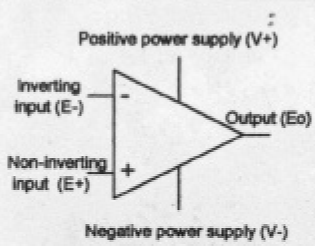
MEGR 3171 – Introduction to Measurement and Instrumentation

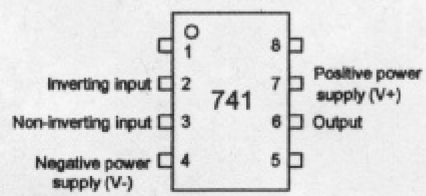
Formula Sheet

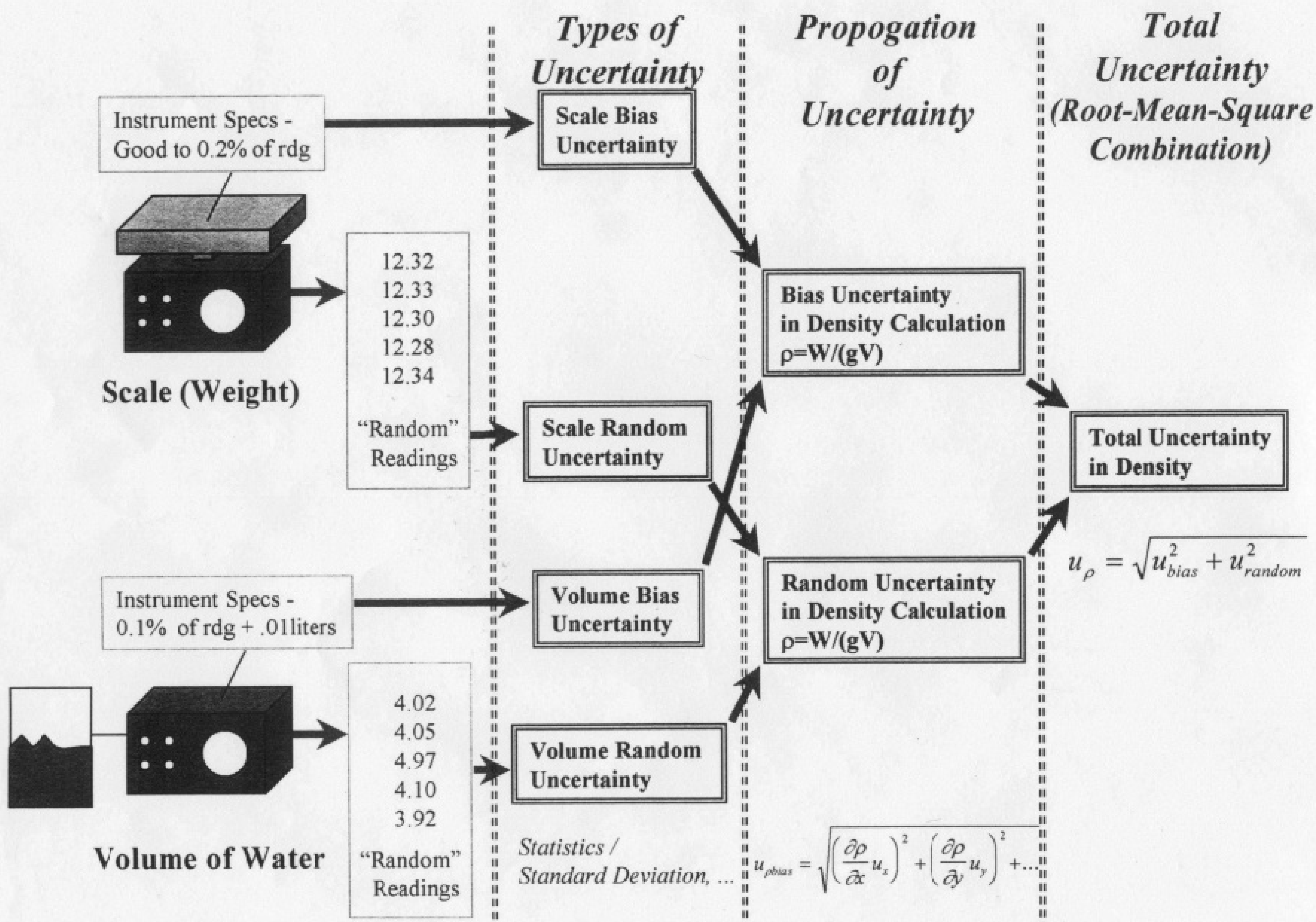
$\mu = \dfrac{x_1 + x_2 + \ldots + x_n}{n}$	$\sigma = \sqrt{\dfrac{d_1^2 + d_2^2 + \ldots + d_n^2}{n}} = \sqrt{\dfrac{\sum x^2 - n\mu^2}{n}}$
$\bar{x} = \dfrac{x_1 + x_2 + \ldots + x_n}{n}$	$S = \sqrt{\dfrac{d_1^2 + d_2^2 + \ldots + d_n^2}{n-1}} = \sqrt{\dfrac{\sum x^2 - n\bar{x}^2}{n-1}}$
$S_{\bar{y}} = \bar{y}\sqrt{\dfrac{S_{\bar{x}1}^2}{\bar{x}_1^2} + \dfrac{S_{\bar{x}2}^2}{\bar{x}_2^2} + \ldots + \dfrac{S_{\bar{x}n}^2}{\bar{x}_n^2}}$	$V_{RMS} = \sqrt{\dfrac{1}{T}\int_0^T V^2(t)dt}$
$y_o(t) = y_{ss} + \left(y_o(0) - y_{ss}\right)e^{-t/\tau}$	$\lvert Complex\,\#\rvert = \sqrt{(real)^2 + (imag)^2}$
$Amp\ Ratio = \left\lvert\dfrac{E_o}{E_i}\right\rvert = \dfrac{\lvert Num\rvert}{\lvert Den\rvert}$	$Phase = \tan^{-1}\left(\dfrac{imag_{num}}{real_{num}}\right) - \tan^{-1}\left(\dfrac{imag_{den}}{real_{den}}\right)$
$\left\lvert\dfrac{E_o}{E_i}\right\rvert = \dfrac{\omega_b}{\sqrt{\omega_b^2 + \omega^2}}$	$\left\lvert\dfrac{E_o}{E_i}\right\rvert = \dfrac{\omega}{\sqrt{\omega + \omega_p^2}}$
$\dfrac{\Delta R}{R} = F\varepsilon$	$e_o = e_a - e_b = \dfrac{n}{4}F\varepsilon$

$v_i = \dfrac{d}{2^N}v_{FS} + v_{min}$	$\varepsilon = \dfrac{v_{FS}}{2^N}$	$d = Trun\left(\dfrac{v_i - v_{min}}{v_{FS}}2^N\right)$

$C = \dfrac{\varepsilon A}{d}$






Types of Uncertainty
Propogation of Uncertainty
Total Uncertainty (Root-Mean-Square Combination)
Instrument Specs - Good to 0.2% of rdg
Scale (Weight)
12.32
12.33
12.30
12.28
12.34
"Random" Readings
Scale Bias Uncertainty
Scale Random Uncertainty
Bias Uncertainty in Density Calculation $\rho = W/(gV)$
Total Uncertainty in Density
$u_\rho = \sqrt{u_{bias}^2 + u_{random}^2}$
Instrument Specs - 0.1% of rdg + .01liters
Volume of Water
4.02
4.05
4.97
4.10
3.92
"Random" Readings
Volume Bias Uncertainty
Volume Random Uncertainty
Random Uncertainty in Density Calculation $\rho = W/(gV)$
Statistics / Standard Deviation, ...
$u_{\rho bias} = \sqrt{\left(\frac{\partial\rho}{\partial x}u_x\right)^2 + \left(\frac{\partial\rho}{\partial y}u_y\right)^2 + \ldots}$