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R 3469

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2007.

Seventh Semester

(Regulation 2004)

Mechanical Engineering

ME 1402 — MECHATRONICS

(Common to B.E. (Part-Time) Sixth Semester Regulation 2005)

Time : Three hours

Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Distinguish between open-loop and closed-loop system.
2. Suggest a sensor that could be used for a furnace to monitor the rate at which the heating oil flows along a pipe. The output from the measurement system is to be an electrical signal which can be used to adjust the speed of the oil pump.
3. A pneumatic system is operated at a pressure of 1000 kPa. What diameter cylinder will be required to move a load requiring a force of 12 kN?
4. If a stepper motor has a step angle of 7.5° , what digital input rate is required to produce a rotation of 10 rev/s?
5. What are the characteristics of negative feedback?
6. Write the analogous electrical elements in force-voltage analogy for the elements of mechanical translational system.
7. Device a PLC timing circuit that will switch an output on for 10 seconds and then switch it off.
8. What are the logic functions that can be obtained by using switches in series?
9. List down the various mechatronics elements in an automatic camera.
10. Compare and contrast the traditional design of a watch with that of a mechatronics based digital watch.

PART B — (5 × 16 = 80 marks)

11. (a) (i) What are the basic elements of a closed loop system? Explain. (8)
- (ii) What is RTD? Explain the relationship between resistance and temperature for the RTD with temperature resistance curve. (8)

Or

- (b) (i) Identify the various elements of a closed loop system in an automatic water level controller and describe their functions. (8)
- (ii) Explain the function of a capacitive sensor in a robot end effector. (8)
12. (a) (i) A hydraulic cylinder is to be used to move a work piece in a manufacturing operation through a distance of 50 mm in 10s. A force of 10 kN is required to move the work piece. Determine the required working pressure and hydraulic liquid flow if a cylinder with a piston diameter of 100 mm is available. (6)
- (ii) Explain the specification of a stepper motor in detail. (10)

Or

- (b) (i) A flat belt, 7 mm thick and 95 mm wide transmits power between two pulleys running at 1500 m/min. The mass of the belt is 0.85 kg/m length. The angle of lap in the smaller pulley is 155° and the coefficient of friction between the belt and pulley is 0.25. If the maximum permissible stress in the belt is 2 MN/m^2 , find the maximum power transmitted and initial tension in the belt. (10)
- (ii) Compare the functions of series wound D.C. motors and shunt wound D.C. motors. (6)
13. (a) (i) Derive a mathematical model for a machine mounted on the ground to study the effects of ground disturbances on the machine bed displacement. (8)
- (ii) Compare the control system performance for a system with proportional control and a system with integral control. (8)

Or

- (b) (i) Derive the differential equation governing the mechanical system of an electric motor. (8)
- (ii) Explain the characteristics of PID controller. (8)

14. (a) (i) Explain the architecture of a PLC and explain about its elements. (8)
- (ii) Create a ladder diagram for the following application : A pneumatic system with double-solenoid valves controls two double acting cylinder A and B. The sequence of cylinder operations are as follows : Cylinder A extends followed by cylinder B extending, then the cylinder B retracts and finally the cycle is completed by the cylinder A retracting. Explain the logic of the PLC circuit used. (8)

Or

- (b) (i) A work piece is loaded on a conveyor belt and operates between two limits of travel A and B. When limit switch at station A is activated, the conveyor moves forward. When limit switch at station B is activated, the conveyor changes direction. Pressing the start button causes the motor to run in the forward direction, and pressing the stop button stops the motor. Create a ladder logic diagram and explain. (10)
- (ii) What are the factors to be considered while selecting a PLC? (6)
15. (a) (i) Explain about the basis of mechatronics system design considering vehicle engine management system as example. (8)
- (ii) Draw the block diagram showing the interaction of various elements in a domestic washing machine. (8)

Or

- (b) (i) Explain the various mechatronics elements required to design an automated guided vehicle. (8)
- (ii) Device a robot system which can be used for pick and place purpose. Describe the various mechatronics elements used in the design. (8)