SHRI ANGALAMMAN COLLEGE OF ENGINEERING AND TECHNOLOGY
(An ISO 9001:2008 Certified Institution)
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FS 81504

Department Of Electronics and Instrumentation Engineering

ME 1402 Mechatronics

UNIT – 1- MECHATRONICS, SENSORS, TRANSDUSERS

PART – A(2 marks)

1. What are the basic elements of a measurement system and sketch it block diagram?
2. How do you define sensor?
3. State the difference between primary and secondary transducer?
4. Define the term accuracy & precision?
5. What is hysteresis?
6. State the dynamic characteristic of simplified measuring system?
7. Distinguish between touch & practical sensor?
8. Write the working principle of hot wire anemometer?
9. A Quartz piezoelectric crystal having a thickness of 2mm and a voltage sensitivity 0.055Vm/N is subjected to
a pressure of $1.38X10_6$ N/m_2. Calculate the voltage output.
10. Define mechatronics and sketch the representation of mechatronics system?

PART-B- (16 marks)

1. (a) Identify the various elements of a closed loop system in automatic water level controller and describe their functions (8)
   (b) Explain the function of a capacitive sensor in a robot end effect (8)
2. (a) What are the basic elements of a closed loop system? Explain. (8)
   (b) What is RTD? Explain the relationship between resistance and temperature for the RTD With temperature resistance curve (8)
3. (a) Explain the static (steady state) characteristics of transducers (8)
   (b) Explain capacitive push – pull sensor and capacitive proximity sensor (8)
4. (a) Explain the dynamic characteristics of transducers (8)
   (b) Explain any three sensors used for temperature measurement (8)
5. (a) Compare and contrast the control system for the domestic central heating system involving a bimetallic thermostat and that involving a microprocessor (8)
   (b) Explain the static performance characteristics of a sensor (8)
6. (a) Compare open and closed loop system with suitable example. (8)
   (b) Explain the principle of various sensors used for measuring displacement. (8)
7. (a) Explain the static and dynamic characteristics of sensors (8)
   (b) Explain the following: Thermistors and Piezoelectric sensors (8)

UNIT-2- ACTUATION SYSTEM

PART – A (2 marks)

1. Why sequential valves are necessary in pneumatic system?
2. What is meant by cylinder sequencing?
3. What is MOSFET? Stable its fractures?
4. State the objectives of DCVs? Classify them?
5. What are the factors to be considered for selecting solenoids?
6. Name three output characteristics of transistor configuration.
7. What are the types of field effect transistor?
8. List down the feature of JFET.
9. List down the features of synchronous motor.
10. What is a stepper motor?

PART-B (16 marks)

1. (a) A hydraulic cylinder is to be used to move a work piece in a manufacturing operation through a distance of 50 mm in 10_S. 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)

   (b) Explain the specification of a stepper motor in detail. (10)

2. (a) A flat belt , 7 mm thick and 95 mm wide transmits power between two pulleys running at 1500 rpm/min. The mass of the belt is 0.85kg/m length. The angle of lap in the smaller pulley is 155_0 and the coefficient of friction between the belt and the pulley is .25. if the maximum permissible stress in the belt is $2MN/m_2$, find the maximum power transmitted and initial tension in the belt (6)

(b) Compare the functions of series wound D.C motors and shunt wound D.C Motors (10)

3. (a) Explain the working principle of stepper motor in half step mode (8)

(b) Explain fluid system building blocks (8)

4. (a) Explain various types of ball and roller bearings (8)

(b) Explain thyristors and triacs in detail (8)

5. Discuss about the following actuation systems:

(i) Self – excited wound field shunt configuration DC motor

(ii) Self – excited wound field series configuration DC motor

(iii) Stepper motor

(iv) Induction motor (16)

6. (a) A flat belt, 7 mm thick and 95mm wide transmits power between two pulleys running at 1500m/min. The mass of the belt is 0.85kg/m length. The angle of lap in the smaller pulley is 155_0 and the coefficient of friction between the belt and pulley is 0.25. If the maximum permissible stress in the belt is

2MN/m2 find the maximum power transmitted and initial tension in the belt (8)

(b) Compare the function of series wound D.C motors and shunt wound D.C motors (8)

7. (a) What are the various types of ball bearing ? Mention the application of each type. (8)

(b) How will you specify a stepper motor? Explain the general characteristics of a stepper motor.

8. (a) An actuator has a stem movement which at full travel is 40 mm. It is mounted with a linear plug process control valve which has a minimum flow rate of 0 and a maximum flow rate of 0.2 m3/sec What will be the flow rate when the stem movement is 20 mm? (8)

(b) A hydraulic cylinder is to be used to move a work piece in a manufacturing operation through a distance of 50 mm in 10 sec. A force of 10 kN is required to move the work piece. Determine the required working pressure and hydraulic liquid flow rate if a cylinder with a piston diameter of 100 mm is available. (8)

UNIT-3- SYSTEM MODELS AND CONTROLLER

PART-A (2MARKS)

1. What are MRACs?
2. List down the various tasks performed by I/O interface.
3. List down the applications of logic gate?
4. Define encoding and decoding processes?
5. How are micro controllers describe?
6. Write short notes on programming counter register?
7. How is stability defined in Routh-Hurwitz method?
8. Define Transfer function?
9. What are Boolean algebra and Boolean numbers?
10. Mention various features of digital controllers?

PART-B (16 marks)

1. (a) Derive a mathematical model for a machine mounted on the ground to study the effects of ground disturbances on the machine bed displacement. (8)
(b) Compare the control system performance for a system with proportional control and a system with integral control. (8)
2. (a) Derive the differential equation governing the mechanical system of an electric motor. (8)
(b) Explain the characteristics of PID controller. (8)
3. (a) Explain fluid system building blocks. (6)
(b) Explain electronic proportional derivative (PD) controller with necessary circuit diagrams. (10)
4. (a) Explain building blocks for thermal systems. (6)
(b) Explain electronic proportional integral (PI) controller with necessary circuit diagrams. (10)
5. (a) Propose a model for a stepped shaft used to rotate a mass and derive an equation relating the input torque and the angular rotation. Neglect damping effect (8)
(b) Describe and compare the characteristics of
(i) proportional controller (ii) proportional plus integral controller. (8)
6. A hot object with capacitance C and temperature T, cools in a large room at temperature $T a_o$ If the thermal system has a resistance R, derive an equation describing how the temperature of the hot object changes with time and give an electrical analogue of the system (16)
7. (a) Propose a model for a stepped shaft used to rotate a mass and derive an equation relating the input torque and the angular rotation. Neglect damping (8)
(b) Explain the construction of PID controller. Also write mathematical equations for this. (8)
8. Explain in detail adaptive control system (16)

UNIT-4- PROGRAMMABLE LOGIC CONTROLLERS

PART-A (2 marks)

1. What is meant by program scan?
2. List down the different types of timers?
3. What are shift registers? Where are they used?
4. What are the factors to be considered for selecting PLC?
5. State two methods of Input / Output processing and explain briefly:
6. What is meant by program scan?
7. State two methods of input/output processing and explain briefly.
8. List down PLC programming methods.
9. What is meant by a “retentive timer”?
10. What are counters?

PART – B (16 marks)

1 (a) Explain the architecture of a PLC and explain about its elements. (8)
(b) 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)
2. (a) 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 the motor. Create a ladder logic diagram and explain. (l0)
(b) What are the factors to be considered while selecting a PLC? (6)
3.(a) Write the specifications of a PLC. (8)
(b) Device a circuit that could be used with a domestic washing machine to switch on a pump water for 100s into the machine, then switch off and switch on a heater for 50s to heat the water. The heater is then switched off and another pump is to empty the water from the machine for 100s. (8)
4. (a)Explain the basis of ladder programming used in PLC’s (8)
(b)Devise a circuit that could be used with a conveyor belt which is used to move an item to a work station. The presence of the item at the work station is detected by means of breaking a contact activated by a beam of light to a photosensor. There it stops for 100 sec for an operation to be carried out before moving on and off the conveyor. The motor for the belt is started by a normally open start switch and stopped by a normally closed switch. (8)
5. Devise a circuit that could be used with a domestic washing machine to switch on a pump to pump water for 100 sec into the machine, then switch off and switch on a heater for 50 sec to heat the water. The heater is then switched off and another pump is switched on for another 100sec to empty the water from the machine. (16)
6. Devise a circuit that could be used with a domestic washing machine to switch on a pump to pump water for 100 sec into the machine, then switch off and switch on a heater for 50 sec to heat the water. The heater is then switched off and another pump is switched on for another 100sec to empty the water from the machine. (16)
7. Devise a circuit that could be used with a conveyor belt which is used to move an item to a work station. The presence of the item at the work station is detected by means of breaking a contact activated by a beam of light to a photo sensor. There it stops for 100 sec for an operation to be carried out before moving on and off the conveyor. The motor for the belt is started by a normally open start switch and stopped by a normally closed switch. (16)

UNIT-5-DESIGN OF MECHATRONICS SYSTEM

PART-A (2MARKS)

1. Mention the stages in designing a mechatronic system?
2. Distinguish between traditional design approach and Mechatronics approach:
3. What are the advantages of PLC system?
4. What is an engine management? List out the various sensors involved in engine management system?
5. What are the uses of sensors? List the various sensors contained in engine management system?
6. How a traditional design of temperature control of domestic central heating system is improved by mechatronic design?
7. What are the various movements of robots?
8. Name the two barriers used in automatic car parking system and state its uses.
9. What are the advantages of PLC system?
10. What are the configurations in operating stepper motor?

PART-B (16MARKS)

1.(a) Explain about the basis of mechatronics system design considering vehicle engine management system as example. (8)
(b) Draw the block diagram showing the interaction of various elements in a domestic washing machine. (8)
2. What is the role of sensors in car engine management system? Explain with a block diagram. (16)
3. With necessary diagrams, explain the automatic car parking system. (16)
4. Design a pick and place robot using mechatronics elements and explain about the robot control.(16)
5. Design a mechatronics system for a pick and place robot and explain the various mechatronics elements.
6. Design a mechatronics system for a automatic camera and explain the various mechatronics elements.