Question Paper

Exam Date & Time: 11-May-2024 (02:30 PM - 05:30 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

IVth SEMESTER (B.TECH) (CYBER PHYSICAL SYSTEMS)
END SEMESTER EXAMINATIONS MAY 2024

INTRODUCTION OF CYBER PHYSICAL SYSTEMS [ICE 2227]

Marks: 50 **Duration: 180 mins.**

Descriptive

Answer all the questions.

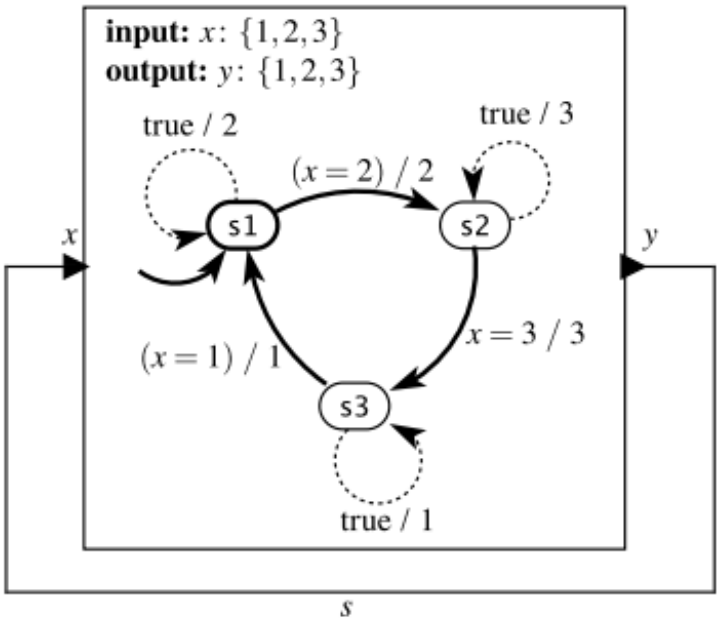
1) Describe the difference between multidrop mode and point to point mode of operation in HART communication protocol. [CO1, BL2, PO1,4] (2)

2) With a suitable example, differentiate between cyber physical systems and embedded systems. [CO1, BL3, PO1,2] (3)

3) A CPS has to be designed for an automated greenhouse system that monitors and controls environmental conditions such as temperature, humidity, light intensity, and soil moisture to optimize plant growth. The system should be scalable, energy-efficient, and capable of remote monitoring and control. Explain the components required including sensors, actuators, processors, network requirements, platform components etc. for the system. Defend your choice of each components with proper reasoning and illustrate the system with a block/flow diagram. [CO2, BL3, PO1,3] (5)

4) Explain the mathematical representation of a discrete signal x[n] and discuss the significance of each element within the signal expression. [CO3, BL2, PO1,PO3] (2)

5) Consider the following state machine in a synchronous feedback composition. With proper analysis, find whether the system is well-formed or ill-formed. (3)



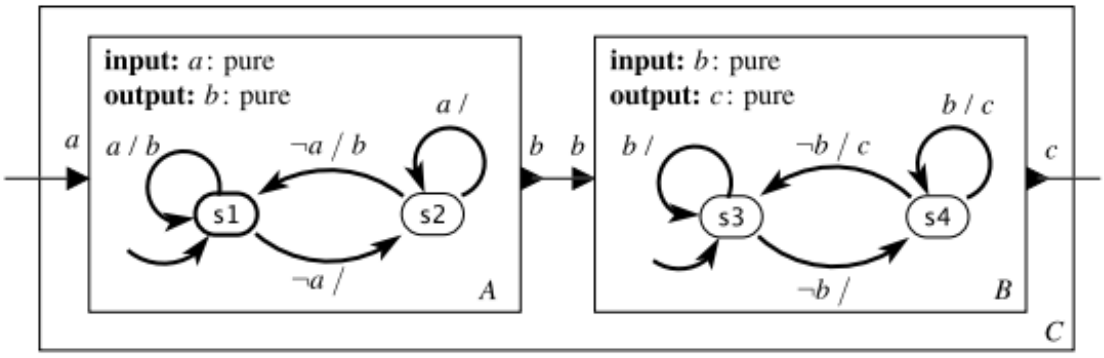
[CO3, BL3, PO2]

6) Design a synchronous state machine for an elevator control system with the following specifications: The elevator has three floors: Ground floor (G), First floor (1), and Second floor (2).The elevator can move up or down.There are buttons inside and outside the elevator for each floor to request the elevator.The elevator should prioritize requests based on the direction it is currently moving (up or down) and the closest requested floor in that direction.Include states for idle, moving up, moving down, and stopping at floors.Implement safety features to prevent simultaneous door opening/closing and ensure smooth transitions between states. [CO3, BL4, PO3] (5)

7) What is non-determinism while designing state machine? List two of its major use. [CO3, BL3, PO3] (2)

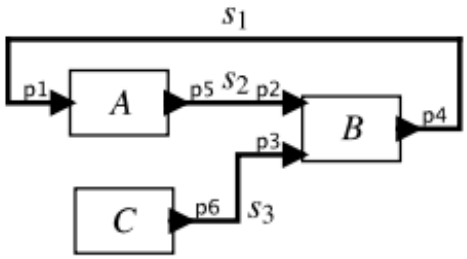
8) Design a side-by-side synchronous state machine for a smart home lighting and climate control system with the following specifications: The smart home has two zones: Living Room and Bedroom, each with its set of lights and HVAC controls. The lighting system includes dimmable LED lights that can be controlled individually or grouped by zone. The HVAC system allows temperature and fan speed control for each zone. The state machine should synchronize lighting and climate control operations between the Living Room and Bedroom while considering user preferences and energy efficiency.[CO3, BL4, PO2,3] (3)

9) Consider the following composition of two state machines A and B. Construct a single state machine C representing the composition. Write all the achievable state transitions possible and find out which states of the composition are unreachable? (5)



[CO4, BL3, PO1,12]

10) Derive the actor model from given system of equations. (2)

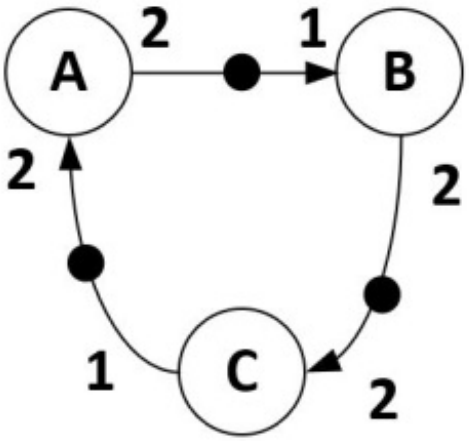


[CO4, BL3, PO2]

11) Design an actor model for a temperature control system with the following components: a temperature sensor, a heater, and a cooler. The actor model should read the temperature from the sensor, decide whether to activate the heater or cooler based on the temperature set point, and display the current temperature and control actions on the front panel. (3)

[CO4, BL4, PO3,12]

12) For the data flow model below: using topology matrix, find out whether a periodic schedule exists and obtain a feasible Periodic Admissible Sequential Schedule (PASS). (5)



[CO4, BL4, PO3]

13) Construct a timed automation which produces ticks with intervals between them of 1 second (three times) and 2 seconds (once). [CO5, BL4, PO2] (2)

14) Differentiate key exchange and cryptographic protocol design with regard to protocol and network security for the design of cyber physical systems. [CO5, BL4, PO2] (3)

15) Consider a ball dropped from an initial height h = h0 with initial velocity =v0. The ball drops freely with its dynamics given by the differential equation dv/dt = -g, where g is the gravitational acceleration. When it hits the ground, that is, when the value of the variable h becomes 0, there is a discontinuous update in its velocity. Assume that the collision is inelastic, and the velocity decreases by a factor a, for some appropriate constant $0 < a < 1$. Develop a hybrid model of this system having a single mode and two state variables. . [CO5, BL4, PO2,3] (5)

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