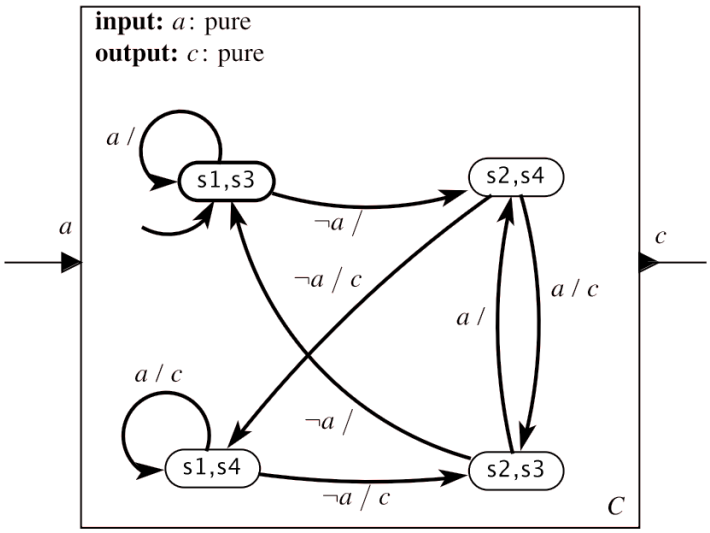
CSE422 “Computer Controlled Systems” Final Exam Model Answer
June, 2022

Question (1):

1. This is an open question.
Industry 4.0 is the industrial revolution that represents the connectivity between industrial equipment and constant data flow to access and analyze centralized information.
Industry 4.0 is the latest transformation within automation and industry, built around the ethos of using cyber-physical systems, which can monitor and augment existing processes, in just about all manufacturing processes, across all segments.

2. This is an open question.
The Internet of Things (IoT) is the connection of people, processes, data and things over an IT network. For businesses, the IoT is at the centre of the merger of Information Technology (IT) and Operational Technology (OT) as data is collected to gain insights, optimize processes and create opportunities. Enabling this connectivity of machines and equipment on the factory floor is one element of Industry 4.0, so the IoT is a component of Industry 4.0.

3. a.

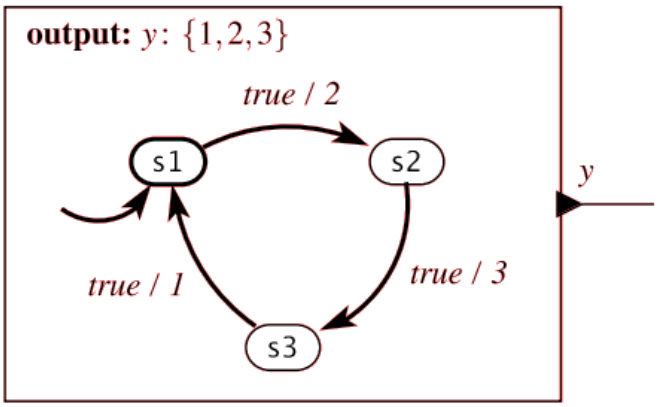


3.b.
All states are reachable.

4. a.
Yes, it is well formed and constructive because in each state, even if the input is unknown, the output can be determined.

4. b.
(2;3;1;2;3;1;2;3;1;2)

4. c.



4. d.

(2;3;1;2;3;1;2;3;1;2)

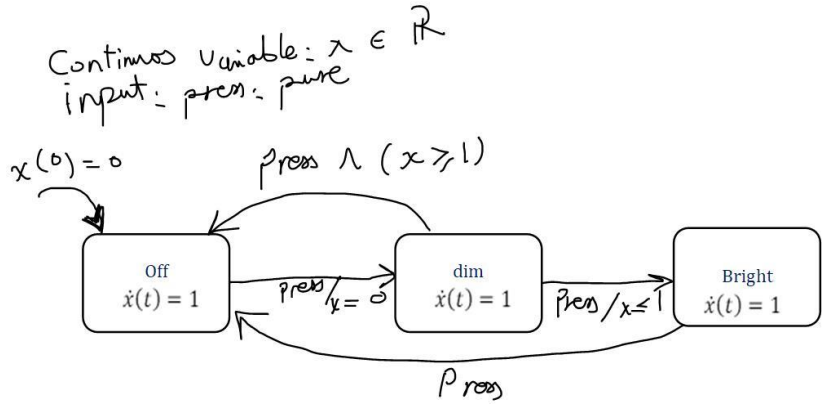
Question (2):

1.

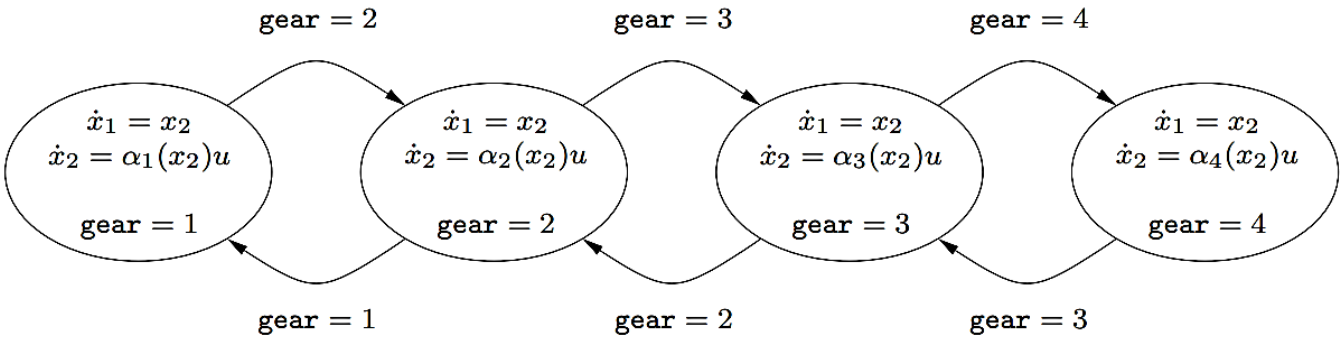
Modal models are hybrid systems that combines refinement of time-based system with modes of operation of the system.

Cyber physical systems contain both continuous and discrete dynamics which can be described by modal models.

2.



3.



Question (3):

1. Model of Computation (MoC):
A collection of three sets of rules that govern the semantics of a concurrent composition of actors:
The first set of rules specifies what constitutes a component.
The second set specifies the concurrency mechanisms
The third specifies the communication mechanisms.

2. a. SDF is a constrained form of dataflow where for each actor, every firing consumes a fixed number of input tokens on each input port and produces a fixed number of output tokens on each output port.

2. b.

$$\begin{aligned} Mq_A &= q_B \\ 2q_B &= q_C \\ Nq_A &= 2q_C \end{aligned}$$

2. c.

N = 4M results in a consistent model.

2. d.

The solution is z = 2M. The minimum solution to the balance equations yields qA = 1, regardless of the value of M or N (for a consistent model). The minimum number of initial tokens that enables this is z = 2M.

2. e.

We need to be able to execute C at least 2M times to avoid deadlock. Hence w = 0, x = 2M, and y = 4M will work. However, so will w = M, x = 0, and y = 4M. The latter has a lower value for w+x+y. There are no more possibilities, so this latter value is the solution.

2.f.

The minimum positive integer solution to the balance equations is qA = 1, qB = M, and qC = 2M. With this solution, the schedule that minimizes the buffer sizes interleaves the executions of B and C. The resulting buffer sizes are bw = M, bx = 2, by = 4M = N, and bz = 2M.
