Physics 2220
Spring 2006
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THIRD MIDTERM

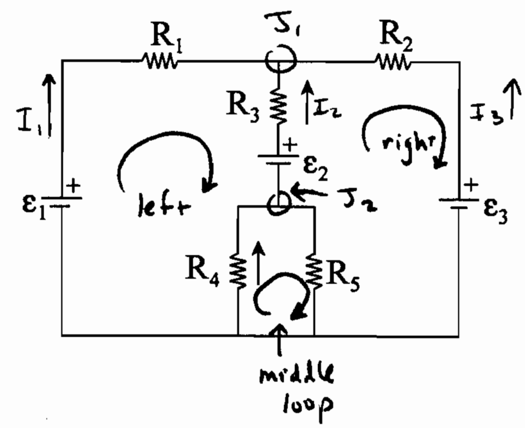
3

Name: Solutions   Student ID #: ______________

Discussion Instructor (circle): Barcikowski   El-Gendy   Johnson   Rodriguez

SHOW ALL WORK!!!!!
REPORT ALL NUMBERS TO THREE SIGNIFICANT FIGURES!
Use the conversion constants and data given on the front page.

For the circuit shown, use the values given below.



8 (a) Calculate the current in R_3, including sign. The arrows show the positive direction.

8 (b) Find the magnitude of the potential across R_1.

9 (c) Find the current, magnitude and sign, through R_4. The arrow shows the positive direction.

$R_1 = 400\ \Omega$	$R_5 = 800\ \Omega$
$R_2 = 300\ \Omega$	$\varepsilon_1 = 115$ V
$R_3 = 150\ \Omega$	$\varepsilon_2 = 17.0$ V
$R_4 = 600\ \Omega$	$\varepsilon_3 = 95.0$ V

At Junction J_1 we have $I_1 + I_2 - I_3 = 0 \ldots (I)$

Consider left loop: $\mathcal{E}_1 - I_1 R_1 + I_2 R_3 + R_{45} I_2 - \mathcal{E}_2 = 0 \ldots (II)$

Consider right loop: $\mathcal{E}_2 - I_2 R_3 - I_3 R_2 - \mathcal{E}_3 - I_2 R_{45} = 0 \ldots (III)$

where $R_{45} = \left(\frac{1}{R_4} + \frac{1}{R_5}\right)^{-1} = 342.857\ \Omega$

a) Solve (I) for $I_1 = I_3 - I_2$, plug into (II) $\Rightarrow \mathcal{E}_1 - (-I_2 + I_3) R_1 + I_2 R_3 + R_{45} I_2 - \mathcal{E}_2 = 0$

Solve (III) for $I_3 = -\frac{1}{R_2}\left(-\mathcal{E}_2 + I_2 R_3 + \mathcal{E}_3 + R_{45} I_2\right) \ldots (IV)$

plug into (II): solve for I_2: $I_2 = -\dfrac{\mathcal{E}_1 R_2 + R_1 \mathcal{E}_2 - R_1 \mathcal{E}_3 + \mathcal{E}_2 R_2}{R_1 R_2 + R_1 R_3 + R_1 R_{45} + R_3 R_2 + R_{45} R_2} = \boxed{-0.130\text{ A} = I_2}$

b) From (IV) $I_3 = -\frac{1}{R_2}\left(-\mathcal{E}_2 + I_2 R_3 + \mathcal{E}_3 + R_{45} I_2\right) = -0.0459$ A

From (I) $I_1 = I_3 - I_2 = -.0459\text{ A} + .130 = .0841$ A

$\Rightarrow V_{R_1} = I_1 R_1 = \boxed{33.8\text{ V} = V_{R_1}}$

c) Consider Middle loop: $-I_4 R_4 + I_5 R_5 = 0$

at Junction J_2: $I_4 + I_5 - I_2 = 0 \Rightarrow I_5 = I_2 - I_4$

Loop becomes: $-I_4 R_4 + (I_2 - I_4) R_5 = 0$

$I_4 = \dfrac{I_2 R_5}{R_4 + R_5} \Rightarrow \boxed{I_4 = -.0745\text{ A}}$