CS/B.TECH (EIE-New)/SEM-4/EI-401/2012

2012

SENSORS AND TRANSDUCERS

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.

GROUP – A

(Multiple Choice Type Question)

1. Choose the correct alternatives for any *ten* of the following: 10 x 1 = 10

i) The gauge factor is defined as

a) $\frac{\frac{\nabla L}{L}}{\frac{\nabla R}{R}}$ b) $\frac{\frac{\nabla R}{R}}{\frac{\nabla L}{L}}$

c) $\frac{\frac{\nabla R}{R}}{\frac{\nabla D}{D}}$ d) $\frac{\frac{\nabla R}{R}}{\frac{\nabla P}{P}}$

ii) The principle of operation of LVDT is based on

a) self inductance b) mutual inductance

c) reluctance d) permeance

iii) Load cell measures

a) force b) temperature

c) strain d) pressure

iv) Self generating type transducers are ..... transducers

a) active b) secondary

c) passive d) inverse.

v) Tachometer encoder has

a) one output b) two outputs

c) three outputs d) all of these.

vi) Which of the following is a primary transducer?

a) LVDT b) Bourdon tube

c) Load cell d) LDR

vii) Hall effect transducers are used to measure

a) magnetic field b) electric field

c) current d) both (a) and (c).

viii) Thermocouples

a) are most commonly used temperature transducers

b) require reference junction compensation

c) have a low output voltage level

d) all of these

ix) What is the order of minimum displacement that can be measured with capacitive transducers?

a) 1 cm b) 1 mm

c) 1 μm d) 1×10^{12} m

x) $P_t - 100$ means temperature bulb having

a) 0 ohm at 0℃ b) 100 ohm at 0℃

c) 0 ohm at 100℃ d) 100 ohm at 100℃

xi) Piezoelectric transducers are

a) passive transducer b) active transducer

c) inverse transducer d) both (b) and (c).

xii) The photodiode as compared to phototransistor has

a) faster switching time

b) lower sensitivity

c) higher size for the same value of O/P current

d) all of these.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. 3 x 5 = 15

2. Explain the construction of wire strain gauges and derive the expression for the gage factor. 2+3

3. Draw the suitable diagram of capacitor microphone and discuss its principle of operation.

4. What is magnetostrictive phenomenon? What do you mean by negative & positive magnetostrictive effect? 2+3

5. With neat sketch, describe the working principle of seismic transducer for acceleration measurement.

6. What are the different materials used for the POT? What happens for the arbitrary choice of the materials? 3+2

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. 3 x 15 = 45

7. a) Derive the expression for the error of a resistive POT when connected across a load of finite resistance.

   b) Draw typical curve to show the variation of errors with input displacement for different values of load resistance.

   c) Why irregularities in sensitivity arise in case of resistance POT?

   d) Sensitivity and linearity are two conflicting parameters in a resistance potential divider. Explain.

e) Total resistance of POT is 20 kohm and the length of the POT resistance is 8 mm. The power rating is 40 mW. Determine O/P voltage when the displacement of the wiper is 3 mm, assuming the maximum possible excitation voltage. Also calculate the accuracy at 50% full scale travel of the wiper with a meter having a resistance twice the resistance of the POT. 4+2+2+3+4

8. a) Explain how the magnitude and the direction of the core of a LVDT can be detected.

b) Draw the schematic diagram of LVDT and explain the electromehanical transfer characteristics.

c) How does frequency response of the LVDT depend on the excitation frequency?

d) How is the strain gauge type load cell used to measure the force? 4+3+3+2+3

9. a) What are thermoelectric effect and electrothermic effect? On which principle amongst these two a thermocouple can work? Mentionthe name, composition and operating range of four commonly used thermocouples.

b) What is CJC? Why is this necessary? Explain the software technique of CJC? (4+1+4)+(3+1+2)

10. a) What is piezoelectric effect?

b) Draw the equivalent circuit for the piezoelectric transducer and hence find the transfer function of the same. Also draw the frequency response characteristic of the piezoelectric transducer.

c) What are Bimorph and Multimorph?

d) A barium titanate piezoelectric pickup has dimensions of 6 mm × 6 mm × 1.5 mm and a voltage sensitivity of 0.012 Vm/N. Determine the voltage developed when a force of 0.8 kg is applied to it. Determine also the charge sensitivity if the relative permittivity of the barium titanate is 1400. 2+(2+3+2)+3+2

11. Write short notes on any *three* of the following: 3 x 5

a) Smart sensor

b) RTD

c) Geiger-Müller (GM) counter

d) Stroboscope

e) Rosettes

f) Villari effect for magnetic sensors.

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