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

(ii) In high-rise buildings, motion induced by earthquake or wind is amplified and this vibration can be reduced by
(a) Tuned mass damper (b) gyroscope
(c) strain gauge (d) electromagnetic flowmeter.

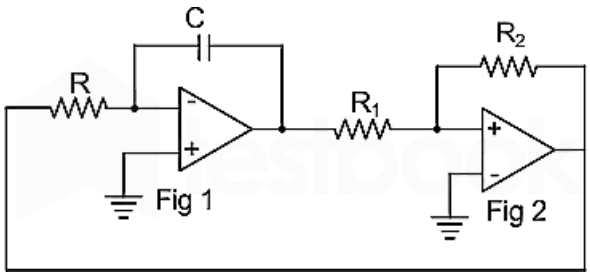
(iii) Mechanical elements / components refer to
(a) gear-pinion (b) servo motor
(c) flexi force sensor (d) relay.

(iv) 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.

(v) 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.

(vi) To reject common mode noise, we prefer
(a) instrumentation amplifier (b) inverting amplifier
(c) integrating amplifier (d) summing amplifier.

(vii) The Fig 1 and Fig. 2 represent
(a) Integrator and differentiator
(b) Oscillator and multivibrator
(c) Integrator and Schmitt trigger
(d) Differentiator and integrator



(viii) 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.

(ix) The number of compactors required in a 4 bit Flash Analog to Digital converter (ADC) is
(a) 4 (b) 5 (c) 15 (d) 16.

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

Fill in the blanks with the correct word

(xi) Robust differential gain amplifier is known as _____amplifier.

(xii) The filter that passes a single frequency is known as _____ filter.

(xiii) Shape memory Alloys (SMAs) have two stable phases - the high-temperature phase, called _____ and the low-temperature phase, called _____.

(xiv) An electromechanical relay is a solenoid used to _____ or _____ mechanical contact between electrical leads.

(xv) DC LVDTs do not require separate _____ circuitry.

Group - B

2. (a) Explain the Disciplinary Foundations of Mechatronics. What do you mean by the key elements of mechatronics? List a few examples on each of the key element.
[(CO2)(Analyze/IOCQ)]

(b) Illustrate the terms multi-disciplinary, cross-disciplinary and inter-disciplinary. Briefly explain various evolution stages of mechatronics. *[(CO1)(Evaluate/HOCQ)]*

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

3. (a) List a few issues that purely mechanical systems inherently suffer from.
[(CO1)(Analyze/IOCQ)]

(b) Why are modelling/simulation in design of mechatronic system so important?
[(CO1)(Remember/LOCQ)]

(c) Assess the role of control computing hardware in a modern mechatronic system.
[(CO1)(Evaluate/HOCQ)]

5 + 4 + 3 = 12

Group - C

4. (a) How do you measure displacement in mm scale? Describe the transduction principle of the said transducer with I/O characteristics. *[(CO1)(Remember/LOCQ)]*

   (b) Name three different types of commonly used LVDTs. Specify their applications in industry. *[(CO2)(Analyze/IOCQ)]*

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

5. (a) Classify sensors based by considering transduction principle. *[(CO4)(Remember/LOCQ)]*

   (c) State the pros and cons of Resistive Foil Strain Gauge. *[(CO2)(Apply/IOCQ)]*

   (d) A single strain gauge of nominal resistance 120Ω and gauge factor of 2 is bonded to a material having an elastic stress limit 400 N/m2 and modulus of elasticity 200 MN/m2. Calculate the change in resistance due to a change in stress equal to 1/10th of the elastic range. *[(CO2)(Apply/IOCQ)]*

4 + 4 + 4 = 12

Group - D

6. (a) How can common mode signal is rejected by using Instrumentation amplifier in signal conditioning circuitry? *[(CO3)(Remember/LOCQ)]*

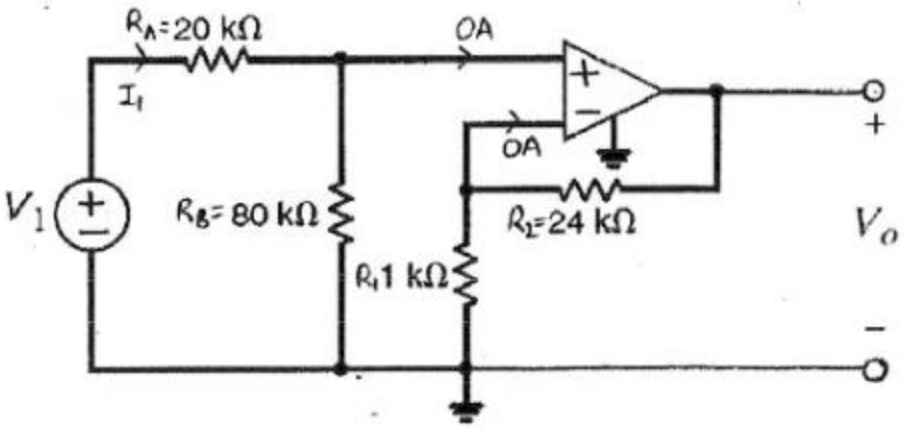
   (b) Compare integrator with differentiator from the application point of view. *[(CO2)(Analyze/IOCQ)]*

   (c) Estimate the percentage error in output voltage due to finite CMRR of 50 dB, when the inputs are V1=1.0 volt and V2= 1.01volt for the OpAmp. *[(CO5)(Evaluate/HOCQ)]*

4 + 6 + 2 = 12

7. (a) Why micro-actuators are part and parcel in medical surgery? Compare Lateral and Transverse comb drive microactuators. *[(CO3)(Remember/LOCQ)]*

   (b) Calculate the gain of the amplifier given below. *[(CO3)(Evaluate/HOCQ)]*



(4 + 3) + 5 = 12

Group - E

8. (a) Examine the final output voltage expression of a 4-bit R-2R ladder type DAC. *[(CO3)(Analyse/HOCQ)]*

(b) Explain the operation of any one type of ADC. *[(CO4)(Remember/LOCQ)]*

(c) Give an example of Digital to Analog Converter in real life. *[(CO2)(Apply/IOCQ)]*

5 + 5 + 2 = 12

9. (a) Explain the importance of microcomputer in mechatronics systems. *[(CO3)(Analyse/IOCQ)]*

(b) What do you mean by embedded system? *[(CO4)(Remember/LOCQ)]*

(c) Describe an embedded system that can be employed for non-contact measurement / monitoring of human body temperature with a suitable block diagram. *[(CO2)(Apply/IOCQ)]*

4 + 3 + 5 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	34.38	43.75	21.88