

**INTRODUCTION TO MECHATRONICS
(AEIE 3111)**

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 sensing principle used by gyroscopes is change in
(a) moment of inertia
(b) linear acceleration
(c) Coriolis force
(d) rotation speed leading to Coriolis force
- (ii) The most important conversion block in sensor signal conversion is
(a) ADC (b) DAC
(c) Impedance matching (d) DSP
- (iii) Which of the following is not a MEMS specific process
(a) Oxidation (b) Wet etching
(c) Wafer Bonding (d) Electroplating
- (iv) Pressure regulation valve is generally used to control
(a) operating pressure (b) operating pressure and maintain it
(c) direction of fluid flow (d) and sense external pressure
- (v) The output circuit to input circuit in a relay is
(a) Mechanically isolated (b) Electrically isolated
(c) Electrically non-isolated (d) Mechanically non-isolated
- (vi) The shaft torque in a DC motor is given by the following equation
(a) $J\ddot{\theta} = K_t i - b\dot{\theta}$ (b) $J\ddot{\theta} = K_t i - b\dot{\theta}$
(c) $Ri = V - K_e \dot{\theta} - L \frac{di}{dt}$ (d) $Ri = \dot{\theta} - L \frac{di}{dt}$
- (vii) The last step in analog to digital conversion is
(a) Encoding (b) Quantizing
(c) Sampling (d) Linearization

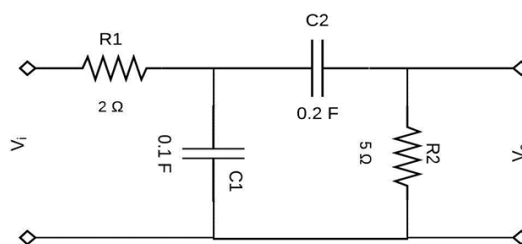
- (viii) The actuation principle used by micro-gripper is
 - (a) Thermal expansion of two dissimilar metals
 - (b) Electrostatic force
 - (c) Electrical actuation
 - (d) Mechanical actuation
- (ix) In a Piezo-resistive type MEMS accelerometer stress leads to
 - (a) capacitance change
 - (b) electrical charges
 - (c) change in resonance frequency
 - (d) resistance change
- (x) The application area for Digital Signal Processors is
 - (a) Filtering
 - (b) Spectral Analysis
 - (c) Impedance matching
 - (d) Synthesis

Group - B

- 2. (a) List the various categories on which sensors can be evaluated. [[CO4] (Remember/LOCQ)]
- (b) Determine the overall transfer function of an inverted pendulum system. [[CO2] (Evaluate/HOCQ)]
- (c) Contrast the two assumptions made in case of thermal systems while modelling them? [[CO1](Analyze/IOCQ)]

3 + 6 + 3 = 12

- 3. (a) State some important criteria based on which sensors are evaluated. [[CO3] (Remember/LOCQ)]
- (b) Analyze the working an Op-amp based current to voltage converter. [[CO2] (Analyze /IOCQ)]
- (c) Estimate the output of the circuit for input signal frequency (a) $\omega=0$ and (b) $\omega=\infty$, along with the overall transfer function. [[CO5] (Evaluate/HOCQ)]



3 + 3 + 6 = 12

Group - C

- 4. (a) Assess how voice coils work. [[CO4] (Evaluate/HOCQ)]
- (b) Demonstrate with a neat diagram the parts of a voice coil. [[CO2] (Understand/LOCQ)]
- (c) Examine the physical principle that MEMS gyroscopes use to detect orientation change. [[CO1] (Analyze/IOCQ)]

3 + 4 + 5 = 12

5. (a) Describe the expression used to calculate the normal force between two misaligned charged plates kept at a distance “d”. [(CO4)(Analyze/IOCQ)]
(b) State the working of a spool direction control valve in hydraulic systems. [(CO2) (Understand/LOCQ)]
(c) Explain the symbol of a flow valve. [(CO1)(Evaluate/HOCQ)]
- 5 + 5 + 2 = 12**

Group - D

6. (a) Assess the two different types of micro-grippers based on their construction of electrodes? [(CO3) (Evaluate/HOCQ)]
(b) Identify the expression used to calculate induced normal force between two charged plates kept at a distance “d”. [(CO4) (Apply/IOCQ)]
(c) Show how this force varies with distance “d”. [(CO4) (Understand/LOCQ)]
- 4 + 6 + 2 = 12**
7. (a) Assess the working principle of a stop valve. [(CO4) (Evaluate/HOCQ)]
(b) Interpret a few application areas where stop valves are used. [(CO2) (Understand/LOCQ)]
(c) Examine the actuation principle of a MEMS cantilever beam using a SMA as actuating element. [(CO1)(Analyze/IOCQ)]
- 3 + 4 + 5 = 12**

Group - E

8. (a) Where are Shape memory alloys used? [(CO4) (Remember/LOCQ)]
(b) Identify the various programming languages described in the IEC 1131-3 standard for programming a PLC. [(CO2) (Apply/IOCQ)]
(c) What do you understand by a scan cycle in a PLC? [(CO1)(Evaluate/HOCQ)]
- 4 + 5 + 3 = 12**
9. (a) Assess with a neat circuit diagram the working of an R-2R type DAC. [(CO4) (Evaluate/HOCQ)]
(b) Examine the final out voltage expression of a 4-bit R-2R type DAC. [(CO2) (Analyze/IOCQ)]
(c) Demonstrate the digital NOT logic using PLC ladder diagram. [(CO1) (Understand/LOCQ)]
- 4 + 5 + 3 = 12**

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	29.2%	38.5%	32.3%

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

Department & Section	Submission Link
AEIE	https://classroom.google.com/c/NDA1MjkwNzIzODIw/a/NDY0MTczODAzNDMx/details