Problem 1.5 - Uncertainty Analysis, Case B

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Get[ "UCAnalysis.m", Path → {NotebookDirectory[]} ]
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$$\frac{p}{\rho_{H2O}\, g} \;\mapsto\; \begin{pmatrix} \rho_{H2O} & 998 \pm 0.5 & \text{Uniform}\mathcal{D} \\ g & 9.80665 & \\ p & 101 \times 10^3 \pm 0.5 \times 10^3 & \text{Uniform}\mathcal{D} \end{pmatrix}$$

Evaluated Functional Relationship

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?AnalysisEnvironment
```

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

Variable		Uncertainty Interval	Distribution	$\lvert \partial f/\partial x_i \rvert$
x_1	ρ_{H2O}	$(9.980 \pm 0.005) \times 10^2$	Uniform	1.03405×10^{-2}
x_2	g	$9.80665 \times$ (exact) 10^0		1.05232
x_3	p	$(1.010 \pm 0.005) \times 10^5$	Uniform	1.02176×10^{-4}

y	10.3197732976724	
y_{min}	10.2635432553111	$= y - 0.05623$
y_{max}	10.3760597110035	$= y + 0.0562864$
ε_{max}	0.056258213725183	$= 0.545\,\%$
$y \pm \varepsilon_{max}$	$(1.032 \pm 0.006) \times 10^1$	$= 1.032(6) \times 10^1$
u_c	0.0296463242544561	$= 0.287\,\%$
$y \pm u_c$	$(1.032 \pm 0.003) \times 10^1$	$= 1.032(3) \times 10^1$

Absolute Maximum Uncertainty

$$\varepsilon_{max} = \sum_{i=1}^{n} \lvert \partial_{x_i} f[x] \rvert\, \varepsilon_i ; \quad f[x] \pm \varepsilon_{max} \;\; // \; ?UCE$$

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10.3197732976724 ± 0.0562582
 ∈ [10.26352; 10.37603]
≃ (1.032 ± 0.006) × 10^1 = 1.032(6) × 10^1
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Combined Standard Uncertainty

$$u_c = \left(\sum_{i=1}^{n} (\partial_{x_i} f[x])^2\, u_i^2 \right)^{1/2} ; \quad f[x] \pm u_c \;\; // \; ?UCA$$

```
10.3197732976724 ± 0.0296463
 ∈ [10.29013; 10.34942]
≃ (1.032 ± 0.003) × 10^1 = 1.032(3) × 10^1
```

Monte Carlo Simulation

```
Block[ { data, trials = 10^6 },
  data = f @@ Table[RandomReal[fDist[i], {trials}], {i, 1, n}];
  Mean[data] ± StandardDeviation[data] ] // QUCA
```

```
10.319779478191 ± 0.0296612
 ∈ [10.29012; 10.34944]
≃ (1.032 ± 0.003) × 10^1 = 1.032(3) × 10^1
```