Total number of printed pages–5

53 (IE 502) TDEN

2019

TRANSDUCER ENGINEERING

Paper : IE 502 (Backlog)

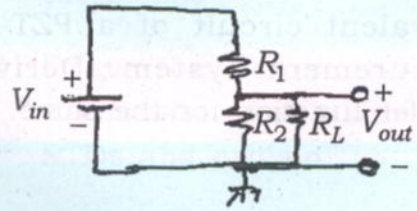
Full Marks : 100

Time : Three hours

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

*Answer **any five** questions.*

1. *(a)* For the following figure, derive the expression of the output voltage (V_{out}) when load resistance *(i)* $R_L \neq \infty$ and *(ii)* $R_L = \infty$.



Contd.

Determine the volume of V_{out} when $R_1 = 4.7k\Omega$, $R_2 = 3.3k\Omega$, $R_L = 0.5k\Omega$ and $V_{in} = 5Volts$. 12

(b) Explain, how a potentiometer can be used to measure liquid level. 8

2. (a) Explain, with a schematic diagram, the construction and the working principle of an LVDT. 10

(b) Draw the input-output characteristics of an LVDT and explain. What is residual voltage and how it can be eliminated? 10

3. (a) Define: charge sensitivity, voltage sensitivity and pressure sensitivity of a Piezoelectric transducer. Derive the different relations between them. 8

(b) Draw the block diagram and electrical equivalent circuit of a PZT-based measurement system. Derive the transfer function for the same. 12

4. (a) Define the gauge factor of strain gauge. Prove that $G_f = 1 + 2\nu + \frac{\Delta\rho/\rho}{\Delta l/l}$, where G_f is the gange factor, ν is the Poisson's ratio and $\frac{\Delta\rho/\rho}{\Delta l/l}$ is the change in resistance due to Piezoresistive effect. 10

(b) Explain the operation of full-bridge strain measurement system. 6

(c) A strain gauge of 120Ω nominal resistance is fixed on a steel frame subjected to a strain of $250\mu m/m$. If the gauge factor is 2.0, determine the change in gauge resistance. 4

5. (a) Explain the Law of intermediate temperature and the Law of intermediate metal. What is thermopile? 8

(b) Draw the schematic diagram for connection of a 3-Wire and a 4-Wire RTDs and explain. 8

(c) For a certain thermistor, $\beta = 3200K$ and its resistance at $20°C$ is known to be 1056Ω. The thermistor is used for temperature measurement and the measured resistance is 2325Ω. Find the measured temperature. What will be the thermistor's new resistance if the temperature is increased to $55°C$? 4

6. (a) Explain, with schematic diagram, the working principle of an Eddy-current sensor. 10

(b) A Hall effect element used for measuring a magnetic field strength gives an output voltage of $12.3mV$. The element is made of Silicon and is $5mm$ thick and carries a current of $2A$. The Hall coefficient for Silicon is $3.8\times10^{-6}Vm/A-Wb/m^2$. Determine the magnetic field strength. 6

(c) Mention *four* applications of Smart Sensors. 4

7. Write short notes on ***any four*** of the following: 4×5=20

(a) Semiconductor-based temperature measurement technique

(b) Capacitive type accelerometer

(c) Cold-junction Compensation technique for T/c.

(d) Villari effect and its applications

(e) Angular displacement measurement using potentiometer

(f) Photoresistive transducer and its applications.