## 2 STAIRS (35%)

The traces corresponding to Figure 1 may be classified into positive, inconclusive and negative.

2a) What is the minimal number of events in a trace that is inconclusive with respect to the sequence diagram in Figure 1. Explain your answer.

We need to find a trace which is inconclusive and have the minimal number of events. For this diagram the "empty trace" (<>) is inconclusive. Thus the answer is 0.
Note that there are infinitely many inconclusive traces for the diagram in Figure 1. The empty trace is just one of them, and obviously the shortest.
Note also that traces consist of events. An event e can never be inconclusive, only traces can be inconclusive including a trace <e> consisting of only one event.

2b) What is the minimal number of events in a trace that is positive with respect to the sequence diagram in Figure 1. Explain your answer.

A shortest trace is the one, which contains the messages outside the outer alt-combined fragment and messages in the second alternative of the outer alt-combined fragment. Let us use the following shortcuts:
Sms("Stud1 konto oystein histpict...") - a
PosRequest - b
PosResult - c
GetHistPict("N595564...") - d
NoMoreHistoricPict(0, "No pictures found") - e
Sms("HISTPICT:...") - f
Then the shortest trace is <?a,!b,?c,!d,?d,!e,?e,!f>, thus the minimum number is 8.

Remember that the traces of a diagram contain only events positioned on the lifelines of the diagram.

Consider only the loop construct in Figure 1, in other words, ignore everything before and after the loop construct.

2c) How many positive traces is described by the loop construct? Explain your answer.

Let us use the following shortcuts:
Sms("Stud1 konto oystein nextpict"...) - a
NextHistoricPict() - b
NoMoreHistorciPict(1, "..") - c
Sms("HISTPICT: Nothing...") - d
OneHistoricPict("http://...") - e
Sms("Picture: ...") - f

If we had not had the loop-combined fragment, we would have just 2 positive traces, i.e.

<?a,!b,?b,!c,?c,!d> - <t1>, <?a,!b,?b,!e,?e,!f> - <t2> . This corresponds to the number of traces if the loop-combined fragment is executed only once.

The second iteration gives us 4 more traces: <t1, t1>, <t1, t2>, <t2, t1>, <t2, t2>. Thus we have 2 + 4 = 6 non-empty traces if the loop-combined fragment is executed once or twice.

The third option, that the loop-combined fragment is not executed at all results in the empty trace <>.

The answer is therefore 1+2+4=7 traces.

Consider again the full sequence diagram in Figure 1. Replace "opt" with "loop(0,2)". Refer to the result as *icus_histpict_2*.

2d) Is *icus_histpict_2* a refinement of *icus-histpic* in Figure 1? If so, is it a supplementing or narrowing? Explain your answer.

Yes. It is supplementing. If the loop-combined fragment is not executed at all or once, then we get the same traces as in 2c). If it is executed twice we get additional fresh traces.

Consider again the full sequence diagram in Figure 1. Replace "opt" with "neg". Refer to the result as *icus_histpict_3*.

2e) Is *icus_histpict_3* a refinement of *icus-histpic* in Figure 1? If so, is it a supplementing or narrowing? Explain your answer.

Yes. It is narrowing, we moved some positive traces to the negative domain.

Consider again the full sequence diagram in Figure 1. Replace both occurrences of "alt" with "xalt". Refer to the result as *icus_histpict_4*.

2f) How many interaction obligations does *icus_histpict_4* describe? Explain your answer.

AV: 9 interaction obligations. The first alternative of the xalt-combined fragment describes 8 interaction obligations since the loop is an alt between three operands of which the first has no xalts (one interaction obligation), the second has one binary xalt (two interaction obligations) and the third has two binary xalts composed in sequence (four interaction obligations).

2g) Is *icus_histpict_4* a refinement of *icus-histpic* in Figure 1? Explain your answer.

No, it is not a refinement some positive and negative traces in *icus-histpic* are inconclusive in each interaction obligation in *icus_histpict_4*.