

## FY116G Problem 3.1 - Uncertainty Analysis

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Get[ "UCAnalysis.m", Path -> {NotebookDirectory[]} ]
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$$\frac{p_1 V_1}{V_2} \mapsto \begin{pmatrix} p_1 & 1.0 \text{ atm} \pm 0.05 \text{ atm} & \text{Uniform} & \text{"Pa"} \\ V_1 & 6.0 \times 10^{-3} & \text{Uniform} & \text{"m}^3\text{"} \\ V_2 & 5.5 \times 10^{-3} & \text{Uniform} & \text{"m}^3\text{"} \end{pmatrix}$$

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atm = 101325; (*Pa*)
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UCResult[ pStyle[2,Smaller], Pa, UCPrecision -> 2, Precision -> 6 ]
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$$\begin{aligned} p_2 &= (110536.4 \pm 3286.54) \text{ Pa} \\ &\in [107249.8; 113822.9] \text{ Pa}; \text{Normal} \\ &\approx (1.105 \pm 0.033) \times 10^5 \text{ Pa} = 1.105(33) \times 10^5 \text{ Pa} \end{aligned}$$

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AnalysisEnvironment
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$$y = \frac{x_1 x_2}{x_3}$$

Quantity		Estimate $\pm$ Uncertainty	Distribution	$ \partial \mathcal{F} / \partial x_i $
$x_1$	$p_1$	$(1.0132500 \pm 0.0506625) \times 10^5$	Uniform	1.09091
$x_2$	$V_1$	$(6.00 \pm 0.05) \times 10^{-3}$	Uniform	$1.84227 \times 10^7$
$x_3$	$V_2$	$(5.50 \pm 0.05) \times 10^{-3}$	Uniform	$2.00975 \times 10^7$

$y$	110536.3636363636363636363636363636		
$y_{\min}$	103196.31756757	$= y - 7340.05$	
$y_{\max}$	118104.04816514	$= y + 7567.68$	
$\varepsilon_{\max}$	7452.83057851239669421487603306	$= 6.74 \%$	
$y \pm \varepsilon_{\max}$	$(1.105 \pm 0.075) \times 10^5$	$= 1.105(75) \times 10^5$	
$u_c$	3286.53755275991229802244754095	$= 2.97 \%$	
$y \pm u_c$	$(1.105 \pm 0.033) \times 10^5$	$= 1.105(33) \times 10^5$	

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MonteCarlo[ 10^6 ] // UC
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$$\begin{aligned} &110537 \pm 3285.69 \\ &\in [107251.3; 113822.7] \\ &\approx (1.105 \pm 0.033) \times 10^5 = 1.105(33) \times 10^5 \end{aligned}$$

# Sanity Check

## ∅DumpRelationship

$$p_2 = \frac{p_1 V_1}{V_2}$$

## ∅DumpQuantities

$$\begin{aligned} p_2 &= (110\,536.4 \pm 3286.54) \text{ Pa} \\ &\in [107\,249.8; 113\,822.9] \text{ Pa; Normal}\mathcal{D} \\ &\approx (1.105 \pm 0.033) \times 10^5 \text{ Pa} = 1.105(33) \times 10^5 \text{ Pa} \end{aligned}$$

$$\begin{aligned} p_1 &= (101\,325 \pm 5066.25) \text{ Pa} \\ &\in [96\,258.75; 106\,391.2] \text{ Pa; Uniform}\mathcal{D} \\ &\approx (1.013 \pm 0.051) \times 10^5 \text{ Pa} = 1.013(51) \times 10^5 \text{ Pa} \end{aligned}$$

$$\begin{aligned} V_1 &= (0.006 \pm 0.00005) \text{ m}^3 \\ &\in [0.00595; 0.00605] \text{ m}^3; \text{Uniform}\mathcal{D} \\ &\approx (6.00 \pm 0.05) \times 10^{-3} \text{ m}^3 = 6.00(5) \times 10^{-3} \text{ m}^3 \end{aligned}$$

$$\begin{aligned} V_2 &= (0.0055 \pm 0.00005) \text{ m}^3 \\ &\in [0.00545; 0.00555] \text{ m}^3; \text{Uniform}\mathcal{D} \\ &\approx (5.50 \pm 0.05) \times 10^{-3} \text{ m}^3 = 5.50(5) \times 10^{-3} \text{ m}^3 \end{aligned}$$