

**II B.Tech II Semester Supplementary Examinations,  
November/December 2005  
TRANSDUCERS IN INSTRUMENTATION  
( Common to Electronics & Instrumentation Engineering and Electronics &  
Control Engineering)**

**Time: 3 hours****Max Marks: 80**

**Answer any FIVE Questions  
All Questions carry equal marks**

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1. (a) Define the following static characteristics with necessary examples and graphs:
  - i. Accuracy
  - ii. sensitivity
  - iii. static error
  - iv. Dead space
  - v. Drift
- (b) A voltage has a true value of 1.50 volts. An Analog indicating instrument with a scale range of 0-2.50 volts shows a voltage of 1.46 volts. What are the values of absolute error and correction. Express the error as a traction of the true value and the full-scale deflection. [10+6]
2. (a) An input of  $\sin 2t + 0.3\sin 20t$  is applied to a first order instrument having a time constant of 0.2 sec. Find the output. If the same input is applied to an instrument having a time constant of 0.002 sec. what will be the out put ? Comment upon the results.
- (b) Classify various errors and explain their significance with necessary examples. [8+8]
3. (a) Explain how a thermo couple is used to measure temperature.
- (b) List and explain the three laws of thermo couples.
- (c) What are the common materials used for thermo couples. [6+6+4]
4. (a) How the capacitive transducer useful for measuring displacement using the principle of change in dielectric constant.
- (b) A pressure-measuring instrument uses a capacitive transducer having a spacing of 4mm between its diaphragms. A pressure of  $600\text{kN/m}^2$  produces an average deflection of 0.3mm of the diaphragm of the transducer. The transducer, which has a capacitance of 300pf before application of pressure and is connected in an oscillator circuit having a frequency of 100kHz. Determine the change in frequency of the oscillator after the pressure is applied to the transducer. [8+8]
5. (a) Describe the different modes of operation of Piezo electric transducers.
- (b) Define and sketch binders and twistors.
- (c) Explain the application of Piezo electric transducers. [6+6+4]

6. (a) With schematic diagram, explain about Electrostatic Force-balance transducer for the measurement of gas pressures.  
(b) Starting from fundamentals, derive an expression for sensitivity of Electrostatic Force-balance pressure transducer. [8+8]
7. (a) Explain briefly the methods used to measure the output from thermocouples.  
(b) A chromel-alumel thermocouple having a linear relationship between temperature and emf indicates zero at  $0^{\circ}\text{C}$  and 45.14 mV at  $1100^{\circ}\text{C}$ . The thermocouple is exposed to a temperature of  $840^{\circ}\text{C}$  with cold junction maintained at  $25^{\circ}\text{C}$ , calculate the induced emf. [8+8]
8. Describe the working and construction of resistance thermometers. Describe the materials used for RTDs along with their properties. Sketch this typical characteristic curve. [16]

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1. (a) Classify various transducers and give an example of each and mention their applications.  
(b) What is the true value of voltage across the  $500\text{ K}\Omega$  resistor connected between terminals A and B as shown in fig. below ? What would a voltmeter with a sensitivity of  $20\text{ K}\Omega/\text{v}$  read on the following ranges: 50, 15,5 volts when connected across terminals C and D. [8+8]
2. (a) Explain why it is necessary to carryout frequency domain analysis of measurement systems? What are the two plots obtained when the frequency response of a system is carried out?  
(b) A first order system when subjected to a step input has a temperature rise of  $25^\circ\text{C}$  after one hour and  $37.5^\circ$  after two hours starting from cold conditions. Calculate its final steady temperature rise and the thermal time constant. [8+8]
3. (a) Explain the calibration procedure for an hotwire anemometer with necessary sketches  
(b) Mention the differences between thermistor, RTD and anemometers. [8+8]
4. (a) Describe the moving coil microphone system and identify the primary and secondary transducers of the arrangement.  
(b) Explain the basic principles of operation of variable permeability transducers and show how the phenomenon of permeability enables measurement of certain physical quantities. [8+8]
5. (a) Describe the properties of materials used for Piezo-electric transducers.  
(b) Derive the expressions for voltage and charge sensitivities. [8+8]
6. (a) Draw the schematic diagram and explain about Force balance type linear-acceleration transducer with goldplated pendulous mass and torsion springs.  
(b) Draw the schematic diagram and explain about Three-point suspension of servo-coil. [8+8]
7. (a) Write short notes on thin film platinum RTD.  
(b) List the materials used for resistance thermometer construction. [8+8]

8. (a) List the detectors used in radiation and optical pyrometers.  
(b) Explain the factors affecting the static accuracy of filled in thermometers.  
[8+8]

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- (b) A voltage has a true value of 1.50 volts. An Analog indicating instrument with a scale range of 0-2.50 volts shows a voltage of 1.46 volts. What are the values of absolute error and correction. Express the error as a fraction of the true value and the full-scale deflection. [10+6]
2. Derive an expression for time response of a  $2^{nd}$  order under damped system when subjected to unit ramp input. Show that the nature of the response is the same as that for a unit step input. Find an expression for the steady state error. [16]
3. (a) Discuss with a suitable processing circuit how efficient load cells are constructed using metallic strain gauges.
- (b) A strain gauge of nominal resistance  $200\Omega$  is fixed on one flat surface of a short column of 2 cm x 2 cm cross sectional area. The column is subjected to an axial force of 100 n. The strain gauge forms, one arm of a bridge with other arms all-equal to  $200\Omega$  . Find the open circuit output of the bridge excited by 10v. Given, young's modulus of elasticity =  $2.1 \times 10^{11}$  N/m<sup>2</sup> . [8+8]
4. Describe clearly the principle of constructing a capacitive transducer using
  - (a) Cantilever spring plate.
  - (b) Quartz diaphragms. [8+8]
5. (a) Derive the expression for impulse response of piezo electric transducers.
- (b) Sketch the response curves. [10+6]
6. (a) With schematic diagram, explain about Electrostatic Force-balance transducer for the measurement of gas pressures.
- (b) Starting from fundamentals, derive an expression for sensitivity of Electrostatic Force-balance pressure transducer. [8+8]

7. (a) Write short notes on resistance thermometers.  
(b) What are the possible sources of errors in filled in thermometers and how are they minimized. [6+10]
8. (a) List the detectors used in radiation and optical pyrometers.  
(b) Explain the factors affecting the static accuracy of filled in thermometers. [8+8]

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1. (a) Define accuracy and precisim of a measuring instruments with suitable examples.  
(b) An Instrument reads the values for four different readings 4.0, 4.1, 3.9, 4.2. What is the absolute error and mean error.  
(c) An Instrument measures 4.1V, 4.1V, 4.1V and 4.1V in four readings. Is the instrument precise explain. If the true value is 4V what is the error?  
(d) Is the precise Instrument is better than the errganeous instrument - Explain  
[4x4]
2. (a) An input of  $\sin 2t + 0.3\sin 20t$  is applied to a first order instrument having a time constant of 0.2 sec. Find the output. If the same input is applied to an instrument having a time constant of 0.002 sec. what will be the out put ? Comment upon the results.  
(b) Classify various errors and explain their significance with necessary examples.  
[8+8]
3. (a) What are strain gauge rosettes and how are they used in experimental stress analysis.  
(b) In a Wheatstone bridge, arm 1 is an active strain gauge of advance alloy and 120-ohm resistance, arm 4 is a similar dummy gauge for temperature compensation, and arms 2 and 3 are fixed 120-ohm resistors. The maximum gauge current is to be 0.030
  - i. what is the maximum permissible dc bridge excitation voltage.
  - ii. If the active gauge is on a steel member, what is the bridge output voltage per 1,000 lb/in of stress?
  - iii. Compute the value of a shunt-calibrating resistor that would give the same bridge output as 10,000-lb/in stress in a steel member.  
[8+8]
4. (a) Describe the design features of capacitive pressure transducers.  
(b) Obtain expression relating the capacitance variation with pressure for the cases of
  - i. Thin plate diaphragm and

- ii. a metal-coated membrane.
- (c) Explain how a capacitive transducer can be used as a microphone and show what are the additional considerations applied while designing the same. [4+6+6]
- 5. (a) Describe the properties of materials used for Piezo-electric transducers.  
(b) Derive the expressions for voltage and charge sensitivities. [8+8]
- 6. (a) Draw the schematic diagram and explain about Rate-of-climb transducer.  
(b) Draw the schematic diagram and explain about Gas-inertia angular-acceleration transducer. [8+8]
- 7. (a) Explain with sketches the factors to be considered in the installation of thermocouples for accurate measurement of temperature.  
(b) Write the principle of operation of an optical pyrometer. [8+8]
- 8. (a) List the detectors used in radiation and optical pyrometers.  
(b) Explain the factors affecting the static accuracy of filled in thermometers. [8+8]

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