CS/M.TECH(EIE)/SEM-1/EIEM-103C/2012-13

2012

MECHATRONICS

Time Allotted : 3 Hours   *Full Marks* : 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words
as far as practicable.

Answer any *five* questions.   5 × 14 = 70

1. a) Specify the key elements of mechatronics with a suitable block diagram.

   b) What are the disciplinary foundations of mechatronics.

   c) How can technological advances in design, manufacturing and operation of engineering products/devices/processes be traced ? State the benefits associated with Revolutions of Mechatronics as a Contemporary Design Paradigm.   4 + 2 + (3 + 5)

2. a) What are the most important criteria for evaluating sensors ? 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.

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b) State the pros and cons of Resistive Foil Strain Gauge. A single strain gauge of nominal resistance 120 Ω 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.

(3 + 3 + 3) + (2 + 3)

3. a) Define unconventional actuators.

b) Describe the working principle of hydraulic actuators. What do you mean by single acting and double acting hydraulic cylinders ? What is air muscle ? How does the electromechanical actuator work ?

c) Write down the operating specifications for hydraulic cylinders.   2 + (4 + 2 + 1 + 3) + 2

4. What are the uses of microcomputer in mechatronics ? Draw the basic block diagram of a microcomputer. Compare between microcontroller and microprocessor. Define application specific processes (ASICS).   2 + 2 + 5 + 5

5. 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.

c) State the advantages of FFT compared to DFT.

5 + 5 + 4
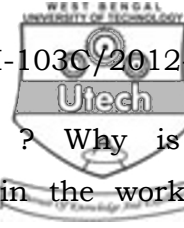
6. a) What do you mean by AC LVDT ? Why is it advantageous over DC LVDT ? Explain the working principle of a piezoelectric accelerometer.

   b) How does a photo-resistor work ? A parallel plate capacitive transducer uses plates area 100 mm^2 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 $8·85 \times 10^{-12}$ F/m. (3 + 2 + 4) + (2 + 3)

7. How will you identify a simple Harmonic oscillator ?

   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).

   a) What is the angular frequency of the oscillator ?

   b) What is the period of the oscillator ?

   c) Write the equation of motion of the oscillator including the phase.

   d) Briefly discuss process elements in lumped parameter systems. What is the difference between theoretical and experimental models ?

   e) What are the applications of absorbers and dampers in mechanical systems ? (2 + 2 + 1 + 2) + 2 + 2 + 3

8. a) What is the full form of SMA ? Describe the mechanism of Stress Free Shape Recovery of SMA.

    b) Write short notes on any *three* of the following :

        i)   Steeper motor

        ii) Micro-actuator

        iii) Industrial Robot

        iv) Servomechanism in robotics manipulation

        v)   Parameter Estimation for Discrete Time Signals.

                                    (1 + 4) + (3 × 3)

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