VIT
Vellore Institute of Technology

Final Assessment Test – April 2019

Course: ECE1005 - Sensors and Instrumentation
Class NBR(s): 1259 / 1267 / 1274 / 1281 / 1289 / 1295
Time: Three Hours

Slot: TE2
Max. Marks: 100

Answer any TEN Questions
(10 X 10 = 100 Marks)

1. a) Illustrate the block diagram of a generalized measurement system considering a typical sensor employed for sensing some physical parameter. [6]

   b) A platinum resistance thermometer has a resistance of 200 Ω at 0°C. Find its resistance at 300°C if the platinum has a resistance temperature co-efficient of 0.00392 /°C. If the thermometer has a resistance of 500 Ω, calculate the temperature. [4]

2. a) Discuss the principle of operation of the strain gauge with illustration. Specify the concerned parameters of strain gauge with definition and give its expression. [7]

   b) Explain the working principle of resistive hygrometers with a neat diagram. [3]

3. A steel support structure of a bridge needs to be monitored for its fatigue. The steel structure with a modulus of elasticity, $E = 2 \times 10^{11}$ N/m^2, is fitted with two strain gauges one made of nickel and the other with nichrome. The fatigue is sensed as a voltage change in the Wheatstone bridge initially in a balanced state with two appropriate standard resistances. The Wheatstone bridge is energized by a constant 9V battery at all times. [10]

Strain gauge	Gauge Factor	Unstrained Resistance	Position
Nickel	2.5	140 Ω	Top
Nichrome	-1.2	120 Ω	Bottom

4. a) Describe the working principle of a resistive type liquid conductivity sensor in relation to the ionization process involved in the electrolyte. [4]

   b) A LVDT is used to measure angular displacement of a shaft from (0 to 180) degrees. The primary winding is energized by 10 V ac source. The secondary windings are identical in all aspects. The LVDT provides a combined null output across its secondary, if the core is at 90 degree position. Determine the voltage across each of the secondary and total combined voltage across both the secondary windings, if the shaft is at a) 35 degrees and b) 150 degrees. [6]

5. a) Explain the working principle of a DC slide wire potentiometer with neat sketch. How will you determine the emf of an unknown source using this potentiometer? [7]

   b) Explain the working principle of eddy current sensors and give at least one limitation of these kind of sensors. [3]

6. a) Comment on the working of a metal oxide based gas sensor. Identify a few materials that can be used to sense gases. What are the constraints in operating conditions to use a metal oxide as a gas sensors. [4]

b) A highly sensitive magnetic field sensor works on the basis of parallel connection of two Josephson junctions. Identify the sensor and elaborate on its operation. [6]

7. a) Explain the construction and working principle of a magnetoresistor employing the anisotropic magneto resistance effect (AMR). [6]

b) Define Magnetostrictive effect. Comparatively analyse piezoelectric and magnetostrcitve sensors based on their pros and cons. [4]

8. a) Discuss the working principle of pyroelectric sensors with reference to an application. [4]

b) Identify a sensor and the sensing material used in the sensor which can be used to provide an electrical change in its response with change in optical intensity. Suggest and describe an application based on this sensor. [6]

9. a) Identify the principle of operation for a thermocouple based temperature sensors. [3]

b) A thermocouple was found to have linear calibration between 0°C and 300°C with emf at maximum temperature (reference junction temperature 0°C) equal to 58.45 mV. [7]

i) Determine the correction which must be made to the indicated emf, if the cold junction temperature is 30°C.

ii) If the indicated emf is 20.87 mV in the thermocouple circuit, determine the temperature of the hot junction.

10. a) Classify the various types of instruments based on their method of operation and indicate which type of electrical inputs they can each measure. [7]

b) Comment on the process of calibration and its significance towards reliable operation of a measuring instrument. [3]

11. Explain the working of a Moving coil voltmeter with a neat sketch. Derive the torques equation relating the angular moment to the voltage measured. [10]

12. A nuclear power plant would obviously require integration of various sensors for monitoring its operation at any given time. Identify at least 3 sensors that would be used in the nuclear reactor side of the operation and at least 2 sensors on the power generation side of the operation. Comment briefly on their principle of operation. [10]

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