Total number of printed pages – 8   **B. Tech**

CPEN 5301

Eighth Semester Examination – 2008

SENSORS AND SIGNALS

Full Marks – 70

Time : 3 Hours

Answer Question No. 1 which is compulsory and any five from the rest.

The figures in the right-hand margin indicate marks.

1.   Answer the following questions :   2 ×10

   (a)   A 50 kilo ohm resistive potentiometer is used for measurement of displacement. It has 50 turns and a movable sliding contact. Calculate the resolution of the potentiometer.

   (b)   Draw a sketch of a variable reluctance tachogenerator for the measurement of angular velocity. Also write the expression of the output signal.

   (c)   Write a typical transfer function representing the dynamics of a mass-spring-damper force sensor. Define the terms used in the transfer function.

   (d)   Modulation with a carrier frequency shifts the signal from low frequency to high frequency. Justify mathematically.

   (e)   Write down the ideal and typical values of operational amplifier characteristics.

   (f)   Mention the advantages of using FM system over AM system.

   (g)   Define the term "Quantisation" used in signal processing elements and software.

(h) In several cases, the output signal from primary sensing or signal conditioning element is an a.c. voltage with a frequency which depends on the measured variable. Give two examples.

(i) Draw a typical Torque-angular velocity characteristics graph of an a.c. position servo motor. In the characteristics graph, show how the torque developed varies with change in control winding current ?

(j) How different types of hazards are classified in intrinsically safe measurement system based on overall probability of an explosion ?

2. (a) What is reference junction compensation of a thermocouple ? How bridge circuit is used for this compensation ?   5

(b) Draw the schematic diagram of an elastic torque sensing element using strain gauges. How the strain gauges are placed so that maximum strain is experienced by the gauges ?   5

3. (a) Explain direct piezoelectric effect and inverse piezoelectric effect.   2

(b) Draw an equivalent circuit of a piezo-electric sensor connected to a resistive recorder by a cable.   3

(c) Derive the transfer function of a basic piezoelectric force measurement system.   5

4. (a) Explain the basic principle of operation of photo conductive and photo voltaic photo detectors.   5

(b) Explain the principle of operation of LVDT used for displacement measurement. Draw and explain the output voltage vrs. displacement characteristics. 5

5. (a) Draw the circuit diagram and explain the principle of operation of a two element resistive thermometer bridge. Show that the unbalanced bridge output voltage is proportional to the difference of temperature between two prints. 5

(b) Draw the operational amplifier circuits and write the expression of the output voltages for the following signal conditioning elements : 5

(i) Inverting amplifier

(ii) Non-inverting amplifier

(iii) Voltage follower

(iv) Differential amplifier

(v) Voltage summer.

6. (a) Draw a simplified schematic diagram and simplified block diagram of a closed loop differential pressure transmitter. Derive the expression of the output current of the transmitter. Explain how to obtain 4-20 mA current range representing the range of measurement of differential pressure. 5

(b) How inductive sensors and capacitive sensors are used in oscillators ? Explain the basic principle of measurement in both the sensors. 5

7. (a) Explain different methods of converting a digital signal to analogue signal. Draw the circuit diagram, explain the principle of operation and write the expression of the analogue output voltage. 5

(b) Describe LED characteristics and circuits used as a data presentation element. Explain the current vrs. voltage character-istics, luminous intensity vrs. current char-acteristics and relative intensity vrs. wave-length characteristics. Also draw the circuits used for interconnection of LEDS in order to represent character. 5

8. (a) What is the role of zener barrier circuit used in intrinsically safe electronic system ? Draw the equivalent circuit of zener barrier under fault condition. Describe how the maximum energy available to create a spark is made less than the minimum ignition energy (MIE) for the gas-air mixture. 5

(b) Draw the schematic diagram and electrical equivalent circuit of a flapper/nozzle displacement sensing element. Also derive the steady state relation between pressure and displacement. Hence, draw the steady state characteristics of the sensor. 5

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