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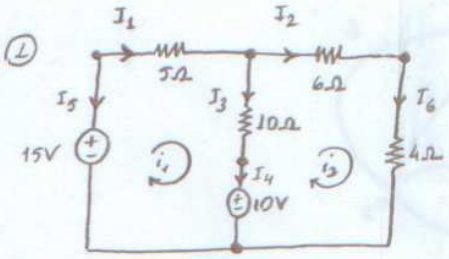
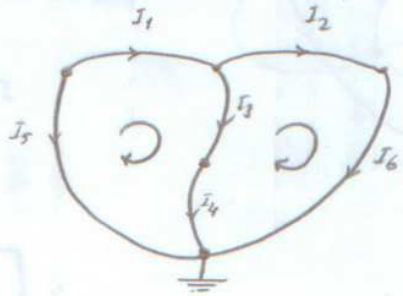
EE 201 Section 4

HW # 1

① 

a) 

b) $\underline{\underline{M}} = \begin{bmatrix} 1 & 0 & 1 & 1 & -1 & 0 \\ 0 & 1 & -1 & -1 & 0 & 1 \end{bmatrix}$

$\underline{i}$ = $\underline{\underline{M}}^T \cdot \underline{I}$ = $\begin{bmatrix} I_1 \\ I_2 \\ I_3 \\ I_4 \\ I_5 \\ I_6 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \\ 1 & -1 \\ 1 & -1 \\ -1 & 0 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \end{bmatrix} = \begin{bmatrix} i_1 \\ i_2 \\ i_1 - i_2 \\ i_1 - i_2 \\ -i_1 \\ i_2 \end{bmatrix}$

($\underline{i}$: branch currents; $\underline{I}$: mesh currents)

$I_1 = -I_5 = i_1$

$I_2 = I_6 = i_2$

$I_3 = I_4 = i_1 - i_2$

c) $\underline{V} = \underline{\underline{R}} \cdot \underline{i} + \underline{V_s}$

$$\begin{bmatrix} V_1 \\ V_2 \\ V_3 \\ V_4 \\ V_5 \\ V_6 \end{bmatrix} = \begin{bmatrix} 5 & 0 & 0 & 0 & 0 & 0 \\ 0 & 6 & 0 & 0 & 0 & 0 \\ 0 & 0 & 10 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 4 \end{bmatrix} \cdot \begin{bmatrix} I_1 \\ I_2 \\ I_3 \\ I_4 \\ I_5 \\ I_6 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 0 \\ 10 \\ 15 \\ 0 \end{bmatrix} = \begin{bmatrix} 5 & 0 & 0 & 0 & 0 & 0 \\ 0 & 6 & 0 & 0 & 0 & 0 \\ 0 & 0 & 10 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 4 \end{bmatrix} \cdot \begin{bmatrix} i_1 \\ i_2 \\ i_1 - i_2 \\ i_1 - i_2 \\ -i_1 \\ i_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 0 \\ 10 \\ 15 \\ 0 \end{bmatrix}$$

d) $\underline{V} = \underline{\underline{R}} \cdot \underline{i} + \underline{V_s} = \underline{\underline{R}} \cdot \underline{\underline{M}}^T \cdot \underline{I} + \underline{V_s}$

$\underline{\underline{M}} \cdot \underline{V} = \underline{\underline{M}} \cdot \underline{\underline{R}} \cdot \underline{\underline{M}}^T \underline{I} + \underline{\underline{M}} \cdot \underline{V_s} = 0$

$$\begin{bmatrix} 5 & 0 & 10 & 0 & 0 & 0 \\ 0 & 6 & -10 & 0 & 0 & 4 \end{bmatrix} \cdot \begin{bmatrix} 1 & 0 \\ 0 & 1 \\ 1 & -1 \\ 1 & -1 \\ -1 & 0 \\ 0 & 1 \end{bmatrix} \cdot \begin{bmatrix} i_1 \\ i_2 \end{bmatrix} + \begin{bmatrix} -5 \\ -10 \end{bmatrix} = 0$$

$$\begin{bmatrix} 15 & -10 \\ -10 & 20 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \end{bmatrix} = \begin{bmatrix} 5 \\ 10 \end{bmatrix} \longrightarrow \begin{matrix} 15 i_1 - 10 i_2 = 5 \\ -10 i_1 + 20 i_2 = 10 \end{matrix} \rightarrow \begin{matrix} 3 i_1 - 2 i_2 = 1 \\ -i_1 + 2 i_2 = 1 \end{matrix}$$

$i_1 = 1A$

$i_2 = 1A$

e) from part (b):

$I_1 = i_1 = 1A$

$I_2 = i_2 = 1A$

$I_3 = i_1 - i_2 = 0A$

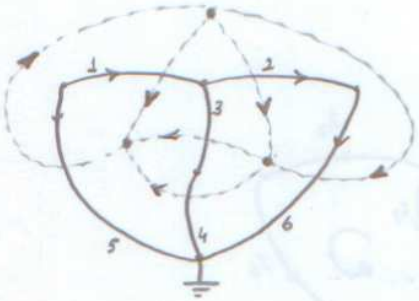
and

$I_5 = -1A$

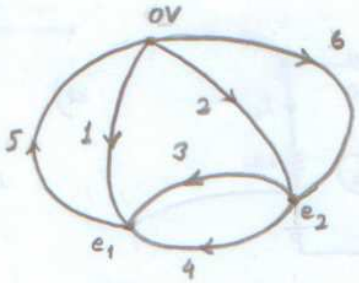
$I_6 = 1A$

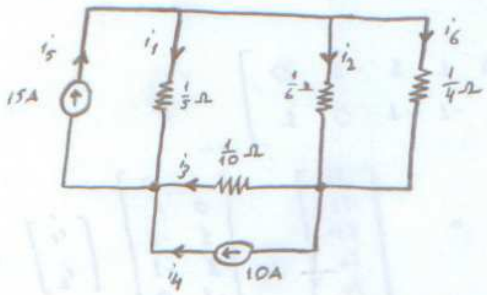
$I_4 = 0A$

(2)



a)





b)

$$\begin{bmatrix} V_1 \\ V_2 \\ V_3 \\ V_4 \\ V_5 \\ V_6 \end{bmatrix} = \underline{\underline{A}}^T \cdot \begin{bmatrix} e_1 \\ e_2 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \\ 1 & -1 \\ 1 & -1 \\ -1 & 0 \\ 0 & 1 \end{bmatrix} \cdot \begin{bmatrix} e_1 \\ e_2 \end{bmatrix}$$

$$\begin{bmatrix} V_1 \\ V_2 \\ V_3 \\ V_4 \\ V_5 \\ V_6 \end{bmatrix} = \begin{bmatrix} e_1 \\ e_2 \\ e_1 - e_2 \\ e_1 - e_2 \\ -e_1 \\ e_2 \end{bmatrix}$$

$V_1 = -V_5 = e_1$

$V_2 = V_6 = e_2$

$V_3 = V_4 = e_1 - e_2$

c)

$$\underline{i'} = \underline{\underline{Y}} \cdot \underline{v} + \underline{i_s}$$

$$\begin{bmatrix} i_1 \\ i_2 \\ i_3 \\ i_4 \\ i_5 \\ i_6 \end{bmatrix} = \begin{bmatrix} 5 & 0 & 0 & 0 & 0 & 0 \\ 0 & 6 & 0 & 0 & 0 & 0 \\ 0 & 0 & 10 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 4 \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \\ V_3 \\ V_4 \\ V_5 \\ V_6 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 0 \\ 10 \\ 15 \\ 0 \end{bmatrix}$$

d)

$$\underline{i'} = \underline{\underline{Y}} \cdot \underline{v} + \underline{i_s} = \underline{\underline{Y}} \cdot \underline{\underline{A}}^T \cdot \underline{e} + \underline{i_s}$$

$$\underline{\underline{A}} \cdot \underline{i'} = \underline{\underline{A}} \cdot \underline{\underline{Y}} \cdot \underline{\underline{A}}^T \cdot \underline{e} + \underline{\underline{A}} \cdot \underline{i_s} = 0$$

$$\begin{bmatrix} 5 & 0 & 10 & 0 & 0 & 0 \\ 0 & 6 & -10 & 0 & 0 & 4 \end{bmatrix} \cdot \begin{bmatrix} 1 & 0 \\ 0 & 1 \\ 1 & -1 \\ 1 & -1 \\ -1 & 0 \\ 0 & 1 \end{bmatrix} \cdot \begin{bmatrix} e_1 \\ e_2 \end{bmatrix} + \begin{bmatrix} -5 \\ -10 \end{bmatrix} = 0 \Rightarrow \begin{bmatrix} 15 & -10 \\ -10 & 20 \end{bmatrix} \begin{bmatrix} e_1 \\ e_2 \end{bmatrix} = \begin{bmatrix} 5 \\ 10 \end{bmatrix}$$

$$\underline{e_1 = 1V}$$
$$\underline{e_2 = 1V}$$

e) from part (b):

$V_1 = e_1 = 1V$

$V_2 = e_2 = 1V$

$V_3 = V_4 = e_1 - e_2 = 0V$

$V_5 = -e_1 = -1V$

$V_6 = e_2 = 1V$