LAM

Engineering 11
Electrical Circuit Analysis
Exam 1 Solutions

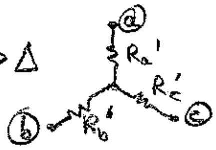
2005

① a. $V_3 = \frac{R_3}{(R_1+R_2)+R_3} V_S$ ($V \div$) b. let $R_{eq} = R_1 \| R_2 = \frac{R_1R_2}{R_1+R_2}$; $I_3 = \frac{R_{eq}}{R_{eq}+R_3} I_S$ ($I \div$)

② a. R_2 irrelevant since it is shorted $\Rightarrow \sum i = \frac{V_L - 0}{R_1} - I_S + \frac{V_L - 0}{R_L} = 0 \Rightarrow I_S = \frac{1}{10^3} + \frac{1}{10^3} = 2mA$

b. Power delivered to circuit $P_{Delivered} = V_L I_S = 2mW$

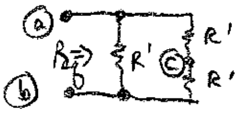
second 2. $Y \to \Delta$



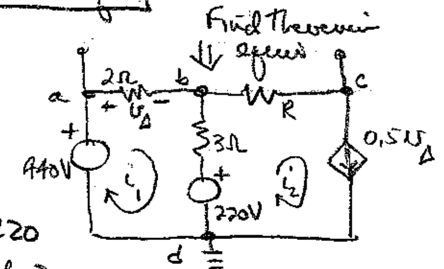
$\Longleftrightarrow$

$R_{ab} = R_{ac} = R_{bc} = \frac{R^2+R^2+R^2}{R} = 3R$

Now $R_{ab} \| R_{ab}' = \frac{3R(R)}{3R+R} = \frac{3R}{4} = R'$ (same for other pairs)



$R_{eq} = \frac{R'(2R')}{R'+2R'} = \frac{2(R')^2}{3R'} = \frac{2}{3}R' = \frac{2}{3}\left(\frac{3R}{4}\right) = \frac{R}{2} = R_{eq}$

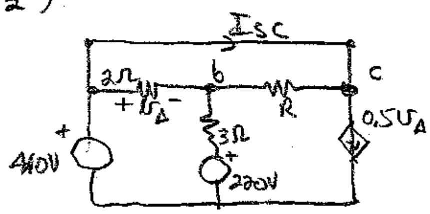


3. Maximize power to load resistor $R_L = 7 \| 3.08 = 2.12\Omega$

V_T: $\sum_{abdc} v = 0 = 440 - v_\Delta - 3(i_1 - i_2) - 220 \Rightarrow 3i_1 - 3i_2 + v_\Delta = 220$

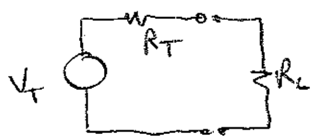
$i_2 = 0.5 v_\Delta \quad v_\Delta = 2i_1 \Rightarrow i_2 = 0.5(2i_1) = i_1 \Rightarrow v_\Delta = 220$

so $V_{oc} = V_T = v_\Delta + i_2 R = v_\Delta + i_1 R = v_\Delta + R\frac{v_\Delta}{2} = 220\left(1 + \frac{R}{2}\right)$



I_{sc}: $\sum_b i = \frac{v_\Delta}{2} - \frac{(440 - v_\Delta) - 220}{3} - \frac{(440 - v_\Delta) - 440}{R} = 0 \Rightarrow v_\Delta = \frac{440R}{5R+6}$

$\sum_c i = I_{sc} - 0.5 v_\Delta + \frac{(440 - v_\Delta) - 440}{R} = 0 \Rightarrow I_{sc} = \frac{R+2}{5R+6}(220)$



$V_T = 220\left(1 + \frac{R}{2}\right)$

$R_T = \frac{V_T}{I_{sc}} = \frac{[(R+2)/2]\,220}{[(R+2)/(5R+6)]\,220} = \frac{5R+6}{2}$

$R_L = 2.12\Omega$

Max power @ $R_T = R_L \Rightarrow \frac{5R+6}{2} = 2.12 \Rightarrow 5R + 6 = 4.24 - 6 \Rightarrow R < 0$

not possible, so set $R = 0$ for max power transfer.