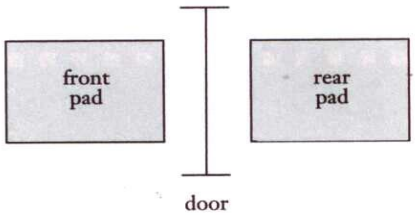
CS 2SD3 Midterm Test
March 3, 2023, 19:00-20:20, Total: 58 pts

Virtual Take Home Midterm Test

- THIS EXAMINATION PAPER HAS **3** PAGES AND **6** QUESTIONS.
- The test starts at 19:00 and ends at 20:20pm, i.e. 80 minutes (for students without extra time permissions). This includes the exam time (60 minutes) plus extra time for technology (20 minutes)
- Please submit the solutions via Avenue using the same procedure as for the assignments.
- Any question regarding the exam during this midterm, ask by sending an e-mail to Ryszard Janicki (janicki@mcmaster.ca); any question regarding technology ask by sending an e-mail to Mahdee Jodayree (mahdijaf@yahoo.com).

1.[5] Consider the controller for an automatic door. Often found at supermarkets entrances and exits, automatic doors swing open when the controller senses the person is approaching. An automatic door has a pad in front to detect the presence of the person about to walk through the doorway. Another pad is located to the rear of the doorway so that the controller can hold the door open enough for the person to pass all the way through and also so that the door does not strike someone standing behind it as it opens. The configuration is shown in the following figure:



The controller is in either of two states: OPEN or CLOSED, representing the corresponding condition of the door, and there are four possible actions/conditions:
FRONT - the person is standing on the pad in front of the doorway,
REAR - the person is standing on the pad to the rear of the doorway,
BOTH - the people are standing on both pads,
NEITHER - no one is standing on either pad.

Model this controller as an *FSP* process, DOOR_CONTROLLER.

2.[10] A small hotel cafeteria is used by several customers eating breakfast. The customers either drink tea or coffee. There are one Tea Machine and one Coffee Machine. When either Tea Machine or Coffee Machine runs out of tea or coffee, new tea or coffee is provided by the cafeteria staff. Assume capacities of both machines are the same: *N* drinks. Initially, both machines are full.

a.[5] Provide an FSP description of the above scenario. You must provide also a brief description of the intended behavior for each one of the processes you define.

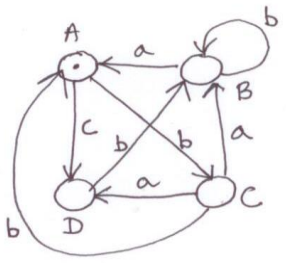
Hint: Possible processes for the above scenario are CUSTOMER, TEA_MACHINE, COFFEE_MACHINE, and STAFF_MEMBER.

b.[5] Provide a Petri nets (any kind) description of the above scenario.
Hint. While any kind on nets can be applied, *using Place/Transition nets is advised as they seem to be the most natural tool*.

3.[5] Provide the Finite State Process (FSP) description of the following Labelled Transition Graph (dot indicate the initial state). Use the following pattern for writing equations:

A = ….
B = ….
C = ….

i.e. eliminate the process D.



4.[10] Consider the following problem. Three processes P, Q, and R continuously perform a certain task separately. In order to achieve that task, each process needs to obtain two resources, say, *a* and *b*. Obtaining and releasing a resource requires to perform actions *get* and *put* in this order. With FSP this is modeled by:

RESOURCE = (get −> put −> RESOURCE).

To work properly, process P needs to get *a* before *b*, process Q needs to get *b* before *a*, while for process R the order does not matter.

a.[5] Model the situation described above carefully avoiding deadlock with FSP.

b.[5] Model the situation described above carefully avoiding deadlock with Petri nets (any kind).
Hint. While any kind on nets can be applied, *using Elementary nets is advised as they seems to be the most natural tool.*

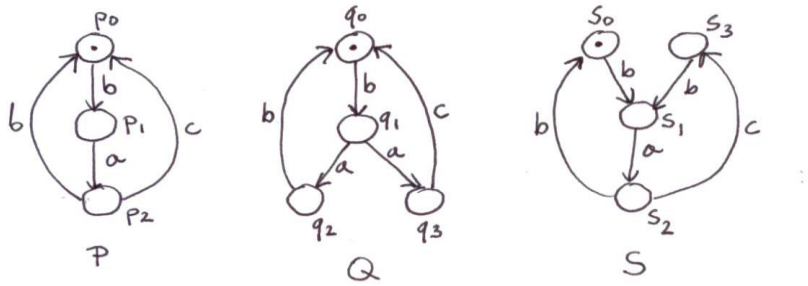
5.[10] A central computer, connected to remote terminals via communication links, is used to automate seat reservations for a concert hall. A booking clerk can display the current state of seat reservations on the terminal screen. In order to book a seat, a client chooses a free seat and then the clerk enters the number of the chosen seat at the terminal and issues a ticket. A system is required to avoid the double-booking of seats while allowing clients to choose available seats freely.

Construct an FSP model and argue that the model does not permit double-booking.

6.[12] Consider three Labelled Transition Systems given below: P, Q and S. Prove that:

a.[5] P $\not\approx$ Q, i.e. P and Q are *not bisimilar.*

b.[7] P $\approx$ S, i.e. P and S are *bisimilar*.



7.[6] Consider the following processes:

P1 = (a → b → c → P1 | a → c → b → P1)
P2 = (a → (b → c → P2 | c → b → P2))
Q = (b → c → Q)

and

||P1Q = (P1 || Q)
||P2Q = (P2 || Q)

Show that Traces(P1) = Traces(P2) but ||P1Q and ||P2Q cannot be considered equivalent since one of them deadlocks while the other does not (show which one).