CS 2SD3

Assignment #1. Due February 5 (Monday), 2024, 23:59 via Avenue. Do not hesitate to discuss with TA or instructor all the problems as soon as you discover them. This assignment labour consuming. Start early!

Instructions: For all assignments, the students must submit their solution to Avenue → Assessments → Assignment #

Students can simply solve the exercises on a paper and use a smartphone app called Microsoft Lens - PDF Scanner **and convert their entire solution into a single PDF file and submit it to avenue. The maximum upload file size is 2Gb in avenue for each submission. Please also attach your LTSA and PDF files separately.**

Please make sure that the final PDF file is readable.

Students, who wish to use Microsoft word and do not have Microsoft Word on their computer, are suggested to use google document editor (Google Docs**). This online software allows you to convert your final file into PDF file.**

There will be a mark deduction for not following the submission instruction.

First please finish the assignment on your local computer and then attach your solution as a PDF file.

You will have an unlimited number of submissions until the deadline.

Students must submit their assignments to Avenue**. *Any problem with Avenue, please discuss with Sepehr Bayat < bayats1@mcmaster.ca >, the lead TA for this course.***

Total: 134 pts

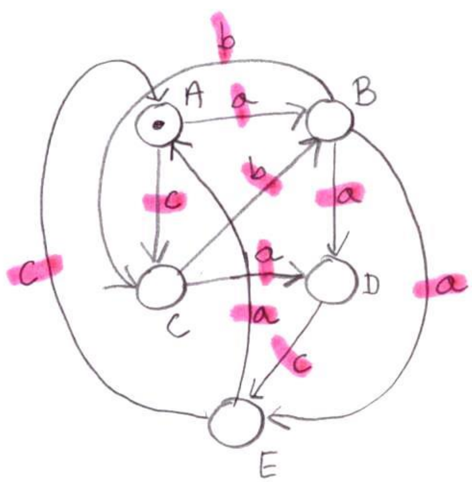
1.[10] Model the following Road Deicing protocol as FSP. The road could be in one of the following states: Predicted Safe For Use, Predicted Unsafe For Traffic But Open, Closed. If road is ‘Predicted Safe For Use’, coming ‘Predicted Ice Formation’ changes its status to ‘Predicted Unsafe For Traffic But Open’. If road is ‘Predicted Unsafe For Traffic But Open’, ice may melt (i.e. action ‘Ice melts’ occurs) and the road is again ‘Predicted Safe For Use’, or it becomes unsafe for use (action ‘Unsafe for Use’) and it is in the state ‘Closed’, or it is treated (action ‘Road treated’) and it is in the state ‘Predicted Safe For Use’ again. If the road is ‘Closed’, either ‘Ice melts’ or it is treated (action ‘Road treated’), in both cases it becomes ‘Predicted Safe For Use’.

Provide an appropriate Labelled Transition System (use LTSA).

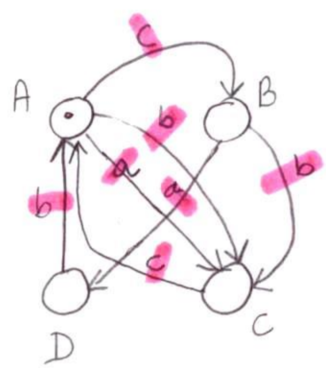
Hint: The processes: ROAD-DEICING, PREDICTED-SAFE, PREDICTED-UNSAFE, CLOSED.

2.[15] a.[9] For each one of the following three processes, give the Finite State Processes (FSP) description of the labelled transition graph. Dots indicate initial states.

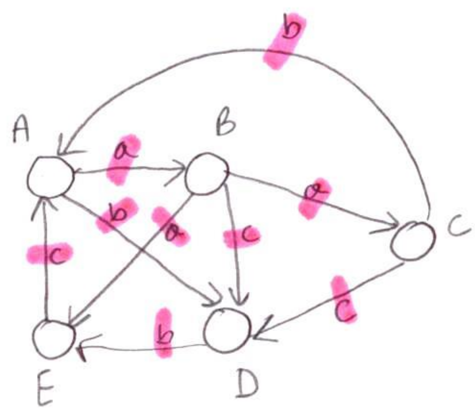
b.[6] Use LTSA to transform the solutions to 1.a back into labelled transition systems. Compare the results and discuss differences (if any).



P_1



P_2



P_3

3.[15] Consider the following set of FSPs:

$A = (a \rightarrow (b \rightarrow C)) \mid (b \rightarrow (a \rightarrow D \mid c \rightarrow A)) \mid c \rightarrow B)$
$B = (b \rightarrow (a \rightarrow A \mid c \rightarrow (b \rightarrow C \mid a \rightarrow D)))$
$C = (a \rightarrow (b \rightarrow (c \rightarrow B)))$
$D = (c \rightarrow A \mid c \rightarrow (b \rightarrow B))$

a.[12] Construct an equivalent Labelled Transition System using the rules from page 16 of Lecture Notes 2.
b.[3] Use LTSA to derive appropriate LTS, and, if different than yours, analyse and explain differences.

4.[8] A sensor measures the water *level* of tank. The level (initially 5) is measured in units 0 ... 11. The sensor outputs a *low-danger* signal if the level is less than 2, a *low* signal if the level is 2 or 3, a *high* signal if the level is 8 or 9, and a *high-danger* signal if the level is more than 9; otherwise it outputs *normal*. Model the sensor as an FSP process *SENSOR* (this process is intended to be a part of bigger system that is not a subject of this question).

Hint: The alphabet of *SENSOR* is { *level*[0..9], *high-danger*, *high*, *low*, *low-danger*, *normal* }

5.[10] A miniature portable FM radio has three controls. An on/off switch turns the device on and off. Tuning is controlled by two buttons scan and reset which operate as follows. When the radio is turned on or reset is pressed, the radio is tuned to the top frequency of the FM band (108 MHz). When scan is pressed, the radio scans towards the bottom of the band (88 MHz). It stop scanning when it locks onto a station or it reaches the bottom (end). If the radio is currently tuned to a station and scan is pressed then it start to scan from the frequency of that station towards the bottom. Similarly, when reset is pressed the receiver tunes to the top. Model the radio as a *FSP* process RADIO. Also provide an appropriate labelled transition system.

Hint: The alphabet of RADIO is {on, off, scan, reset, lock, end}.

6.[18] a.[8] Show that the processes ||S1 and S2 generate the same Labelled Transition Systems, i.e. LTS(||S1) = LTS(S2) (or equivalently, they generate the same behaviour)

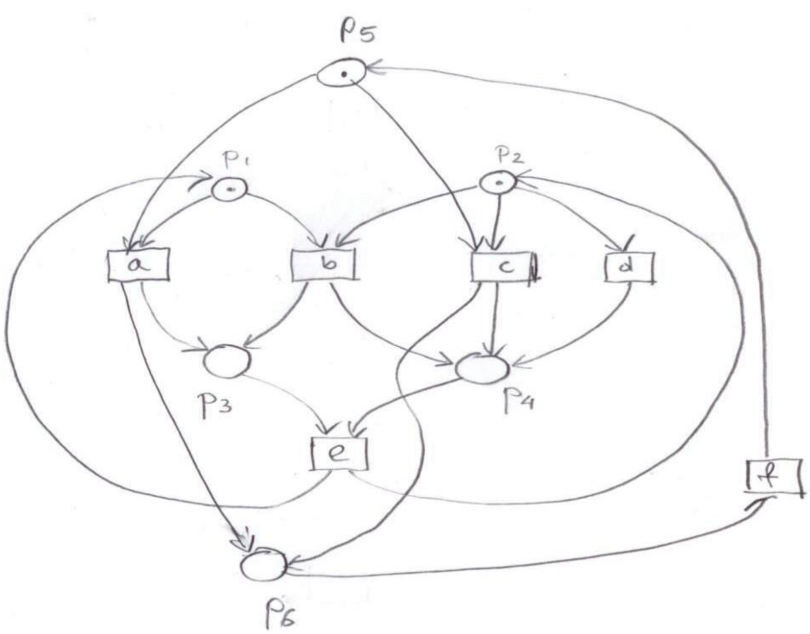
P = (a → b → P).
Q = (c → b → Q).
R = (d → b → R).

||S1 = (P || Q || R).

S2 = (a → c → d → b → S2 | a → d → c → b → S2 |
c → a → d → b → S2 | c → d → a → b → S2 |
d → a → c → b → S2 | d → c → a → b → S2).

b.[10] Using a method presented on page 17 of Lecture Notes 3 and pages 10-11 of Lecture Notes 4, transform the processes ||*S*1 and *S*2 into appropriate Petri nets. Are these nets identical? Explain the difference. Which one allows *simultaneity*?

7.[10] Consider the Petri net below:



Model this net as a composition of *FSP* processes.

8.[10] Model the system from page 10 of Lecture Notes 3 as a composition of *FSP* processes. In this case, the entities that are represented by places in the Petri Nets model, must be represented by actions/transitions in *FSP* model.

9.[10] Construct *reachability graph* (defined on page 18 of Lecture Notes 3) for the Petri net from Question 8.

10.[28] Consider three Labelled Transition Systems (Finite State Machines, Finite Automata) given below: P_1, P_2 and P_3. Tokens represent initial states. Show that:

- a.[8] $P_2 \approx P_3$, i.e. P_3 and P_3 are *bisimilar*,
- b.[6] $P_1 \not\approx P_2$, i.e. P_1 and P_2 are *not bisimilar*,
- c.[6] $P_1 \not\approx P_3$, i.e. P_1 and P_3 are *not bisimilar*,
- d.[8] Traces(P_1) = Traces(P_2) = Traces(P_3) = Pref(*give a proper regular expression*).