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) With feedback, _____ decreases.
(a) system stability (b) gain
(c) sensitivity (d) disturbance

(ii) Which of the following is a characteristic of an ideal operational amplifier?
(a) Low bandwidth
(b) Open loop gain is infinite
(c) Zero input impedance
(d) Infinite output impedance.

(iii) The damping ratio and peak overshoot are measures of
(a) relative stability (b) speed of response
(c) steady state error (d) stability.

(iv) Error signal in a closed loop control system is
(a) reference signal (b) output signal-reference signal
(c) reference signal-feedback signal (d) feedback signal-output signal.

(v) Which electrical actuator is generally used with a valve?
(a) Motor (b) Converter (c) Compressor (d) Solenoid.

(vi) What is the number of ports in a 5/3 DCV?
(a) 5 (b) 8 (c) 2 (d) 3.

(vii) Resolution of an instrument is
(a) the maximum quantity it can measure
(b) the maximum non-linearity
(c) the minimum quantity it can measure
(d) ability to distinguish polarity.

(viii) What is the ratio of amplitude of response to that of the input?
(a) Response (b) Gain (c) Phase (d) Frequency.

(ix) 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.

(x) How much external data memory can be interfaced with an 8051?
(a) 32KB (b) 64KB (c) 128KB (d) 256KB.

Fill in the blanks with the correct word

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

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

(xiii) _____ is the ability of the sensor to indicate the same output over a period of time for a constant input.

(xiv) A circuit which restricts low frequency signal and allows the high frequency signal is called _____.

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

Group - B

2. (a) Write the advantages, disadvantages and uses of pneumatic actuators. *[(CO1)(Analyse/IOCQ)]*

(b) Explain the functioning of a double-acting cylinder using a suitable diagram. *[(CO1)(Apply/IOCQ)]*

6 + 6 = 12

3. (a) Explain the working principle of servomotor using potentiometer with sketches. *[(CO1)(Apply/IOCQ)]*

(b) Explain how to control backlash of a recirculating ball screw system with the help of a sketch. *[(CO1)(Apply/IOCQ)]*

6 + 6 = 12

Group - C

4. (a) Draw and explain the working principle of an inductive sensor. *[(CO2)(Apply/IOCQ)]*

(b) Draw the circuit diagram to show how an op amp can be used as a summing amplifier to add three voltages. *[(CO4)(Remember/LOCQ)]*

6 + 6 = 12

5. (a) Explain in detail about the working principle of an absolute optical encoder. *[(CO2)(Understand/LOCQ)]*

(b) A Wheatstone bridge circuit with one arm connected to strain gauge is shown in Fig.1. 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)(Apply/IOCQ)]*

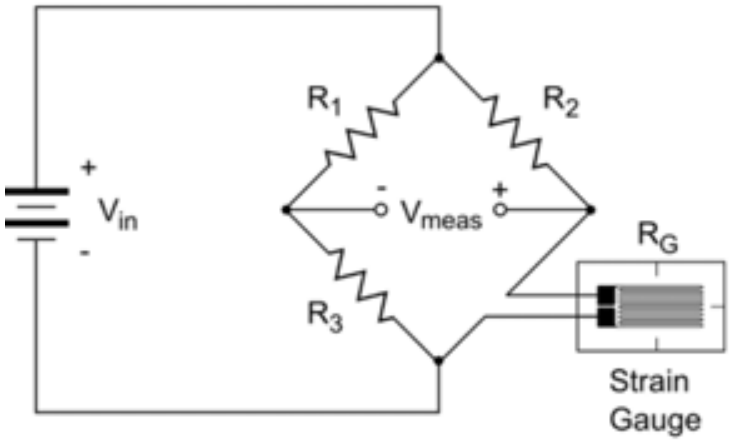

Fig. 1

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 $\frac{d^2x}{dt^2}$ are zero at time t=0. *[(CO3)(Apply/IOCQ)]*

   (b) What do you mean by rise time, maximum percentage overshoot, settling time and steady state error for a system? *[(CO4)(Understand/LOCQ)]*

6 + 6 = 12

7. (a) Explain three methods of representing frequency response functions. *[(CO4)(Understand/LOCQ)]*

   (b) What is an On-Off controller? What are the advantages of a PID controller over an On-Off controller? *[(CO4)(Remember/LOCQ)]*

6 + 6 = 12

Group - E

8. (a) What are the major components of an input module circuit of a PLC? Explain its role. *[(CO6)(Understand/LOCQ)]*

   (b) 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)]*

6 + 6 = 12

9. (a) One open tank as shown in Fig. 2 is installed in the plant of which liquid level is to be controlled. When level reaches the level low, outlet flow is blocked and inlet flow is allowed until high level is achieved. And when level high is detected, outlet flow is allowed and inlet flow is blocked. Draw the ladder diagram for this problem. *[(CO6)(Create/HOCQ)]*

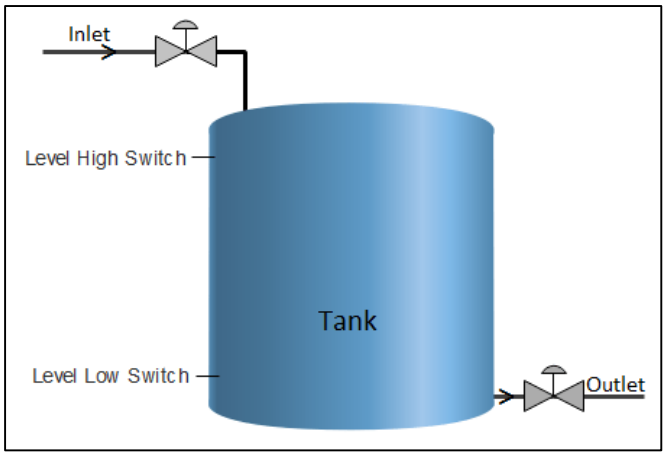

Fig. 2

(b) Draw the architecture of an 8051 microcontroller and explain the role of each component. *[(CO5)(Remember/LOCQ)]*

6 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	43.75	43.75	12.5

Course Outcome (CO):

After the completion of the course students will be able to
CO1: Identify different types of drive system for implementation in engineering applications
CO2: Identify suitable sensors for an engineering system
CO3: Apply the concept of signal processing and signal conditioning for industrial applications
CO4: Explain, analyze and evaluate different control systems
CO5: Describe the basic knowledge of microcontroller and write program for industrial applications
CO6: Explain the basics of PLC and write program for industrial applications.

**LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question.*