

MECHATRONICS
(AEIE 5131)

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) The basic low pass filter resembles
(a) a multiplier (b) a divider
(c) an integrator (d) a differentiator.
- (ii) The total bandwidth of a Phase Modulation (PM) signal can be given by
(a) $2(1+2\beta)B$ where, $\beta=2$ (b) $2(1+\beta)B$ where, $\beta=2$
(c) $2(1+2\beta)B$ where, $\beta=4$ (d) $2(1+\beta)B$ where, $\beta=4$.
- (iii) In AC synchronous motor, we make use of
(a) carbon brushes (b) rotating coil
(c) rotating magnet (d) none of these.
- (iv) AC LVDTs
(a) have wider operating temperature range
(b) have external signal conditioning circuitry
(c) deliver DC output in the secondary coils
(d) none of these.
- (v) Derivative of momentum with respect to time results in
(a) acceleration (b) velocity
(c) force (d) pressure.
- (vi) In resistive torque measurement system dummy strain gauge is used to compensate
(a) pressure (b) strain
(c) temperature (d) humidity.

- (vii) 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.
- (viii) Low pressure positioner is operated by
(a) electrical and magnetic forces
(b) pneumatically generated forces
(c) hydraulically generated forces
(d) electrostatic forces.
- (ix) Under dark condition, a photoresistor exhibits
(a) few hundred ohms resistance (b) few MΩ resistance
(c) short circuit (d) none.
- (x) On application of stress, the SMA changes from _____ to _____.
(a) Twinned Martensite (unstressed), Detwinned Martensite (stressed deformed)
(b) Detwinned Martensite (stressed deformed), Twinned Martensite (unstressed)
(c) Detwinned Martensite (stressed deformed), Detwinned Martensite (un-stressed deformed)
(d) Austenite (undeformed), Detwinned Martensite (un-stressed deformed).

Group - B

2. (a) What are the important elements of mechatronics? Explain with a suitable block diagram.
(b) What are the most important criteria for evaluating sensors? Why signal conditioning circuitry is required to process the sensor output? Can you replace an instrumentation amplifier used in the signal conditioning circuit of a particular transducer by a differential amplifier? Give reasons.
- (4 + 2) + 6 = 12**
3. (a) Define thermopile. What do you mean by T, K and J type thermocouples? What are the differences between AC and DC LVDT?
(b) Classify different types of LVDT from constructional and application view point.

(2 + 4 + 2) + 4 = 12

Group - C

4. (a) What are the uses of microcomputer in mechatronics? Draw the basic block diagram of a micro computer.
- (b) A parallel plate capacitive transducer uses plate area 100 mm² which are separated by a distance 0.2 mm. Calculate the value of the change in capacitance if a linear displacement reduces the separation distance by 0.02 mm. Take the air as dielectric medium with a permittivity of 8.85×10^{-12} F/m.
- (2 + 5) + 5 = 12**
5. (a) Explain the working principle of electrostatic type micro actuator. What happens to a parallel plate capacitor type micro-actuator when the applied voltage is gradually increased?
- (b) How will you specify the resolution of ADC? Describe the working principle of SAR type ADC with suitable circuit diagram.
- (4 + 2) + (3 + 3) = 12**

Group - D

6. (a) How can CMRR be improved by using Instrumentation amplifier in signal conditioning circuitry?
- (b) Design a typical active bandpass filter. The CMRR of an opamp is 60 dB. The inputs are $V_1 = 1.0$ volt and $V_2 = 1.01$ volt. Find the percentage error in output voltage due to finite CMRR.
- 5 + (4 + 3) = 12**
7. (a) Describe the building blocks of data acquisition system.
- (b) Suggest a suitable transducer for measurement of load in electronic weighing machine. Illustrate the acquisition circuitry required for the suggested transducer applicable for the above mentioned weighing system.
- 4 + (2 + 6) = 12**

Group - E

8. (a) What is the full form of SMA? Describe the mechanism of Stress Free Shape Recovery of SMA.

- (b) What do you mean by power cylinder? Define the advantages of such a pneumatic actuator. Explain the working principle of a circuit breaker.
- (1 + 5) + (2 + 2 + 2) = 12**
9. (a) What do you mean by "Brickwall Filter"? How does the behaviour of a band pass filter change if we increase the order?
- (b) Design a BP filter of 1st order having lower cut off frequency 2 KHz and higher cut off frequency 100 KHz.
- (2 + 6) + 4 = 12**