

**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) 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.
- (ii) Data acquisition is the process in which, physical variables from the real world are _____
(a) converted into electrical signals
(b) modified and converted into a digital format for processing
(c) converted into mechanical signals
(d) both (a) and (b).
- (iii) 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.
- (iv) In robotic surgery, hydraulic actuators are not recommended, because
(a) nonlinear actuation (b) bad efficiency
(c) complex actuation (d) all of the above.
- (v) An air muscle has a power-to-weight ratio of
(a) 16:1 (b) 64:1 (c) 200:1 (d) 400:1
- (vi) In hydraulic rotary actuators, maximum angle of rotation may be larger than 360° in
(a) angle actuator (b) piston rotary actuator
(c) swivel vane rotary actuator (d) all of these.
- (vii) The gauge factor of metal strain gauge is in the range of
(a) 2 to 10 (b) 100 to 150
(c) more than 200 (d) 50 to 100.

- (viii) 'Stents' employed in angioplasty is an actuator of type
(a) electromechanical (b) electrostatic
(c) pneumatic (d) SMA.
- (ix) In a 3-way pneumatic actuator, an important safety feature is that
(a) the valve vents the downstream components each time it is turned off
(b) the valve vents the downstream components each time it is operated
(c) the valve stores the downstream components each time it is actuated
(d) none of the above.
- (x) For the measurement of vibration the most suitable type of LVDT is
(a) unguided armature (b) captive armature
(c) spring-extended armature (d) both (a) and (b).

Group - B

2. (a) State the Disciplinary Foundations of Mechatronics. What do you mean by the key elements of mechatronics? Give a few examples on each of the key element.
(b) Explain the terms multi-disciplinary, cross-disciplinary and inter-disciplinary. Briefly explain various evolution stages of mechatronics.
 $(2 + 2 + 2) + (3 + 3) = 12$
3. (a) How can you classify sensors based by considering transduction principle?
(b) The bottom diameter and piston diameter of a hydraulic cylinder are 5 mm and 3 mm respectively. The pressure at bottom side is 4psi while pressure measured at head side of the cylinder is 2.5 psi. Calculate the pulling force.
 $6 + 6 = 12$

Group - C

4. (a) Classify micro-actuators based on 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.
 $6 + (2 + 2 + 2) = 12$
5. (a) Explain the importance of microcomputer in mechatronics systems.
(b) Define embedded system. Describe an embedded system that can be employed for non-contact measurement / monitoring of human body temperature with a suitable block diagram.
 $4 + (3 + 5) = 12$

Group - D

6. (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) Explain the working principle of a circuit breaker.

(4 + 4) + 4 = 12

7. (a) What do you mean by “Brickwall Filter”? How does the behaviour of a band pass filter change if we increase the order?

(b) Describe the building blocks of data acquisition system. What are the most important criteria for evaluating sensors?

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

Group - E

8. (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

9. (a) What do you mean by power cylinder? Define the advantages of such a pneumatic actuator.

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

6 + (2 + 2 + 2) = 12

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