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B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

January / February 2025 Semester End Main Examinations

Programme: B.E. **Semester: VII**

Branch: Artificial Intelligence and Machine Learning **Duration: 3 hrs.**

Course Code: 24AM7PECPS **Max Marks: 100**

Course: CYBER-PHYSICAL SYSTEMS

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

Important Note: Completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. Revealing of identification, appeal to evaluator will be treated as malpractice.

			UNIT - I	*CO*	*PO*	Marks
1	a)		Differentiate Cyber-Physical Systems and the Internet of Things.	*CO1*	*PO1*	**04**
	b)		Break down the cruise control system into its subcomponents and analyse the role of the MeasureSpeed component in the overall process of speed regulation and throttle control.	*CO2*	*PO2*	**06**
	c)		Company Sensirion are developing a security system for a residential home. The system includes two types of sensors: a MotionSensor that detects movement within the house and a DoorSensor that monitors whether doors are opened or closed. The goal is to ensure the home is secure; if either the motion sensor detects movement or the door sensor registers an open door, the Alarm should activate to alert the homeowners of a potential intrusion. Implement alarm system that integrates the MotionSensor, DoorSensor, and Alarm components, ensuring the alarm activates when either sensor detects an intrusion.	*CO3*	*PO3*	**10**
			OR			
2	a)		Provide a detailed diagram and explain how the key components of CPS interact to achieve system functionality in real-world applications.	*CO1*	*PO1*	**07**
	b)		Interpret how the key features of the synchronous model enhance the reliability and predictability of CPS in critical applications like autonomous vehicles or smart grids?	*CO2*	*PO2*	**05**
	c)		Design a component called Toggle, which has an input event variable toggleEvent and an output variable state. The state variable should toggle between true and false each time the toggleEvent is present.	*CO3*	*PO3*	**08**
			UNIT - II			
3	a)		Examine how the on-the-fly Depth-First Search (DFS) approach is used for invariant verification in transition systems and list the critical steps involved in validating the invariant.	*CO1*	*PO1*	**08**

		b)	Compare the concepts of invariants and inductive invariants, highlighting their definitions, scopes, and usage in ensuring system correctness and safety.	*CO2*	*PO2*	**05**

		c)	Consider a transition system T with two integer variables x and y, and a Boolean variable z. All variables are initially set to 0. The transitions of the system correspond to executing the following conditional statement:
			if (z = 0) then
			(x:= x + 1; z := 1)
			else
			(y:= y + 1; z := 0)
			Analyse the property defined as: P:(x=y) ∨ (x=y+1) and answer the following.
			i.Is P an invariant of the transition system T?
			ii.Is P an inductive invariant of the transition system T?
				CO2	*PO2*	**07**

			OR			
	4	a)	Illustrate invariants and inductive invariants in Cyber-Physical Systems.	*CO2*	*PO2*	**06**
		b)	Explain Reduced Ordered Binary Decision Diagrams (ROBDDs) and their properties.	*CO1*	*PO1*	**06**
		c)	An online food ordering system has three states: Idle**,** Order_In_Progress**,** and Order_Submitted. The system starts in the Idle state with no items. Adding items moves it to Order_In_Progress, submitting the order moves it to Order_Submitted, and completing the order resets it to Idle. Develop the ordering system representing the state changes and the updates to itemCount as the user adds items, submits the order, and completes the order with symbolic transition functions.	*CO3*	*PO3*	**08**
			UNIT - III			
	5	a)	Apply Alternating Bit protocol to solve the reliable transmission problem in Client Server communication and provide the key mechanisms of the protocol that ensure data is transmitted reliably between sender and receiver.	*CO3*	*PO3*	**10**
		b)	Illustrate the concepts of region equivalence, clock regions, clock zones, and differential bounded matrix.	*CO2*	*PO2*	**10**
			OR			
	6	a)	Outline the concept of clock valuation and its significance in timed automata.	*CO1*	*PO1*	**05**
		b)	Analyse the time dependent behavior and interactions between components in a timed automata.	*CO2*	*PO2*	**07**
		c)	i. Explain the design of a Dual-Chamber implantable pacemaker and describe its communication processes. ii. Highlight how its components work together to regulate heart activity effectively.	*CO1*	*PO1*	**08**
			UNIT - IV			
	7	a)	Consider the function:	*CO3*	*PO3*	**10**

			$g(x) = \frac{3x+5}{x+2}$ $for\ x\ \in R, x \neq -2.$ i. Show that g(x) is Lipschitz continuous. ii. Find the Lipschitz constant for g(x).			
		b)	Consider the model of the car moving on a graded road. Suppose the input force F is 0 at all times, and the grade of the road is constant at 5 degrees uphill. Determine the equilibria for the resulting dynamical system.	*CO2*	*PO2*	**10**
			OR			
	8	a)	Explain the concept of Zeno behavior in Cyber-Physical Systems, its causes, impact on system performance, and strategies to prevent it.	*CO1*	*PO1*	**10**
		b)	Apply the Achilles and Tortoise paradox to explain Zeno behavior and discuss its implications for time-dependent processes in Cyber-Physical Systems.	*CO3*	*PO3*	**10**
			UNIT - V			
	9	a)	Outline the strategies to design CPS to withstand emerging side-channel attack techniques.	*CO1*	*PO1*	**10**
		b)	Analyse and explain the impact of a compromised sensor in a CPS environment on the flow of critical control information and propose mitigation strategies.	*CO2*	*PO2*	**10**
			OR			
	10	a)	A smart water distribution system relies on flow and pressure sensors to manage water delivery across a city. A hacker injects false data into the sensor readings, causing the system to misidentify a pipeline leak, prompting unnecessary water rerouting and creating disruptions. Analyze the system sensor data to identify and provide strategies to mitigate the impact of this false data injection attack.	*CO2*	*PO2*	**10**
		b)	Analyse and explain the role of continuous monitoring systems in detecting unauthorized information flow within CPS networks.	*CO2*	*PO2*	**10**

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