ECEN321 : Engineering Statistics
Assignment 4 Submission

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Measurement Error

It is not possible to tell which thermometer is more accurate, as the mean value of both measurements is equidistant from the true value.

1. (Navidi 3.1.2)
   (a) The first thermometer covers the range 16.2 to 16.6 and the second thermometer covers 16.7 to 16.9. Thus the first thermometer shows greater accuracy.
   (b) The second thermometer as a lower uncertainty, there is the more precise measurement.

2. (Navidi 3.1.8)
   0.5 (a) Uncertainty $= s = \pm 0.6$
   0.5 (b) Bias $= 26.18$

Linear Combinations of Measurements

3. (Navidi 3.2.2)
   $\sigma_X = \frac{\sigma}{\sqrt{N}}$
   $N = (\frac{\sigma}{\sigma_X})^2 = (\frac{1.5}{0.5})^2 = 9$

4. (Navidi 3.2.6)
   $C = \frac{20.00-19.90}{2} = 0.05$
   $\sigma_C = \sigma_{\frac{h+p}{2}} = \sqrt{\frac{1}{4}0.01^2 + \frac{1}{4}0.02^2} = 0.01118$
   2

Uncertainties for Functions of One Measurement

5. (Navidi 3.3.4) $T = 300 \pm 0.4$
   $V = 20.04\sqrt{T} = 347.102982$
   $\frac{dV}{dR} = \frac{10.02}{\sqrt{T}}$
   $\sigma_V \approx |\frac{10.02}{\sqrt{T}}| \cdot \sigma_T = |\frac{10.02}{\sqrt{300}}| \cdot 0.4 = 0.231401987891$

   $V = 347.1 \pm 0.23\ m/s$

Uncertainties for Functions of Several Measurements

6. (Navidi 3.4.2) $V = \frac{\pi}{3}r^2h$, $r = 5.00 \pm 0.02\ cm$, $h = 6.00 \pm 0.01\ cm$

   (a) $V = \frac{\pi}{3}25 \cdot 6 = 157.079633$
   $\frac{\delta V}{\delta r} = \frac{2\pi}{6}rh$, $\frac{\delta V}{\delta h} = \frac{\pi}{3}r^2$
   $\sigma_V = \sqrt{(\frac{\pi}{6}rh)^2\sigma_r^2 + (\frac{\pi}{3}r^2)^2\sigma_h^2} = \sigma_V = \sqrt{(\frac{\pi}{6}5 \cdot 6)^2 0.02^2 + (\frac{\pi}{3}25)^2 0.01^2} = 1.28361817673$

   $V = 157 \pm 1.28\ cm^3$

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   (b) $\sqrt{(\frac{\pi}{6}5 \cdot 6)^2 0.01^2 + (\frac{\pi}{3}25)^2 0.01^2} = 0.680678408278$
   $\sqrt{(\frac{\pi}{6}5 \cdot 6)^2 0.02^2 + (\frac{\pi}{3}25)^2 0.005^2} = 1.26343635931$
   $\therefore$ reducing r to 0.01

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7. (Navidi 3.4.14) $R = kl/d^2$, $l = 14.0 \pm 0.1\ cm$, $d = 4.4 \pm 0.1\ cm$

   (a) $R = 14/4.4^2k = \frac{16k}{19.36}$
   $\frac{\delta R}{\delta l} = k/d^2 = k/4.4^2 = \frac{k}{19.36}$
   $\frac{\delta R}{\delta d} = -2kl/d^3 = \frac{-28k}{85.184}$
   $\sigma_R = \sqrt{(\frac{k}{19.36})^2 0.1^2 + (\frac{-28k}{85.184})^2 0.1^2} = 0.03327k$

   $R = \frac{16k}{19.36} \pm 0.033\Omega$

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   (b) $\sigma_l = 0.05 \rightarrow \sigma_R = 0.0329k$
   $\sigma_d = 0.05 \rightarrow \sigma_R = 0.0172k$
   $\therefore$ reducing d's uncertainty

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