Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/M.Tech(EE)/SEM-1/CI-1.4/2009-10

2009

TRANSDUCER TECHNOLOGY

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 Question No. 1 and any *four* from the rest.

1. Justify the *correctness* of the following statements giving brief explanations : 14 × 1

   i) Better accuracy is achieved in capacitive transducers than in inductive transducers.

   ii) The LVDT windings are wound on a cardboard former and protected by an iron casing.

   iii) For temperature compensation the active gauge and the dummy gauge are placed in the adjacent arms of the Wheatstone bridge.

   iv) Resolution and threshold of an instrument are synonymous.

   v) Piezoelectric transducers can be used to measure dynamic pressure only and not even a pressure in the form of a step function.

   vi) The indicating instruments are generally under-damped.

   vii) One of the methods to avoid loading the source during measurement is to use a Force Balance transducer.

   viii) Resolution of a 31/2 digit voltmeter is better than that of a 3 digit voltmeter.

ix) Hot-wire anemometers cannot be designed to find direction of the wind velocity.

x) Strain gauge rosettes are used to find the angular displacement.

xi) Self heating decides the voltage that can be applied to a thermistor.

xii) Potentiometer wiper configuration is also a factor in its resolution.

xiii) Minimum requirement of alpha-numeric display is 14 segment display.

xiv) The demodulators used in conjunction with instruments are very often followed by a filter.

2. a) When and why do we need damping in instruments ? Obtain the expressions for damping factors in electro-dynamic type and eddy current type arrangements. 6

b) How would you measure the following quantities in a 220 kV, 50 Hz three phase power system ?

i) Three phase power — active and reactive

ii) Digital measurement of phase current when the line current in the star connected load is 1000 amp. 8

3. a) Show that wire-wound resistance potentiometer can be used for measurement of linear and angular displacements. Comment on the potentiometer linearity and resolution and discuss the factors affecting these characteristics. 4

b) An unbalanced Wheatstone bridge has two active gauges to monitor the strain in a cantilever. The resistance of the unstrained gauges is 120 ohms each and a gauge factor 2. The strain experienced by the cantilever is 100 micro-strain. Calculate the output voltage from the bridge when its supply voltage is 10 V. Derive the formula used. 4

c) From the basic relations governing the hot-wire anemometer, obtain the expressions for the incremental sensitivity and time constant when operated under constant temperature mode and constant current mode. 6

4. a) Show how moisture content in grain can be measured using a capacitive transducer. Derive the mathematical expressions of the transducer sensitivity and linearity. 5

b) Show how on line measurement of thickness of a moving paper roll of constant moisture content can be implemented. Deduce the expression for sensitivity of the device. 4

c) How are (i) Sensitivity, (ii) Accuracy, (iii) Resolution defined in case of analogue and digital instruments ? 5

5. a) Explain the following : 6

i) Active and passive transducers

ii) Bandwidth, span and range of an instrument

iii) Calibration and standardization

iv) Accuracy and resolution.

b) Discuss the following : 4

i) Non-linearity

ii) Bandwidth

iii) Magnitude and phase sensitivity

iv) Zero shift of an LVDT.

c) Describe how a self inductive transducer can be designed by means of *U* and *I* sections of soft iron for measurement of displacement. Derive sensitivity and linearity of the transducer. 4

6. a) Explain the following : 8

   i) Piezoelectric effect

   ii) *d*-constants

   iii) *g*-coefficients

   iv) *h*-coefficients.

   b) Which type of amplifier is required for measurement of piezoelectric effect ? 2

   c) A piezoelectric crystal has dimension of 6 mm ∞ 6 mm ∞ 1·5 mm and *g*-coefficient is 0·012 Vm/N. Determine the voltage developed when a force of 0·8 kg is applied. 4

7. a) Discuss different types of telemetry and advantages of electronic transmission over other telemetry. 6

   b) Explain the recording and reproducing of a signal in magnetic tape recorder. 4

   c) How can optical fibre cable be used to measure the level of the liquid and bending of a surface ? 4

8. Write short notes on any *two* of the following : 2 × 7

   a) Megnetostrictive transducers

   b) Smart sensors

   c) Temperature compensation of thermocouples

   d) Electromagnetic flowmeter.