George Williams

**THIRD MIDTERM**

Name (print) Mikhail Portnoi Name (signed) _____

Discussion Instructor (circle): Basko Chakhbazian DiCarlo Gundlach Romer Wei

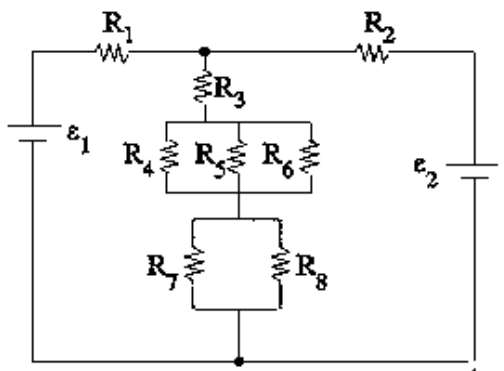
Discussion Section # _____

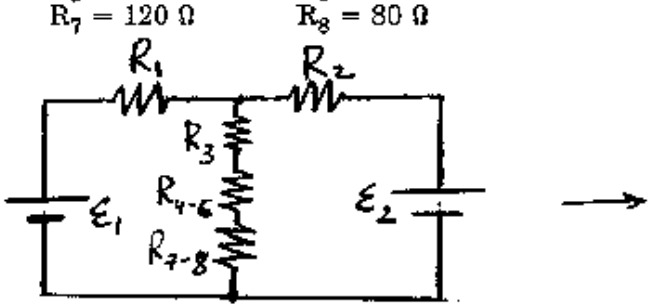
**SHOW ALL WORK!!!!!**
**REPORT ALL NUMBERS TO THREE SIGNIFICANT FIGURES!**
**Use the conversion constants and data given on the front page.**

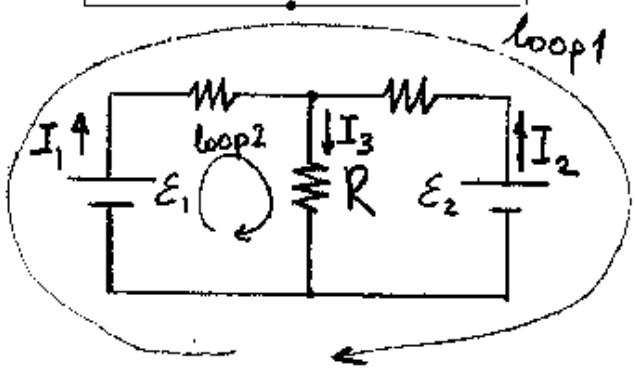
For the circuit shown, and the values given, calculate:

(a) the magnitude of the potential across $R_1$;
(b) the magnitude of the potential across $R_2$;
(c) the power being dissipated in $R_3$;
(d) the power being dissipated in $R_7$.

$\varepsilon_1 = 150$ V $\quad \varepsilon_2 = 100$ V
$R_1 = 650\ \Omega \quad R_2 = 350\ \Omega$
$R_3 = 120\ \Omega \quad R_4 = 50\ \Omega$
$R_5 = 70\ \Omega \quad R_6 = 80\ \Omega$
$R_7 = 120\ \Omega \quad R_8 = 80\ \Omega$




$1/R_{4-6} = 1/R_4 + 1/R_5 + 1/R_6 \Rightarrow R_{4-6} = 1/[1/50 + 1/70 + 1/80] = 21.4\ \Omega$

$1/R_{7-8} = 1/R_7 + 1/R_8 = 1/80 + 1/120 \Rightarrow R_{7-8} = \frac{120 \cdot 80}{200} = 48\ \Omega$

$R = R_3 + R_{4-6} + R_{7-8} = 120 + 21.4 + 48 = 189.4\ \Omega$

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$$\left.\begin{array}{ll} \text{Loop 1:} & -\varepsilon_1 + I_1 R_1 - I_2 R_2 + \varepsilon_2 = 0 \\ \text{Loop 2:} & -\varepsilon_1 + I_1 R_1 + I_3 R = 0 \\ \text{Node:} & I_1 + I_2 = I_3 \end{array}\right\} \Rightarrow \left\{\begin{array}{l} I_2 = [I_1 R_1 - (\varepsilon_1 - \varepsilon_2)]/R_2 \\ I_1 R_1 + (I_1 + I_2) R = \varepsilon_1 \end{array}\right. \Rightarrow$$

$$I_1 R_1 + \left(I_1 + \frac{I_1 R_1 - (\varepsilon_1 - \varepsilon_2)}{R_2}\right) R = \varepsilon_1 \Rightarrow I_1 [R_1 R_2 + (R_1 + R_2) R] = \varepsilon_1 R_2 + (\varepsilon_1 - \varepsilon_2) R$$

$$I_1 = \frac{\mathcal{E}_1 R_2 + (\mathcal{E}_1 - \mathcal{E}_2)R}{R_1 R_2 + (R_1 + R_2)R} = \frac{150 \times 350 + 50 \times 189.4}{350 \times 650 + 1000 \times 189.4} = 0.149\,A$$

$$I_2 = \frac{I_1 R_1 - (\mathcal{E}_1 - \mathcal{E}_2)}{R_2} = \frac{0.149 \times 650 - 50}{350} = 0.134\,A$$

$$I_3 = I_1 + I_2 = 0.283\,A$$

(a) $V_1 = I_1 R_1 = 0.149 \times 650 = 96.9\ V$

(b) $V_2 = I_2 R_2 = 0.134 \cdot 350 = 46.9\ V$

(or $V_2 = V_1 - (\mathcal{E}_1 - \mathcal{E}_2) = 96.9 - 50 = 46.9\,V$)

(c) $P_3 = I_3^2 R_3 = (0.283)^2 \cdot 120 = 9.61\,W$

(d) $P_7 = I_7^2 R_7$, where $I_7 R_7 = (I_3 - I_7) R_8 \Rightarrow$

$$\Rightarrow I_7 = I_3 \frac{R_8}{R_7 + R_8} \Rightarrow P_7 = R_7 \times (I_3)^2 \left(\frac{R_8}{R_7 + R_8}\right)^2 =$$

$$= 120 \times (0.283)^2 \left(\frac{80}{120 + 80}\right) = 1.54\,W$$