Benha University
Faculty of Engineering- Shoubra
Mechanical Engineering Department
Third Year (Mechanical Power)

Final Term Exam
1st Semester 2014-2015
Date: Tuesday 13/01/2015
Duration: 3 hours

Subject: Measurements & Measuring Instrumentations (Code: MPE315)

- **Answer all the following questions.**
- **Illustrate your answers with sketches when necessary.**
- **The exam consists of two pages (three faces).**
- **No. of questions: 6**
- **Total Marks: 90**
- **The first Page**

Question No. 1 (15 Marks) (ILO's: a1, a3, b2, b3, c2)

1-a) Identify the main components in the measuring systems of:

(i) C-shaped Bourdon pressure gauge,

(ii) Room mercury switch in thermostat. **(5 Marks)**

1-b) A temperature device is calibrated against a standard thermometer at boiling water temperature at atmospheric pressure. The relative errors in output signal readings are 0.8, 1.0, 0.4, 0.2, 0.5, −0.1, 0.9, 0.0, 0.4, and 0.6 in percentage. Make statistical analysis of measurement data to describe the calibration of the device for certain measurement process arithmetic. **(10 Marks)**

Question No. 2 (15 Marks) (ILO's: a1, b2, b3, c1, c2, c4)

2-a) Define the error of the measurement and its main types. **(5 Marks)**

2-b) The density of air is to be determined by measuring its pressure and temperature for insertion in the ideal equation of state i.e. $P = \rho RT$. The value of R for air is $287\ J/kg.K \pm 0.2\%$. The temperature and pressure are measured as $T = 25 \pm 0.2℃$, and $P = 100$ kPa, respectively. If the pressure-measuring instrument has the following specifications:

Range:	**0 to 120 kPa**
Linearity error:	**0.10% Reading**
Hysteresis error:	**0.10% Reading**
Sensitivity error:	**0.15% Reading**
Zero drift:	**0.20% Reading**

Determine the nominal value for the density in kg/m^3 and its uncertainty. **(10 Marks)**

Question No. 3 (15 Marks) (ILO's: a1, a2, a3, c1, c2, c3, c4)

3-a) Synthesis the following terms as applied to measurement system:
Variable, parameter, hysteresis error, non-linearity error, sensitivity, accuracy, precision, uncertainty, time constant, rise time and time lag. **(5 Marks)**

3-b) Suppose a bulb thermometer originally indicating $25℃$ is suddenly exposed to a fluid temperature of $65℃$. Develop a model that simulates the thermometer output response. If the thermometer has a time constant of 25 ms and subjected to a step change in input, calculate the 90% rise time. **(10 Marks)**

Face – 1 – of 3 (Turn the page)

With Best Wishes *Dr. Mohamed Reda Salem*