



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.

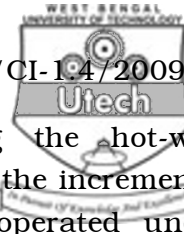
*Candidates are required to give their answers in their own words
as far as practicable.*

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 3 1/2 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 $6\text{ mm} \times 6\text{ mm} \times 1.5\text{ mm}$ 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) Magnetostrictive transducers
 - b) Smart sensors
 - c) Temperature compensation of thermocouples
 - d) Electromagnetic flowmeter.