

BITS PILANI , DUBAI CAMPUS
Dubai International Academic City, Dubai, UAE
Semester I 2013-2014
COMPREHENSIVE EXAMINATION (Closed Book)
BE (Hons) III year EIE

Course No : INSTR F312
Course Title : TRANSDUCERS & MEASUREMENT SYSTEMS
Date : 09.12.13 **Time: 3Hours** **M.M = 80 (40%)**

NOTE: 1. All the symbols and words carry their usual meanings, unless otherwise stated.
2. Total No of Pages.2, No of Questions 8.
3. Answer all the questions sequentially

- 1a. Define transducer.
 1b. What are the functional elements of a generalized measurement system?
 1c. Define dead time.
 1d. What are the types of drift?
 1e. Define deflection factor. **[5*2=10M]**

- 2a. What are the different types of error?
 2b. In an experiment, ten observations of pressure are made which are given below:

Trial No	1	2	3	4	5	6	7	8	9	10
Scale reading(K Pa)	10.02	10.20	10.26	10.20	10.22	10.13	9.97	10.12	10.09	9.9

Find (i) Arithmetic Mean (ii) Average deviation (iii) Standard deviation (iv) variance

- 2c. How will you calculate the probable error. **[2+6+2=10]**

- 3a. The error in the potentiometer is not to exceed 1 part in 10,000. What is the linearity?
 3b. A force digital transducers measure the pressure in the range of 0 to 200N, with a resolution of 0.1% of full scale. What is the smallest change it can measure?
 3c. A spring scale requires a change of 20 Kgf in the applied weight to produce a 20mm change in the deflection of the spring scale. What is the static selectivity of the spring scale?
 3d. A pressure gauge is calibrated from 0 to 100KN/m². It has a uniform a scale with 100 divisions. One fifth of a scale division can be read with certainty. Determine the resolution.
 3e. A pressure gauge has a range of 0 to 1000 KN/m². It has a guaranteed accuracy of 1% of full scale deflection. For a true value of 100 KN/m², what will be the possible reading? **[5*2=10M]**

4a. A piezo electric pressure transducer has a sensitivity of 60pC/bar. If it has a capacitance of 1nF, determine its output voltage when the input pressure is 1.6 bar.

4b. A quartz crystal having a thickness of 5mm and voltage sensitivity of 0.055v-m/N is subjected to a pressure of 1.5×10^6 N/m². Calculate the voltage output. If the permittivity of quartz is 40.6×10^{-12} F/M, calculate the charge sensitivity.

4c. Determine the uniaxial strain sensed by a 500 Ω strain gauge, if it has a gauge factor of 2 and the resistance change produced by the strain is 2.5 Ω . **[4+4+2=10M]**

5a. The output of an LVDT is connected to a 5V voltmeter through an amplifier whose amplification is 100. An output of 2mv appears across the terminals of LVDT when the core moves through a distance of 0.2mm. Calculate the sensitivity of the LVDT and that of the whole setup. The mill voltmeter scale has 100 divisions. The scale can be read to 1/5 of a division. Calculate the resolution of the instrument in mm.

5b. Determine the inductance of a coil whose area of cross section is 0.1m² and the number of turns of coil is 4. Length of each turn of the coil is 0.01m and $\mu = 0.25 \times 10^{-3}$ **[6+4=10M]**

6a. What is type of the synchro transducer?

6b. Mention the output of Hall Effect transducer and how it is calculated?

6c. Which is the most commonly used transducer to measure linear velocity and what are the types of it?

6d. Define gating period. **[2+ + +2=10M]**

7a. Define vacuum pressure.

7b. Which device is used for extremely small pressure measurement?

7c. Mention the principle of Pirani gauge.

7d. How will you calculate the difference in transit time in ultrasonic flowmeter.

7e. If the resistance of a platinum resistance thermometer is 100 Ω at 20°C. Calculate the resistance at 60°C. (Resistance temperature coefficient of platinum is 0.00392 $\Omega / \Omega^\circ\text{C}$). **[5*2=10M]**

8a. Mention the law of intermediate metals.

8b. Write short notes on thermistors.

8c. Define Relative Humidity.

8d. What are the elements of data acquisition system.

8e. What are the types of filled system thermometer.? **[5*2=10M]**

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BITS PILANI , DUBAI CAMPUS
Dubai International Academic City, Dubai, UAE
Semester I 2013-2014
TEST II (Open Book)
BE (Hons) III year EIE

Course No : INSTR F312
Course Title : TRANSDUCERS & MEASUREMENT SYSTEMS
Date : 31.10.13 Time: 50MINS M.M = 20 (20%)

NOTE: 1. All the symbols and words carry their usual meanings, unless otherwise stated.
2. Answer all the questions sequentially

1. A barium titanate pickup has the dimensions of 5mm x 5mm x 1.25mm (width X length X thickness). The force acting on it is 5N. The charge sensitivity of barium titanate is 150pC/N and its permittivity is 12.5×10^{-9} F/m. If the modulus of elasticity of barium titanate is 12×10^{10} N/m² calculate the strain. Also calculate the charge, voltage sensitivity and capacitance. [7M]

2. A 100 Ω strain gauge is bonded to a low carbon steel bar which is subjected to a tensile load. If the bar has a preloaded uniform cross sectional area of 0.5×10^{-4} m² and young's modulus for carbon steel is 200 GN/ m². Determine the gauge factor if a load of 50 KN produces a change of 1 Ω in the gauge resistance. [4M]

3. A piezo electric pressure transducer has a sensitivity of 80pC/bar. If it has a capacitance of 1nF, determine its output voltage when the input pressure is 1.4 bar. [4M]

4. A measuring system consists of a transducer with sensitivity $S = 0.2\text{mv}/^\circ\text{C}$, amplifier gain $S = 2\text{v/mv}$ and recorder $S = 5\text{mm/v}$. What is the overall sensitivity of the measuring system? [2M]

5. A capacitive transducer uses two quartz diaphragm of area 750 mm² separated by a distance of 3.5mm. A pressure of 900KN/ m² when applied to the top diaphragm produces a deflection of 0.6mm. The capacitance is 370pF when no pressure is applied to the diaphragm. Find the value of the capacitance after the application of a pressure of 900KN/ m². [3M]

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3a. Find the open loop gain and the time constants for the following first order system.

$$G(s) = \frac{5}{(s+2)} \quad [2.5M]$$

3b. Find the response of the first order system for unit impulse input. [2.5M]

4. Temperature of a metal bath is measured 100 times with variations in apparatus, procedures and persons. The readings are tabulated below.

Temp °C	397	398	399	400	401	402	403	404	405
Freq	1	3	12	23	37	16	4	2	2

Find (i) Mean (ii) Mode (iii) Mean deviation (iv) Standard deviation (v) probable error of one reading. [5M]

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BITS PILANI , DUBAI CAMPUS
Dubai International Academic City, Dubai, UAE
Semester I 2013-2014
QUIZI (Closed Book)
BE (Hons) III year EIE

Course No : INSTR F312

Course Title : TRANSDUCERS & MEASUREMENT SYSTEMS

Date : 23.10.13

Time: 20MINS

M.M = 10 (10%)

NOTE: 1. All the symbols and words carry their usual meanings, unless otherwise stated.
2. Answer all the questions sequentially

1. A LVDT is 100mm long. It is uniformly wound with a wire having a resistance of 10 K Ω . Under normal conditions, the slider is at the centre of the potentiometer. It is displaced by a displacement D. The measured resistance is 3850 Ω . The value of D will be

- (a) 5.75mm (b) 8.66mm
(c) 11.5mm (d) 38.5mm

2. A capacitive transducer with its plate separation of 1mm under static condition has a capacitance of 10pF. As a displacement transducer, the change in capacitance is accurately measured to be +1 pF, the displacement will be

- (a) 0.1mm (b) 1 mm
(c) 1.414mm (d) 10 mm

3. An inverse transducer is,

- (a) potentiometer (b) LVDT
(c) Both (a & b) (d) piezo electric crystal

4. A resistance potentiometer is a

- (a) first order instrument (b) zero order instrument
(c) second order instrument (d) none of the above

5. In synchro- transmitter, the induced voltages in the three windings of the stator are

- (a) displaced 120° in time phase (b) are in time phase with each other
(c) displaced 90° in time phase (d) none of the above

6. Quartz and Rochelle salt belong to

- (a) natural group of piezo electric materials
- (b) synthetic group of piezo electric materials
- (c) can belong to natural or synthetic group of piezo electric materials provided properly polariaed
- (d) All of the above.

7. Hall effect transducers are used to measure

- (a) displacement
- (b) current
- (c) power
- (d) all of the above.

8. Determine the uniaxial strain sensed by a 100Ω strain gauge, if it has a gauge factor of 2 and the resistance change produced by the strain is 1.2Ω .

9. Self inductance of a coil is given by

10. What are the trade names of synchros?

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Dubai International Academic City, Dubai, UAE
Semester I 2013-2014
QUIZI (Closed Book)
BE (Hons) III year EIE

Course No : INSTR F312

Course Title : TRANSDUCERS & MEASUREMENT SYSTEMS

Date : 28.11.13

Time: 20MINS

M.M = 10 (10%)

1. A variable reluctance type tachometer has 60 rotor teeth. The counter records 3600 counts per second. Determine the speed in rpm.

2. What is thermopile?

3. What are the types of bourdon tubes?

4. Define gauge pressure.

5. What are the units of vacuum measurement?

6. What are the types of interferential flow meter?

7. What are the types of obstruction meter?

8. What is the formula to calculate the vortex frequency?

9. Name the materials of non metallic thermocouple?

10. What is the most widely used RTD material?

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