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
any 5 (five) from Group B to E, taking at least one 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)   Higher order polynomial indicates that the filter is
            (a) of practical type   (b) of falling slope
            (c) of ideal type   (d) easier to design.

    (ii)   Which type of LVDT has infinite resolution
            (a) Unguided Armature   (b) Captive Armature
            (c) Spring-extended Armature   (d) all of these.

    (iii)   Micro-sensor used to measure acceleration due to gravity
            (a) MEMS accelerometer
            (b) MEMS gyroscope
            (c) Micro-gripper
            (d) Electromechanical actuator.

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

    (v)   In hydraulic rotary actuators, maximum angle of rotation may be larger
            than 360° in
            (a) angle angle actuator
            (b) piston rotary actuator
            (c) swivel vane rotary actuator
            (d) all of these.

    (vi)   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.

(vii)   External electronic commutation circuitry is required for
(a) stepper motor   (b) BLDC motor
(c) shunt motor   (d) servo motor.

(viii) In angioplasty, the Stents are actuators of
(a) pneumatic type   (b) SMA type
(c) electrostatic type   (d) electromagnetic type.

(ix)   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.

(x)   For broad frequency bandwidth (typically 0.2 – 5 kHz), the accelerometer we recommend is
(a) piezoelectric type   (b) capacitive type
(c) electromechanical type (d) piezoresistive type.

Group – B

2. (a)   State the mechanical elements of Mechatronics. Give a few examples on electromechanical elements of mechatronic system.

(b)   How can technological advances in design, manufacturing and operation of engineering products/devices/processes be traced? State the benefits associated with Revolutions of Mechatronics as a Contemporary Design Paradigm.

(3 + 3) + (3 + 3) = 12

3. (a)   What are the most important criteria for evaluating sensors? Why signal conditioning circuitry is required to process the sensor output?

(b)   Can you replace an instrumentation amplifier used in the signal conditioning circuit of a particular transducer by a differential amplifier? Give reasons.

(4 + 3) + (2 + 3) = 12

Group – C

4. (a)   Describe the building blocks of data acquisition system.

(b)   Suggest a suitable transducer for measurement of vibration in machinery. Illustrate the acquisition circuitry required for the suggested transducer applicable for the above mentioned system.

4 + (2 + 6) = 12

5. (a)   What are the uses of microcomputer in mechatronics? Draw the basic block diagram of a micro computer.

(b)   State the differences between Von Neumann and Harvard architecture.

(3 + 5) + 4 = 12

Group – D

6. (a)   Explain briefly the working principle of hydraulic actuator. Specify the term "stroke" in case of hydraulic cylinders.

(b)   What is the significance of power cylinder in pneumatic line? Define the advantages of such a pneumatic actuator.

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

7. (a)   Design a BP filter of 1st order having lower cut off frequency 2 kHz and higher cut off frequency 100 kHz.

(b)   A parallel plate capacitive transducer uses plate's area 100 mm^2 which are separated by a distance 0.2 mm. Calculate the value of the change in capacitance if by a linear displacement reduces the separation distance of 0.02 mm. Take the air as dielectric medium with a permittivity of 8.85×10^{-12} F/m.

6 + 6 = 12

Group – E

8. (a)   What do you mean by Shape Memory Effect?

(b)   Draw the stress-strain curve of SMA and explain its characteristics. Define the application area of SMA.

4+ (6 + 2) = 12

9. (a)   Write in brief the basic differences between lateral and transverse comb drive microactuator.

(b)   Suggest a suitable actuation system for position control purpose with proper justification.

6+ (4 + 2) = 12