Course No: INSTR UC381

Course Title: Transducers & Measurement Systems

Date:27.11.05   Time: 50 Minutes   M.M = 20(20%)

NOTE : ONLY TEXT BOOK IS ALLOWED.

1. A thermistor has a resistance of 2500Ω at the ice point (0 °C) and 1000Ω at 50 °C. The resistance – temperature relationship is given by

$R_T = a\, R_0 \exp(\,b\,/\,T)$

  a. Calculate the constants

  b. Calculate the range of resistance to be measured in case the temperature varies from 60 °C to 80 °C.

(6 Marks)

2. A bimetallic strip is constructed of strips of yellow brass and Invar bonded together at 30 °C .Each has a thickness of 0.3mm.Calculate the radius of curvature when a 6cm strip is subjected to a temperature of 100 °C. (Table is enclosed)

(3 Marks)

Mechanical properties of some commonly used thermal materials

Material	Thermal Coefficient of Expansion Per °C	Modulus of Elasticity	
		psi	GN/m^2
Invar	1.7×10^{-6}	21.4×10^6	147
Yellow brass	2.02×10^{-5}	14.0×10^6	96.5
Monel 400	1.35×10^{-5}	26.0×10^6	179
Inconel 702	1.25×10^{-5}	31.5×10^6	217
Stainless-steel type 316	1.6×10^{-5}	28×10^6	193

3. **What is the interfering input that affects the measurement of temperature in the below mentioned devices. And explain the method to nullify the effect to interfering input in all the below devices.**

    a. **Thermocouple**   **(2 Marks)**

    b. **RTD**   **(2 Marks)**

    c. **Pressure thermometer**   **(2 Marks)**

    d. **Liquid in glass thermometer**   **(2 Marks)**

4.**The hot junction of chromel Alumel is connected to a potentiometer terminals is at 20° C . The potentiometer whose terminals are 20° C reads 25.65mv. What is the temperature of the thermocouple junction. The calibration chart of the thermocouple is**

Temperature	20	24	28	....	430	436	442
Voltage(mv)	0.7	0.85	1.62		26.35	26.72	26.84

                                                      (3 Marks)

BITS, PILANI – DUBAI CAMPUS
Knowledge Village, Dubai
Year III – Semester I   2005 – 2006
COMPREHENSIVE EXAMINATION (Closed Book)

Course No   : INSTR UC381

Course Title   : Transducers & Measurement Systems

Date   : January 5th 2006

Time   : 3 Hours   **Max.Marks**   : 80 (40 %)

NOTE:

ANSWER ALL QUESTIONS FROM PART A & PART B.

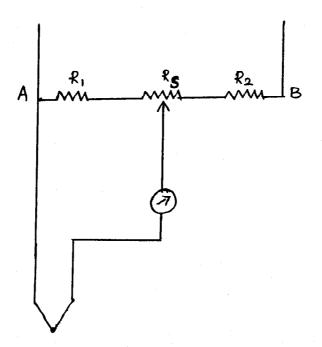## PART - A   (10 x 2 = 20)

I

1. What is the difference between the Dead time and Dead Zone?

2. Draw the different types of phase angle adjustment circuits for LVDT.

3. List out the transducers used for velocity measurements.

4. Which is the special sub class of Instrumentation amplifier. What are the types of it? Explain.

5. What is the difference between the Land line and FM/FM telemetry?

6. Which device is used for flow measurement using strouhal number? Explain how the flow is measured.

7. Draw the block diagram of a meter which is used for sound pressure level measurement

8. What is the difference between the Thermopile and bolometer.

9. A differential amplifier has two inputs 5mV and 3 mV. The output is 300 mV. What is the amplifier gain? If, now the inputs of 153mV and 155mV are applied, What is the output voltage?

10. A piezo electric crystal having dimensions of 5mm * 5mm *1.5mm and a voltage sensitivity of 0.055Vm/N is used for force measurement. Calculate the force if the voltage developed is 100V.

PART B   **(6*10=60)**

II. A strain gauge is bonded to a beam 0.2m long and has a cross sectional are $4cm^2$. Young's modulus for steel is 207 GN/m^2. The strain gauge has an unstrained resistance of 250 Ω and a gauge factor of 2.2. When a load is applied, the resistance of gauge changes by 0.013Ω. Calculate the change in length of the steel beam and the amount of force applied to the beam.

III. The emf of an iron constantan thermocouple is to be measured by the potentiometer shown in fig below. A potential difference of 1.2142 V is applied over points A and B. The current through the resistors is to be 2 mA. And the range of temperature measurement is to be from 350 °C to 950° C. Calculate the value of resistances R1, R2, Rs for an ambient temperature of 20 °C. The emf of the iron constantan couple with reference junction at 0 °C is 1.3333mV at 20 °C , 13.553 mV at 350 °C, 48.71 mV at 950 °C.

IV. A voltage controlled oscillator produces output proportional to the input voltage. Explain the block diagram to measure the total number of cycles produced by the oscillator per second using counters.

V. Sixteen different analog transducers are used to measure and transmit the various parameters of the boiler plant simultaneously, for monitoring the process from the control room, which is far from the plant. Assume the center frequency of the variables ranges from 500 to 60,000Hz. Explain the circuitry involved for the above.

VI. a. A differential amplifier with a common mode input of 500mV and a difference mode input of 30mV has an output of 5mV due to the common mode input and 3V due to difference mode input. Find the difference mode and the common mode gains. Also find the common mode rejection ratio.(3M)

b. A wheat stone bridge has a three out of four resistor have 1KΩ and the fourth resistor is 1010Ω. If the battery voltage is 100V, What is the approximate value of the output voltage? Design an instrumentation amplifier to amplify the output from the bridge with the gain of 1000. (7M)

VII. What are data loggers? Where it is used? Explain with block diagram.

ALL THE BEST

BITS,PILANI- DUBAI CAMPUS

Knowledge Village, Dubai

Year III – Semester I   2005 – 2006

QUIZ (Closed Book) / VERSION A

Course No: INSTR UC381

Course Title: Transducers & Measurement Systems

<u>Date: 17.11.05</u>   Time: 30 Minutes   <u>M.M = 20(10%)</u>

Note: Select the most appropriate option among the given options.

1. Bellows are

    (a) Cascaded diaphragm

    (b) Cascade Capsules

    (c) Welded stamped annular ring

    (d) All the above.

2. Vacuum is the gauge pressure that is ………….. atmospheric pressure

    (a) Above

    (b) Below

    (c) Equal to

    (d) None of the above

3. A manometer which has one leg sealed, the other leg open measures

    (a) Gauge pressure

    (b) Absolute pressure

    (c) Atmospheric pressure

    (d) None of the above

4. Dynamic response consists of

    (a) steady state and transient response

    (b) Only transient response

    (c) only steady state response

    (d) steady state and transient frequency response

5. Which is the false statement

(a) Thermal conductivity is the working principle of pirani gauge

(b) Ionization gauge sensitivity is directly proportional to the electron current

© Bridgman method is used for high pressure measurement

(d) None of the above

6. In connection with the manometer which are the following statements are true.

1. It is used as a pressure standard

2. Inclined manometer is used because of its convenience in required reading of only a single leg

3. For the known $P_1 - P_2$ and at a given location, the 'h' is directly proportional to the density of manometer fluid

(a) 1,2 only

(b) 1,3 only

(c) 2,3 only

(d) None of the above

7. Which is the false statement

(a) The velocity pickup allows the measurement only at frequency w_n

(b) Destructive forces in machinery are closely related to acceleration than the displacement and velocity

(c) Sensitivity of the seismic velocity pickup increases with damping factor

(d) None of the above

8   The instrument with null output is

(a) Bourdon gauge

(b) A platform weighing scale

(c) Manometer

(d) Accelerometer

9. The elastic deflection force transducers are intended for measurement of

(a) Static Loads

(b) Dynamic Loads

(c) Static & Dynamic Loads

(d) None of the above

10.Which type of accelerometers are in wide use for shock and vibrations

      (a) LVDT Accelerometer

      (b) Piezoelectric Accelerometer

      (c) Potentiometer Accelerometer

      (d) Bonded strain gauge Accelerometer

11.The high frequency vibration has

      (a) Large displacement and small acceleration

      (b) Small displacement and small acceleration

      (c) Large displacement and large acceleration

      (d) Small displacement and Large acceleration

12. The construction of the resistance element in potentiometer is strongly influenced to

      (a) accuracy

      (b) Precision

      (c) Resolution

      (d) Sensitivity

13. Dynamic response of a resistance strain gauge type load cell is very good over a

      (a) Wide range of frequency

      (b) Narrow range of frequency

      (c) Short range of frequency

      (d) All range of frequency

14. A Piezo electric force transducers are intended for

      (a) Static Force

      (b)Dynamic forces

      © Gravitational forces

      (d) All of the above.

15. Which type of second order system   oscillates before settling to a final value.

      (a) Critical damped systems

      (b) Over damped systems

      (c) Under damped systems

      (d) Un damped systems

16. Drift occurs only over a portion of span of an instrument is called as

    (a) span drift

    (b) Zero drift

    (c) Sensitivity drift

    (d) Zonal drift

17. A force measuring system using an elastic element can be treated as a

    (a) Zero order system

    (b) First order system

    (c) Second order system

    (d) Third order system

18. Say TRUE or FALSE ....

    In LVDT the output voltage at the null position is ideally zero, but harmonics in the excitation voltage and stray capacitance coupling between the primary and secondary usually results in a small but nonzero null voltage.

19. LVDT attached to the free end of the Bourdon tube is

    (a) a primary transducer

    (b) used to convert linear displacement

    (c) both (a) and (b) are true.

    (d) a secondary transducer to give electrical voltage output.

20. Pure delay or Transport lag elements are otherwise called as

    (a) Dead Zone elements

    (b) Dead time elements

    (c) Drift elements

    (D) None of the above.

Course No: INSTR UC381

Course Title: Transducers & Measurement Systems

Date: 09.10.05   Time: 50 Minutes   M.M = 20(20%)

ANSWER ALL THE QUESTIONS

PART A   (5*2 =10)

1. Define precision and Accuracy.

2. What are the methods of correction for interfering and modifying inputs?

3. a. Define Five time constant.

   b. Define damping Ratio.

4. A resistance strain gauge uses a soft iron wire of small diameter. The gauge factor is 4.2, Neglecting the piezo resistive effect, Calculate the poisons ratio.

5. What is the principle of Synchros and mention the types.

PART B

1. Explain in detail of the frequency response of the first order system.

                                                                (3Marks)

2. A capacitive transducer uses two quartz diaphragms of area 750mm^2 separated by a distance of 3.5mm. A pressure of 900KN/ m^2 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 capacitance after the application of a pressure of 900KN/ m^2.   (3Marks)

3. Derive the response of second order system for critically damped case when subjected to unit step input.   (4Marks)