EX/PE/T/415/74/10(S)

B. Power Engg. 4th year First Semester Supplementary Examination(2010)
Sensors and Transducers

Ref. No.
Time: 3 hrs.
Full Marks: 100

Answer Any Five

1. a. Define offset, gain and hysteresis error for a sensor. 6
   b. Distinguish between primary and secondary transducers. 4
   c. A transducer with a gain of 1mV/mm and connected to an amplifier with a supply of ±5 Volts is used to measure a displacement which varies between −10cm to +10cm. Suggest a suitable amplifier gain for a meaningful reading. 8
   d. What happens if a high amplifier gain is used? 2

2. a. Deduce an expression for gauge factor of a strain gauge. 15
   b. How does a strain gauge differ from a piezo-resistive material? 5

3. a. A sensor described by $G(s) = 0.01/(0.2s + 1)$ and is connected to an amplifier with an open-loop gain of 1000 and a supply voltage of 10V is used to measure displacement in the form of vibration. Calculate the following:

      i. Cut-off frequency in Hertz.
      ii. Maximum amplitude of vibration the sensor can pick up
      iii. The amplitude of the sensor-amplifier output if the frequency of vibration is 100Hz.

      15
   b. What are the different configurations of a piezo crystal? 5

4. a. Draw the schematic for measurement of level with a capacitive transducer. Derive the relationship. 15
   b. Can this be used for measurement of any liquid level? What can be done in those cases this scheme cannot be used? 5

5. With the help of a neat schematic explain the principle of temperature measurement using an IC sensor. Assume a suitable IC sensor and explain how the biasing resistances are selected. 20

6. a. A shaft is fitted with a disc of radius r cms. which is encoded with n tracks. The encoding is decoded using a laser sensor which has a processing delay T_d secs. The shaft rotates at a uniform speed of ω rad/s. Calculate the following:

   i. Width of each bit along the radius
   ii. Maximum value of T_d 10

   b. Explain the principle of digital frequency measurement. 10

7. a. How can thermal conductivity of a gas be measured? Explain with a neat schematic. 5

   b. Explain the principle of temperature measurement using an optical pyrometer. 5

   c. A fluid flows with a velocity v in a pipe of diameter D and a length L. If L is large enough, deduce an expression for v measured by ultrasonic means.

8. a. State and deduce the law of intermediate junctions for thermocouples. 5

   b. Enumerate and compare the different temperature sensors from a linearity perspective. 5

   c. Deducing necessary expressions, explain the 3-wire RTD method of measurement of temperature. 10