Example of Determining Uncertainty

ME 552

A displacement transducer has the relationship, y=Bv. Determine the uncertainty in y for V=5.00 V, if B=12 mm/V and u_B=+/- 0.15 mm/V and u_V=+/-0.05 V at 95% confidence.

Example for Determining Uncertainty

Displacement

transducer with curve $y = BV$, determine the uncertainty in y for $V = 5.00V$, if $B = 12\,mm/V$ with $u_B = \pm 0.15\,mm/V$ and $u_V = \pm 0.05V$ at 95% confidence

Known

$y = BV$ $\quad u_V = \pm 0.05\,V$

$V = 5.00V$ $\quad u_B = \pm 0.15\,mm/V$

$B = 12\,mm/V$

Find

u_y

Solution:

I. Propagation of Error

$y = BV \qquad \frac{\partial y}{\partial V} = B \;,\; \frac{\partial y}{\partial B} = V$

$$u_y = \left[\left[\left(\frac{\partial y}{\partial V}\right)u_V\right]^2 + \left[\left(\frac{\partial y}{\partial B}\right)u_B\right]^2\right]^{1/2} = u_y = \left[(B\cdot u_V)^2 + (V\cdot u_B)^2\right]^{1/2}$$

$$u_y = \left[(12\cdot 0.05)^2 + (5\cdot 0.15)^2\right] = 0.96\,mm$$

$y = \left(12\ \frac{mm}{V}\right)(5.00V) = 60mm$ $\qquad$ **$60 \pm .96mm$**

II. Sequential Perturbation

$y_0 = BV$

$y_0 = 60mm$

$y_1^+ = (B+u_B)V \qquad y_1^- = (B-u_B)V$

$y_2^+ = B(V+u_V) \qquad y_2^- = B(V-u_V)$

$$\delta y_1 = \frac{|y_1^+ - y_0| + |y_1^- - y_0|}{2}, \qquad \delta y_2 = \frac{|y_2^+ - y_0| + |y_2^- - y_0|}{2}$$

$$u_y = \pm\left[(\delta y_1)^2 + (\delta y_2)^2\right]^{1/2} = \pm 0.96mm \qquad \textbf{$60 \pm 0.96mm$}$$