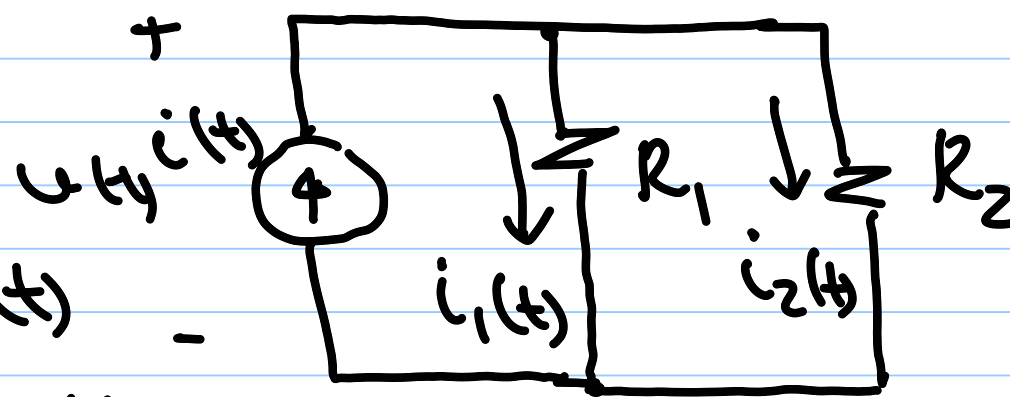
Lecture 4

From Sections 2.4 - 2.6 of Textbook

Solve E2.10 - E2.16 and

2.38, 2.40, 2.41, 2.43, 2.44, 2.48, 2.51, 2.53, 2.55, 2.61, 2.63, 2.70

Current Divider



* Using KCL

$$i(t) = i_1(t) + i_2(t)$$

$$i(t) = \frac{v(t)}{R_1} + \frac{v(t)}{R_2}$$

$$\Rightarrow i(t) = \left(\frac{1}{R_1} + \frac{1}{R_2}\right) v(t) \Rightarrow i(t) = G_p v(t)$$

$$\Rightarrow v(t) = i(t) R_p \text{ where } \frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$$

Current Divider (Cont'd)

$$i(t) = \left(\frac{R_1 + R_2}{R_1 R_2}\right) v(t) \Longrightarrow v(t) = \frac{R_1 R_2}{(R_1 + R_2)} i(t)$$

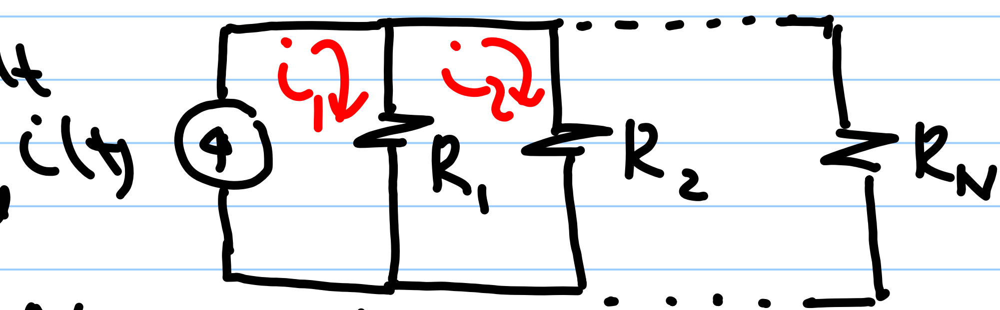
$$i_1(t) = \frac{v(t)}{R_1} \Longrightarrow i_1(t) = \frac{R_2}{(R_1 + R_2)} i(t)$$

$$i_2(t) = \frac{v(t)}{R_2} \Longrightarrow i_2(t) = \frac{R_1}{(R_1 + R_2)} i(t)$$

The smaller resistor gets more current!

Multiple Parallel Resistors

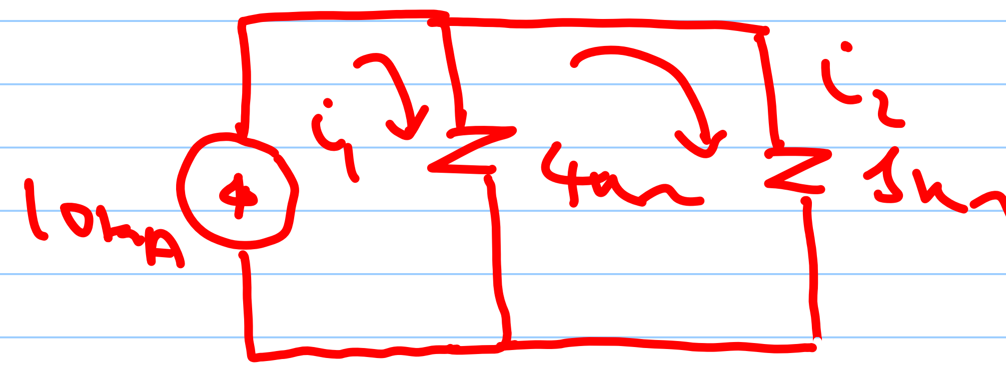
* The previous result can be generalized to the case of N resistors in parallel



$$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \cdots + \frac{1}{R_N}$$

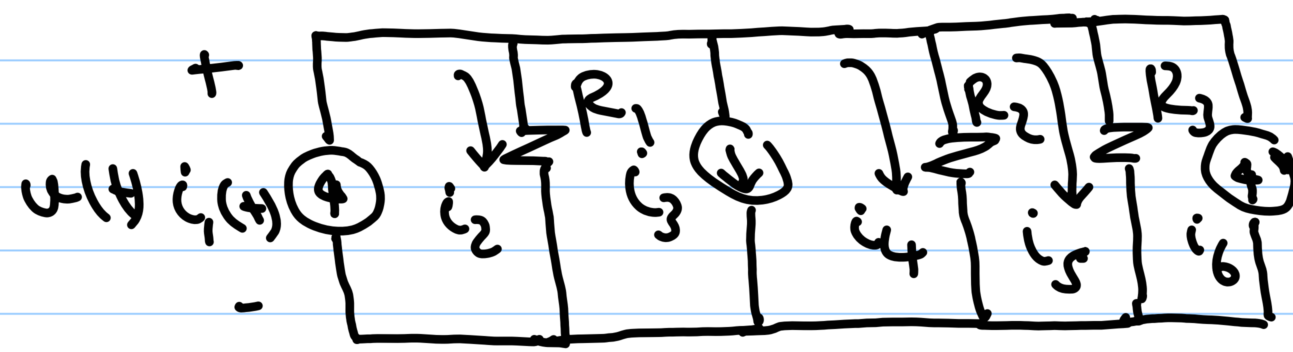
$$i_1 = \frac{(R_2 + R_3 + \cdots + R_N)}{(R_1 + R_2 + \cdots + R_N)} i \quad \Big| \quad i_k = \frac{\sum_{k \neq i} R_k}{\sum_{k=1}^{N} R_k} i$$

Example



Find $i_1(t)$ and $i_2(t)$

Multiple Sources



Applying KCL, we get

$$i_1 + i_6 = i_2 + i_3 + i_4 + i_5$$

$$\Rightarrow i_1 - i_3 + i_6 = i_2 + i_4 + i_5$$

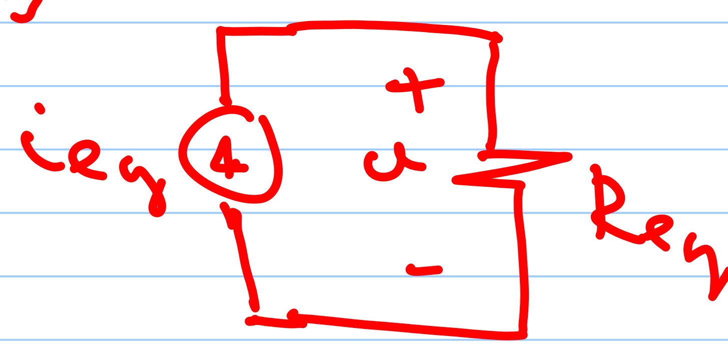
$$\Rightarrow i_1 - i_3 + i_6 = v(t)\left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right)$$

Multiple Sources (cont'd)

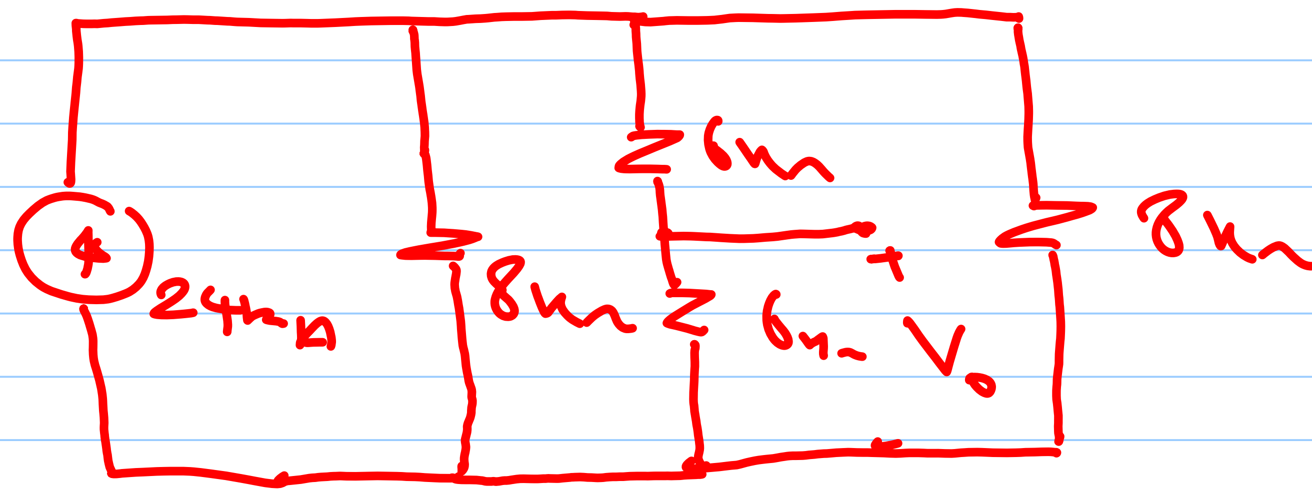
$\Rightarrow i_{eq} = v(t)\, G_{eq} \Rightarrow v(t) = i_{eq} R_{eq}$

$i_{eq} = i_1 - i_3 + i_6$

$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$

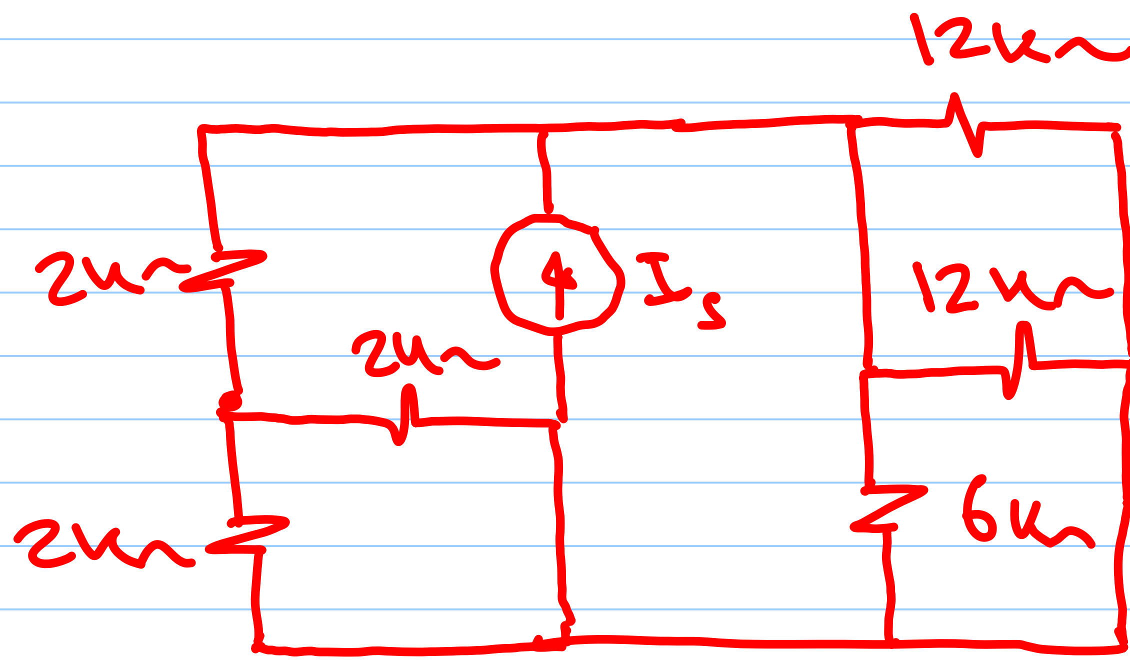


Example



Find V_o in the shown circuit

Example



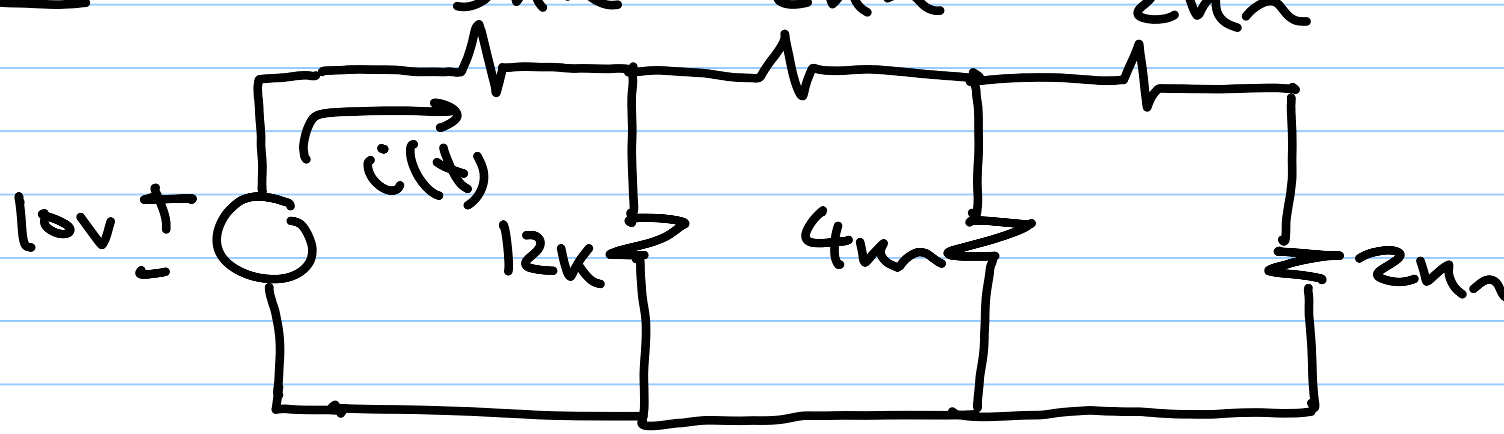
If $P_{6k\Omega} = 56\text{mW}$, find I_s

Series and parallel Combinations

* Most circuits Contain a Combination of series and parallel Connections

* Networks are reduced to much simpler circuits

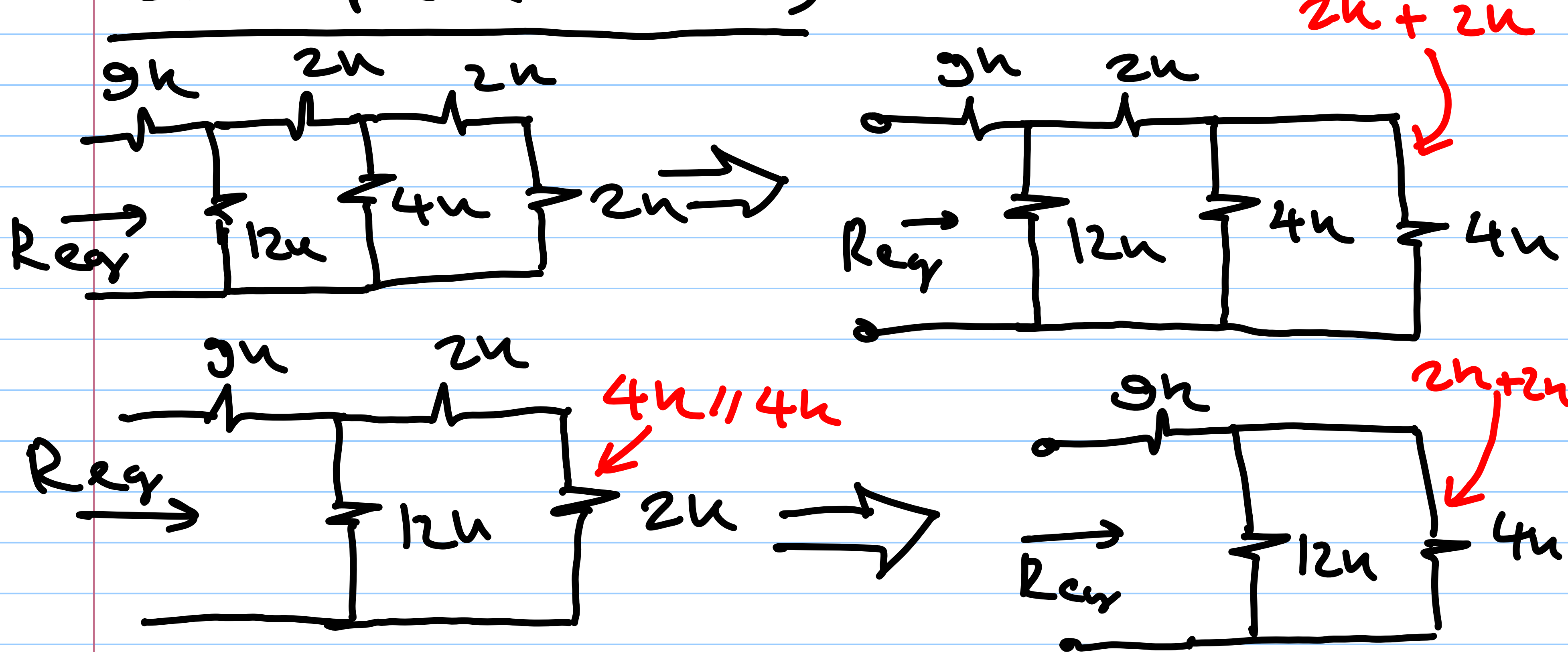
Example



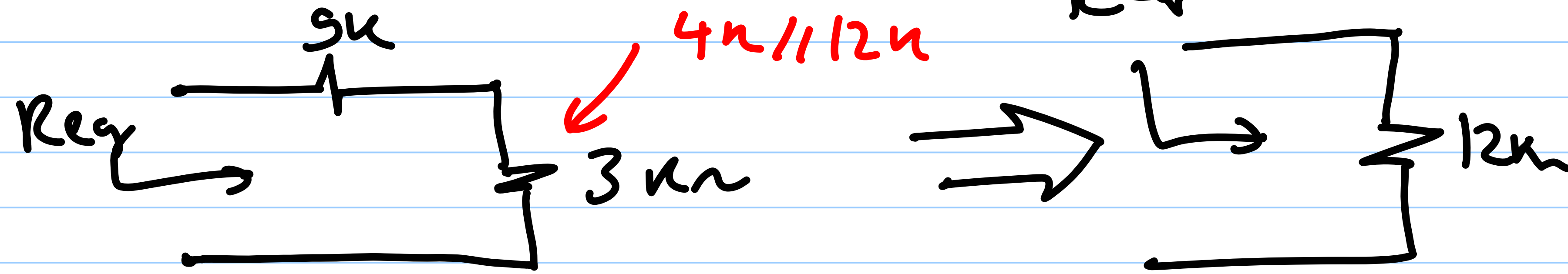
For the shown circuit find i(t).

Sol: $i(t) = \frac{10V}{R_{eq}}$

Example (Cont'd)



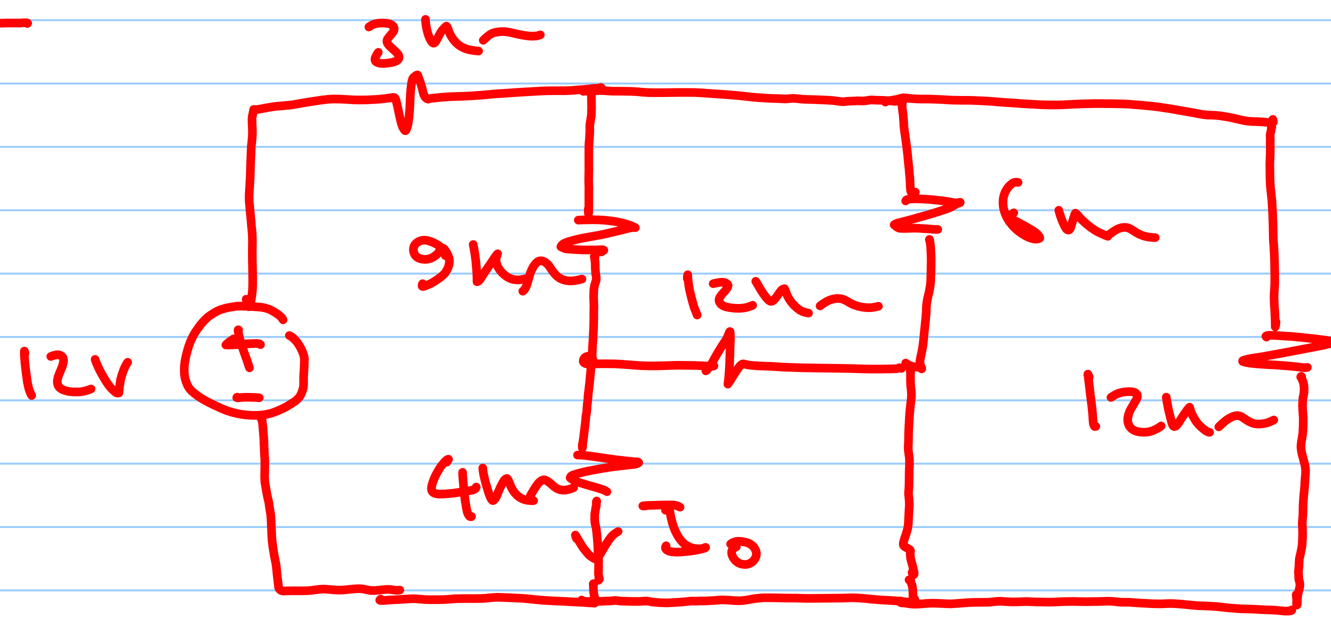
Example (Cont'd)



$$R_{eq} = 12\,k\Omega$$

$$i(t) = \frac{v(t)}{R_{eq}} = \frac{10}{12\,k\Omega} = 0.83\,mA$$

Example



Find I_o in the shown Circuit