

**MECHATRONICS**  
**(AEIE 5141)**

**Time Allotted : 2½ hrs**

**Full Marks : 60**

*Figures out of the right margin indicate full marks.*

*Candidates are required to answer Group A and any 4 (four) from Group B to E, taking one from each group.*

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

**Group – A**

1. Answer any twelve:

**12 × 1 = 12**

*Choose the correct alternative for the following*

- (i) The transducer sensing motion in smart phones is
  - (a) MEMS gyroscope
  - (b) MEMS accelerometer
  - (c) MEMS capacitive sensor
  - (d) MEMS inductive sensor.
- (ii) 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.
- (iii) Microgrippers used in microsurgery are actuators of type
  - (a) electromechanical
  - (b) electrostatic
  - (c) pneumatic
  - (d) SMA.
- (iv) In industrial environment, the most preferable actuator for lifting heavy objects is of
  - (a) hydraulic type
  - (b) pneumatic type
  - (c) electrical type
  - (d) electromechanical type
- (v) For the measurement of vibration, the most suitable type of LVDT is
  - (a) unguided armature
  - (b) captive armature
  - (c) spring-extended armature
  - (d) guided armature type.
- (vi) An electrical actuator used to protect an electrical circuit from damage caused by overload or short circuit is
  - (a) safety switches
  - (b) relay
  - (c) circuit breaker
  - (d) fuse.
- (vii) In Data acquisition, physical variables from the real world are
  - (a) converted into pneumatic signals
  - (b) modified and converted into a digital format for processing
  - (c) converted into mechanical signals
  - (d) modified and converted into hydraulic signal.

- (viii) The domestic water meter is of  
 (a) Swivel vane rotary actuator type (b) Piston rotary actuator type  
 (c) Double-acting piston type (d) Single-acting plunger type.
- (ix) In a standard control system, the block between the comparator and plant is  
 (a) Final control element (b) Sensor  
 (c) Actuator (d) Both (a) and (c).
- (x) In robotic surgery, hydraulic actuators are not recommended, because  
 (a) nonlinear actuation (b) bad efficiency  
 (c) complex actuation (d) all of the above.

*Fill in the blanks with the correct word*

- (xi) In robotic/ laparoscopic surgery, the \_\_\_\_\_ type actuators are recommended.
- (xii) In hydraulic cylinders, stroke is the \_\_\_\_\_ that the piston travels through the cylinder.
- (xiii) DC LVDTs do not require separate \_\_\_\_\_ circuitry.
- (xiv) Schmitt Trigger is known as \_\_\_\_\_ comparator.
- (xv) Photoresistors exhibit a \_\_\_\_\_ characteristics for incident optical illumination versus the resulting resistance.

### **Group - B**

2. (a) Discuss the mechanical elements of mechatronics. [[CO1](Analyse/IOCQ)]  
 (b) Give a few examples of electromechanical elements of a mechatronic system. [[CO1](Apply/IOCQ)]  
 (c) State the process of tracing the technological advances in the design, manufacturing, and operation of engineering products/devices. Describe the benefits associated with Revolutions of Mechatronics as a Contemporary Design Paradigm. [[CO2](Apply/IOCQ)]  
**3 + 3 + (3 + 3) = 12**
3. (a) How do you measure displacement on a millimetre scale? [[CO1](Remember/LOCQ)]  
 (b) Describe the transduction principle of the said transducer with I/O characteristics. [[CO1](Remember/LOCQ)]  
 (c) Classify the most important parameters for the categorization of sensors. Illustrate the importance of signal conditioning circuitry required to process the sensor output. [[CO2](Remember/IOCQ)]  
**3 + 3 + (3 + 3) = 12**

### **Group - C**

4. (a) Why micro-actuators are part and parcel of medical surgery? [[CO3](Remember/LOCQ)]  
 (b) Compare Lateral and Transverse comb drive micro-actuators. [[CO3](Remember/LOCQ)]

- (c) Evaluate a suitable actuation system for position control purposes with proper justification. [[CO3](Evaluate/HOCQ)]  
**4 + 3 + 5 = 12**
5. (a) Explain the importance of microcomputer in mechatronics systems. [[CO4](Analyze/IOCQ)]
- (b) What do you mean by embedded system? Describe an embedded system that can be employed for non-contact measurement / monitoring of human body temperature with a suitable block diagram. [[CO3](Remember/LOCQ)]  
**4 + (3 + 5) = 12**

### Group - D

6. (a) Explain briefly the working principle of the hydraulic actuator. State the term “stroke” in the case of hydraulic cylinders. [[CO4](Analyze/IOCQ)]
- (b) What is the significance of a power cylinder in a pneumatic line? [[CO3](Evaluate/HOCQ)]
- (c) List the few advantages of a pneumatic actuator. [[CO2](Apply/IOCQ)]  
**4 + 4 + 4 = 12**
7. (a) What do you mean by the Shape Memory Effect? [[CO4](Understand/LOCQ)]
- (b) Explain the stress-strain curve of SMA. [[CO3](Evaluate/HOCQ)]
- (c) Describe the applications of SMA in the medical field. [[CO4](Analyze/IOCQ)]  
**3 + 5 + 4 = 12**

### Group - E

8. (a) What do you understand by the term CMRR? [[CO4](Remember/LOCQ)]
- (b) Can you replace an instrumentation amplifier used in the signal conditioning circuit of a particular transducer with a differential amplifier? Give reasons. [[CO3](Examine/HOCQ)]  
**4 + (6 + 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? [[CO5](Remember/LOCQ)]
- (b) Describe the building blocks of data acquisition system. What are the most important criteria for evaluating sensors? [[CO5](Apply/IOCQ)]  
**(3 + 3) + (3 + 3) = 12**

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	35	42	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.*