Total number of printed pages: **2** **UG/4th /UIE402**

2025

SENSORS AND TRANSDUCERS

Full Marks : 100

Time : Three hours

The figures in the margin indicate full marks for the questions.

*Answer **any five** questions.*

1. a) Describe the working of bourdon tube using a suitable diagram. Name the materials used in the construction of bourdon tube. 6

   b) Distinguish between wire type and semiconductor type strain gauge. 6

   c) Determine the linear approximate relation for RTD from the following table: 5

Temperature (°C)	Resistance (Ω)
20	98
30	102
40	106.5
50	111
60	114.7
70	117.8
80	121.4

   d) A resistance wire strain gauge with a gauge factor of 2 is bonded to a steel structure subjected to a stress of 1000 N/m^2. The Young's modulus of elasticity (ratio of applied stress to strain produced) of steel is 500000 N/m^2 .Calculate value of change in the resistance of strain gauge due to the applied stress if the initial resistance is 10Ω. 3

2. a) Describe the working of a variable reluctance type inductive transducer using a suitable diagram. Also, derive the mathematical expression for inductance. 10

   b) Explain the construction and working of synchro pair using a suitable diagram and relevant mathematical expressions. 10

3. a) Derive the expression for output voltage of a differential capacitive 10

transducer.

b) A parallel plate capacitive transducer has cross sectional area of 1000 mm^2, distance between the plates is 5mm and the initial capacitance is 200µF. With the application of a pressure of 500 kN/m^2, it gets deflected inward by a distance of 1.5mm. What is the value of new capacitance? 4

c) A parallel plate capacitive transducer uses plates of area 1000 mm^2, separated by a distance of 0.4 mm and is placed in air medium. Suppose a mica sheet of 0.2 mm thickness is inserted between the plates, what will be the change in capacitance of the capacitive transducer? The permittivity of free space is 8.854×10^{-12} F/m, and the relative permittivity of air and mica are 1 and 5 respectively. 6

4. a) What is piezoelectric transducer? Name some materials which shows piezoelectric properties. Derive the equation for output voltage of a piezoelectric transducer. 10

b) Draw the equivalent circuit of piezoelectric transducer and derive the transfer function between output voltage and input displacement. 6

c) A piezoelectric crystal has a thickness of 1mm and charge sensitivity q of 0.021V-m/N is subjected to a pressure of 1500 N/m^2. Calculate the voltage output and charge sensitivity. The permittivity of the crystal is 20×10^{-12} F/m. 4

5. a) Describe the construction and working of the following optical transducers. 7*2=14

(i) Photoconductive Detector

(ii) Photovoltaic Detector

b) Draw and explain the working of signal conditioning circuit for the following : 6

(i) RTD

(ii) Photodiode

6. a) Write short notes on any two of the following 7*2=14

i. LVDT.

ii. Pyrometers

iii. Shaft encoder.

b) Explain the working of Hall effect transducer using a suitable diagram. 6