

B.E. (EE) Part-III 6th Semester Examination, 2010

**Instrumentation**

**(EE-604)**

Time : 3 hours

Full Marks : 70

Use separate answerscript for each half.

Answer SIX questions, taking THREE from each half.

Two marks are reserved for neatness in each half.

FIRST HALF

1. a) Discuss the following characteristics of an instrumentation system.  
(i) Drift, (ii) Live zero, (in) Fidelity, (iv) Dead zone.  
b) Classify the following transducers  
(i) Diaphragm type pressure transducer, (ii) Servo-manometer,  
(iii) Angular digital encoder, (iv) Thermocouple.  
O What are 'active\*' and 'passive\*' transducers? Give one example of each, expecting these given in Q. 1 (b) above. [4+4+3]
2. a) Explain with neat diagram the working principle of potentiometer type transducers. Discuss different types of potentiometers, the materials used and the merits and demerits of these transducers.  
b) What causes the non-linearity at the output of a potentiometer due to loading? How this effect is eliminated or reduced? [7+4]
3. a) Why the gauge factor of a semiconductor type strain gauge is very large compared that of a metallic strain gauge?  
b) Why do we use multiple no. of strain gauges in an arm of Wheatstone bridge? Does it effect on the bridge sensitivity?  
c) Two strain gauges are mounted in Poisson's configuration on a vertical column type load cell to measure vertical force on it. If the load cell has a circular section of dia 4 cm, Young's Modulus =  $20 \times 10^8$  N/m<sup>2</sup>, nominal resistance of gauge elements = 120Ω with gauge factor = 2.0. Determine the bridge sensitivity expressed in V/kN/V. (4+2+5)

4. a) How do you apply diaphragm type pressure transducer in a condenser microphone? Discuss the working principle with neat diagram.
- b) What are the relative merits and demerits of different temperature transducers?
- c) A thermistor is showing a resistance of  $1\text{ k}\Omega$  at  $40^\circ\text{C}$  and  $5\text{ k}\Omega$  at ice point. Calculate the characteristic constants ( $a$ ,  $p$ ) of the thermistor probe at an ambient of  $25^\circ\text{C}$  and calculate its resistance at  $100^\circ\text{C}$ . [5+2+4]
5. a) What is seismic measurement? Why do we prefer measurement of "acceleration" to that of "displacement"?
- b) Design a 3-bit angular position encoder to produce grey-coded output. What are various non-contact type transducers that can be used for this purpose.
- c) Write down the advantages of push-pull type variable reluctance transducers. [5+4+2]

### SECOND HALF

6. a) With the help of a circuit diagram, find out the gain of a 3-Op.Amp. (OA) configuration of Instrumentation Amplifier. State the merits and demerits of the circuit and suggest any modification to be done for overcoming the demerits.
- b) Following is a circuit diagram (Fig.-1) of a bipolar coefficient multiplier circuit for the gain set between  $+3$  and  $^3$  by using  $R_g$ . Find out the values of  $R_1$ ,  $R_2$ ,  $R_3$  and  $n$  if  $R_1 = 10\text{K}$ ;  $R_2 = R_1/n$ ;  $R_3 = R_1/(n-1)$ . [6+5]

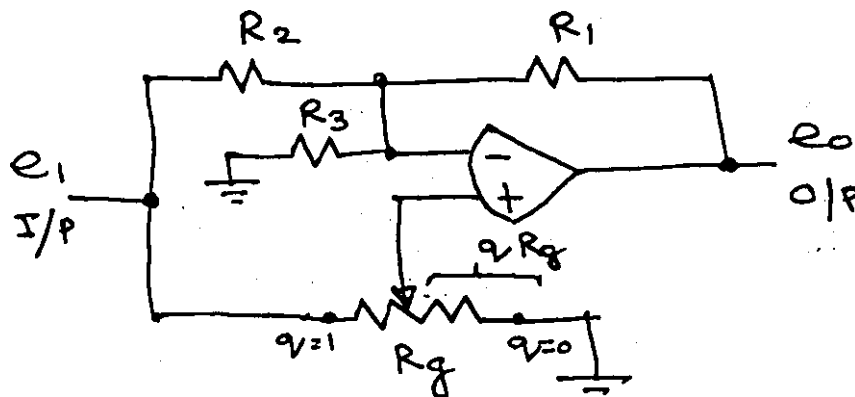


Fig.-1 (for Question No. 6b)

7. a) What is an Isolation Amplifier? Name some isolation couplers suitable for this amplifier. What is Hall Effect? State how does it work.

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- b) Calculate the hall voltage that is developed if the applied magnetic field is 0.70 tesla and supplied current is 100 mA to a thin magnetic copper plate with cross-sectional area  $0.75 \text{ mm}^2$  with thickness 2 mm (Hall coefficient of copper is  $-5.33$ ; Mass of copper =  $63.5 \times 10^{-3} \text{ kg/mol}$ ; Density of copper =  $9 \times 10^3 \text{ kCal/m}$ ; Avogadro number =  $-5.33 \times 10^{-24}$ ). [6+5]
8. a) What is a transdiode? Draw the VI characteristics of a transdiode.  
b) With the help of simple active circuit diagrams, describe operation of a log amplifier and an antilog amplifier. State their uses in a small multiplier.  
c) With the help of a circuit diagram using two pn diodes, two OA's and four resistors develop a precision rectifier circuit showing waveforms at different junctions in the circuit. [2+S+4]
9. a) Draw a Sample and Hold (S/H) circuit and describe its operation.  
b) What are different types of ADC's? Draw the schematic diagram of an ADC where as DAC is utilised. [5+6]
- 10.** Write short notes on any two : **ISVi+S/j)**
- a) An Isolation Amplifier in an ECG machine;
  - b) A 2-bit Programmable Instrumentation Amplifier;
  - c) Successive Approximation (SA) type ADC;
  - d) Speed detector and Direction detector for a rotating shaft;
  - e) 4-bit Shaft Encoder Disc - a DDT.