MECHATRONICS
(AEIE 5141)

Time Allotted : 3 hrs   **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and
<u>any 5 (five)</u> from Group B to E, taking <u>at least one</u> from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

   (i)   An instrumentation amplifier has
         (a) high common mode gain
         (b) high differential mode gain
         (c) low common mode gain
         (d) (b) and (c).

   (ii) Which of the following is not a characteristic of ideal op-amp?
         (a) Zero slew rate   (b) Infinite bandwidth
         (c) Infinite input impedance   (d) Zero output impedance.

   (iii) In hydraulic rotary actuators, maximum angle of rotation may always
         be less than 360° in
         (a) Angle actuator   (b) Piston rotary actuator
         (c) Swivel vane rotary actuator (d) All of these.

   (iv) 'Stents' employed in angioplasty is an actuator of type
         (a) electromechanical   (b) electrostatic
         (c) pneumatic   (d) SMA.

   (v)   The 3/2 Solenoid Valve has
         (a) 3 ports and 2 states   (b) 2 ports and 3 states
         (c) 3/2 ports and 0 states   (d) 3 states only.

   (vi) Bicycle pump is a
         (a) pneumatic cylinder   (b) hydraulic cylinder
         (c) thermal cylinder   (d) both (b) & (c).

   (vii) In robotic surgery, hydraulic actuators are not recommended, because
         (a) nonlinear actuation   (b) bad efficiency
         (c) complex actuation   (d) all of the above.

   (viii) In smart phone, the transducer measuring orientation of the screen is
          (a) MEMS gyroscope   (b) MEMS accelerometer
          (c) MEMS capacitive sensor   (d) MEMS inductive sensor.

   (ix) Low pressure positioner is operated by
         (a) electrical and magnetic forces
         (b) pneumatically generated forces
         (c) hydraulically generated forces
         (d) electrostatic forces.

   (x)   The gauge factor of semiconductor strain gauge is in the range of
         (a) 2 to 10   (b) 100 to 150
         (c) more than 200   (d) 50 to 100.

Group – B

2. (a) Describe the key elements of a mechatronic system with a suitable
        block diagram.

   (b) Write a few mechanical elements commonly used in mechatronic
        systems. State the utility of modelling / simulation in design of such
        systems.

                                        5 + (3 + 4) = 12

3. (a) Write in brief the characterization of micro-actuators by working
        principle.

   (b) Define the working principle of piezoelectric sensor. Name three
        naturally found piezoelectric crystals. State a few applications of such
        actuators in our daily life.

                                        6 + (2 + 2 + 2) = 12

Group – C

4. (a) What role does a regulator play in pneumatic actuation? Give an
        example of any pneumatic actuator from your daily life.

   (b) What do you mean by single acting and double acting hydraulic
        cylinders? Write down the operating specifications for hydraulic
        cylinders.

                                        (4 + 2) + (4 + 2) = 12

5. (a) What is Scanning Laser Vibrometry? What are the basic difference
        between DVRT (Differential Variable Reluctance Transducers) and
        LVDT for displacement measurement?

(b) Which amplifier is known as "robust differential gain amplifier"? Explain – why?

(2 + 4) + (1 + 5) = 12

Group – D

6. (a) Design a passive low pass filter with cut off frequency 2 KHz and high pass filter with cut off frequency 100 KHz. Show how the above filters can be cascaded to form a band pass filter. Also show the resultant transfer function of the overall system.

(b) What is the role of actuator in Mechatronic systems? What is notch filter? Name a few applications where notch filter is used?

(3 + 2 + 1) + (2 + 2 + 2) = 12

7. (a) Why is Shape memory effect useful in medical applications? Define the application areas.

(b) Describe the mechanism of Stress Free Shape Recovery of SMA with suitable diagram.

(4 + 4) + 4 = 12

Group – E

8. (a) What is circuit breaker? Explain the working principle in brief.

(b) How does an electromechanical type actuator work? Describe the working principle of any one electromechanical actuator.

(1 + 4) + (3 + 4) = 12

9. (a) State the working principle of Fiber-optic Temperature Sensor.

(b) Write short notes on any two:
   (i) BLDC motor
   (ii) Micro actuator
   (iii) Electrostatic motor
   (iv) Servomechanism in robotics manipulation

4 + (4 + 4) = 12