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Total Pages : 07

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May 2026

B.Tech. (RAI) (Fourth Semester)

Mechatronics System Design (RAU-208-V)

Time : 3 *Hours*] [*Maximum Marks* : 75

Note : It is compulsory to answer all the questions (1.5 marks each) of Part A in short. Answer any *four* questions from Part B in detail. Different sub-parts of a question are to be attempted adjacent to each other.

Part A

1. (a) Define the Mechatronics. Briefly write its various evolution stages. **1.5**

(b) Identify and list the Mechatronics elements in an Industrial robot. 1.5

(c) Write the role of amplifiers in mechatronics product design. 1.5

(d) Differentiate between sensors and transducers. List different types of sensors used in mechatronic systems. 1.5

(e) What is the importance of FRL in a Pneumatic system ? Draw its schematic diagram. 1.5

(f) Write basic principles of electronic system communication in mechatronic systems. 1.5

(g) What are mathematical models ? Explain briefly. 1.5

(h) Explain the concept of PID controller and its advantage. 1.5

(i) What is meant by of controller tuning ? How is it used to overshoot in system ? 1.5

(j) Differentiate between servo motor and stepper motor. Give their applications in Mechatronics systems. 1.5

Part B

2. (a) Bring out the analogy between Mechanical and Electrical systems. Explain the principles used in model building 5

(b) Design a complete mechatronic system for an automated smart conveyor sorting system. List the components and explain their working. 10

3. (a) Explain how microcontrollers replace traditional relay-based control systems in mechanical equipment and discuss their advantages. **5**

(b) A load cell produces 3 mV/V sensitivity and is powered with 10 V excitation. Maximum load = 2000 N. The signal is connected to a 12-bit ADC (0-5V range). An amplifier with gain options : 100, 200, 400, 800 is available. **10**

Calculate :

(i) Which amplifier gain is most suitable.

(ii) Force resolution for selected gain.

4. Bulk lose material is to be emptied from a dump hopper (Fig. 1), by pressing a press button P1, the dump hopper is tilted and bulk lose material tilted out, by pressing a another press button P2, the dump hopper is returned to its initial position. Design a pneumatic circuit for door operation and describe the components used in the circuit. **15**

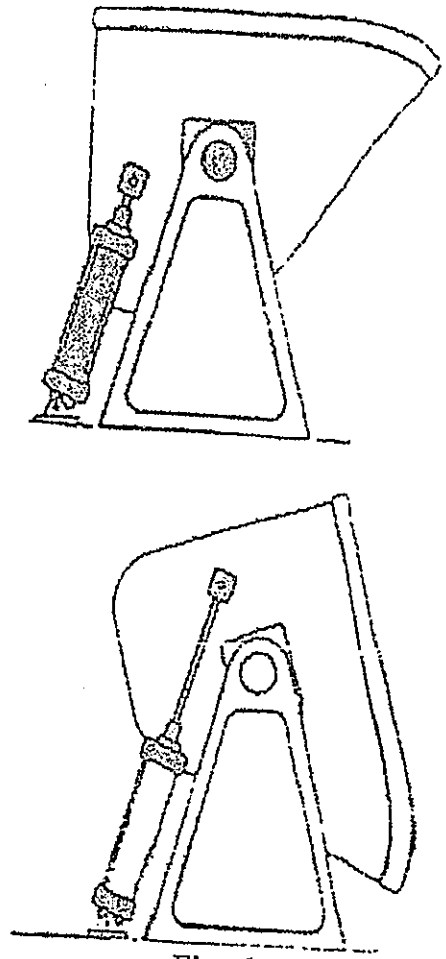

Fig. 1

5. (a) Simplify using Boolean algebra : 5

$$(AB+A\bar{Z})(B+A)+AB(\bar{B}+\bar{C})$$

(b) Draw the circuit diagram of a binary resistor based Digital to Analog Converter (DAC) and explain how does it work. 10

6. (a) Derive the transfer function of an armature controlled DC servomotor. 5

(b) An industrial thermal chamber used for polymer curing exhibits first-order dynamics and is modeled by the transfer function :

$$G(s)=\frac{5}{20s+1}$$

The system experiences steady-state error and sluggish response when controlled by a proportional controller.

Design a complete control strategy for a PID controller that achieves : 10

(i) Settling time < 10 seconds

(ii) Overshoot < 5%

(iii) Zero steady-state error

7. Explain the working of a PLC by drawing its basic architecture and give its importance in Mechatronics system design. Also draw the ladder rungs to represent the two switches normally open and both have to be closed for a motor to operate. 15

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