2015

6

Mechatronics
(AEIE 5131)

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 <u>at least one</u> 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 alternatives for the following: 10 x 1=10

(i) The basic high pass filter resembles
    (a) a multiplier   (b) a divider
    (c) an integrator   (d) a differentiator .

(ii) The total bandwidth of a Phase Modulation (PM) signal can be given by
    (a) $2(1+2\beta)B$ where, $\beta=2$ (b) $2(1+\beta)B$ where, $\beta=2$
    (c) $2(1+2\beta)B$ where, $\beta=4$ (d) $2(1+\beta)B$ where, $\beta=4$.

(iii) External electronic commutation circuitry is required for
    (a) stepper motor   (b) BLDC Motor
    (c) shunt motor   (d) servo motor.

(iv) AC LVDTs
        (a) have wider operating temperature range
        (b) have external signal conditioning circuitry
        (c) deliver DC output in the secondary coils
        (d) none of these.

(v) An Air muscle has a power-to-weight ratio of
    (a) 16:1   (b) 64:1   (c) 200:1   (d) 400:1.

(vi) Dummy strain gauge is used to compensate
    (a) pressure   (b) strain
    (c) temperature   (d) force.

(vii) In hydraulic rotary actuators, maximum angle of rotation may be larger than 360° in
    (a) Angie angle actuator   (b) Piston rotary actuator
    (c) Swivel vane rotary actuator   (d) All of these.

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(viii) Under dark condition, a photoresistor exhibits
    (a) few hundred ohms resistance   (b) few $M\Omega$ resistance
    (c) short circuit   (d) none of these.

(ix) 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.

(x) Derivative of momentum with respect to time results in
    (a) acceleration   (b) velocity
    (c) force   (d) pressure.

Group – B

2.(a) What are the important elements of mechatronics? Explain with a suitable block diagram.

(b) What is the difference between sensor and transducer? Why signal conditioning circuitry is required to process the sensor output? Can you replace an instrumentation amplifier used in the signal conditioning circuit of a particular transducer by a differential amplifier? Give reasons.

$$(4 + 2) + 6 = 12$$

3.(a) Define thermopile. What do you mean by T, K and J type thermocouples? What are the differences between AC and DC LVDT?

(b) Explain the working principle of piezoelectric accelerometer.

$$(2 + 4) + 6 = 12$$

Group – C

4.(a) Explain briefly the working principle of hydraulic actuator. Specify the term "stroke" in case of hydraulic cylinders.

(b) 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/m^2 and modulus of elasticity 200 MN/m^2. Calculate the change in resistance due to a change in stress equal to 1/10th of the elastic range.

$$(4 + 3) + 5 = 12$$

5.(a) What are the uses of microcomputer in mechatronics? Draw the basic block diagram of a micro computer.

(b) A parallel plate capacitive transducer uses plate's area 100 mm² which are separated by a distance 0.2 mm. Calculate the value of the change in capacitance if by a linear displacement reduces the separation distance of 0.02 mm. Take the air as dielectric medium with a permittivity of 8.85×10^{-12} F/m.

(2+5) + 5 = 12

Group – D

6.(a) What do you mean by Shape memory effect?

(b) What is the difference between Data Acquisition System (DAS) and Data Logger?

3+ 6= 12

7.(a) Write in brief the basic differences between amplitude modulation and angle modulation.

(b) An electromechanical actuator is having vibration frequency range 25-50 kHz. Design a suitable circuit that will deactivate the actuator when vibration frequency goes beyond the said range.

6 + 6 = 12

Group – E

8.(a) How does a photo-resistor work? Explain the working principle of micro- electrostatic actuator.

(b) A mass on a spring oscillates 50 times per second. The amplitude of the oscillation is 1 mm. At the beginning of the motion (t=0) the mass is at the maximum amplitude position (+1 mm) (i) What is the angular frequency of the oscillator? (ii) What is the period of the oscillator? (iii) Write the equation of motion of the oscillator including the phase

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

9.(a) What do you mean by "Brickwall Filter"? How does the behaviour of a band pass filter change if we increase the order?

(b) Design an active bandpass filter of 1st order having lower cut off frequency 2 KHz and higher cut off frequency 100 KHz.

(2 + 6) + 4 = 12