MECHATRONICS & CONTROL SYSTEMS
(MECH 3232)

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)   Sensors that require no external power source to create an output is known as a/an _____ sensor.
(a) active   (b) passive   (c) variable   (d) thermo

(ii) The smallest input needed to create a measurable change on the output is known as the sensor's _____
(a) accuracy   (b) linearity   (c) resolution   (d) precision.

(iii) A _____ motor is a step incremental motion machine.
(a) stepper   (b) servo   (c) D. C. Motor   (d) A. C. Motor

(iv) Most common type of electrical actuator is
(a) solenoid   (b) motor   (c) relay   (d) thyristor.

(v)   The device which converts one energy into another is called a
(a) Transistor   (b) Transducer   (c) PLC   (d) Micro controller.

(vi) 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.

(vii) What term describes the maximum expected error associated with a measurement on a sensor?
(a) Precision   (b) Accuracy   (c) Range   (d) Resolution.

(viii) Which of the following statements will add the accumulator and register 3?
(a) ADD @R3, @A   (b) ADD @A, R3
(c) ADD R3, A   (d) ADD A, R3.

(ix)   Which of the following is not a characteristic of an ideal operational amplifier?
(a) Bandwidth is infinite   (b) Open loop gain is infinite
(c) Zero input impedance   (d) Infinite common mode rejection ratio.

(x)   The output of the feedback control system must be a function of
(a) Reference input   (b) Reference output
(c) Output and feedback signal   (d) Input and feedback signal.

Group- B

2. (a)   Draw a neat sketch of a recirculating ball-screw-nut system. Mention its use.
[(CO1)(Understand/LOCQ)]
    (b)   What in 5/2 DCV? Explain with neat sketch.   [(CO1)(Understand/LOCQ)]
6 + 6 = 12

3. (a)   Explain the working principle of stepper motors in half step mode?
[(CO1)(Understand/LOCQ)]
    (b)   Explain with a neat sketch construction and working of the double acting cylinder.   [(CO1)(Understand/LOCQ)]
6 + 6 = 12

Group – C

4. (a)   Write advantages, limitations and applications of Inductive proximity sensor.
[(CO2)(Apply/IOCQ)]
    (b)   Explain in detail about working of incremental encoder and its applications.
[(CO2)(Understand/LOCQ)]
6 + 6 = 12

5. (a)   What are the characteristics of an ideal op-amp?   [(CO3)(Understand/LOCQ)]
    (b)   The following Fig.1 shows a strain gauge connected to a Wheatstone bridge. 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.
    (i)   Calculate the output voltage when strain gauge is stretched for 2%.
    (ii)   Strain applied if the output voltage is 20mV.   [(CO3)(Apply/IOCQ)]
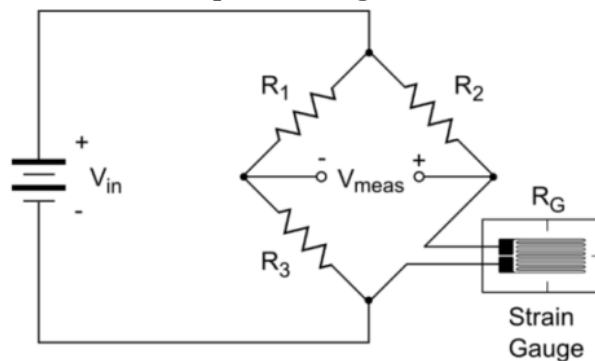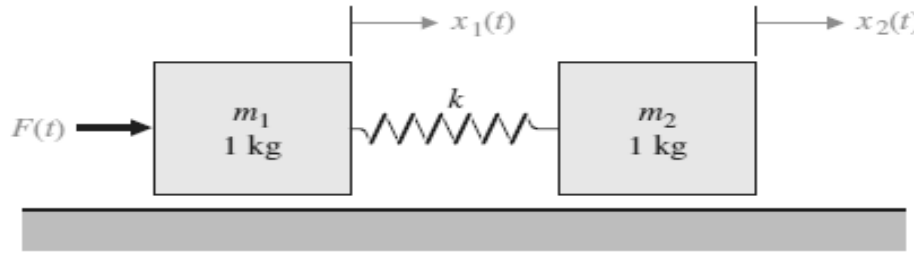

Fig. 1

    (c)   What will be the binary equivalent word that results from a 5.5 V input to a 4-bit A/D converter with an input voltage range 0 to 10 V?   [(CO3)(Apply/IOCQ)]
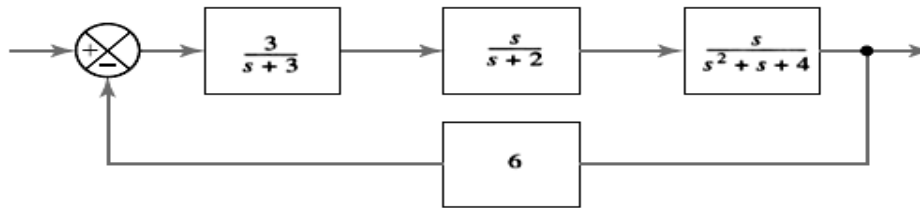**4 + 6 + 2 = 12**

Group - D

6. (a) Determine the transfer function $X_2(s)/F(s)$ for the system shown in Fig. 2. Both masses slide on a frictionless surface and $k = 1$ N/m. [(CO4)(Analyze/IOCQ)]

Fig. 2

(b) Determine the transfer function for the following system shown in Fig. 3. [(CO4)(Analyze/IOCQ)]

Fig. 3

6 + 6 = 12

7. (a) A unity negative feedback system has a forward path transfer function $G(s) = 16/(s(s+4))$. Determine (i) damping ratio, (ii) maximum overshoot, (iii) rise time, (iv) settling time and (v) peak time of the system when the input to the system is unit step. [(CO4)(Analyze/IOCQ)]

(b) Locate the poles and zeros on the S-plane of a system whose transfer function is
$$G(s) = 13(s+7)(s+9)/(s^2+5s+8)$$ [(CO4)(Analyze/IOCQ)]

(c) Define stability. [(CO4)(Understand/LOCQ)]

6 + 4 + 2 = 12

Group - E

8. (a) Compare between PLC and 8051 microcontroller. [(CO5,CO6)(Analyze/IOCQ)]

(b) With the help of neat diagram explain the memory organization of 8051 microcontroller. [(CO5)(Understand/LOCQ)]

6 + 6 = 12

9. (a) Explain 8051 architecture with neat diagram. [(CO5)(Understand/LOCQ)]

(b) Develop a Ladder Logic Diagram for an automatic car parking system, when the parking area is full with 10 cars the red bulb at entry should ON to indicate it is full. If the number of car within the parking area is less than 10 the green bulb should ON to indicate that the space of parking is available. [(CO6)(Create/HOCQ)]

6 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	50	43.75	6.25

Course Outcome (CO):

At the end of the course, a student 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