

MECHATRONICS & CONTROL SYSTEMS
(MECH 3232)

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 fluid power devices that convert the energy of a pressurised fluid into mechanical energy to do work are called
 - (a) Activators.
 - (b) Actuators.
 - (c) Accumulators.
 - (d) Converters.
- (ii) What is the number of ports in a 5/3 DCV?
 - (a) 5
 - (b) 8
 - (c) 2
 - (d) 3
- (iii) Which electrical actuator is generally used with a valve?
 - (a) Motor
 - (b) Converter
 - (c) Compressor
 - (d) Solenoid
- (iv) In LDR sensor, if the intensity of light applied is more, its resistance value becomes ____.
 - (a) Less
 - (b) High
 - (c) Zero
 - (d) Infinity
- (v) A sensor is a device that converts:
 - (a) Physical quantity into measurable signals
 - (b) Physical quantity into mechanical signal
 - (c) Electrical signal into physical quantity
 - (d) Physical quantity into electric signal only

(vi) Percentage of the time at which signal is ON is referred to as _____?
 (a) Input Cycle
 (b) Output Cycle
 (c) Duty Cycle
 (d) Incoming Cycle

(vii) The output of a closed loop control system must be a function of:
 (a) Reference input
 (b) Reference output
 (c) Output and feedback signal
 (d) Input and feedback signal

(viii) Full form of PID control is
 (a) Pressure Induced Desired controller
 (b) Proportional Integral and Derivative controller
 (c) Proportional Induced Derivative controller
 (d) Pressure Induced Derivative controller

(ix) The instructions like MOV or ADD are called as _____
 (a) OP-Code
 (b) Operators
 (c) Commands
 (d) None of the mentioned

(x) MOV A, R1 will
 (a) Copy R1 to the accumulator
 (b) Copy the accumulator to R1
 (c) Copy the contents of memory whose address is in R1 to the accumulator
 (d) Copy the accumulator to the contents of memory whose address is in R1

Fill in the blanks with the correct word

(xi) When a Wheatstone bridge has equal resistance on all four arms. Its output will be _____.

(xii) Gauge factor of a strain gauge is the ratio of _____.

(xiii) _____ is the difference between the maximum and minimum values of the input of a sensor.

(xiv) A wheatstone bridge has equal resistance on all four arms. Its output will be _____.

(xv) _____ number of I/O ports are available in an 8051.

Group - B

2. (a) Show with neat sketches, one mechanism that transform:
 I. Rotary to rotary motion,
 II. Rotary to reciprocating motion
 III. Rotary to translational motion.

[(CO1) (Apply/IOCQ)]

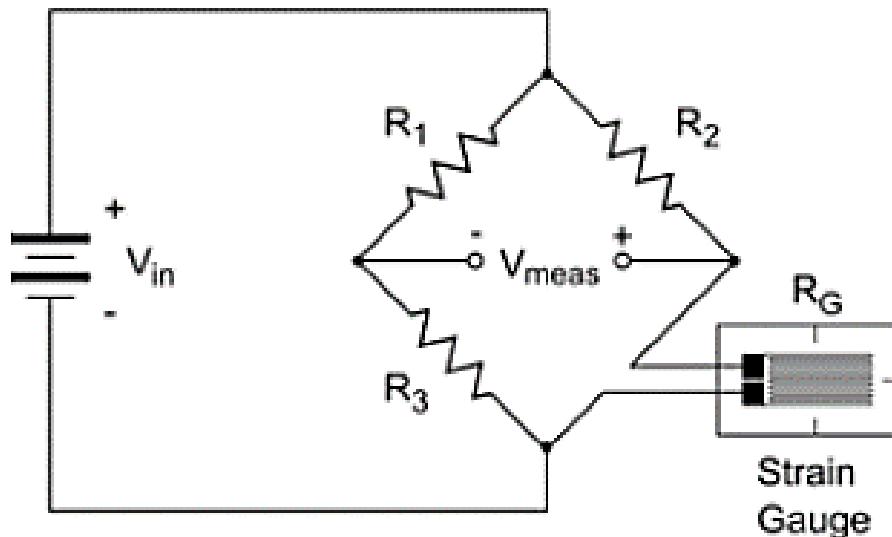
(b) Explain the working principle of stepper motors in half-step mode.
 [(CO1) (Understand/LOCQ)]
6 + 6 = 12

3. (a) Explain the significance of hydraulic accumulators and their role in energy storage.
 [(CO1) (Understand/LOCQ)]
 (b) How does a stepper motor compare to a servo motor?
 [(CO1) (Analyse/IOCQ)]
6 + 6 = 12

Group - C

4. (a) Explain in detail the working principle of an absolute optical encoder.
 [(CO2) (Remember /LOCQ)]
 (b) Explain the importance of different signal conditioning processes in brief.
 [(CO3) (Understand /LOCQ)]
6 + 6 = 12

5. (a) What are the different types of displacement and position sensors? Explain any one of them with a suitable diagram.
 [(CO2) (Apply /IOCQ)]
 (b) A Wheatstone bridge circuit with one arm connected to strain gauge is shown in following figure. The gauge factor of strain gauge is 2. The values of resistances R_1 , R_2 , R_3 , and R_G all are 200 ohm. The supply voltage (V_{in}) is 5 volts. Calculate,
 (i) The output voltage when the strain gauge is stretched for 0.1%.
 (ii) The strain applied if the output voltage is 10mV.



[(CO3) (Analyse /IOCQ)]
6 + 6 = 12

Group - D

6. (a) What is transfer function? Find out the transfer function for a system whose behaviour can be given by the differential equation: $\frac{d^2x}{dt^2} + 5 \frac{dx}{dt} + 4x = f$, where x is the output variable, f is the input and t is the independent variable. Also, $\frac{dx}{dt}$ and x are zero at time $t=0$.
 [(CO4) (Apply/IOCQ)]

(b) Discuss about the impulse, step and ramp input showing their variation in time domain and also find out their transfer function. [(CO4) (Analyse / IOCQ)]

6 + 6 = 12

7. (a) For a spring-mass-damper system with $m = 10 \text{ kg}$, $k = 12 \text{ N/m}$, and $b = 10 \text{ Ns/m}$. Write its transfer function equation and the steady state response equation for step input of 20 N. [(CO4) (Apply / IOCQ)]

(b) Derive the transfer function for a closed loop system if the forward transfer function is G and feedback transfer function is H . [(CO4) (Analyse / IOCQ)]

6 + 6 = 12

Group - E

8. (a) Compare between Microprocessor and Microcontroller. [(CO5) (Analyse / IOCQ)]

(b) Draw a ladder diagram using a timing block to turn on a motor 5 seconds after the start switch is pressed. The motor should turn off 3 seconds after the stop switch is pressed. [(CO6) (Create / HOCQ)]

6 + 6 = 12

9. (a) Write an Assembly Language program for 8051 Microcontroller to add the numbers in 24H and 30H; store the result in registers R5 (LSB) and R6 (MSB). [(CO5) (Create / HOCQ)]

(b) What are the advantages, limitations and applications of PLC? [(CO6) (Analyse / IOCQ)]

6 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	25.00	62.50	12.50