are switched off and are nowhere near you.
- Any attempt at deception leads to failure for this exam, even if it is detected only later.
- Justify your answers. Just providing an answer is insufficient.
- Your are allowed to bring a copy of all slides. No other material is allowed.

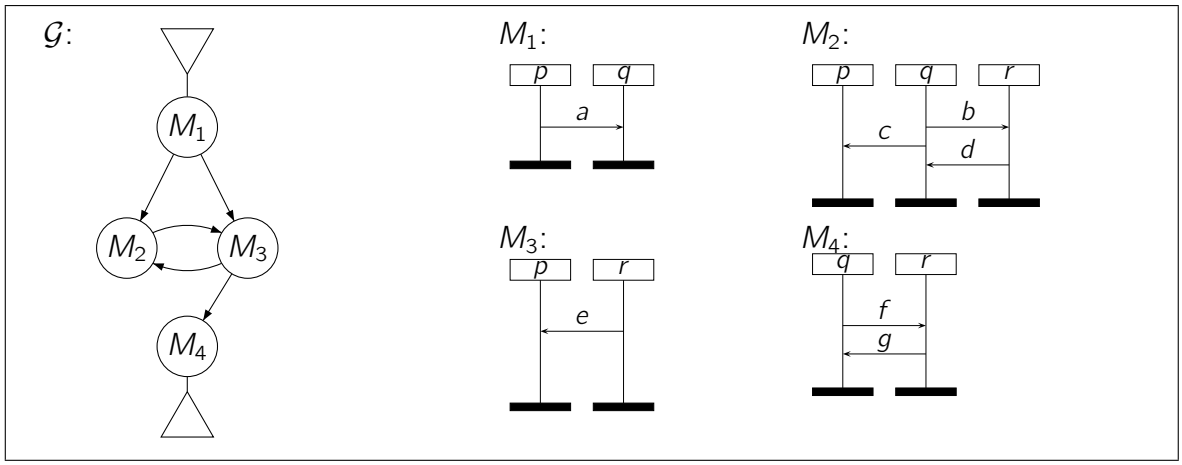
Name: **Matriculation Number:**

Exercise 1 (Races): (5+5 points)

a) Does the following MSC M have a race? If yes, indicate all pairs of events that form a race.



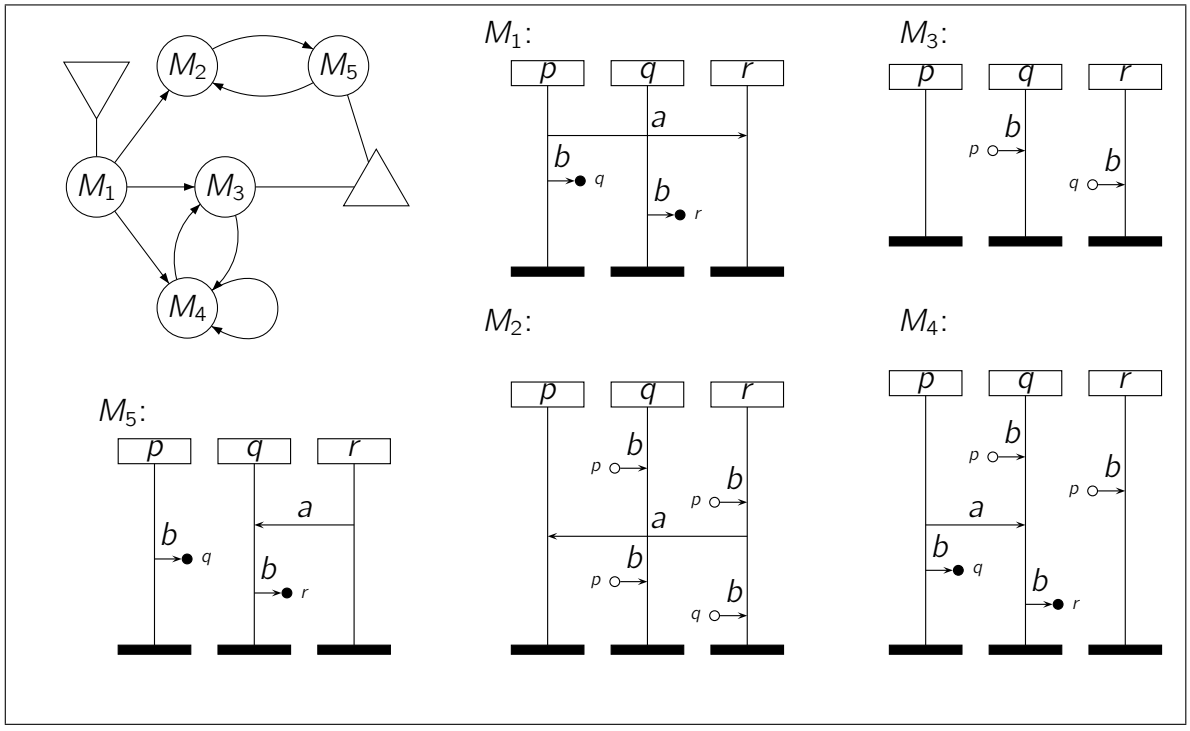
b) Does the following MSG $\mathcal{G}$ have a race? If yes, indicate a path in $\mathcal{G}$ that has a race and give this race.



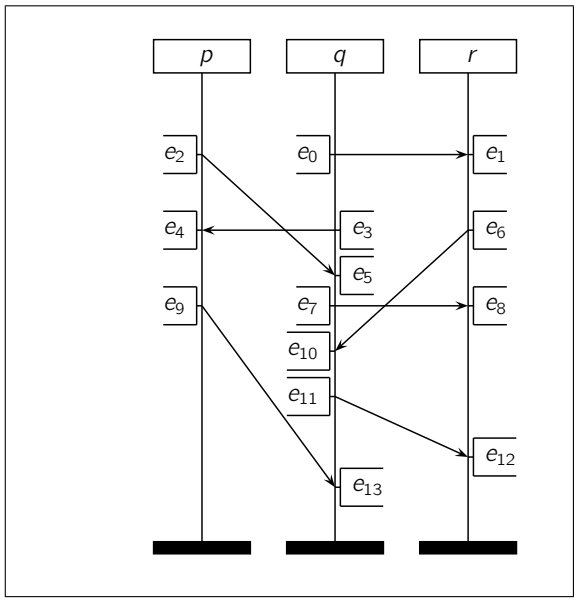
Name: **Matriculation Number:**

Exercise 2 (Safeness and ∃/∀ boundedness): (4+3+3 points)

a) Determine if the following CMSG is safe.

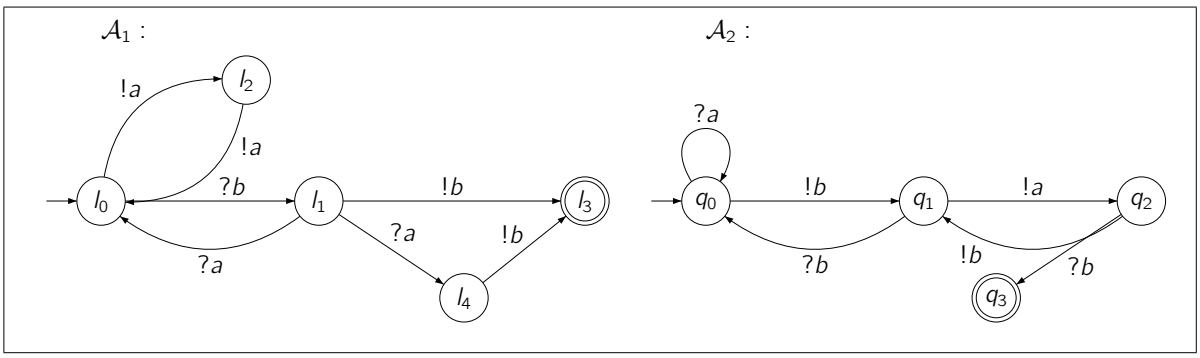


b) Determine for the following MSC if it is existentially ($\exists-$) or universally ($\forall-$) bounded. In case it is $\exists/\forall$-bounded, determine the smallest B such that the MSC is $\exists/\forall$-B-bounded and argue why it cannot be $\exists/\forall-(B-1)-$bounded.



Name: **Matriculation Number:**

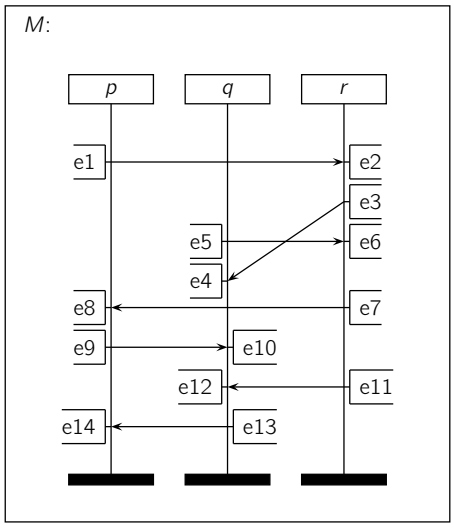
c) Let the following CFM $\mathcal{A}$, described by $\mathcal{A}_1$ and $\mathcal{A}_2$, be given. Is the CFM $\mathcal{A}$ -$\exists$/$\forall$-B-bounded? (if the answer is *yes* find the smallest such B)



Name: Matriculation Number:

Exercise 3 (PDL): (4+6 points)

a) Consider the following MSC M defined over the set of processes $\mathcal{P} = \{p, q, r\}$.



Determine whether the MSC M satisfies the following PDL formulas or not. If your answer is 'yes', provide at least one event that satisfies the corresponding formula.

1) $\exists\langle(proc + msg)^*; \{?(p, q, \cdot)\}\rangle[proc]^{-1}\langle(proc + msg)^*\rangle?(r, q, \cdot)$
2) $\exists\langle\{!p\}; ((proc + \{[msg]^{-1} true\}); \{!q \vee ?p\})^*\rangle?p$
3) $\exists\langle msg\rangle[proc]^{-1}\langle msg\rangle[proc; proc]^{-1} false$

Note: for $p_1, p_2 \in \mathcal{P}$, $?(p_1, p_2, \cdot)$ abbreviates $\bigvee_{a\in\mathcal{C}}?(p_1, p_2, a)$ where $\mathcal{C}$ and $\mathcal{P}$ are the sets of message contents and processes in the MSC M respectively. Moreover, we define $?p_1 = \bigvee_{p'\in\mathcal{P}\setminus\{p_1\}, a\in\mathcal{C}}?(p_1, p', a)$. Similarly we define $!p_1$.

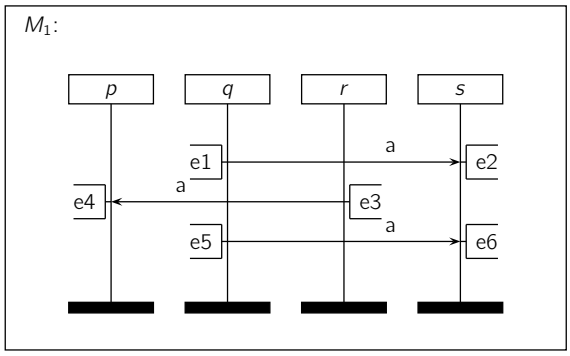
b) Write down the PDL formulas that correspond to the following informal descriptions about the MSC M:

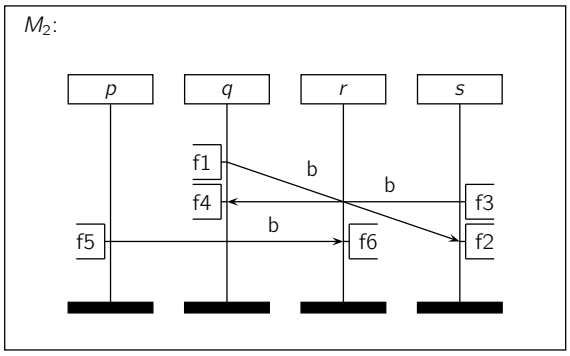
1) Once process p receives a message from process r, it will not receive any message any further.
2) Every message that process r receives from process q is immediately passed from process r to process p.

Name: **Matriculation Number:**

Exercise 4 (Realizability): (4+4+2 points)

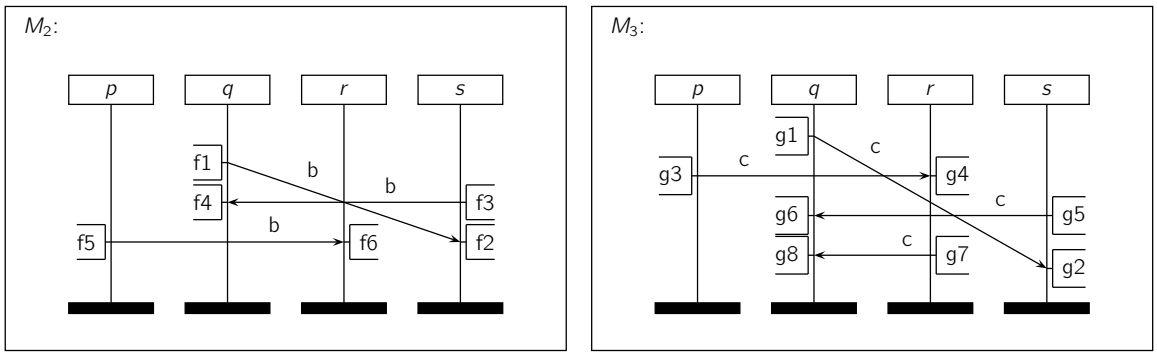
a) Consider the following MSCs M_1 and M_2 defined over the set of processes $\mathcal{P} = \{p, q, r, s\}$.





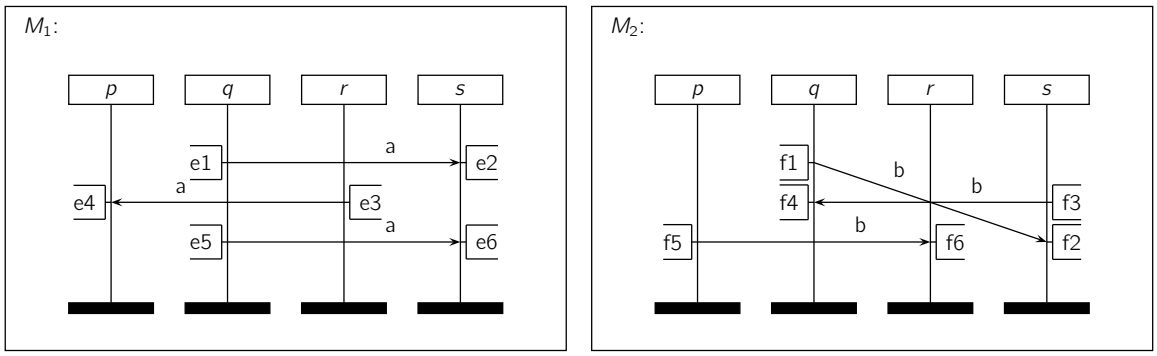
Prove that $L_1 = Lin(M_1) \cup Lin(M_2)$ is not closed under $\models$.

b) Consider the following MSCs M_2 and M_3 defined over the set of processes $\mathcal{P} = \{p, q, r, s\}$.



Prove that $L_2 = Lin(M_2) \cup Lin(M_3)$ is not closed under $\models^{df}$.

c) Consider the following MSCs M_1 and M_2 defined over the set of processes $\mathcal{P} = \{p, q, r, s\}$.

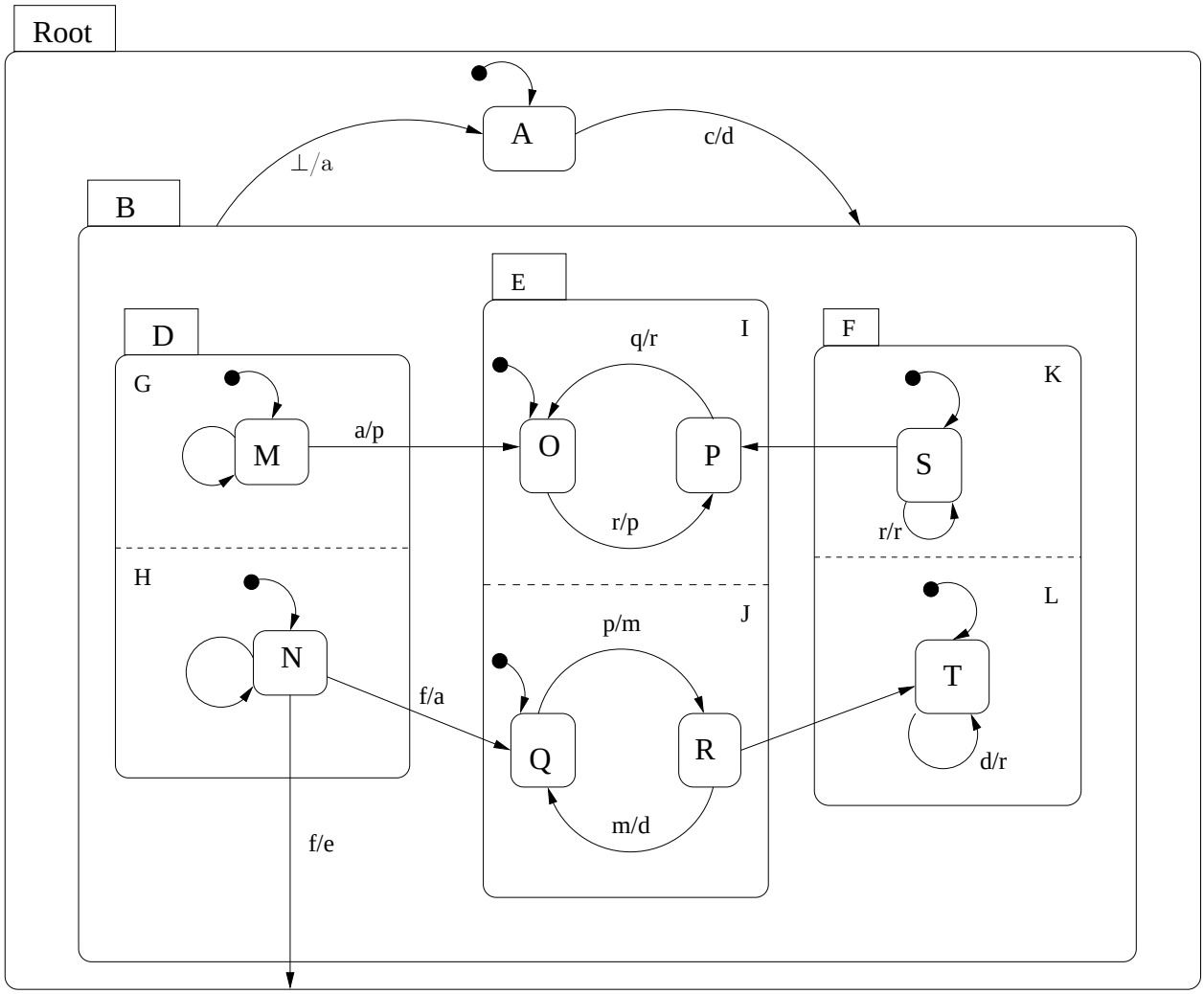


Modify either M_1 or M_2 by adding only one pair of send and receive events such that $Lin(M_1) \cup Lin(M_2)$ is closed under $\models$.

Name: Matriculation Number:

Exercise 5 (Statechart): (1+1+4+1+3 points)

Let the following statechart $\mathbb{S} = (N, E, Edges)$ be given:



Note: In this assignment an edge label of the form e/e' of Statechart $\mathbb{S}$ means that $\mathbb{S}$ is consuming event e and executing an action that is sending the event e' to $\mathbb{S}$ (i.e., to itself).

a) Give the type of the nodes A, B, D and N.

b) Construct the tree that represents the node hierarchy of statechart $\mathbb{S}$.

c) Determine the priority between:

1) moving from N to Q and moving from N to $Root$, and

2) moving from M to M and moving from M to O

provided both the edges are enabled in each of the above cases.

d) Determine the scope of the edges:

1) $\{R\} \longrightarrow \{T\}$
2) $\{Q\} \longrightarrow \{R\}$

e) Consider the configuration $C = \{Root, B, E, O, Q\}$ in the statechart $\mathbb{S}$.

1) Provide the maximal set of events I that can be consumed in the configuration C.

2) Provide all possible steps in configuration C.