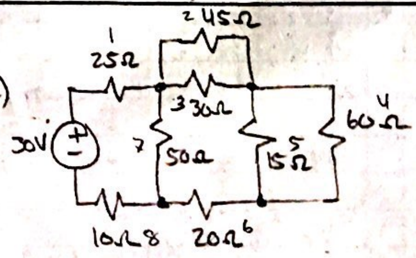
ENGR 221 HW # 3 | Due 5/1/20 | Sean Lai

Ch 3 : #'s 7, 12, 27, 29, 51, 61

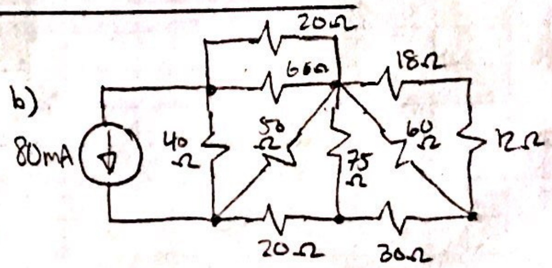
3.7.

Given:

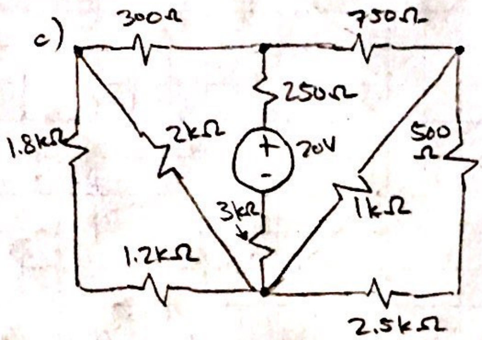
a)



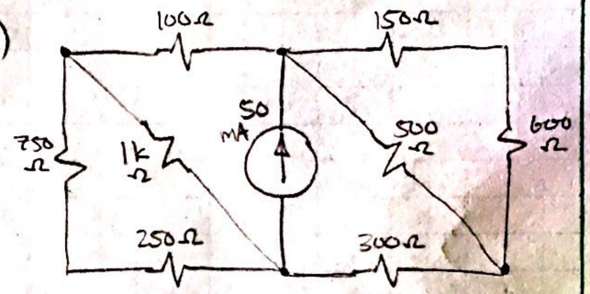
b)



c)



d)



Find: for each a) – d), find:

a) R_{eq}

b) P_{source}

Solution:

a) $R_{23} = \left(\frac{1}{45} + \frac{1}{30}\right)^{-1} = 18\Omega$

$R_{45} = \left(\frac{1}{60} + \frac{1}{15}\right)^{-1} = 12\Omega$

$R_{23456} = R_{23} + R_{45} + R_6 = 18 + 12 + 20 = 50\Omega$

$R_{234567} = \left(\frac{1}{R_{23456}} + \frac{1}{R_7}\right)^{-1} = 25\Omega$

$R_{eq} = R_{234567} + R_1 + R_8 = \boxed{60\Omega \text{ a)}}$

$P = VI = V^2/R_{eq}$

$\boxed{P = 15W \text{ b)}}$

b) $R_{eq} = \left((20||60) + \left[\left((18+12)||60 + 30\right)||75\right] + 20\right]||50\Big)||40$

$= \left((15) + \left(\left((20+30)||75 + 20\right)||50\right)\right)||40$

$= \left((15) + (30+20)||50\right)||40$

$= 40||40$

$\boxed{R_{eq} = 20\Omega \text{ a)}}$

$P = I^2R = \boxed{128\text{mW b)}}$

→ continued

3.7 continued →

c) $R_{eq} = 250 + [750 + 1k \| (500 + 2.5k)] \| [300 + 2k \| (1.8k + 1.2k)] + 3k$

$= 250 + [750 + 750] \| [300 + 1200] + 3k$

$= 250 + 750 + 3k$

$\boxed{R_{eq} = 4k\Omega \text{ a)}}$

$P = \frac{V^2}{R} = \boxed{100\,mW \text{ b)}}$

d) $R_{eq} = [(150 + 600) \| 500 + 300] \| [100 + (750 + 250) \| 1k]$

$R_{eq} = [600] \| [600]$

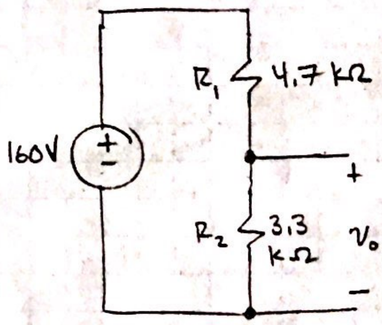
$\boxed{R_{eq} = 300\Omega \text{ a)}}$

$P = I^2R$

$\boxed{P = 750\,mW \text{ b)}}$

3.12:

Given:



Find: a) Calculate v_o

b) P_{R_1}, P_{R_2}

c) For 0.5W resistors, v_o as in a), specify smallest R_1, R_2

Solution:

$I = \frac{V_s}{R_{eq}}$, $V_s = 160V$, $R_{eq} = 3.3k + 4.7k = 8k\Omega$

$I = 20mA$

$V_o = IR_2$

$V_o = 20mA \cdot 3.3k\Omega$

a) $\boxed{V_o = 66V}$

b) $P_{R1} = V_{R1} I$, $V_{R1} = V_s - V_o = 94V$

$\rightarrow \boxed{P_{R1} = 1.88W}$

$P_{R2} = V_o I$

$\boxed{P_{R2} = 1.32W}$

c) $\frac{R_1}{R_2}$ must stay the same.

R_1 will draw most power $\rightarrow$ $P_{R1} = 0.5W = \frac{V_{R1}^2}{R_1}$

$R_1 = \frac{V_{R1}^2}{P_{R1}}$, $P_{R1} = 0.5W$, $V_{R1} = 94V$

$\boxed{R_1 = 17.67k\Omega}$

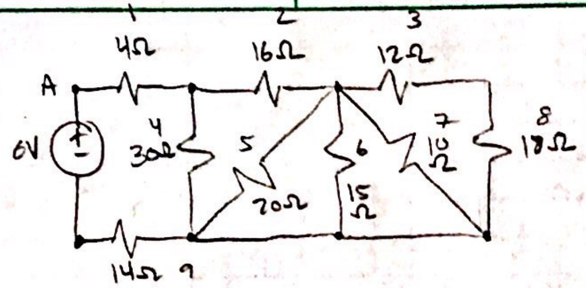
$\frac{R_1}{R_2} = \frac{R_{10}}{R_{20}} \rightarrow R_2 = \frac{R_1 R_{20}}{R_{10}}$

$R_2 = \frac{17.67k\Omega \cdot 3.3k\Omega}{4.7k\Omega}$

$\boxed{R_2 = 12.41k\Omega}$

3.27:

Given:



Find: a) $V_{4\Omega}$
b) $I_{4\Omega}$ →
c) $I_{16\Omega}$ →
d) $I_{10\Omega}$ ↓
e) $V_{10\Omega}$ ↓
f) $V_{18\Omega}$ ↓

Solution: let $V_s = 6V$

$$R_{eq} = R_1 + R_4 \| \left(R_2 + \left(R_5 \| R_6 \| R_7 \| (R_3 + R_8)\right)\right) + R_9$$

$$R_{eq} = 4\Omega + 30\Omega \| \left[16\Omega + (20\Omega \| 15\Omega \| 10\Omega \| 30\Omega)\right] + 14\Omega$$

$$R_{eq} = 18\Omega + 30\Omega \| (16\Omega + 4\Omega)$$

$$R_{eq} = 30\Omega$$

a) $V_{4\Omega} = i \cdot 4\Omega = \frac{V_s}{R_{eq}} \cdot 4\Omega$

$\boxed{V_{4\Omega} = 0.8V}$

b) $I_{4\Omega} = V_{4\Omega}/4\Omega = \boxed{0.2A}$

c) $R_{235678} \rightarrow R_{eq1}$

$$R_{eq1} = 16 + 30 \| 10 \| 15 \| 20$$

$$R_{eq1} = 20\Omega$$

$$I_{16\Omega} = \frac{V}{R_{eq1}} = \frac{R_{eq1} \| 30 \cdot I_{4\Omega}}{R_{eq1}}$$

$\boxed{I_{16\Omega} = 0.12A}$

d) $I_{10\Omega} = \frac{R_{\|10\Omega}}{R_{10\Omega}} \cdot I_{16\Omega}$

$$I_{10\Omega} = \frac{30 \| 10 \| 15 \| 20}{10} \cdot 0.12$$

$\boxed{I_{10\Omega} = 0.048A}$

continued →

3.27 continued →

e) $V_{10\Omega} = I_{10\Omega} \cdot 10\Omega$

$V_{10\Omega} = 0.048A \cdot 10\Omega$

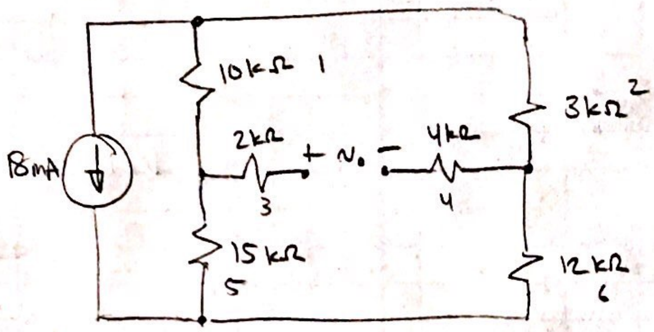
$\boxed{V_{10\Omega} = 0.48V}$

f) $V_{18\Omega} = \frac{V_{10\Omega}}{30\Omega} \cdot 18\Omega$

$\boxed{V_{18\Omega} = 0.288V}$

3.29:

Given:



Find: v_o

Solution: Let $I_s = 18mA$

$R_{eq} = (10+15) \| (3+12)$ kΩ

$R_{eq} = 9.375$ kΩ

$I_{15} = \frac{R_{eq}}{R_{15}} \cdot I_s$

$I_{15} = 6.75mA$

$I_{26} = 18 - 6.75 = 11.25mA$

$v_5 = I_{15} \cdot 15k\Omega$

$v_5 = 101.25V$

$v_6 = I_{26} \cdot 12k\Omega$

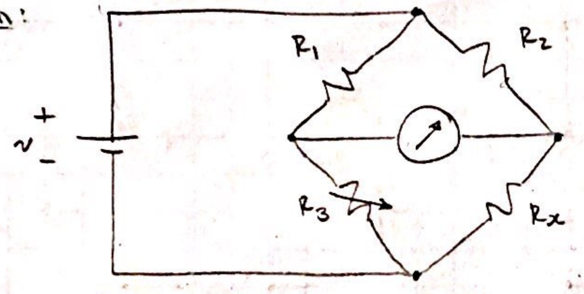
$v_6 = 135V$

$\boxed{v_{diff} = v_6 - v_5 = 33.75V}$

Scanned with CamScanner

3.51:

Given:



$v = 24V$

balanced when:

$R_1 = 500\Omega$

$R_2 = 1000\Omega$

$R_3 = 750\Omega$

Find: a) R_x

b) i_s source current

c) which resistor absorbs most power, how much?

d) " " " least " " "

Solution:

a) $R_x = \frac{R_2}{R_1} R_3$ when current reads 0A

$\boxed{R_x = 1500\Omega}$

b) $R_{eq} = (500 + 750) || (1000 + 1500)$

$R_{eq} = 833.3\ \Omega$

$i_s = \frac{v}{R_{eq}} \longrightarrow \boxed{i_s = 28.8\,mA}$

c) $P = VI = I^2R$

$I_{13} = \frac{R_{eq}}{R_{13}} i_s$

$I_{13} = \frac{833.3\Omega}{1250} \cdot 28.8\,mA$

$I_{13} = 19.2\,mA$, $I_{2x} = i_s - I_{13} = 9.6\,mA$

most power will be drawn from largest resistor in brach with most current.

$\rightarrow P_{max} = I_{13}^2 \cdot R_3$

$P_{max} = (19.2\,mA)^2 \cdot 750\Omega$

$\boxed{P_{max} = 0.276\,W}$ in R_3 (750Ω)

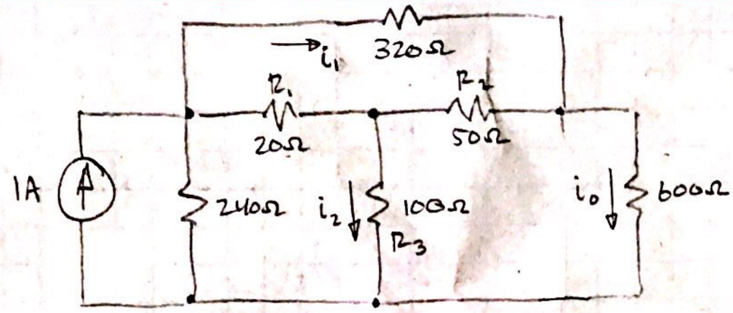
d) $P_{min} = I_{2x}^2 R_2$

$\boxed{P_{min} = 0.09216\,W}$ in R_2 (1000Ω)

Scanned with CamScanner

3.61 :

Given:



Find: a) i_o

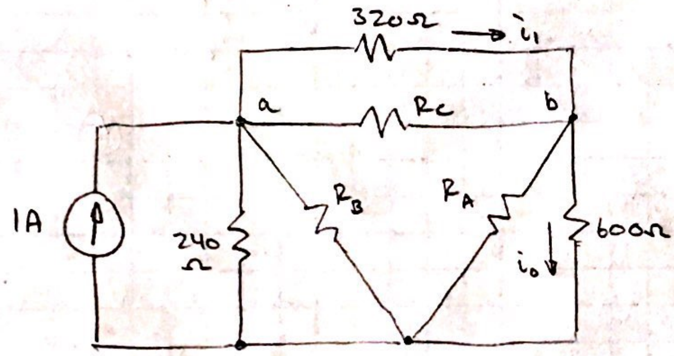
b) i_1

c) i_2

d) P_s source power

Solution:

a) Y–Δ for 20, 50, 100Ω resistors

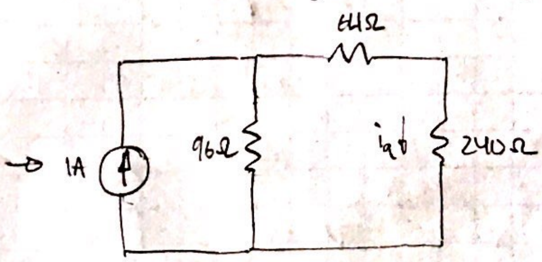


let $R_t = R_1R_2 + R_2R_3 + R_3R_1$

$R_a = \frac{R_t}{R_1}$ $R_b = \frac{R_t}{R_2}$ $R_c = \frac{R_t}{R_3}$

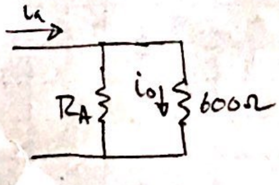
$R_t = 8000\Omega$

→ $R_a = 400\Omega$, $R_b = 160\Omega$, $R_c = 80\Omega$



$i_a = \frac{96}{96+64+240} i_s$

$i_a = 240mA$



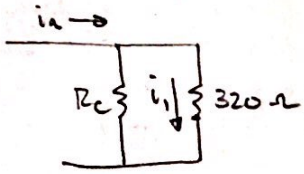
$i_o = \frac{400}{400+800} \cdot 240mA$

$\boxed{i_o = 96mA}$

continued →

3.61 continued →

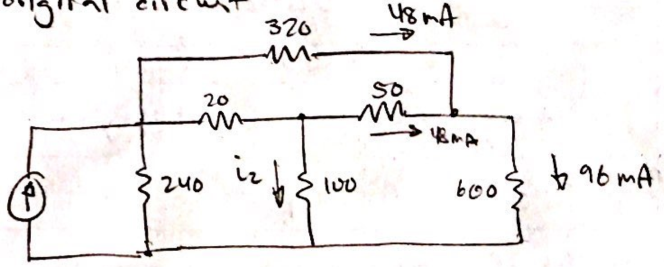
b)



$i_1 = \frac{80}{400} \cdot 240mA$

$\boxed{i_1 = 48mA}$

c) original circuit



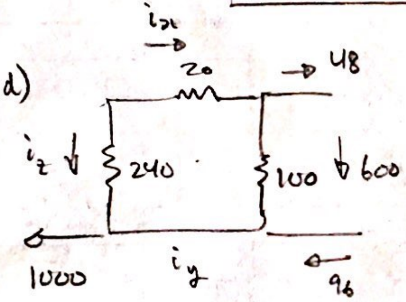
by KCL, $i_{50} = 96 - 48 = 48mA$

by KVL, $50 \cdot 48 + 96 \cdot 600 - i_2 \cdot 100 = 0$

$\to i_2 = \frac{1}{100}(2400 + 57600)$

$\boxed{i_2 = 600mA}$

d)



$i_x = 648$
$i_y = 696$

$\to i_z = 1000 - 696$
$i_z = 304$

$\to v_s = v_{240} = i_z(240\Omega)$

$v_s = 72.96V$

$P_s = i_s v_s$

$\boxed{P_s = 72.96W}$