Name : ………………………………………………………

Roll No. : …………………………………………………………

Invigilator's Signature : ………………………………….

CS/B.Tech(EIE/OLD)/SEM-4/EI-402/2013

2013

SENSORS & 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 the following :

$$10 \times 1 = 10$$

   i)   A Hall effect transducer having Hall coefficient
        -52×10^{-12} V-m/A-Wbm^{-2} is used for measurement
        of a magnetic field of 1.5 Wb/m^2 . The thickness of
        the element is 2 mm and the current passing is 5A.
        Find the voltage generated.

        a) $-0.195\ \mu V$

        b) $-1.95\ \mu V$

        c) -0.195 mV

        d) -1.95 mV.

ii) Which one of the following can act as the inverse transducer ?

   a)   Resistance potentiomenter

   b)   LVDT

   c)   Capacitive transducer

   d)   Piezoelectric transducer.

iii) In a resistance potentiometer, the non-linearity

   a)   increase with increase of load to potentiometer resistance

   b)   decrease with increase of load to potentiometer resistance

   c)   is not dependent upon load to potentiometer resistance

   d)   none of these.

iv) In metal wire strain gauge, the change in resistance on application of strain is mainly due to

   a)   change in length of the wire

   b)   change in diameter of the wire

   c)   change in both length and diameter of the wire

   d)   change in resistivity.

v) The order in which the temperature transducers exhibit non-linearity (decreasing manner) is

   a)   Thermocouple, RTD, Thermistor

   b)   Thermistor, Thermocouple, RTD

   c)   RTD, Thermocouple, Thermistor

   d)   Thermistor, RTD, Thermocouple.

vi) An LVDT is excited with a frequency of 20 kHz. The maximum value of frequency of the core motion to be measured should not exceed

    a)   0.5 kHz

    b)   1 kHz

    c)   1.5 kHz

    d)   2 kHz.

vii) Quartz and Rochelle salt belong to

    a)   natural group of piezoelectric materials

    b)   synthetic group of piezoelectric materials

    c)   can belong to both groups

    d)   none of these.

viii) Dummy strain gauge is used to

    a)   increase the efficiency

    b)   increase the range

    c)   compensate for temperature changes

    d)   make the bridge self-balancing.

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

    a) Thermistor

    b) LVDT

    c) Encoder

    d) RTD.

x) Which one among the following is a active transducer ?

    a) Strain gauge

    b) Thermistor

    c) Piezoelectric crystals

    d) RTD.

GROUP – B
(Short Answer Type Questions)

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

2. Describe the operation of the disappearing filament type total radiation pyrometer.

3. Why cold junction compensation is important for thermocouple ? Discuss the hardware method of cold junction compensation with suitable circuit diagram.   1 + 4
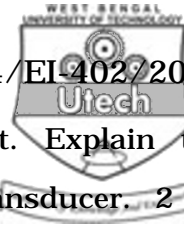
4. Define Villari effect and Widemann effect. Explain the working of the magnetostrictive type force transducer. 2 + 3

5. Explain the principle of operation of liquid filled thermometers.

6. a) Explain how the variation of dielectric between the two plates of a capacitor can be used as a means of a transducer.

   b) Explain that sensitivity and linearity are two conflicting requirements in a resistance potential divider. 3 + 2

GROUP – C

(Long Answer Type Questions)

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

7. a) Draw and describe the push-pull configuration of variable reluctance type transducer.

   b) What type of material is used for LVDT core and why ?

   c) Describe the demodulated electromechanical transfer characteristics of the LVDT with necessary circuit diagram.

   d) Describe the working of the inductive proximity pickup used for angular speed measurement with a neat sketch. 5 + 2 + 4 + 4

8. a) Write down the advantages and disadvantages of the semiconductor type strain gauge.

   b) Define strain gauge rosette. Why is it used ?

   c) A strain gauge has a gauge factor of 4. If the strain gauge is attached to a metal bar that stretches from 0.25 m to 0.255 m when strained, what is the percentage change in resistance ? If the unstained resistance of the gauge is 120 Ω, what is the resistance value of the gauge after application of strain ?

   d) Derive the sensitivity of a Quarter Bridge arrangement of a strain gauge load cell. What are the other ways to increases sensitivity ?   3 + 2 + 4 + (4 + 2)

9. a) Draw the equivalent circuit for the piezoelectric transducer and hence find out the transfer function of the same in frequency domain. Also draw the frequency response curve.

   b) A quartz crystal has the dimension of 2 mm × 2 mm × 1 mm. Quartz has the following properties : Charge sensitivity = 21 C/N. Young's modulus = 8.6×10^{10} N/m^2. Permittivity = 40.6×10^{-12} F/m. Calculate the value of force, charge and voltage if the crystal is subjected to a strain of 10×10^{-6} m/m.

   c) Describe the operation of the ultrasonic doppler flow meter with necessary diagram and calculation. Also draw the signal conditioning circuit to detect the Doppler shift.   (2 + 3 + 1) + 3 + (4 + 2)

10. a) Explain photoelectric effect. 4

b) Explain the principle of operation of photo multiplier tube. 6

c) Explain the principle of operation of photodiode. 5

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

a) 3-wire RTD

b) LDR

c) Geiger Counter

d) Parallel plate capacitive transducers

e) Vapour filled thermometers.

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