


Mansoura University		Mechanical Power Engineering Department Total Marks :100	Faculty of Engineering
Course title: Measurements and Measuring Devices		Course Code: MPE 4213	
Date: Jan, 2014 (1 <sup>st</sup> term)		Allowed time : 3 hrs	
		No. of Pages: 2	
<b>Remarks: (Answer the following questions, and assume any missing data)</b>			

**Question (1) [20 Marks]**

**1-(a) What is meant by the following terms? [5 Marks]**

- Zero drift - Modifying inputs – Measuring lag – Beta ratio – Discharge time constant.

**1-(b) Discuss in details the different methods of corrections for the interfering and modifying inputs. give examples and sketches as possible. [5 Marks]**

**1- (c) Put (✓) or (x), GIVE REASONS for your answer either true or false and CORRECT the wrong one [10 Marks]**

1. ( ) Rotameter is a variable head type flow meter.
2. ( ) Dynamic error decreases with decreasing time constant.
3. ( ) In the single-sample test, measurements are performed only one time
4. ( ) Electromagnetic flow meters are suitable for electrically conducting fluids.
5. ( ) Manometer may be oriented in an inclined position to increase accuracy.

**Question (2) [25 Marks]**

**2-(a) For the following measurement devices state clearly construction and theory of operation with neat sketches: [12 Marks]**

- 1- Optical pyrometer for temperature measurement.
- 2- Pirani gauge for pressure measurement.
- 3- Ultrasonic flow meter.
- 4- Dew-point hygrometer.

**2-(b) State the advantages and disadvantages of: [5 Marks]**

- a- Bimetallic thermometer.
- b- Pressure gauge thermometer

**2-(c) A first order system when subjected to a step input has a temperature rise of 25 °C after one hour and 37.5 °C after two hours starting from cold condition. Calculate its final steady temperature rise and the thermal time constant. [8 Marks]**

**Question (3) [30 Marks]**

**3-(a) In an experimental test, temperature is measured 100 times with different devices and procedures as shown in the following table:**

Temperature, °C	297	298	299	300	301	302	303	304	305
Frequency of occurrence	1	3	11	25	35	14	6	4	1

- What is the type of this sample?
- Calculate: (a) arithmetic mean (b) mean deviation (c) standard deviation (d) probable error of one reading. [10 Marks]

**3-(b)** The stress in a mild steel flat circular diaphragm is given by:

$$s = \frac{3r^2 p}{4t^2} \quad \text{N/m}^2$$

where

- r: radius of the diaphragm, m
- t: thickness of the diaphragm walls, m
- p: applied pressure, Pa

and this diaphragm has a radius of  $8 \pm 0.2$  mm, and a thickness of  $0.21 \pm 1\%$  mm. The pressure applied is  $800 \pm 1.5\%$  kPa. Calculate the stress and included error in the following cases:

- The errors are absolute limits,
- The errors are uncertainty. [12 Marks]

**3-(c)** For the McLeod gage deduce a relation between the applied vacuum pressure, p, and scale, h. If the bulb has a volume of  $V=100 \text{ cm}^3$  and a capillary diameter of 1 mm. Calculate the pressure indicated by a reading of 3.00 cm. [8 Marks]

**Question (4) [25 Marks]**

**4-(a)** The density of air in a duct is  $1.2 \text{ kg/m}^3$  and its maximum velocity is 20 m/s. The duct is 100 mm in diameter and the velocity is to be measured using a 70 mm diameter orifice and a differential manometer. If the co-efficient of discharge is assumed to be 0.8. Calculate the necessary scale range of the manometer in mm of  $\text{H}_2\text{O}$ . [10 Marks]

**4-(b)** A quartz pizo-electric crystal having thickness of 2 mm and a voltage sensitivity of 0.055 V m/N is subjected to a pressure of  $1.5 \text{ MN/m}^2$ . Calculate the voltage output and its charge sensitivity if the permittivity of quartz is  $40 \times 10^{-12} \text{ F/m}$ . [5 Marks]


**4-(c)** In an engineering application it is required to measure a temperature in a rang of (200-400 °C ). If you haven't any temperature measurement system, and you have a thermocouple (type T) with enough amount and a voltmeter has a dead zone of 10 mV and scale range of 100 mV. The reference temperature of the thermocouple can be maintained at 150 °C. Use the above available data and materials to construct a temperature measurement system to measure the required temperature range. The calibration chart for the thermocouple is: [10 Marks]

Temperature, °C	50	100	200	300	400
Voltage, mV	2.036	4.279	9.288	14.862	20.872

تمنياتي بالتوفيق،،،،

د. وليد العوضى



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**Question (1) [15 Marks]**

**1-(a) What is meant by the following terms? [5 Marks]**

- Resolution- Dead zone – Sensitivity-Vena contracta - Scale span

**1-(b) Discuss in details** the different methods of corrections for the interfering and modifying inputs. give examples and sketches as possible. [5 Marks]

**1- (c) Put (✓) or (x), and CORRECT the wrong one [5 Marks]**

1. ( ) Dynamic error decreases with decreasing time constant.
2. ( ) Electromagnetic flow meters are suitable for electrically conducting fluids.
3. ( ) Rotameter is a variable head type flow meter.
4. ( ) In the single-sample test, measurements are performed only one time
5. ( ) Manometer may be oriented in an inclined position to increase accuracy.

**Question (2) [30 Marks]**

**2-(a) For the following measurement devices state clearly construction and theory of operation with neat sketches: [15 Marks]**

- |   |                           |
|---|---------------------------|
| 1- Optical pyrometer for temperature measurement. | 2- Ultrasonic flow meter. |
| 3- Pirani gauge for pressure measurement.         | 4- Crystal hygrometer.    |
| 5- Moving-coil pickup for velocity measurement.   |                           |

**2-(b) Compare between thermocouple and RTD (resistive temperature detector) that are used to measure a fluid temperature. [5 Marks]**

**2-(c) A voltmeter is connected across the terminals A and B of the circuit shown in Fig. (1). Find the voltage drop between A and B and the reading of the voltmeter under condition of load. Find the accuracy and the loading error. The voltmeter has a resistance of 1000 kΩ. [10 Marks]**

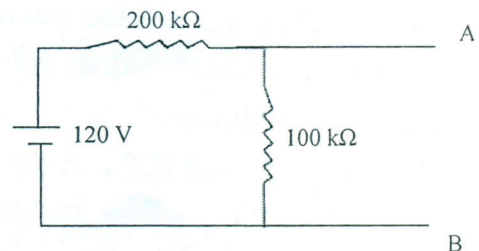


Fig. (1)

**Question (3) [32 Marks]**

**3-(a) A thermocouple system has a time constant of 20 s. The system is used to measure the temperature of a furnace, which fluctuates sinusoidally around 650 °C with ± 40 °C, with a periodic time of 80 s. Determine the maximum and minimum values of the temperature indicated. Calculate also the phase shift angle and the time lag. [10 Marks]**

**3-(b)** In an experimental test, temperature is measured 100 times with different devices and procedures as shown in the following table:

Temperature, °C	297	298	299	300	301	302	303	304	305
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**3-(c)** The stress in a mild steel flat circular diaphragm is given by:

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- The errors are absolute limits,
- The errors are uncertainty. **[12 Marks]**

**Question (4) [23 Marks]**

**4-(a)** A well type U-tube manometer using a liquid of specific gravity of 0.8 has a well of 50 mm diameter and a tube of 2 mm bore. Calculate the reading on scale when a pressure difference of 8 mm of mercury is applied. Calculate the percentage error in reading and the actual error in  $\text{N/m}^2$ . Assume mercury specific gravity is 13.6. **[8 Marks]**

**4-(b)** A rotameter has a base internal diameter of 16 mm, the float is chosen to give the optimum density ratio, the float volume is  $500 \text{ mm}^3$ , with effective diameter of 12 mm, cross sectional area of  $100 \text{ mm}^2$ , and a vertical movement of 200 mm. Estimate the range of flow which can be measured if the using fluid is water. Also calculate the height of the float in the tube at which the mean flow rate would occur. The angle of taper of the tube is  $7^\circ$ . Assume  $C_d=0.8$ . **[10 Marks]**

**4-(c)** A quartz pizo-electric crystal having thickness of 2 mm and a voltage sensitivity of  $0.055 \text{ V m/N}$  is subjected to a pressure of  $1.5 \text{ MN/m}^2$ . Calculate the voltage output and its charge sensitivity if the permittivity of quartz is  $40 \times 10^{-12} \text{ F/m}$ . **[5 Marks]**

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