CS/B.Tech (EEE-NEW)/SEM-4/EI (EEE)-401/2013
2013
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 Questions)

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

    i)   An inverse transducer converts

        a)   mechanical energy to electrical energy

        b)   electrical energy to light energy

        c)   electrical energy to mechanical form

        d)   all of these.

ii) The gauge factor is defined as

a) $\left(\dfrac{\Delta L}{L}\right)\left(\dfrac{\Delta R}{R}\right)$

b) $\dfrac{\left(\dfrac{\Delta R}{R}\right)}{\left(\dfrac{\Delta L}{L}\right)}$

c) $\dfrac{\left(\dfrac{\Delta R}{R}\right)}{\left(\dfrac{\Delta D}{D}\right)}$

d) $\dfrac{\left(\dfrac{\Delta R}{R}\right)}{\left(\dfrac{\Delta P}{P}\right)}$.

iii) The smallest change in input that a transducer can sense is known as

a) sensitivity

b) resolution

c) precision

d) accuracy.

iv) Gauge factor of a strain gauge indicates its

a) accuracy

b) sensitivity

c) dead zone

d) none of these.

v) The principle of operation of LVDT is based on variation of

a) self inductance

b) mutual inductance

c) reluctance

d) permeance.

vi) Which one of the following is a digital transducer ?

a) Thermistor

b) LVDT

c) Encoder

d) RTD.

vii) Dummy strain gauge is used to

a) to increase sensitivity

b) to measure tensile strain

c) for temperature compensation

d) to measure compressive strain.

viii) Piezoelectric crystals produce an *emf*

a) when external mechanical force is applied to it

b) when external magnetic field is applied to it

c) when radiant energy stimulates the crystal

d) when junction of such two crystals is heated.

ix) Radiation pyrometers are used in temperature range of

a) 0° C to 500° C   b) 500° C to 2000° C

c) – 250° C to 500° C   d) 1200° C to 3000° C.

x) What is the order of minimum displacement that can be measured using capacitive transducer ?

a) 1 cm   b) 1 mm

c) 1 micrometer   d) 1×10^{-12}.

xi) A Hall effect transducer can be used to measure

a) power   b) current

c) displacement   d) all of these.

xii) Which of the following is not a piezoelectric material ?

a) Quartz   b) Barrium titarate

c) Cadmium sulphate   d) None of these.

GROUP – B
(Short Answer Type Questions)
Answer any *three* of the following.   3 × 5 = 15

2. What are the different materials used in the resistance non-wire wound potentiometer ? What are the relations between linearity and sensitivity of a potentiometer ?   2 + 3

3. What do you mean by negative and positive magneto-strictive effect ? Explain magnetostrictive transducer.   1 + 4

4. Derive the expression of gauge factor of a strain gauge.

5. How will you measure angular velocity using proximity sensor ? Give the expression of rotational speed in r.p.m. related with frequency ?   3 + 2

6. Explain the working principle of L.D.R. What is photomultiplier ?   3 + 2

GROUP – C

(**Long Answer Type Questions**)

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

7.   a)   State the principle on which the thermocouples work. Mention the name along with its temperature range and two commonly used thermocouples. What is thermopile ?   3 + 3 + 2

     b)   Name two IC type temperature sensors. Explain any of them with neat diagram. What is the advantage of semiconductor type temperature sensors ?   1 + 4 + 2

8.   a)   Explain piezoelectric effect by Quartz Lattice structure. Derive the expression of voltage and charge sensitivities of piezoelectric transducer.

     b)   Briefly explain the loading effect and frequency response of piezoelectric transducer with equivalent circuit diagram.   7 + 8
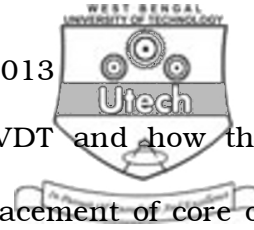
9. a) Explain the working principle of LVDT and how the magnitude and direction of the displacement of core of an LVDT detected ?

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

   c) Why the sensitivity and linearity are two conflicting requirements in a resistive potentiometer.   8 + 5 + 2

10. a) What is capacitive transducer ?

   b) Explain how by using a differential arrangement, a capacitive transducer which works on the principle of variation of capacitance with displacement between two plates, the response can be made linear.

   c) A parallel plate capacitive transducer uses plates of area 100 mm^2 which are separated by a distance 0·2 mm. Calculate the value of charge in capacitance if a linear displacement reduced the separation distance of 0·02 mm. (air dielectric medium : $8·85 \times 10^{-12}$ F/m)
                                                                        3 + 5 + 7

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

    a)   RTD

    b)   Load cell

    c)   Total radiation pyrometer

    d)   Burdon tube

    e)   Smart sensor.