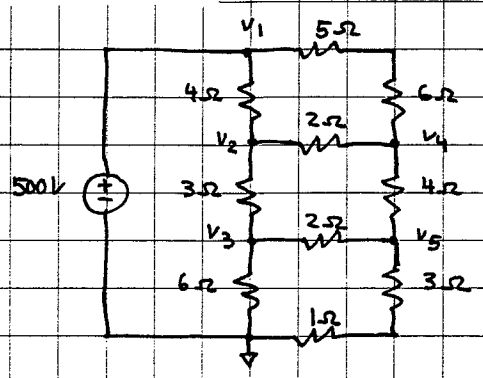
ex:



6 essential nodes
but v_1 is known
∴ we need (6-1) − 1 eq'ns
or 4 eq'ns for v_2, v_3, v_4, v_5

a) Use node-V to power in 5Ω R. Use Matlab.

We put ref at bottom of 500V so we know $v_1 = 500V$.
∴ we don't need an eq'n for v_1.

$$\frac{v_2 - v_1}{4\Omega} + \frac{v_2 - v_4}{2\Omega} + \frac{v_2 - v_3}{3\Omega} = 0$$

$$\frac{v_3 - v_2}{3\Omega} + \frac{v_3 - v_5}{2\Omega} + \frac{v_3}{6\Omega} = 0$$

$$\frac{v_4 - v_1}{5\Omega + 6\Omega} + \frac{v_4 - v_2}{2\Omega} + \frac{v_4 - v_5}{4\Omega} = 0$$

$$\frac{v_5 - v_4}{4\Omega} + \frac{v_5 - v_3}{2\Omega} + \frac{v_5}{3\Omega + 1\Omega} = 0$$

Write as matrix

$$\begin{bmatrix} -1/4\Omega + 1/2\Omega + 1/3\Omega & -1/3\Omega & -1/2\Omega & 0/\Omega \\ -1/3\Omega & 1/3 + 1/2 + 1/6\Omega & 0/\Omega & -1/2\Omega \\ -1/2\Omega & 0/\Omega & 1/4 + 1/2 + 1/4\Omega & -1/4 \\ 0/\Omega & -1/2\Omega & -1/4\Omega & 1/4 + 1/2 + 1/4\Omega \end{bmatrix} \begin{bmatrix} v_2 \\ v_3 \\ v_4 \\ v_5 \end{bmatrix} = \begin{bmatrix} 500V/4\Omega \\ 0 \\ 500V/1\Omega \\ 0 \end{bmatrix}$$

Now use Matlab to solve this matrix eqn.

From Matlab we get: $v_2 = 300\,V$ $v_3 = 180\,V$ $v_4 = 280\,V$ $v_5 = 160\,V$.

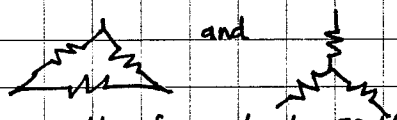
The power dissipated in the 5Ω Resistor is $i_5^2 \cdot 5\Omega$

where $i_5 = \dfrac{v_4 - v_1}{5\Omega + 6\Omega} = \dfrac{280 - 500\,V}{11\Omega} = \dfrac{-220\,V}{11\Omega} = -20\,A.$

$\therefore P_{5\Omega} = (-20)^2 \cdot 5\ W = 2000\ W$ or $2\ kW$

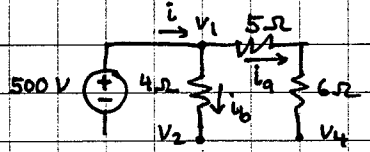
b) Find the power supplied by 500V source.

We might be tempted to calculate the equivalent resistance, R_{eq}, for all the resistors in the diagram and then use $pwr = (500\,V)^2 / R_{eq}$.

Unfortunately, we would have to deal with Δ and Y configurations:  and

We would need results from text, section 3.7. This approach would also be very tedious.

Instead, we just note that current i flowing out of the 500V source must equal the currents thru the 5Ω and 4Ω R's connected to node v_1: $i = i_a + i_b$



$i_a = \dfrac{v_1 - v_4}{5\Omega + 6\Omega}$ $\quad i_b = \dfrac{v_1 - v_2}{4\Omega}$

or $i_a = \dfrac{500 - 280\,V}{11\Omega} = \dfrac{220\,V}{11\Omega} = 20\,A$ $\quad i_b = \dfrac{500 - 300\,V}{4\Omega} = \dfrac{200\,V}{4\Omega} = 50\,A$

$\therefore i = 20\,A + 50\,A = 70\,A$

$P_{500V} = i \cdot 500\,V = 70\,A \cdot 500\,V = 35\,000\,W$ or $35\ kW$