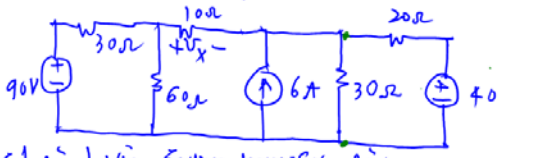
EE 101 Lecture 11 Feb 2, 2018

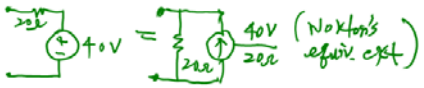
Circuit theorems (continued)

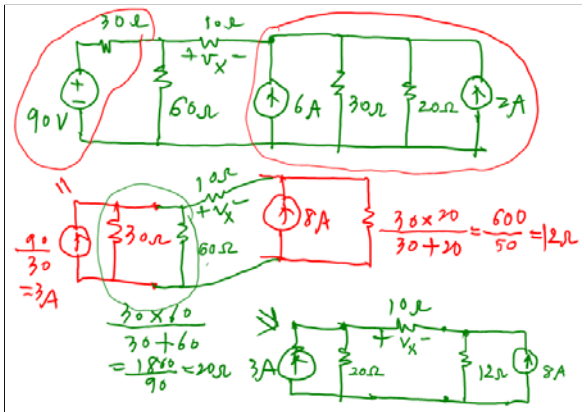
Prob 4.17 Find v_x

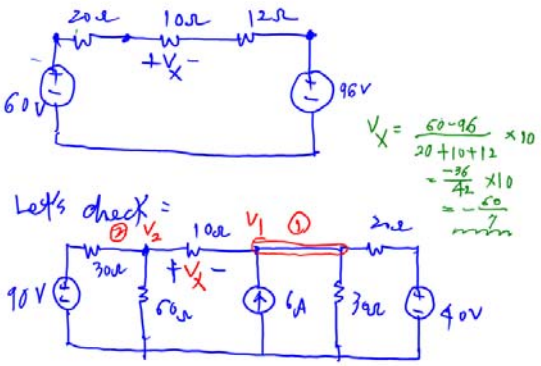


Solution) via source transformation

Step 1 :







Let's check :

KCL at node ① : $6+\frac{v_2-v_1}{10}=\frac{v_1}{30}+\frac{v_1-40}{20}$ (1)

" ② : $\frac{90-v_2}{30}=\frac{v_2}{60}+\frac{v_2-v_1}{10}$ (2)

(1) × 60 ⇒ $360+6v_2-6v_1=2v_1+3v_1-120$ (1)′

(2) × 60 ⇒ $180-2v_2=v_2+6v_2-6v_1$ (2)′

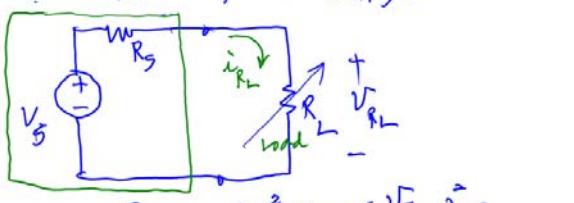
$$\Rightarrow \begin{bmatrix} 11 & -6 \\ -6 & 9 \end{bmatrix}\begin{bmatrix} v_1 \\ v_2 \end{bmatrix}=\begin{bmatrix} 480 \\ 180 \end{bmatrix}$$

$$v_1=\frac{\begin{vmatrix} 480 & -6 \\ 180 & 9 \end{vmatrix}}{\begin{vmatrix} 11 & -6 \\ -6 & 9 \end{vmatrix}}=\frac{480(9)+6(180)}{99-36}=\frac{5400}{63}\left(=\frac{600}{7}\right)$$

$$v_2=\frac{\begin{vmatrix} 11 & 480 \\ -6 & 180 \end{vmatrix}}{\begin{vmatrix} 11 & -6 \\ -6 & 9 \end{vmatrix}}=\frac{11(180)+6(480)}{63}=\frac{4860}{63}$$

$$v_x=v_2-v_1=\frac{4860-5400}{63}=\frac{-540}{63}=\frac{-60}{7}\ \text{(check)}$$

Maximum Power Transfer



$$P_{Load}=i_{R_L}^2 R_L=\left(\frac{V_S}{R_S+R_L}\right)^2 R_L$$

$$=V_S^2\frac{R_L}{(R_S+R_L)^2}$$

$P_{Load}^{max}=?$

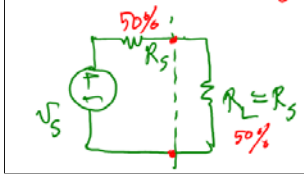
$$\frac{\partial}{\partial R_L}P_{Load}=V_S^2\frac{(R_S+R_L)^2-R_L\,2(R_S+R_L)}{(R_S+R_L)^4}=0$$

$$(R_S+R_L)^2-R_L\,2(R_S+R_L)=0$$

$$R_S+R_L-2R_L=0$$

$$\Rightarrow \boxed{R_L=R_S}$$

$$P_{Load}^{max}=\left(\frac{V_S}{2R_S}\right)^2 R_S=\frac{V_S^2}{4R_S}$$



Now let's solve some problems !