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Question Paper Code	13142
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B.E. / B.Tech. - DEGREE EXAMINATIONS, NOV / DEC 2024
 Seventh Semester
Mechanical and Automation Engineering
20MUPC702 - Mechatronics System Design
 Regulations - 2020

Duration: 3 Hours

Max. Marks: 100

PART - A (MCQ) (20 × 1 = 20 Marks)

Answer ALL Questions

- | | <i>Marks</i> | <i>K-
Level</i> | <i>CO</i> |
|---|--------------|---------------------|-----------|
| 1. Which is an example of a recent advancement in mechatronics?
(a) Automated Guided Vehicles (AGVs) (b) Manual machinery
(c) Analog control systems (d) Hand-operated hydraulic systems | 1 | K1 | CO1 |
| 2. Which of the following is not a key element of a mechatronics system?
(a) Sensors (b) Actuators (c) Power source (d) Engine | 1 | K1 | CO1 |
| 3. What is the primary objective of the mechatronics system design process?
(a) Reduce cost
(b) Maximize mechanical strength
(c) Integrate multiple engineering disciplines for efficient control
(d) Focus on electronic design only | 1 | K1 | CO1 |
| 4. Which of the following best defines a mechatronic system?
(a) A system that involves only mechanical components
(b) A system that integrates electrical, mechanical, and computer control
(c) A system that is purely electronic.
(d) A system that focuses only on software development | 1 | K1 | CO1 |
| 5. Which system identification method involves minimizing the error between the predicted and actual output?
(a) Direct method (b) Bond graph method
(c) Least squares method (d) State space representation | 1 | K1 | CO2 |
| 6. What is a key feature of the bond graph approach in system modeling?
(a) It models systems using energy flow across components
(b) It focuses only on electrical systems
(c) It is used exclusively for mechanical systems
(d) It uses only differential equations | 1 | K1 | CO2 |
| 7. Which of the following is not a method of system representation?
(a) Block diagrams (b) Signal flow graphs (c) Transfer function (d) Control theory | 1 | K1 | CO2 |
| 8. Why is system modeling necessary?
(a) To increase system complexity
(b) To analyze, predict, and control system behavior
(c) To build systems without any analysis
(d) To create purely mathematical problems | 1 | K1 | CO2 |
| 9. What does Hardware-in-the-Loop (HIL) simulation involve?
(a) Using only software models
(b) Integrating real hardware components with a simulated environment
(c) Simulating hardware failures
(d) Simulating the entire system using software alone | 1 | K1 | CO3 |

10. What is the purpose of validation in simulation?
 - (a) To test whether the simulation software is working
 - (b) To compare simulation results with real-world data for accuracy 1 K1 CO3
 - (c) To increase the speed of the simulation
 - (d) To make the system less complex
11. Which of the following is a feature of Monte Carlo simulation?
 - (a) It uses deterministic methods to solve equations
 - (b) It relies on random sampling and probability to predict outcomes 1 K1 CO3
 - (c) It is only used for mechanical systems
 - (d) It provides exact solutions for all system types
12. Which software environment is commonly used for controller prototyping in simulations?
 - (a) Fusion 360 (b) MATLAB/Simulink (c) Excel (d) Ansys 1 K1 CO3
13. Which programming technique is best suited for problems with non-differentiable functions?
 - (a) Linear programming (b) Nonlinear programming 1 K1 CO4
 - (c) Genetic algorithms (d) Lagrange multiplier method
14. In non-linear programming, what type of function is being optimized?
 - (a) A linear function (b) A quadratic function 1 K1 CO4
 - (c) A function that is not linear in its variables (d) A constant function
15. What is the main goal of optimization in design?
 - (a) To maximize the system complexity (b) To minimize cost and maximize performance 1 K1 CO4
 - (c) To avoid constraints in design (d) To increase the number of design variables
16. Which optimization technique is inspired by natural selection and evolution?
 - (a) Linear programming (b) Simulated annealing 1 K1 CO4
 - (c) Genetic algorithms (d) Gradient descent
17. What is the main purpose of a power window system in automobiles?
 - (a) Control fuel efficiency (b) Adjust the engine timing 1 K1 CO5
 - (c) Control the window movement (d) Engage the clutch system
18. Automatic transmission controllers help vehicles by
 - (a) Enhancing braking system (b) Improving manual driving control 1 K1 CO5
 - (c) Automatically selecting gear shifts (d) Increasing power window speed
19. In a power window system, what controls the direction of window movement?
 - (a) Speed sensors (b) Motor polarity (c) Brake system (d) Actuator pressure 1 K1 CO5
20. The modeling of an ABS system requires consideration of which key parameter?
 - (a) Window speed (b) Wheel slip (c) Engine temperature (d) Air pressure 1 K1 CO5

PART - B (10 × 2 = 20 Marks)

Answer ALL Questions

21. Define mechatronics and mention two key elements of a mechatronic system. 2 K1 CO1
22. State the characteristics of negative feedback. 2 K1 CO1
23. What is the purpose of state space representation in system modeling? 2 K1 CO2
24. Define non-touching loop. 2 K1 CO2
25. What is Monte Carlo simulation, and where is it commonly applied? 2 K1 CO3
26. What is the simulation life cycle? 2 K1 CO3
27. Differentiate between linear and nonlinear programming. 2 K2 CO4
28. What is the significance of the Simplex method in optimization? 2 K1 CO4
29. Explain the role of a clutch lookup table in automotive engine control. 2 K1 CO5
30. How do Stewart platforms utilize actuators for precise movement? 2 K1 CO5

PART - C (6 × 10 = 60 Marks)

Answer ALL Questions

31. a) Analyze the stages of the Mechatronics design process with the help of a flow diagram. 10 K3 CO1

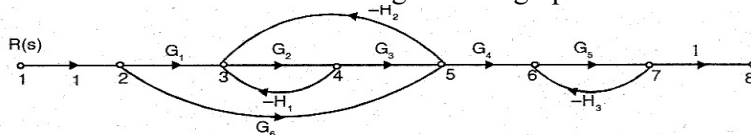
OR

- b) Explain the recent advancements in mechatronics and their impact in the field of recent innovations with example. 10 K3 CO1

32. a) Obtain the transfer function of Armature controlled and field controlled DC Motor. 10 K3 CO2

OR

- b) Find the overall transfer function for the signal flow graph as shown in fig.



10 K3 CO2

33. a) Differentiate the hardware in loop simulation and control prototyping processes in the design of Mechatronics system. 10 K2 CO3

OR

- b) Analyze the response of zeroth, first, and second-order systems with examples. 10 K2 CO3

34. a) Find the initial solution for the problem given below using NWCR method and optimal solution by MODI method

	W1	W2	W3	Supply
P1	7	6	9	20
P2	5	7	3	28
P3	4	5	8	17
Demand D_j	21	25	19	

10 K3 CO4

OR

- b) Solve the following LPP using Big M method
 $Z = 7X_1 + 15X_2 + 20X_3$ subjected to
 $2X_1 + 4X_2 + 6X_3 \geq 24$
 $3X_1 + 9X_2 + 6X_3 \geq 30$
 $X_1, X_2, X_3 \geq 0$

10 K3 CO4

35. a) Analyze the factors for accurate simulation of actuators on a Stewart platform. 10 K3 CO5

OR

- b) Describe the functioning of mechatronic systems applied in Engine Management Systems. 10 K3 CO5

36. a) i) Differentiate the linear & nonlinear programming used in optimization. 5 K2 CO4
 ii) How does an anti-lock braking system (ABS) prevent wheel lock-up during braking? 5 K2 CO5

OR

- b) i) How does optimal design improve the performance of a mechatronic system? 5 K3 CO4
 ii) Explain the role of sensors and actuators in a car's power window system. 5 K2 CO5