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)   Dummy strain gauge is used to compensate
         (a) pressure   (b) strain   (c) temperature   (d) force.

   (ii) In dual-stage actuated servo system for Hard Disk Drives (HDD), the commonly used actuator is
         (a) micro-electrostatic type   (b) micro-electromagnetic type
         (c) shape memory type   (d) micro-thermal type.

   (iii) In pneumatic actuators, air storage capacity is a function of
         (a) pressure x volume
         (b) volume x length of cylinder
         (c) pressure x length of cylinder
         (d) pressure x cross section area of cylinder.

   (iv) In hydraulic rotary actuators, maximum angle of rotation is always smaller than 360° in
         (a) angle-angle actuator   (b) piston rotary actuator
         (c) swivel vane rotary actuator   (d) cylinder.

   (v)   Under dark condition, a photoresistor exhibits
         (a) few hundred ohms resistance   (b) few MΩ resistance
         (c) short circuit   (d) few kΩ resistance.

   (vi) In micro-computer system architecture, the full form of HLLCA –
         (a) High Language Level Computer Architecture
         (b) High Level Language Computer Architecture
         (c) High Level Language Complex Architecture
         (d) High Limited Language Computer Architecture.

   (vii) The fibre optic gauge is immune to
         (a) EM and electrostatic noise   (b) bending losses
         (c) applied pressure   (d) optical waves.

(viii) For lower frequency bandwidth (typically 0 – 800 Hz), the recommended accelerometer is
    (a) piezoelectric type   (b) capacitive type
    (c) electromechanical type   (d) piezoresistive type.

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

(x) AC LVDTs
    (a) have wider operating temperature range
    (b) have external signal conditioning circuitry
    (c) deliver DC output in the secondary coils
    (d) have wide bandwidth.

Group- B

2. (a) What are the key elements of mechatronics? [(CO1)(Remember/LOCQ)]
   (b) Explain in brief a few mechanical elements commonly used in mechatronic systems. [(CO2)(Analyze/IOCQ)]
   (c) Describe the process flow chart followed to realize mechatronic systems. [(CO1)(Evaluate/HOCQ)]
   5 + 4 + 3 = 12

3. (a) Estimate the various disciplinary foundations of mechatronics. [(CO3)(Evaluate/HOCQ)]
   (b) Identify the technological advances in design, manufacturing and operation of engineering products/devices/processes be traced? [(CO4)(Apply/IOCQ)]
   (c) Interpret the benefits associated with revolutions of mechatronics as a contemporary design paradigm. [(CO4)(Understand/LOCQ)]
   3 + 3 + 6 = 12

Group – C

4. (a) Describe the importance of electrostatic actuation in micro/robotic surgery. [(CO3)(Evaluate/HOCQ)]
   (b) Identify three applications of piezoelectric crystals. [(CO6)(Apply/IOCQ)]
   (c) Compare VLSI with MEMS. [(CO3)(Understand/LOCQ)]
   3 + 5 + 4 = 12

5. (a) Where is shape memory alloy used? [(CO4)(Remember/LOCQ)]
   (b) List the application areas of shape memory alloy. [(CO2)(Analyze/IOCQ)]
   (c) Compare briefly the basic differences between lateral and transverse comb drive micro-actuator. [(CO1)(Evaluate/HOCQ)]
   5 + 5 + 2 = 12

Group – D

6. (a) How can common mode signal is rejected by using Instrumentation amplifier in signal conditioning circuitry?   [(CO3)(Remember/LOCQ)]
   (b) Compare integrator with differentiator from the application point of view.
                                                                 [(CO2)(Analyze/IOCQ)]
   (c) Estimate the percentage error in output voltage due to finite CMRR of 50 dB, when the inputs are V_1=1.0 volt and V_2= 1.01 volt for the Op amp.
                                                                 [(CO5)(Evaluate/HOCQ)]
                                                                 4 + 6 + 2 = 12

7. (a) Explain the operation of 'brickwall filter'.   [(CO2)(Evaluate/HOCQ)]
   (b) Demonstrate the working of a first order band pass filter with a suitable circuit diagram.   [(CO3)(Understand/LOCQ)]
   (c) Illustrate the working principle of Schmitt trigger with a suitable circuit diagram.
                                                                 [(CO1)(Analyze/IOCQ)]
                                                                 2 + 4 + 6 = 12

Group – E

8. (a) Construct a suitable actuation system for position control with proper justification.
                                                                 [(CO4)(Create/HOCQ)]
   (b) Examine what do you mean by resolution of an ADC?   [(CO2)(Analyze/IOCQ)]
   (c) State the significance of Data Acquisition System (DAS) in today's digitization scenario.   [(CO1)(Remember/LOCQ)]
                                                                 3 + 5 + 4 = 12

9. (a) Determine the applications of embedded system in mechatronics with proper block diagram.   [(CO4)(Evaluate/HOCQ)]
   (b) Examine the final output voltage expression of a 2-bit R-2R type DAC.
                                                                 [(CO2)(Apply/IOCQ)]
   (c) Demonstrate with a simple diagram the data flow path in a microcomputer based mechatronic system.   [(CO1)(Understand/LOCQ)]
                                                                 4 + 5 + 3 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	36.4	40.6	23

Course Outcome (CO):

After the completion of the course students will be able to:
1. Understand a real time mechatronics system.
2. Identify the key elements of mechatronics systems and its representation in terms of block diagram.

3. Gain knowledge of different types of Sensors required for developing mechatronics systems.
4. Learn the functions of different types of actuators and identify their application areas.
5. Understand concept of signal conditioning and use of interfacing systems such as comparator, filters, amplifiers, etc.
6. Learn the hardware and software interfacing for embedded systems.

*LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question.