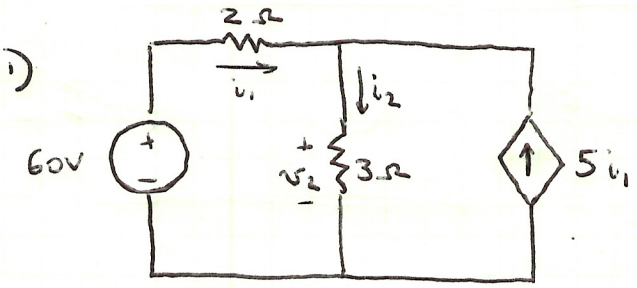
ENGR 2910
MIDTERM 1 SOLUTIONS

1)



$$i_1 = \frac{60 - v_2}{2} \qquad i_2 = \frac{v_2}{3}$$

KCL: $i_1 + 5i_1 = i_2$

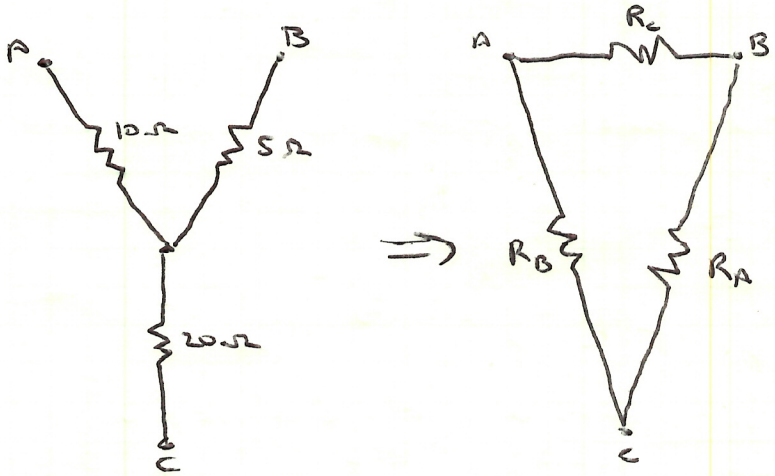
$$6i_1 = i_2$$

$$6\left(\frac{60 - v_2}{2}\right) = \frac{v_2}{3}$$

$$180 - 3v_2 = \frac{1}{3}v_2$$

$$\boxed{v_2 = \frac{180}{3.33} = 54V}$$

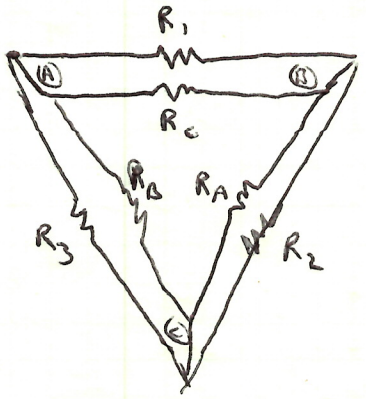
2)



$$R_A = 5 + 20 + \frac{(5)(20)}{10} = 35\,\Omega$$

$$R_B = 10 + 20 + \frac{(10)(20)}{5} = 70\,\Omega$$

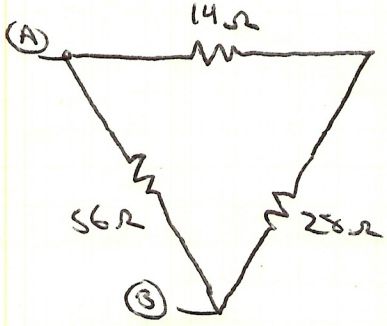
$$R_C = 5 + 10 + \frac{(5)(10)}{20} = 17.5\,\Omega$$



$R_1 \| R_C = 14\,\Omega$

$R_2 \| R_A = 28\,\Omega$

$R_3 \| R_B = 56\,\Omega$

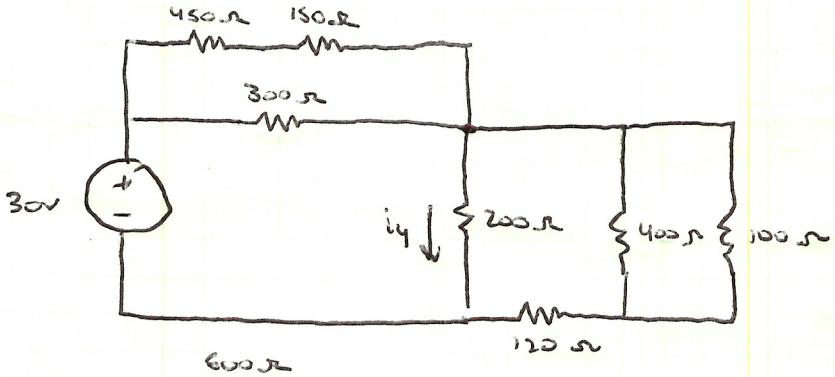


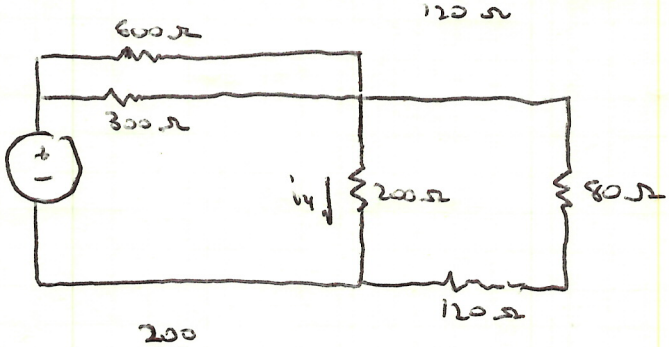
$$R_{EQ} = 56 \,\|\, (14 + 28)$$

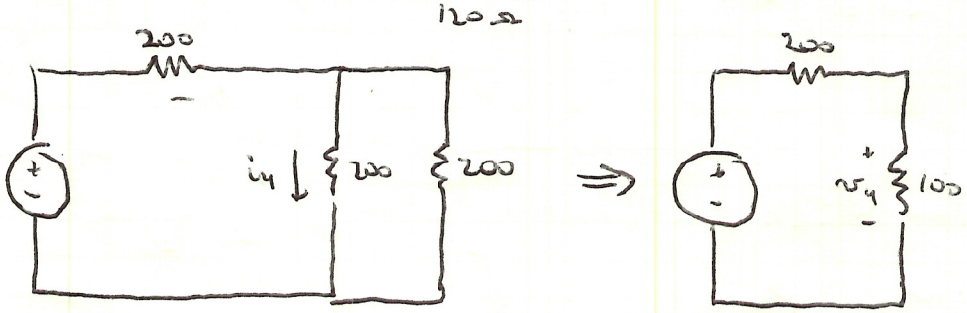
$$= 56 \,\|\, 42$$

$$\boxed{R_{EQ} = 24\,\Omega}$$

3) REDRAW AS







$$R_{EQ} = 300\,\Omega$$

$$v_4 = \frac{100}{100+200}(30)$$

$$= 10\,V$$

$$i_4 = \frac{10}{200} = 0.05\,A$$

$$i_4 = 50\,mA$$

4) VOLTAGE DIVIDER

a) $v_{out} = \frac{R_2}{R_1+R_2} v_{in}$

$3 = \frac{R_2}{42+R_2} 10$

$\boxed{R_2 = 18\ \Omega}$

b) $R_L = 9\ \Omega$

i) $\frac{R_2 \| R_L}{R_1 + (R_2 \| R_L)} = \frac{3}{10}$

$R_2 \| R_L = 18 \| 9 = 6\ \Omega$

$\boxed{R_1 = 14\ \Omega}$

ii) $v_{out} = 3V$

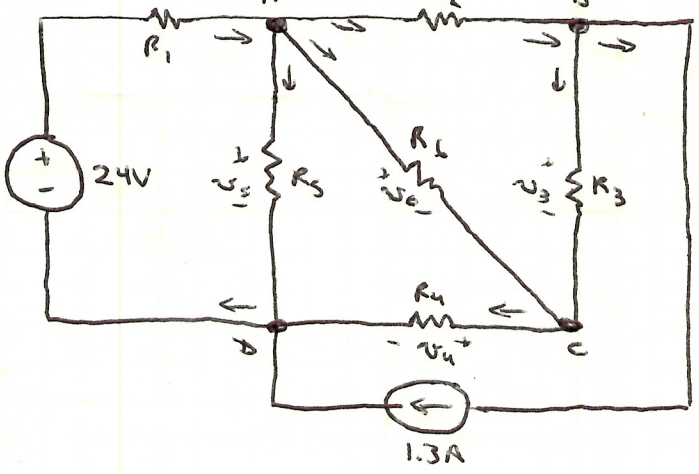
$P_L = \frac{(V_{out})^2}{R_L} = \frac{9}{9} = \boxed{1\ W}$

iii) $R_{EQ} = 14 + 18 \| 6 = 20\ \Omega$

$I = 0.5A$

$P = IV = (0.5)(10) = \boxed{5W}$

5) REDRAW



a) $n_c = 4$

b) $b_c = 7$

c) 24-R_1, R_2, R_3, R_4, R_5, R_6, 1.3A

d) # KCL = $n_c - 1 = 3$

e) # KVL = $b_c - (n_c - 1) = 3$

↑ current unknown (6)

5) (A): $\frac{24 - v_5}{R_1} = \frac{v_5}{R_3} + \frac{v_5 - v_4}{R_6} + \frac{v_5 - (v_4 + v_3)}{R_2}$

(B): $\frac{v_5 - (v_4 + v_3)}{R_2} = \frac{v_3}{R_3} + 1.3$

(C): $\frac{v_5 - v_4}{R_6} + \frac{v_3}{R_3} = \frac{v_4}{R_4}$

NOTE: SOLUTION VARIES DEPENDING ON NODES AND LOOPS CHOSEN

(L1): $24 - v_1 - v_5 = 0$

(L2): $v_5 - v_6 - v_4 = 0$

(L3): $v_6 - v_2 - v_3 = 0$

$$\left[\begin{array}{cccccc|c}
0 & 0 & \frac{-1}{R_2} & -\frac{1}{R_2} + \frac{1}{R_6} & \frac{1}{R_1} + \frac{1}{R_5} + \frac{1}{R_6} + \frac{1}{R_2} & 0 & \frac{24}{R_1} \\
0 & 0 & -\frac{1}{R_2} - \frac{1}{R_3} & \frac{-1}{R_2} & \frac{1}{R_2} & 0 & 1.3 \\
0 & 0 & \frac{1}{R_3} & -\frac{1}{R_4} - \frac{1}{R_6} & \frac{1}{R_2} & 0 & 0 \\
1 & 0 & 0 & 0 & 1 & 0 & 24 \\
0 & 0 & 0 & -1 & 1 & -1 & 0 \\
0 & -1 & -1 & 0 & 0 & 1 & 0
\end{array}\right]$$

$$\left[\begin{array}{cccccc|c}
0 & 0 & -0.01 & -0.02 & 0.04 & 0 & 0.24 \\
0 & 0 & -0.02 & -0.01 & 0.01 & 0 & 1.3 \\
0 & 0 & 0.01 & -0.02 & 0.01 & 0 & 0 \\
1 & 0 & 0 & 0 & 1 & 0 & 24 \\
0 & 0 & 0 & -1 & 1 & -1 & 0 \\
0 & -1 & -1 & 0 & 0 & 1 & 0
\end{array}\right]$$