ECEN321 Engineering Statistics

Homework 3 (5%)

Submit your work, clearly written, ONLINE.

Measurement Error

1. (Navidi 3.1.2) Two thermometers are calibrated by measuring the freezing point of glacial acetic acid, which is 16.6 °C. Equal numbers of measurements are taken with each thermometer. The result from the first thermometer is 16.4 ±0.2 °C and the result from the second thermometer is 16.8 ±0.1 °C.

   (a) Is it possible to tell which thermometer is more accurate? If so, say which one. If not, explain why not.

   [1 mark]

   (b) Is it possible to tell which thermometer is more precise? If so, say which one. If not, explain why not.

   [1 mark]

2. (Navidi 3.1.8) A kilogram mass standard is weighed five times on a different scale. The measurements are as follows, in units of micrograms *above* 1 kg: 25.6, 26.8, 26.2, 26.8, 25.4.

   (a) Is it possible to estimate the uncertainty in these measurements? If so, estimate it. If not, explain why not.

   [1 mark]

   (b) Is it possible to estimate the bias in these measurements? If so, estimate it. If not, explain why not.

   [1 mark]

Linear Combinations of Measurements

3. (Navidi 3.2.2) A measurement of the circumference of a disk has an uncertainty of 1.5 mm. How many measurements must be made so that the diameter can be estimated with an uncertainty of only 0.5 mm?

   [1 mark]

4. (Navidi 3.2.6) A cylindrical hole is bored through a steel block, and a cylindrical piston is machined to fit into the hole. The diameter of the hole is 20.00 ±0.01 cm, and the diameter of the piston is 19.90 ±0.02 cm. The clearance is one-half the difference between the diameters. Estimate the clearance and find the uncertainty in the estimate.

   [2 marks]

Uncertainties for Functions of One Measurement

5. (Navidi 3.3.4) The velocity V of sound in air at temperature T is given by $V = 20.04\sqrt{T}$, where T is measured in kelvin (K) and V is in m/s. Assume that $T = 300 \pm 0.4$ K. Estimate V, and find the uncertainty in the estimate.

   [2 marks]

Uncertainties for Functions of Several Measurements

6. (Navidi 3.4.2) The volume of a cone is given by $V = \pi r^2 h/3$, where r is the radius of the base and h is the height. Assume the height is measured to be $h = 6.00 \pm 0.01$ cm and the radius is $r = 5.00 \pm 0.02$ cm.

   (a) Estimate the volume of the cone, and find the uncertainty in the estimate.

   [3 marks]

   (b) Which would provide a greater reduction in the uncertainty in V: reducing the uncertainty in h to 0.005 cm or reducing the uncertainty in r to 0.01 cm?

   [2 marks]

7. (Navidi 3.4.14) The resistance R (in ohms) of a cylindrical conductor is given by $R = kl/d^2$, where l is the length, d is the diameter, and k is a constant of proportionality.

   Assume that $l = 14.0 \pm 0.1$ cm and $d = 4.4 \pm 0.1$ cm.

   (a) Estimate R, and find the uncertainty in the estimate. (Your answer will be in terms of the proportionality constant k).

   [3 marks]

   (b) Which would provide the greater reduction in the uncertainty in R: reducing the uncertainty in l to 0.05 cm or reducing the uncertainty in d to 0.05 cm?

   [2 marks]