

ENGR-325 HW #2

- 1) There is a heating element in a piece of equipment that you are using and you wish to determine the power being dissipated by the heating element. The heating element can be assumed to be a simple resistance. Assume that you have measuring instruments with the following characteristics:

	<u>Resolution</u>	<u>Uncertainty (% of reading)</u>
Voltmeter	1.0mv	0.5%
Ohmmeter	1.0ohm	0.1%
Ammeter	0.1A	0.5%

- a) Since power can be found as  $V \times I$  or  $I^2 \times R$ , which should you use in this situation to obtain a value with least uncertainty?
- b) If you measure  $I = 4.8 \text{ A}$  and  $R = 900 \text{ ohms}$ , what will be the uncertainty in the calculated power?
- 2) Based on everyday experience, estimate the bias error in the following measuring instruments: bathroom scale; plastic ruler scale; micrometer; kitchen window bulb thermometer; automobile speedometer.
- 3) A tachometer has an analog display dial graduated in 5 revolutions per minute (rpm) increments. The user manual states an accuracy of 1% of reading. Estimate the uncertainty in the reading at 10, 500, 5000 rpm.
- 4) For a thin-walled pressure vessel of diameter  $D$  and wall thickness  $t$  subjected to an internal pressure  $p$ , the tangential stress is given by  $pD/2t$ . During one test, 10 measurements of pressure yielded a mean of  $8610 \text{ lb/ft}^2$  with standard deviation of 273.1. Cylinder dimensions are based on a set of 10 measurements which yielded: mean diameter = 6.2in with standard deviation of 0.18 in and mean thickness of 0.22 in with standard deviation of 0.04 in. Determine the best estimate of the stress in the vessel wall.
- 5) An equipment catalog boasts that a pressure transducer system comes in 3 1/2 digit (i.e. 19.99) or 4 1/2 digit (i.e. 19.999) displays. The 4 1/2 digit model costs 50% more. Both units are otherwise identical. The specifications, which apply to both, are:  
 Linearity error: 0.15% Full scale  
 Hysteresis error: 0.20% Full scale  
 Repeatability error: 0.25% Full scale  
 For a full scale pressure of 200 kPa, which product would you select. Explain.