CS 3SD3

Assignment #3. Due December 7 (Tuesday), 2021, 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 also labour consuming. Start early!

FOR THIS ASSIGNMENT THE ONLY LEGAL DEADLINE EXTENSION IS DEC 8!

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

For each question student will have a rich format text box for each question which also allows them to copy and paste their solutions directly from Microsoft word in to the text box or attach any image file or pdf file or other required files to that text box.
Please first finish the assignment on your local computer and at the end, **copy and paste their solution to each avenue textbox or attach your solution as a PDF file. The suggested format for the attached image files is .png format.**
Make sure to save you work for each question in avenue by clicking on the outside of the textbox box in avenue, will allow avenue you save your response.

PLEASE DO NOT USE THE SUBMIT button every time to SAVE your work.
Only use the submit button for your final submission.

Student can easily create a snap shot of their LTS diagrams by using windows snipping tool (Grab for Mac) with these tools students can directly save the image as .png file and attach it to each textbox at the end after they finalized their solution. Students, who do not have Microsoft Word on their computer, are suggested to use google document editor (Google Docs).
There will be a mark deduction for not following the submission instruction.

For questions that do not involve using the LTSA tool or producing FSPs, hand-drawn pictures are allowed, but a solution should be in image format inserted or attached into the textbox (if a student need to scan a hand written note and insert it into the textbox is encouraged to use a smartphone app called CamScanner).

Students must submit their assignments to Avenue. *Any problem with Avenue, please discuss with Mahdee Jodayree <mahdijaf@yahoo.com>, a TA for this course.*

Total: 123 pts

1.[10] Consider the Coloured Petri Net solution to Dining Philosophers with a butler, presented as a sample solution to Question 5 of Assignment 2. Prove that this solution is deadlock-free by mimicking the proof of Proposition from page 33 of Lecture Notes 12.

2.[15] A self-service gas station has a number of pumps for delivering gas to customers for their vehicles. Customers are expected to prepay a cashier for their gas. The cashier activates the pump to deliver gas.

a.[5] Provide a model for the gas station with *N* customers and *M* pumps. Include in the model a range for different amounts of payment and that customer is not satisfied (ERROR) if incorrect amount of gas is delivered.

b.[5] Specify and check (with *N*=2, *M*=3) a safety property FIFO (First In First Out), which ensures that customers are served in the order in which they pay.

c.[5] Provide a simple Java implementation for the gas station system with *N*=2, *M*=3.

3.[15] The cheese counter in a supermarket is continuously mobbed by hungry customers. There are two sorts of customer: bold customers who push their way to the front of the mob and demand services; and meek customers who wait patiently for service. Request for service is denoted by the action *getcheese* and service completion is signalled by the action *cheese*.

(a)[5] Assuming that there is always cheese available, model the system with FSP for a fixed population of two bold customers and two meek customers.

(b)[5] Assuming that there is always cheese available, model the system with Petri nets (any kind).

(c)[5] For the FSP model, show that meek customers may never be served when their requests to get cheese have lower priority than those of bold customers.

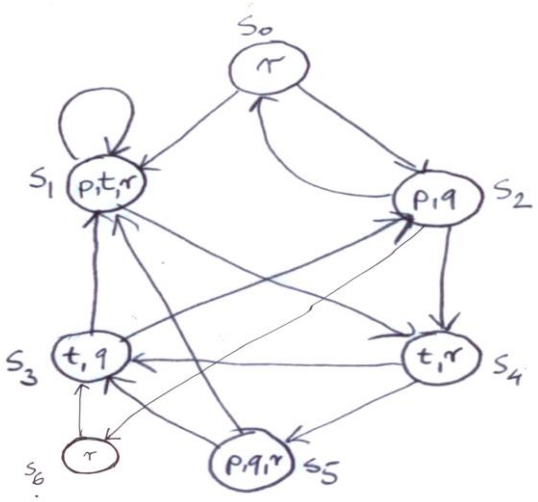
4.[10] To restore order, the management installs a ticket machine that issues tickets to customers. Tickets are numbered in the range 1..*MT*. When ticket *MT* has been issued, the next ticket to be issued is ticket number 1, i.e. the management install a new ticket roll. The cheese counter has a display that indicates the ticket number of the customer currently being served. The customer with the ticket with the same number as the counter display then goes to the counter and is served. When the service is finished, the number is incremented (modulo *MT*). Model this system (with FSP) and show that, even when their requests have low priority, meek customers are now served.

5.[10] Translate the model of the cheese counter from Question 4 into a Java program. Each customer should be implemented by a dynamically created thread that obtains a ticket, is served cheese and then terminates.

6.[10] Design (with FSP) a message-passing protocol which allows a producer process communicating with a consumer process by *asynchronous* messaging to send only a bounded number of messages, *N*, before it is blocked waiting for the consumer to receive a message. Construct a model which can be used to verify that your protocol prevents queue overflow if ports are correctly dimensioned.

7.[38] This question deals with Model Checking.

(a) Consider the system *M* defined below:



Determine whether $M, s_0 \models \varphi$ and $M, s_2 \models \varphi$ hold and justify your answer, where φ is the LTL or CTL formula:

(i)[2] $\neg p \Rightarrow r$
(ii)[2] $\neg$ EG r
(iii)[2] E(t U q)
(iv)[2] F q

b.[6] Express in LTL and CTL: 'Event *p* precedes *s* and *t* on all computational paths' (You may find it easier to code the negation of that specification first).

c.[6] Express in LTL and CTL: 'Between the events *q* and *r*, *p* is never true but *t* is always true'.

d.[6] Express in LTL and CTL: 'Φ is true infinitely often along every paths starting at s'. What about LTL for this statement?

e.[6] Express in LTL and CTL: 'Whenever p is followed by q (after some finite amount of steps), then the system enters an 'interval' in which no r occurs until t'.

f.[6] Express in LTL and CTL: 'Between the events q and r, p is never true'.

8.[15] Consider *Readers-Writers* as described in the first part of LN12 and Chapter 7 of the textbook. Take the case of two readers and two writers and provide a model in LTL or CTL (your choice). You have to provide a state machine that defines the model as figures on pages 30 and 33 of LN15 for *Mutual Exclusion*, appropriate atomic predicates as n_1, n_2, t_1, t_2, c_1, c_2 for Mutual Exclusion, and appropriate safety and liveness properties.