Time: 40 mins | Total marks: 25

- ***The exam is open book and notes.***
- ***Results/proofs covered in class/problem sessions/assignments may simply be cited, unless specifically asked for.***
- ***Unnecessarily lengthy solutions will be penalized.***
- ***If you need to make any assumptions, state them clearly.***
- ***Do not copy solutions from others or indulge in unfair means.***

1. For purposes of this question, we will use the following notation.

   - $e!$ in the description of a process P signifies the generation of an event on e by P.
   - $e?$ in the description of P denotes the arrival *and* receipt of an event on e by P. The arrival of an event is considered synonymous with its receipt by P.

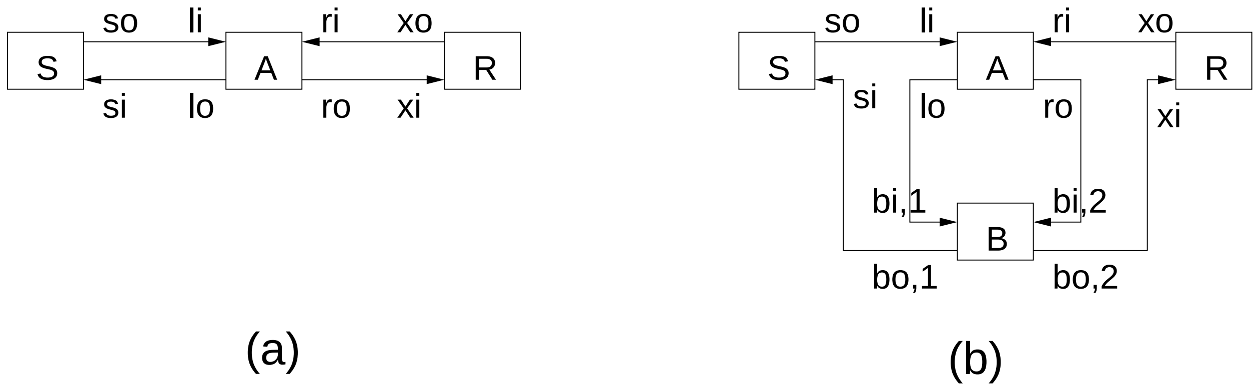

Figure 1: Communication through a malicious agent

In the scenario depicted in Fig. 1a, sender S communicates with receiver R through a malicious agent A on the network. Both S and R follow a two-phase handshaking protocol at their interface. Thus, the sequence of events at S's interface is described by: $S = s_o! \rightarrow s_i? \rightarrow S$. Similarly, the sequence of events on R's interface is given by $R = x_i? \rightarrow x_o! \rightarrow R$. Agent A non-deterministically chooses whether a message from S should reach R or not. The sequence of events on A's interface is given by $A = ((l_i? \rightarrow (l_o))[](r_i? \rightarrow l_o!)) \rightarrow A$. Thus, A can prevent S's message from reaching R without either S or R being aware of its malicious intentions. We wish to rectify this situation by composing A with another process B as shown in Fig. 1b. Note that B looks only at A's outputs, while S and R receive inputs from B.

   (a) *[10 marks]* Give a process algebraic description of B such that all messages from S are eventually forwarded to R in the configuration shown in Fig. 1b.

   (b) *[7.5 + 7.5 marks]* Draw the state transition diagram (STD) of B, label the states with the binary values of $b_{o,1}, b_{o,2}, b_{i,1}, b_{i,2}$ and indicate whether there are any CSC conflicts.