

## CS 2SD3

**Assignment #1. Due February 10 (Monday), 2025, 23:59 via Avenue. Do not hesitate to discuss with TA or instructor all the problems as soon as you discover them.**

**This assignment is 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.

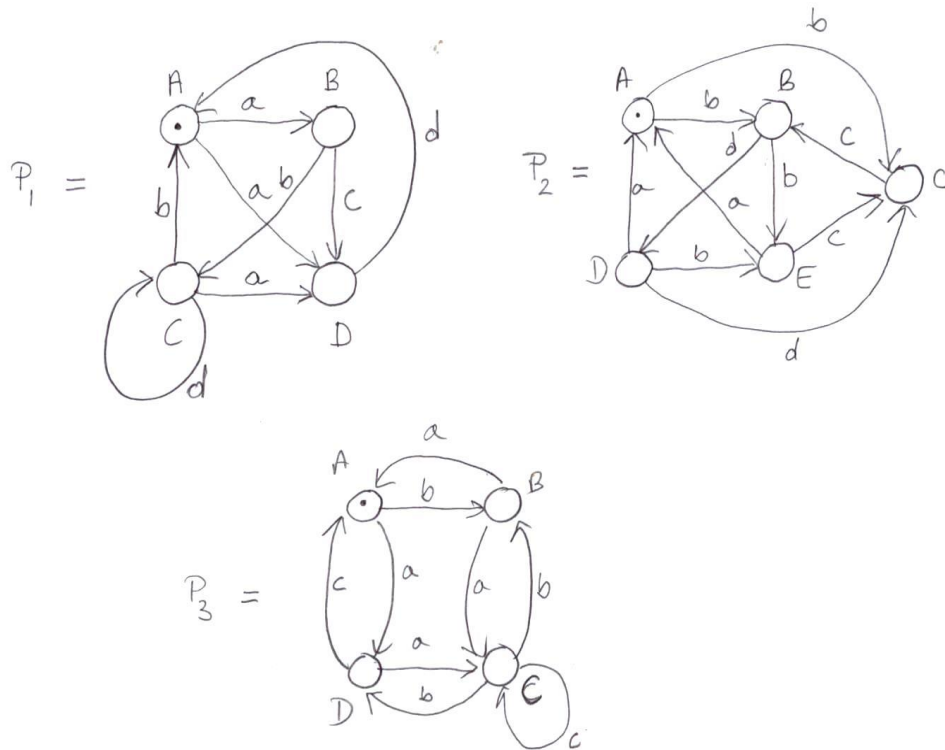
First please finish the assignment on your local computer and then attach your solution as a PDF file.

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 Atiyeh Sayadi: [atiye.sayadi@yahoo.com](mailto:atiye.sayadi@yahoo.com) the lead TA for this course or Jatin Chowdhary: [chowdhaj@mcmaster.ca](mailto:chowdhaj@mcmaster.ca), an experienced Avenue user.*

**Total: 166 pts**

- 1.[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).



- 2.[10] Consider the following simple hotel reservation system. A customer makes a room request. If room is available, a confirmation is sent to the customer, otherwise the customer is put on a reservation list. If a room is confirmed, the customer may either use it, pay for the room, leave and the whole transaction is archived. However the customer may also cancel his/her reservation. When the customer is on waiting list, a room may become available, and then a confirmation is sent to a customer. The customer may also give up waiting and cancel his/her request.

Model this reservation system as a FSP process reservation. Note that this process always stops, so you have to use the process STOP. Also provide appropriate labelled transition system (use LTSA).

- 3.[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 stops 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}.

4.[15] Program the radio of Question 3 in Java, complete with graphic display (if you can).

5.[15] A drinks dispensing machine charges 15c for can of Sugerola, 20c for a can of SugerolaDiet and 25c for a can of SugerolaSuperDiet. The machine accepts coins with denominations 5c, 10c and 25c and gives changes. Model the machine as an *FSP* process, DRINKS.

6.[15] Consider the following set of FSPs:

$$\begin{aligned} A &= ((a \rightarrow (b \rightarrow A)) \mid (c \rightarrow (a \rightarrow C \mid c \rightarrow B)) \mid c \rightarrow C)) \\ B &= (b \rightarrow (a \rightarrow B \mid c \rightarrow (a \rightarrow A \mid b \rightarrow B))) \\ C &= ((a \rightarrow (b \rightarrow (c \rightarrow B))) \mid (a \rightarrow C)) \end{aligned}$$

a.[12] Construct an equivalent Labelled Transition System using the rules from page 16 of Lecture Notes 2.

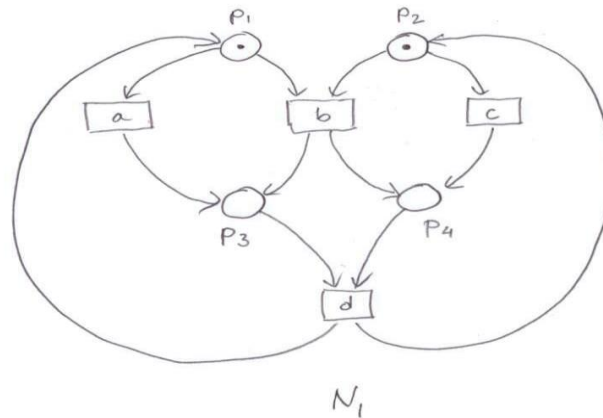
b.[3] Use LTSA to derive appropriate LTS, and, if different then yours, analyse and explain differences.

7. [18] a.[8] Show that processes  $\parallel S1$  and  $S2$  generate the same Labelled Transition Systems, i.e.  $LTS(\parallel S1) = LTS(S2)$  (or equivalently, they generate the same behaviour)

$$\begin{aligned} P &= (a \rightarrow b \rightarrow d \rightarrow P) \\ Q &= (c \rightarrow b \rightarrow e \rightarrow Q) \\ \parallel S1 &= (P \parallel Q) \end{aligned}$$
$$\begin{aligned} S2 &= (a \rightarrow S2A \mid c \rightarrow S2B) \\ S2A &= (c \rightarrow b \rightarrow d \rightarrow S2C \mid c \rightarrow b \rightarrow e \rightarrow S2D) \\ S2B &= (a \rightarrow b \rightarrow d \rightarrow S2C \mid a \rightarrow b \rightarrow e \rightarrow S2D) \\ S2C &= (e \rightarrow S2 \mid a \rightarrow e \rightarrow S2A) \\ S2D &= (d \rightarrow S2 \mid c \rightarrow d \rightarrow S2B) \end{aligned}$$

b.[10] Using a method presented on page 17 of Lecture Notes 3 and pages 10-11 of Lecture Notes 4, transform the processes  $\parallel S1$  and  $S2$  into appropriate Petri nets. Are these nets identical? Explain the difference. Which one allows *simultaneity*?

8.[10] Consider a Petri net below:



Model the net  $N_1$  as a composition of *FSP* processes.

9.[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.

10.[10] A roller-coaster control system only permits its car to depart when it is full. Passengers arriving at the departure platform are registered with the roller-coaster controller by a turnstile. The controller signals the car to depart when there are enough passengers on the platform to fill the car to its maximum capacity of  $M$  passengers. Ignore the synchronization detail of passengers embarking from the platform and car departure. The roller-coaster consists of three processes: *TURNSTILE*, *CONTROL* and *CAR*. *TURNSTILE* and *CONTROL* interact by the shared action *passenger* indicating an arrival and *CONTROL* and *CAR* interact by the shared action *depart* signalling the car departure. Provide FSP description for each process and the overall composition.

11.[10] Construct *reachability graph* (defined on page 18 of Lecture Notes 3) for the Petri net from Question 8.

12.[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.  $P_2$  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]  $\text{Traces}(P_1) = \text{Traces}(P_2) = \text{Traces}(P_3) = \text{Pref}(\text{give a proper regular expression})$ .

