

5. (15 pts) Use mesh analysis.

- a. How many mesh equations are needed to solve the circuit below? \_\_\_\_\_  
 b. Write the mesh equations.  
 c. Solve the equations and calculate the power delivered by the 8 V. source. (bonus)

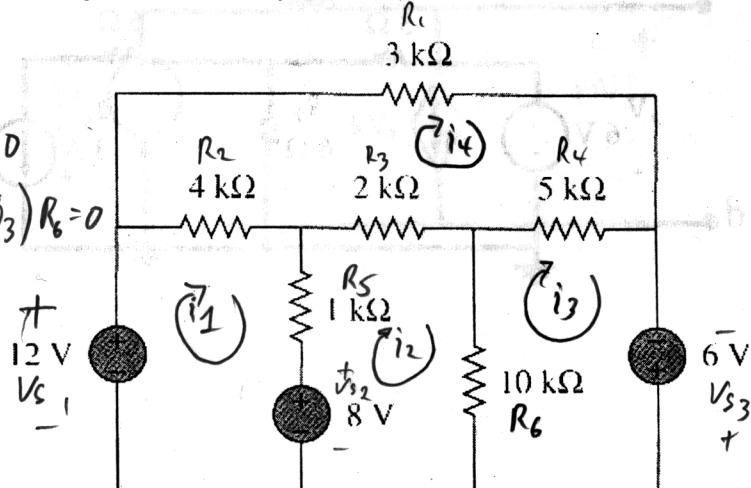
$$P_{8V} = \underline{6.96 \text{ mW}}$$

$$V_{S_1} - (i_1 - i_4)R_2 - (i_1 - i_2)R_5 - V_{S_2} = 0$$

$$V_{S_2} - (i_2 - i_1)R_5 - (i_2 - i_4)R_3 - (i_2 - i_3)R_6 = 0$$

$$V_{S_3} - (i_3 - i_2)R_6 - (i_3 - i_4)R_4 = 0$$

$$\begin{aligned} -i_4 R_1 - (i_4 - i_3)R_4 - (i_4 - i_2)R_3 \\ - (i_4 - i_1)R_2 = 0 \end{aligned}$$



$$\begin{pmatrix} -R_2 - R_5 & R_5 & 0 & R_1 \\ +R_5 & -R_5 - R_3 - R_6 & R_6 & R_3 \\ 0 & R_6 & -R_6 - R_4 & R_4 \\ R_2 & R_3 & R_4 & -R_1 - R_4 - R_3 - R_2 \end{pmatrix} \begin{pmatrix} i_1 \\ i_2 \\ i_3 \\ i_4 \end{pmatrix} = \begin{pmatrix} -V_{S_1} + V_{S_2} \\ -V_{S_2} \\ -V_{S_3} \\ 0 \end{pmatrix}$$

$$\begin{pmatrix} -5k\Omega & 1k\Omega & 0 & 4k\Omega \\ 1k\Omega & -13k\Omega & 10k\Omega & 2k\Omega \\ 0 & 10k\Omega & -15k\Omega & 5k\Omega \\ 4k\Omega & 2k\Omega & 5k\Omega & -14k\Omega \end{pmatrix} \begin{pmatrix} i_1 \\ i_2 \\ i_3 \\ i_4 \end{pmatrix} = \begin{pmatrix} -4V \\ -8V \\ -6V \\ 0 \end{pmatrix} \Rightarrow \begin{pmatrix} i_1 \\ i_2 \\ i_3 \\ i_4 \end{pmatrix} = \begin{pmatrix} 7.22 \text{ mA} \\ 8.09 \text{ mA} \\ 7.79 \text{ mA} \\ 6.00 \text{ mA} \end{pmatrix}$$

$$P_{S_2} = V_{S_2} (i_2 - i_1)$$

$$= 6.96 \text{ mW}$$