

# PHY108 LAB EC4

VI-1

Unknown Resistor	$L_1$	$L_2$	Uncertainty L	$R_3$	$R_m$ (DDM)
A	49.2	50.8	0.05	144	148.4
B	49.1	50.9	0.05	208	215.4
C	49.1	50.9	0.05	374	385
D	49.1	50.9	0.05	950	982

WHEN THE BRIDGE IS BALANCED

$$V_1 = V_2 \Rightarrow I_1 R_1 = I_2 R_3$$

$$V_2 = V_x = I_1 R_2 = I_2 R_x$$

SOLVING FOR  $R_x$  WE GET

$$R_x = R_3 \left( \frac{R_2}{R_1} \right) \quad \text{AND BECAUSE } l \propto R$$

↓

WE CAN REPLACE  $R_2/R_1$  WITH  $l_2/l_1$

$$R_x = R_3 \left( \frac{l_2}{l_1} \right) \quad \sigma_x = R_3 \left( \frac{1}{l_1} + \frac{l_2}{l_1^2} \right) \sigma_l$$

A

$$R_A = (140) \left( \frac{50.8}{49.2} \right) = 144.55$$

$$\sigma_A = (140) \left( \frac{1}{49.2} + \frac{50.8}{(49.2)^2} \right) 0.05 = 0.29$$

$$R_A \pm \sigma_A = 145 \pm 0.3 \Omega$$

B

$$R_B = (208) \left( \frac{50.9}{49.1} \right) = 215.63$$

$$\sigma_B = (208) \left( \frac{1}{49.1} + \frac{50.9}{(49.1)^2} \right) 0.05 = 0.43$$

$$R_B \pm \sigma_B = 216 \pm 0.4 \Omega$$

C

$$R_C = (374) \left( \frac{50.9}{49.1} \right) = 387.71$$

$$\sigma_C = (374) \left( \frac{1}{49.1} + \frac{50.9}{(49.1)^2} \right) 0.05 = 0.78$$

$$R_C \pm \sigma_C = 388 \pm 1 \Omega$$

D

$$R_D = (950) \left( \frac{50.9}{49.1} \right) = 984.83$$

$$\sigma_D = (950) \left( \frac{1}{49.1} + \frac{50.9}{(49.1)^2} \right) 0.05 = 1.97$$

$$R_D \pm \sigma_D = 985 \pm 2 \Omega$$

The values calculated were all just barely outside of the values measured with the DDM some of the values even falling within one or two ohms. This is likely due to the bridge being measured millimeters off from what the actual measurement is

# PHY108 LAB EC4

## VI-2

Unknown Resistor	$L_1$	$L_2$	Uncertainty L	$R_3$	$R_m$ (DDM)
A	48.4	51.6	0.05	140	148.4
B	48.4	51.6	0.05	203	215.4
C	48.4	51.6	0.05	364	385
D	48.4	51.6	0.05	930	982

WHEN THE BRIDGE IS BALANCED

$$V_1 = V_3 \Rightarrow I_1 R_1 = I_2 R_3$$

$$V_2 = V_x = I_1 R_2 = I_2 R_x$$

SOLVING FOR  $R_x$  WE GET

$$R_x = R_3 \left( \frac{R_2}{R_1} \right) \quad \text{AND BECAUSE } l \propto R$$

WE CAN REPLACE  $R_2/R_1$  WITH  $L_2/L_1$

$$R_x = R_3 \left( \frac{L_2}{L_1} \right) \quad \sigma_{R_x} = R_3 \left( \frac{1}{L_1} + \frac{L_2}{L_1^2} \right)$$

**A**

$$R_A = (140) \left( \frac{51.6}{48.4} \right) = 149.26$$

$$\sigma_A = (140) \left( \frac{1}{48.4} + \frac{51.6}{(48.4)^2} \right) \cdot 0.05 = 0.30$$

$$R_A \pm \sigma_A = 149 \pm 0 \Omega$$

**B**

$$R_B = (203) \left( \frac{51.6}{48.4} \right) = 216.42$$

$$\sigma_B = (203) \left( \frac{1}{48.4} + \frac{51.6}{(48.4)^2} \right) \cdot 0.05 = 0.43$$

$$R_B \pm \sigma_B = 216 \pm 0 \Omega$$

**C**

$$R_C = (364) \left( \frac{51.6}{48.4} \right) = 388.07$$

$$\sigma_C = (364) \left( \frac{1}{48.4} + \frac{51.6}{(48.4)^2} \right) \cdot 0.05 = 0.78$$

$$R_C \pm \sigma_C = 388 \pm 1 \Omega$$

**D**

$$R_D = (930) \left( \frac{51.6}{48.4} \right) = 991.49$$

$$\sigma_D = (930) \left( \frac{1}{48.4} + \frac{51.6}{(48.4)^2} \right) \cdot 0.05 = 1.99$$

$$R_D \pm \sigma_D = 991 \pm 2 \Omega$$

These values were quite far off from the DDM measurement this is likely due to the DC power supply being set to the wrong hertz.

## PHY108 LAB EC4

VI-3

Unknown Capacitor	$C_3$ (f)
A	2.10E-09
B	3.80E-09

ACCORDING TO THE LAB MANUAL

$C_1 = R_1$  &  $C_2 = R_2$  , SO:

$$C_x = C_3 \left( \frac{C_2}{C_1} \right) \text{ \& } \sigma_x = C_3 \left( \frac{1}{C_1} + \frac{C_2}{C_1^2} \right)$$

WHERE  $C_1 = C_2 = 0.022 \pm 0.0022 \mu\text{f}$

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**A**  $C_A = C_3 \left( \frac{0.022 \pm 0.0022 \mu\text{f}}{0.022 \pm 0.0022 \mu\text{f}} \right) = (2.1 \cdot 10^{-9} \text{f})(1) = 2.1 \cdot 10^{-9} \text{f}$

$$\sigma_{C_A} = C_3 \left( \frac{1}{C_1} + 1 \right) \sigma_{C_3} = (2.1 \cdot 10^{-9}) \left( \frac{1}{0.022 \pm 0.0022} + 1 \right) (C_3 \cdot 0.5) = 4.5 \cdot 10^{-10}$$

$$\boxed{C_A \pm \sigma_{C_A} = 2.1 \cdot 10^{-9} \pm 4.5 \cdot 10^{-10} \text{f}}$$

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**B**  $C_B = C_3 (1) = 3.8 \cdot 10^{-9} (1) = 3.8 \cdot 10^{-9}$

$$\sigma_{C_B} = C_3 \left( \frac{1}{C_1} + 1 \right) = (3.8 \cdot 10^{-9}) \left( \frac{1}{0.022} + 1 \right) (C_3 \cdot 5) = 1.49 \cdot 10^{-15}$$

$$\boxed{C_B \pm \sigma_{C_B} = 3.8 \cdot 10^{-9} \pm 1.5 \cdot 10^{-15} \text{f}}$$

These calculated values have no data to compare.