

Total No. of Questions : 8]

SEAT No. :

[Total No. of Pages : 4

**P2688**

**[5034]-202**

**M.Sc.**

**ELECTRONIC SCIENCE**

**EL2 UT06 : Instrumentation and Measurement Techniques**

**(2013 Pattern) (Semester-II) (Credit System)**

*Time : 3 Hours]*

*[Max. Marks : 50*

*Instructions to the candidates:*

- 1) Answer any Five questions.*
- 2) Figures to the right indicate full marks.*
- 3) All questions carry equal marks.*
- 4) Neat diagram must be drawn wherever necessary.*
- 5) Use of non-programmable calculator is allowed.*

**Q1) a)** What is significance of measurement? Classify instruments and compare deflection type and null type instruments. **[4]**

b) List the static characteristic parameters of measurement system. Explain Accuracy, Precision and Noise. **[3]**

c) What is static sensitivity of measurement system? A Wheatstone Bridge requires a change of  $7\Omega$  in the unknown arm of the bridge to produce a change in deflection of 3 mm of the galvanometer. Determine the sensitivity and deflection factor. **[3]**

**Q2) a)** What is loading effect? Explain the importance of input and output impedance of measurement system. Describe loading effect due to series connected instrument. **[4]**

b) Describe step response of first order instruments. **[3]**

c) What is error? State types of errors involved in measurement. A wattmeter having range of 1000 W has an error of  $\pm 1\%$  of FSD. If the true value of power is 100 W. What would be the range of reading? If the error is specified as percentage of true value, what would be the range of reading? **[3]**

**P.T.O.**

**Q3) a)** Describe the properties of piezoelectric materials. Draw equivalent circuit of piezo-electric transducer. Write the equation of charge and output voltage. List the applications of piezo electric transducer. [4]

b) Explain the various factors influencing the choice of transducer for measurement of physical parameter. [3]

c) State dynamic characteristic parameters of measurement system.

A linear second order system with single degree of freedom has a mass of  $8 \times 10^{-3}$  kg and stiffness of 1000 Nm. Calculate the natural frequency of the system. Determine the damping constant necessary to prevent overshoot in response to a step input of force. [3]

**Q4) a)** Describe the response of second order system. Explain the three conditions of the response for a unit step input. [4]

b) A resistance is determined by voltmeter-Ammeter method. The voltmeter reads 100 V with a probable error of  $\pm 12$  V and the ammeter reads 10 A with probable error of  $\pm 2$  A. Determine the probable error in the computed value of resistance. [3]

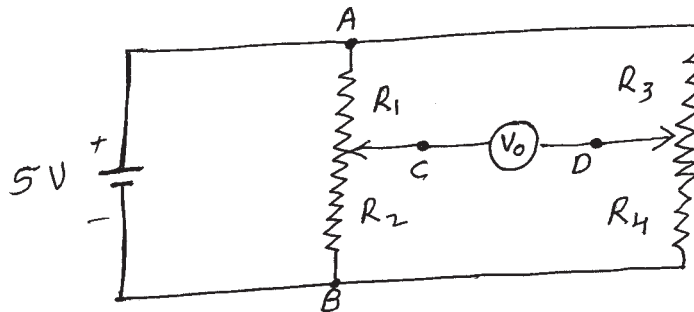
c) With block diagram explain the generalised measurement system. [3]

**Q5) a)** List the types of transducers used for- [4]

- i) Displacement measurement
- ii) Force measurement
- iii) Pressure measurement and
- iv) Acceleration measurement

b) As shown in fig. 1 a resistance potential divider  $R_1 R_2$  with resistance of  $5 \text{ K}\Omega$  and a shaft stroke of 125 mm is used in the arrangement. A potentiometer  $R_3 R_4$  has a resistance of  $5 \text{ k}\Omega$  and the input voltage is 5V. The initial position is used as a reference point in such a case  $R_1 = R_2$ . At the start of the test potentiometer  $R_3 R_4$  is adjusted so that the bridge is balanced, the bridge output is 0V. The displacement being measured will move a maximum distance of 12.5 mm towards point A. Calculate the value of output voltage. [3]

Fig. 1.



- c) A strain gauge is bonded to a beam of 0.1m long and has cross sectional area of  $4 \text{ cm}^2$ . Young's modulus of steel is  $207 \text{ GN/m}^2$ . The unstrain resistance of strain gauge is  $240 \Omega$  and gauge factor of 2.2. When load is applied the change in resistance of the guage by  $0.013 \Omega$ . Calculate the change in length of steel beam and the amount of force applied to the beam. [3]

**Q6) a)** Describe thermistor temperature transducer. State advantages of it. List the applications of thermistor. [4]

- b) What is RTD?

A platinum thermometer has a resistance of  $100 \Omega$  at  $25^\circ\text{C}$ . Find its resistance at  $60^\circ\text{C}$ . Platinum has a resistance temperature coefficient of  $0.00392/^\circ\text{C}$ . If the thermometer has resistance of  $150 \Omega$ . Calculate the temperature. [3]

- c) What is LVDT? State advantages of LVDT. The output voltage of LVDT is 2.5V at the maximum displacement. At a load of  $500 \text{ k}\Omega$ , the deviation from linearity is maximum and it is  $\pm 0.003 \text{ V}$  from a straight line through origin. Find the linearity at given load. [3]

**Q7) a)** What is thermocouple? Why reference junction is required? Explain reference junction compensation in thermocouple temperature measurement.

A Chromel-alumel thermocouple with output of 33.3V when measuring a temperature of 800°C with reference junction at 0°C. The resistance of meter coil  $R_m$  is 50Ω and current of 0.1 mA gives full scale deflection. The resistance of the junction and lead  $R_e$  is 12Ω. Calculate: [5]

- i) Value of series resistance at 800°C to give FSD.
  - ii) The approximate error due to rise of 1Ω in  $R_e$ .
- b) Describe working principle of capacitive transducer. State applications of capacitive transducer. A parallel plate capacitor used in force measurement with area of plate is 500 mm<sup>2</sup> and distance of 0.2mm. Calculate the value of capacitance with air dielectric having permittivity of  $8.85 \times 10^{-12}$  F/m. Calculate the change in capacitance if a linear displacement reduces the distance between the plates to 0.18 mm also calculate ratio of per unit change of capacitance to per unit change in displacement. [5]

- Q8)** a) List velocity measurement transducers. Give working principle of stroboscope.

A speed of shaft rotating at 2880 rpm is measured using a stroboscope. The stroboscope dial is slowly turned from setting of 4320 rpm to 1400 rpm corresponding to flash rate at 96 to 24 per second. Indicate the speed setting which gives single, double and triple steady images. What is the observation when the flashing rate is 50 per second? [5]

- b) List the different methods of flow measurement. Give working principle of [5]
- i) Electromagnetic flowmeter.
  - ii) Ultrasonic flowmeter.

