

**B. Power Eng. 4<sup>th</sup> Year First Semester Supplementary Examination 2017  
Sensors and Transducers**

Answer any Five  
Time: 3 hours

Full Marks 100

1. A sensor described by  $G(s) = 0.01/(0.2s + 1)$  and connected to an amplifier with an open-loop gain of 1000 and a supply voltage of  $\pm 5V$  is used to measure displacement in the form of vibration. Calculate the following:
- Cut-off frequency in Hertz.
  - Maximum amplitude of vibration the sensor can pick up
  - The amplitude of the sensor-amplifier output if the frequency of vibration is 100Hz.

5+5+5

5

Explain linearity error and offset error for a sensor

2. Draw the schematic for measurement of linear displacement with capacitive transducer such that the output has a linear relationship with displacement. Derive the relationship.

10

Derive the frequency response characteristics of a piezo-resistive sensor used for measurement of vibration, with suitable assumptions.

10

3. A transmitter produces a 4-20mA output corresponding to signal produced by a LVDT with a range of  $\pm 40\text{mm}$ . The transmitter output is terminated by a 250 ohm resistance. What will be the voltage across the resistor for a displacement of -20mm? If the voltage signal is digitized using a 12 bit Sign Adjusted ADC what is the ADC count corresponding to this displacement?

10+10

4. Design a IC based temperature measurement circuit to measure a temperature in the range of 0 to 50 deg, C.

20

5. An ultrasonic probe is used to measure velocity of water flowing in a pipe. The maximum velocity of the flow is 5m/sec. and the minimum is 2 m/sec. The distance between the transceivers is 20 cms. And the velocity of ultrasound in water is 1482 m/sec. Calculate the minimum and maximum difference in transit times. Now assuming that the transit time recorded has a minimum value below which the measurement does not work, is it possible to increase the range of the instrument by a simple modification. Explain your answer with suitable deductions.

12+8

6. What are the problems associated with a 2-wire RTD? Explain how temperature is measured with a 3-wire RTD.

5+15

7. Why is the IR region suited for temperature measurement? With a neat schematic explain the principle of IR thermometry.

2+8

Explain how frequency is measured electronically.

10

8. Write short notes on any two: Capacitive level measurement, Turbine type flow measurement, Thermal conductivity measurement.

10+10