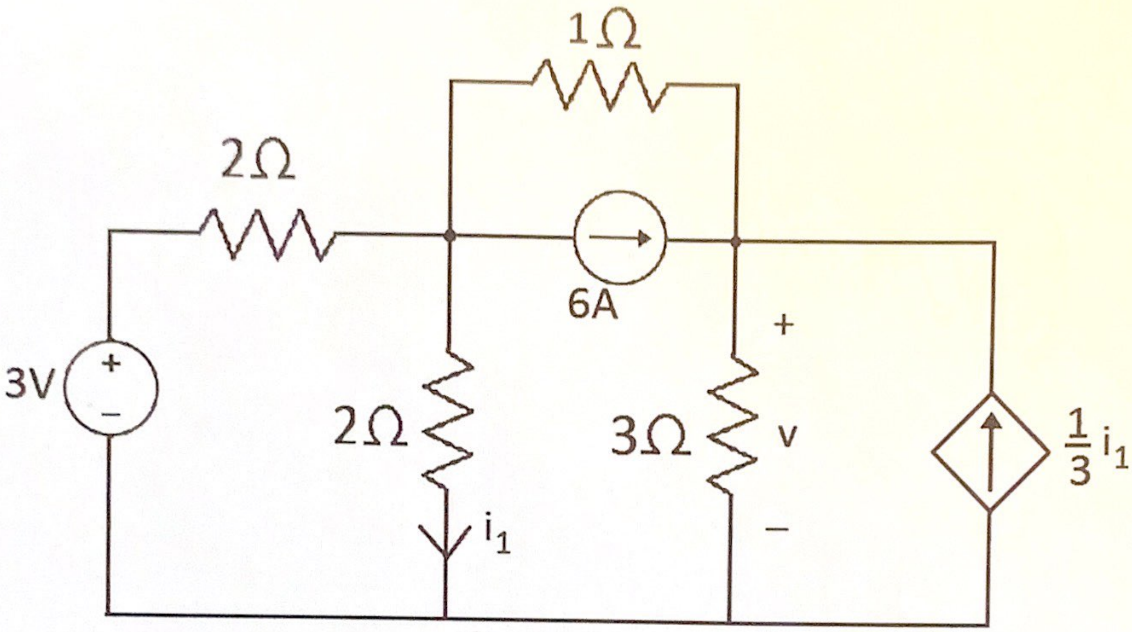
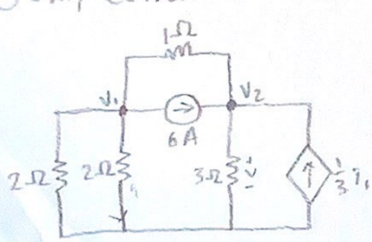
Part 2:

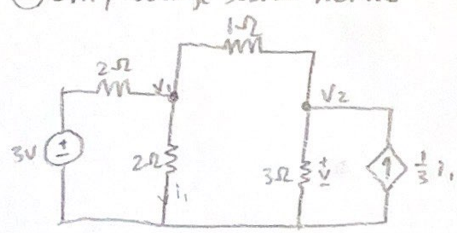
Q1. Use superposition principle in the circuit in the figure below to find the power consumed by that 2Ω resistor which has current i1 flowing through it (as labeled in the circuit).



① Only Current Source Active



② Only Voltage Source Active



$\frac{V_1-3}{2} + \frac{V_1}{2} + V_1 - V_2 = 0$

Node Voltage Analysis @ V_1

$\frac{V_1-0}{2} + \frac{V_1-0}{2} + \frac{V_1-V_2}{1} + 6 = 0$

Node Voltage Analysis @ V_2

$\frac{V_2-V_1}{1} - 6 + \frac{V_2-0}{3} - \frac{1}{3}i_1 = 0$

$V_1 = -4/3 \quad V_2 = 10/3$

$i_1 = \frac{V_1}{2}$

$i_1 = \frac{-4}{6} \quad i_1 = -0.67A$

NVA @ V_1

① $\frac{V_1-3}{2} + \frac{V_1-0}{2} + \frac{V_1-V_2}{1} = 0$

NVA @ V_2

$\frac{V_2-V_1}{1} + \frac{V_2-0}{3} - \frac{1}{3}i_1 = 0$

$\frac{V_2-V_1}{1} + \frac{V_2}{3} = \frac{1}{3}i_1 \quad (i_1 = \frac{V_1}{2})$ [Ohm's Law]

$V_2 - V_1 + \frac{V_2}{3} = \frac{1}{3}(\frac{V_1}{2})$

$V_2 + \frac{V_2}{3} - V_1 - \frac{V_1}{6} = 0$

③ $(1+\frac{1}{3})V_2 + (-1-\frac{1}{6})V_1 = 0$

$V_1 = \frac{4}{3} \quad V_2 = \frac{7}{6}$

$i_1 = 0.67A$

$\boxed{P_{2\Omega} = 0W}$

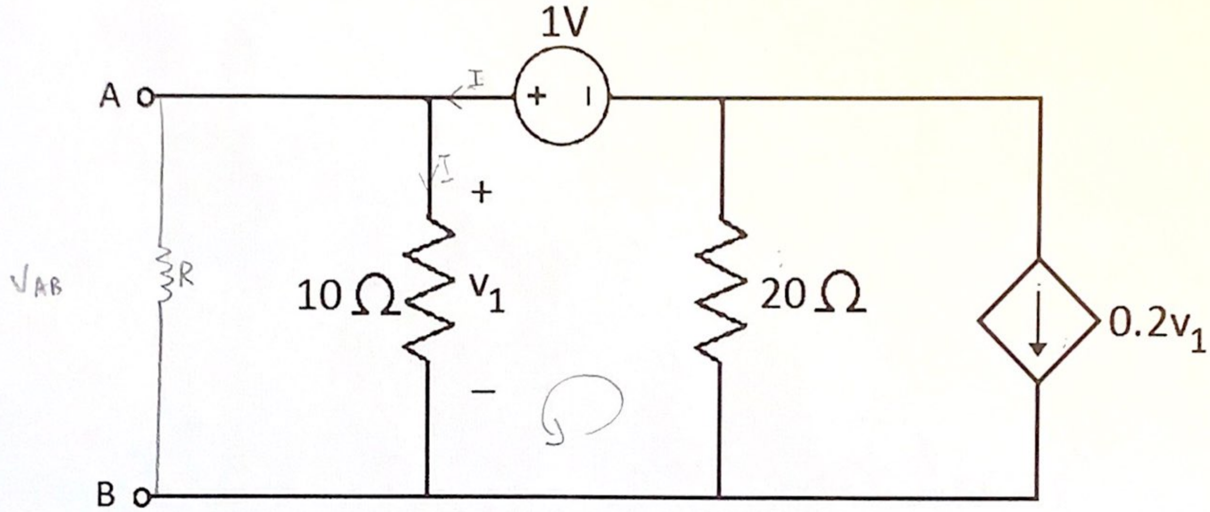
$i_1 = 0A?$ $\quad P_{2\Omega} = 0W?$

eh

Part 2:

Q2. Consider the circuit in the figure below. A resistor R is connected between terminals A and B
of the circuit. Find power dissipated in the resistor R when:
R=10Ω
R=20Ω

$V_1 = V_{oc}$



[Hint: Use Norton's theorem to solve this problem.]

Use KVL on middle loop to solve for I

$1 - V_1 - 20(I + 0.2V_1) = 0$

$1 - V_1 - 20I - 4V_1 = 0$

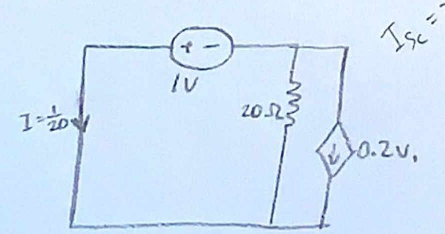
$V_1 = 10I$

$1 - 10I - 20I - 40I = 0$

$-70I = -1$

$I = \frac{1}{70}A \quad V_1 = \frac{1}{7}V = V_{AB}$

Short Circuit

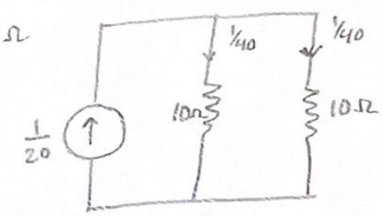


$R_T = \frac{V_T}{I} = \frac{\frac{1}{7}}{\frac{1}{70}} = 10\Omega$

Norton Equivalent

Use circuit divider equation

R=10Ω



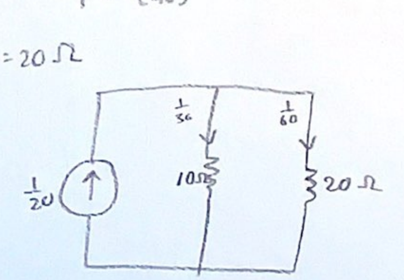
$P = I^2R$

$P = \left(\frac{1}{40}\right)^2 \times 10 = 0.00625W$

R=10Ω

$\boxed{P = 0.00625W}$

R=20Ω



$\left(\frac{1}{20} \times \frac{10}{30}\right) = \frac{1}{60}$

$P = I^2R$

$P = \left(\frac{1}{60}\right)^2 \times 20 = 0.0055W$

R=20Ω

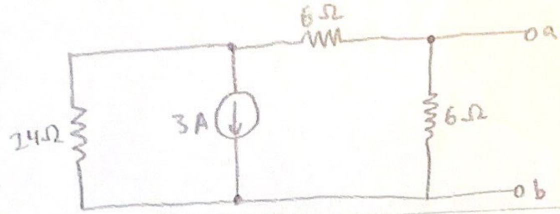
$\boxed{P = 0.0055W}$

$\boxed{P_R = 0.00625W, 0.0055W}$

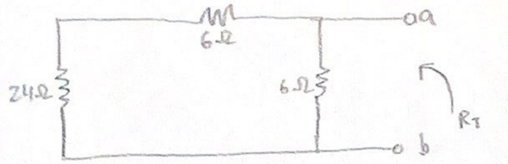
Part 2:

Q3. Problem 2.90 from the book.

Find the maximum power that can be delivered to a resistive load by the circuit shown below. For wat value of load resistance is the power maximum?



• Find R_T



$\frac{d}{dt}$ $R_L = R_T$

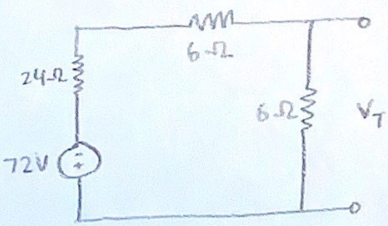
$24 + 6 = 30\Omega$

$30 \| 6 = \frac{30 \times 6}{30 + 6} = \frac{180}{36} = 5\Omega$

$R_T = 5\Omega$

• Find V_T

Source Transformation



Voltage Division Method

$V_T = -72 \frac{6}{24+6+6}$

$V_T = -12V$

$P = \frac{V_T^2}{4 \cdot R_L}$

• Maximum Power

$P_R = \frac{V_T^2}{4R_L}$

$P_R = \frac{(-12)^2}{4 \cdot 5} = \frac{144}{20} = 7.2W$

The maximum power delivered is 7.2W.

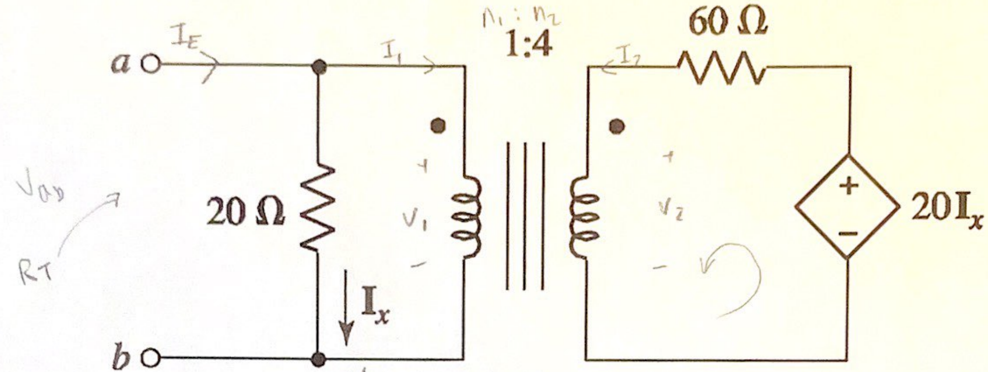
For maximum power transfer, $R_L = R_T = 5\Omega$.

$\boxed{P_R = 7.2W}$

OK

Part 2:

Q4. Find the Thévenin equivalent at terminals *a* and *b* for the network shown below.



$R_T = \frac{V_{ab}}{I_E}$

$n = \frac{n_2}{n_1} = 4$

$V_2 = nV_1$ $\quad i_2 = -\frac{1}{n} i_1$

$\frac{V_1}{V_2} = \frac{n_1}{n_2}$ $\quad -\frac{i_2}{i_1} = \frac{n_1}{n_2}$

(1) $I_E = I_x + I_1$ (KCL)

(2) $I_x = \frac{V_{ab}}{20}$ (Ohm's Law)

(3) $V_2 = 20I_x + 60(-I_2)$ (KVL)

$V_{ab} : V_2$ $\quad -I_1 : -I_2$

1 : 4 $\quad$ 1 : 4

$\frac{V_{ab}}{V_2} = \frac{1}{4}$ $\quad \frac{-I_2}{I_1} = \frac{1}{4}$

(4) $V_2 = 4V_{ab}$ (5) $I_1 = -4I_2$

$4V_{ab} = 20I_x - 60I_2$

$4V_{ab} = 20I_x - 60(-\frac{I_1}{4})$

$4V_{ab} = 20I_x + 15I_1$

$4V_{ab} = 20I_x + 15I_1$

$4V_{ab} = 20(\frac{V_{ab}}{20})(15I_1)$

$4V_{ab} = V_{ab}(15I_1)$

$3V_{ab} = 15I_1$

$V_{ab} = 5I_1$

$I_1 = \frac{V_{ab}}{5}$

$I_E = \frac{V_{ab}}{20} + \frac{V_{ab}}{5}$

$I_E = \frac{1}{4} V_{ab}$

$R_T = \frac{V_{ab}}{I_E}$

$R_T = \frac{5I_1}{\frac{1}{4}(5I_1)}$

$\boxed{R_T = 4\Omega}$

$V_T = 0$ $\quad V_{oc}$

$I_N = 0$ $\quad I_{sc}$

Thévenin: $R_T = 4\Omega$