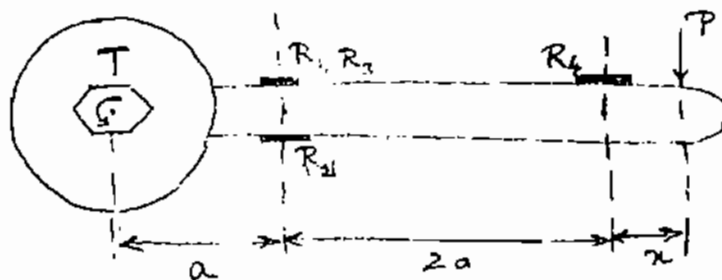


Department of Applied Mechanics  
Major Test in AML 130 (Experimental Methods & Analysis)  
Second Semester (2006-07)

Time: 2 Hours

Marks: 70

- Q.1 (a) Name the instruments based on the following physical principles. Also mention their typical applications.
- (i) Boyle's law
  - (ii) Interference of light
  - (iii) Doppler frequency shift
- (b) Draw a schematic sketch of one of these instruments
- Q.2 (a) Name the instruments which make use of the change of resistance of metals and alloys in the measurement of following quantities:
- (i) Very high temperature ( $\sim 1700$  K)
  - (ii) Very low pressure
  - (iii) Fluid velocity
- (b) Explain the working of one such instrument
- Q.3 Four gauges  $R_1, R_2, R_3$  and  $R_4$ , each of  $120 \Omega$ , are mounted on a torque wrench shown below and connected as four arms of a Wheatstone bridge. Show that this arrangement measures torque  $T$  irrespective of the position of  $P$  as long as it is to the right of all gauges.



- Q.4 (a) Giving an example of a second order measurement system, write down its governing equation. Write expressions for the amplitude ratio and phase angle when a second order system is subjected to a harmonic input. Identify various terms involved.
- (b) A typical second order system has an undamped natural frequency of 500 Hz and a damping ratio of  $0.6$ . Find the frequency of the input signal so that the output signal increases by 20%. Find the corresponding phase angles.

- Q.5 (a) Derive an expression for  $\sigma[U_n]$ . What role does this quantity play in data analysis? (8)
- (b) A field was measured for its length 100 times and the average length and standard deviation were found to be 110.785 m and 2.316 m, respectively. Express your result in a proper engineering format and give the statistical interpretation for this format. (5)
- Q.6 A nozzle is fitted in a horizontal pipe-line (diameter = 15 cm) carrying gas of density  $1.15 \text{ kg/m}^3$  in order to measure flow-rate. A U-tube manometer using oil of specific gravity 0.8 as the manometric fluid indicated a pressure drop of 10 cm across the nozzle. The coefficient of discharge for the system is known to be 0.8 and the nozzle diameter is 5 cm. Determine the flow rate of gas in the pipe-line. (10)
- Q.7 Indicate whether the following statements are true or false. A wrong answer will carry 50 % penalty. (10)
- (i) A U-tube manometer is used to measure the pressure difference between two pipes carrying fluids. The difference in elevation of two pipes has no influence on the measurement.
  - (ii) Dynamic characteristics of a thermocouple are improved by using thicker wires.
  - (iii) Vapour pressure thermometers have uniformly divided scales.
  - (iv) The accuracy of a liquid-in-metal thermometer is independent of the length of capillary.
  - (v) A proving ring is a device using Newton's rings to measure displacements.
  - (vi) For the same flow-rate, if the area of the orifice is doubled, the pressure difference across the orifice is halved (assuming that other parameters remain unchanged).
  - (vii) The best estimate of the true value of a measured quantity is  $x_n \pm \sigma_n$  where  $x_n$  and  $\sigma_n$  have the usual meanings.
  - (viii) It is essential that rotameter is installed vertically for flow measurement.
  - (ix) Pitot tube quite suitable for measuring low velocity of fluids.
  - (x) Calibration of McLeod Gauge depends on the size of the bulb, but is independent of the type of gas whose pressure is to be measured.