Kafrelsheikh University		Subject: **Measurements** [MEP2208]
Faculty of Engineering		Final Examination
Dept. of Mechanical Engineering		Date: June. 20th, 2021
Year: 2nd		Time allowed: 3 hour
Semester: 2nd Semester		Full Mark: 75
Questions and Answers Booklet		

(a) This exam measures NARS & ARS 2018 competencies: A2, A5, A10, and C2

(b) No. of pages: 5 - No. of questions: 5.

(c) This is a close book exam.

(d) Ask for clarification if any question statement is not clear to you and assume any missing data.

Question #1: **(15 Mark)**

1-a) Select the correct answer. (10 Marks)

1- ..... is the comparison of an unknown quantity with some known quantity of the same kind.

a) Unit b) Measurement c) Dimension d) Accuracy

2- ..... is the energy required to raise the temperature of 1 lbm of water at 68 F by 1 F.

a) Cal b) Dimensional Homogeneity c) BTU d) Joule

..... is the deviation of the instrument reading from a known value.

a) Readability b) Least count c) Accuracy d) Error

4- The temperature difference in Celsius = the temperature difference in ..... scale.

a) Rankin b) Kelvin c) Fahrenheit d) Reaumur

5- ..... is about how close measurements are to one another.

a) Readability b) Sensitivity c) Precision d) Error

6- The range of U tube manometers depends on the .....

a) Length of the tube b) Specific gravity of the fluid c) a & b d) Volume of the tube

7- .....is an instrument that calibrates pressure by determining the weight of force divided by the area the force is applied.

a) Diaphragm b) U-tube manometer c) Bourdon-Tube d) Dead Weight Tester

8- When a piezoelectric material (crystals) is compressed a..... is created which is proportional to the applied force.

a) resistance b) voltage c) magnetic force d) none of the previous

9- What is the law which the pyrometer depends on?

a) Newton's law b) Stephan-Boltzman's law c) Gas law d) Hook's law

- For the LDA work must contain some type of small particles to scatter .....

a) the sound b) the light c) the radiation d) the flow

1-b) A well-type manometer has the measurement leg inclined at 30° from the horizontal. The diameter of the measurement column is 5 mm and the diameter of the well is 5 cm. An oil having a specific gravity of 0.85 is used as the fluid. A differential pressure in air at 1 atm and 20° C is made which produces a displacement in the measurement column of 15 cm from the zero level. What is the differential pressure in pascals? What is the sensitivity of this manometer? How can you double the sensitivity of this manometer (for the same manometric fluid)? (5 Marks)

Question #2: **(15 Mark)**

2-a) Distinguish among gauge pressure, absolute pressure, and vacuum? How much does 30 mm Hg vacuum (-30 mm gauge) pressure equal on the absolute pressure scale in kPa? (5 Marks)

2-b) Draw a neat sketch of a bourdon-tube gauge showing it's main composition? What are some advantages and disadvantages of the bourdon-tube, diaphragm, and bellows gauges? (5 Marks)

2-c) A McLeod gauge is available which has a volume V_B of 150 cm^3 and a capillary diameter of 0.3 mm. Calculate the gauge reading for a pressure of 30 μm mercury. Derive an expression for the gauge sensitivity and estimate it. If the capillary length is 200 mm, what is the range of the gauge? (5 Marks)

estion #3: (15 Mark)

) What basic methods are used for calibration of flow-measurement devices? How to do a calibration of a nurimeter? (4 Marks)

) Compare between the principle of measurement (with equations if possible) and precautions of the following wmeters: (6 Marks)

- Hot-Wire anemometer
- Turbine flowmeter
- Magnetic flowmeter

A Pitot tube is used to measure the velocity of an airstream at 20° C and 1.0 atm. If the velocity is 2.5 m/s, what is the amic pressure in newtons per square meter? What is the uncertainty of the velocity measurement if the dynamic ssure is measured with a manometer having an uncertainty of 0.5 mm water? What modification is needed to reduce uncertainty in velocity measurement? (5 Marks)

stion #4: **(15 Mark)**

Classify the temperature measurement methods? **(5 Marks)**

Compare between the thermocouple, thermistor, RTD, and I.C. sensors? **(5 Marks)**

During the calibration of a type K-thermocouple the following results were obtained: **(5 Marks)**

°C]	42	47	54	61	67	76	83	90	96	104	110
mV]	0.6	0.8	1.1	1.4	1.7	2.0	2.3	2.6	2.9	3.2	3.5

ne e.m.f-temperature relation can be put in the form [E = b + aT

-]Obtain the values of *a*, and *b* by using the method of least squares and show them graphically on a plot.
- Find the temperatures when the milliVoltmeter reads 2.5, 3.0, and 4.0 mV.
- Calculate the sensitivity of the thermocouple.
- Show with a sketch how can you magnify the signal (e.m.f)

$$a = \frac{n\sum x_i y_i - \left(\sum x_i\right)\left(\sum y_i\right)}{n\sum x_i^2 - \left(\sum x_i\right)^2}$$

$$b = \frac{\left(\sum y_i\right)\left(\sum x_i^2\right) - \left(\sum x_i y_i\right)\left(\sum x_i\right)}{n\sum x_i^2 - \left(\sum x_i\right)^2}$$

Question #5: (15 Mark)

5-a) Mention the questions that should be asked in the initial phases of experiment planning? (5 Marks)

5-b) The shown readings are taken from a digital tachometer that measures the rotational speed of the spindle of a center lathe. (5 Marks)

Reading	1	2	3	4	5	6	7	8	9	10
N [rpm]	1566	1478	1596	1498	1530	1534	1437	1513	1570	1609

- Compute the mean reading, standard deviation, and variance using the "unbiased" basis.
- Using Chauvenet's criterion, test the data points for possible inconsistency. Given that for n=10 → $d_{max}/\sigma = 1.96$.
- Eliminate the questionable points (if any) and calculate a new standard deviation for the adjusted data.

2-c) The following figure shows a venturimeter for measurement of air flowrate in a pipe. (5 Marks)

The relation describing the flowrate is:

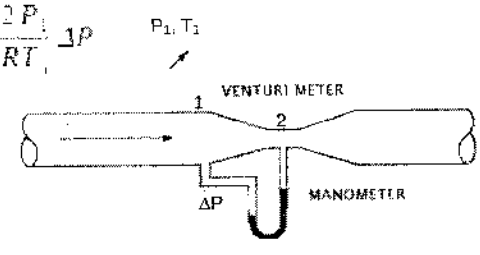
$$\dot{m} = KA_2 \sqrt{\frac{2P_1}{RT_1}\Delta P}$$

Assuming incompressible flow (M < 0.25), calculate the air mass flowrate and the uncertainty of the mass flowrate in percentage, knowing that; (R = 287 J/kg·K)

K = 0.96 ± 0.005

A_2 = 5 cm² ± 0.006 cm²

P_1 = 1.7 bar ± 0.034 bar

T_1 = 21 °C ± 1.0 %

ΔP = 0.095 bar ± 1.5 %