Advanced lab day 1 → Error analysis

$f' = \frac{A-B}{\sqrt{\delta_A^2 + \delta_B^2}}$ $\quad f' \begin{cases} < 1 \\ \in [1,3] \\ > 3 \end{cases}$ Good mech ii

Fractional uncertainty

$\frac{\delta x}{x} \leq 10\%$ Good for this class

Standard deviation

$\sigma = \sqrt{\frac{\sum_i (x_i - \bar{x})^2}{N-1}}$

N = number of data points
$\bar{x}$ = average

Random error, $\delta_x \to \sigma_{\bar{x}} = \frac{\sigma}{\sqrt{N}}$

Adding and subtracting measured quantities (Significant)

$p = p_b \pm \delta p$ & $q = q_b \pm \delta q$

$p \pm q = (p_b \pm q_b) \pm (\delta p + \delta q)$

Mult. and div. of measured quantities

$q = \frac{x}{y} \to q = \frac{x_b}{y_b}\left(1 \pm \left(\frac{\delta x}{x_b} + \frac{\delta y}{y_b}\right)\right)$ ÷

$q = xy \to q = x_b y_b \left(1 \pm \left(\frac{\delta x}{x_b} + \frac{\delta y}{y_b}\right)\right)$ *

Independent non-random

powers

$q = x^n \to \frac{\delta q}{q_b} = n\frac{\delta x}{x_b}$

Adding

$q = x + y + \ldots \to \delta q = \sqrt{\delta x^2 + \delta y^2}$

÷ or *

$q = \frac{xy}{w} \to \sqrt{\left(\frac{\delta x}{x_b}\right)^2 + \left(\frac{\delta y}{y_b}\right)^2 + \left(\frac{\delta w}{w_b}\right)^2}$

Independent Random Error

$\delta q \sqrt{\left(\frac{\partial q}{\partial x}\delta x\right)^2 + \left(\frac{\partial q}{\partial y}\delta y\right)^2 + \ldots}$