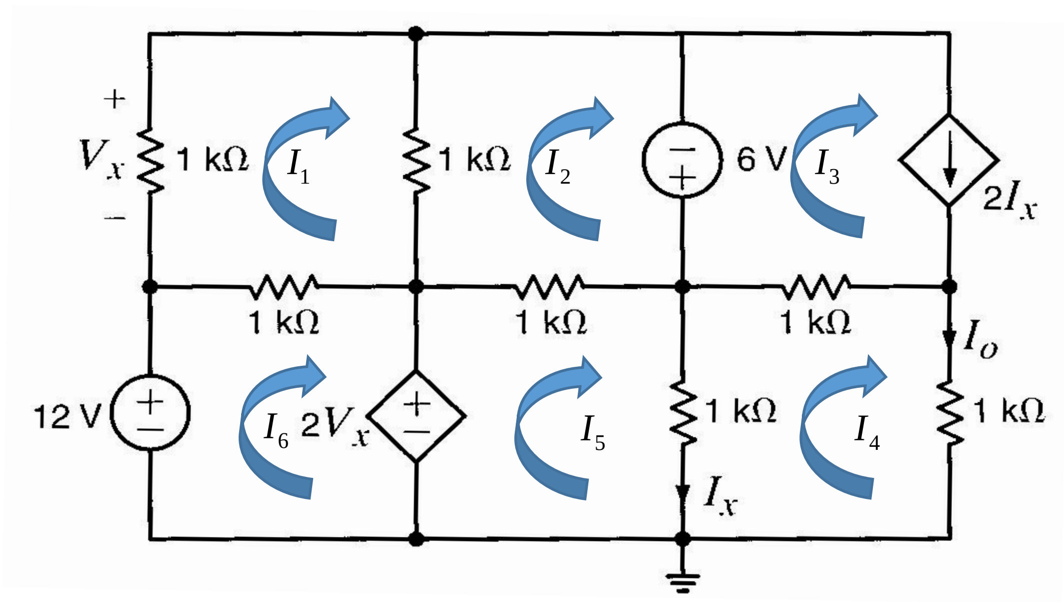
1.(20%) Please determine I_o in Fig. 1.



$$I_1 \times 1k = -V_x, I_3 = 2I_x$$

$$I_5 - I_4 = I_x$$

$$\Rightarrow I_3 = 2I_5 - 2I_4 \quad ①$$

$$KCL: 3k \times I_1 - 1k \times I_6 - 1k \times I_2 = 0$$

$$\Rightarrow -3V_x - 1k \times I_6 - 1k \times I_2 = 0 \quad ②$$

$$KCL: 1k \times I_6 + 2V_x - 1k \times I_1 - 12 = 0$$

$$\Rightarrow 1k \times I_6 + 3V_x - 12 = 0 \quad ③$$

可得：$I_2 = -12mA$

$$KCL: 2k \times I_2 - 1k \times I_1 - 1k \times I_5 - 6 = 0$$

$$\Rightarrow -24 + V_x - 1k \times I_5 - 6 = 0 \quad ④$$

$$KCL: 2k \times I_5 - 1k \times I_2 - 1k \times I_4 - 2V_x = 0$$

$$\Rightarrow 2k \times I_5 + 12 - 1k \times I_4 - 2V_x = 0 \quad ⑤$$

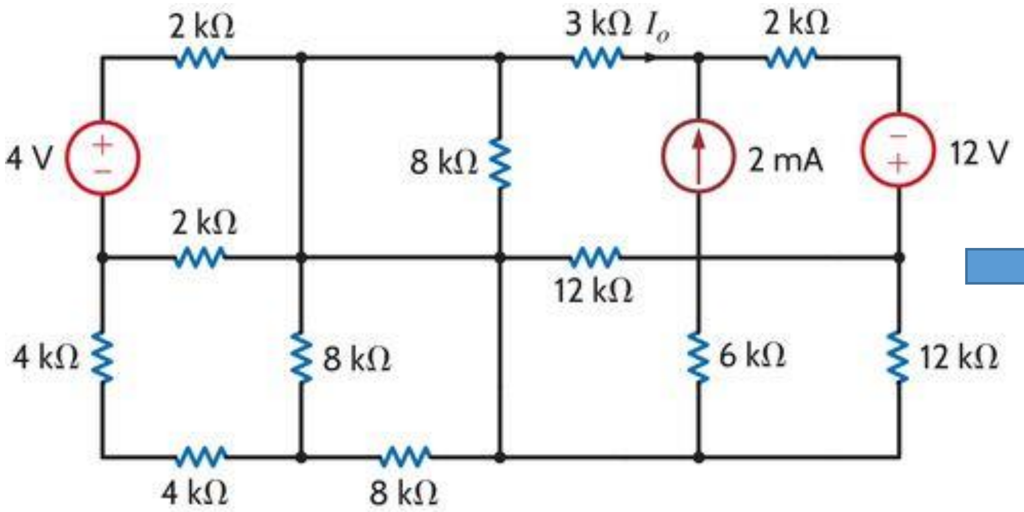
$$KCL: 3k \times I_4 - 1k \times I_5 - 1k \times I_3 = 0$$

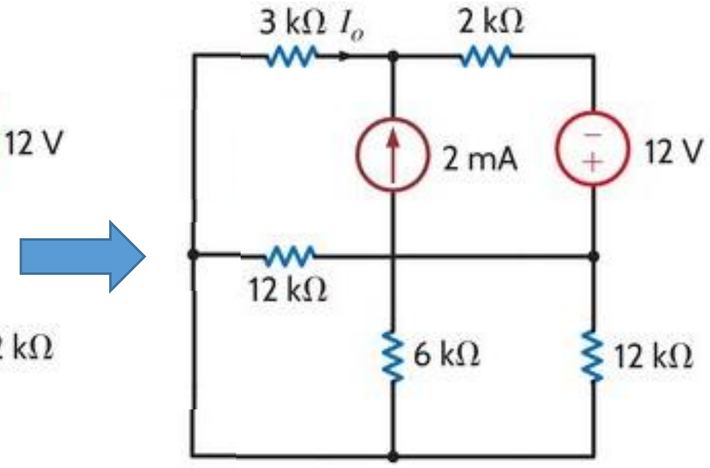
$$\Rightarrow 3k \times I_4 - 1k \times I_5 = 1k \times I_3$$ 與①有: $5k \times I_4 - 3k \times I_5 = 0$ ⑥

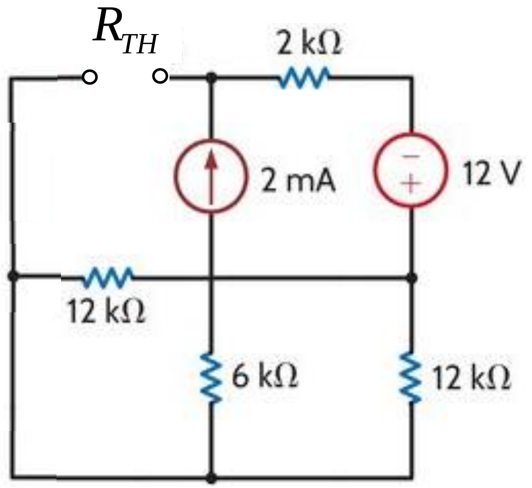
聯立④⑤⑥解得：$V_x = -50V, I_4 = -48mA$

$$I_0 = I_4 = -48mA$$

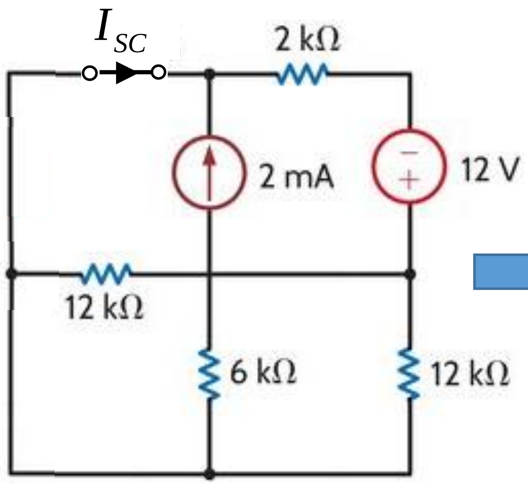
2.(15%) Please using Norton's theorem to determine I_o in Fig. 2.

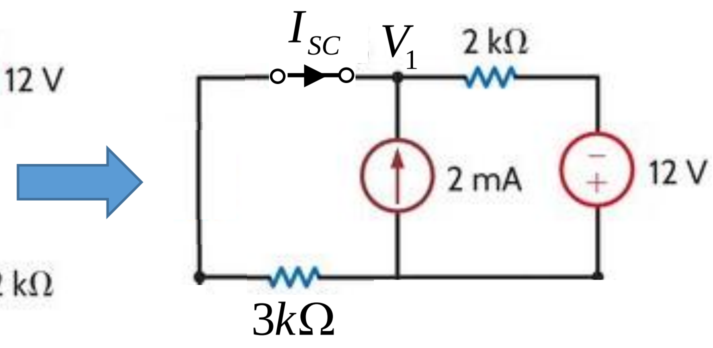






$$R_{TH} = (12k\Omega // 6k\Omega // 12k\Omega) + 2k\Omega = 5k\Omega$$

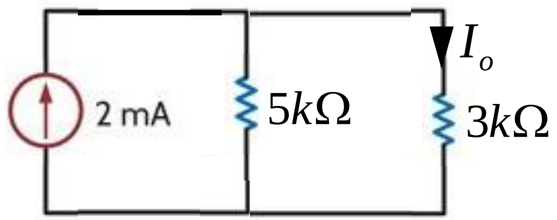




$$\frac{V_1 - (-12)}{2k} + \frac{V_1}{3k} = 2m$$

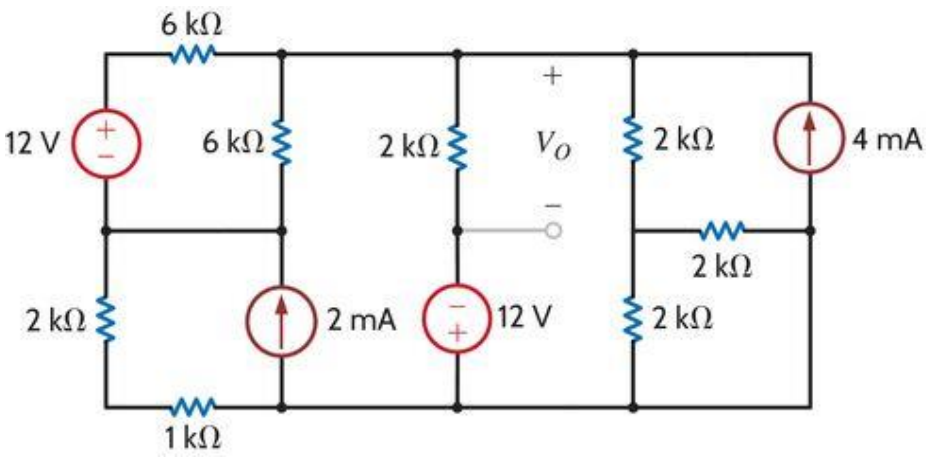
$$\Rightarrow V_1 = -\frac{24}{5} V$$

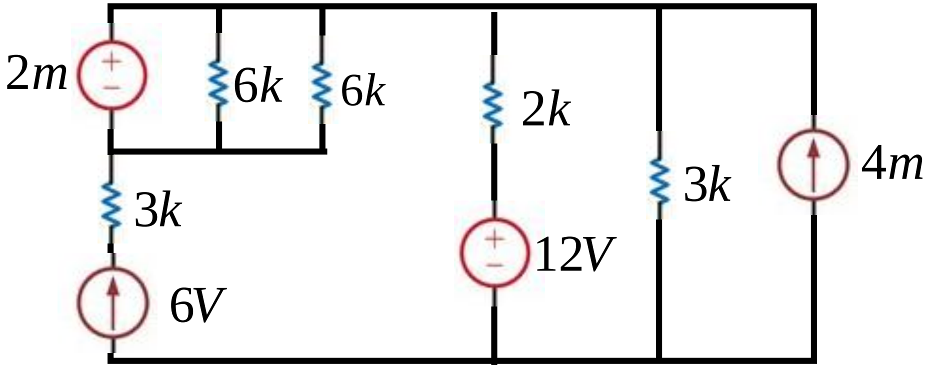
$$I_{SC} = -\frac{V_1}{3k} = 1.6mA$$

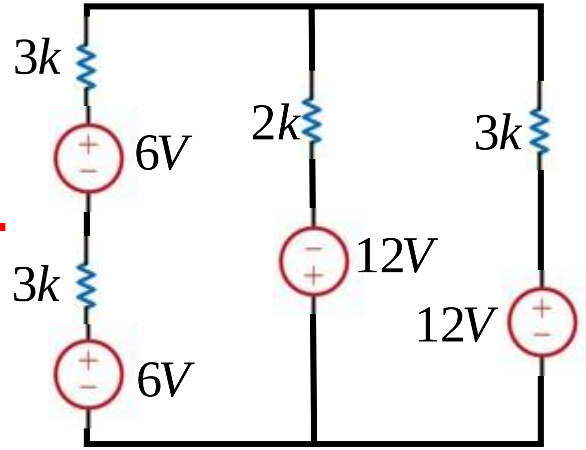


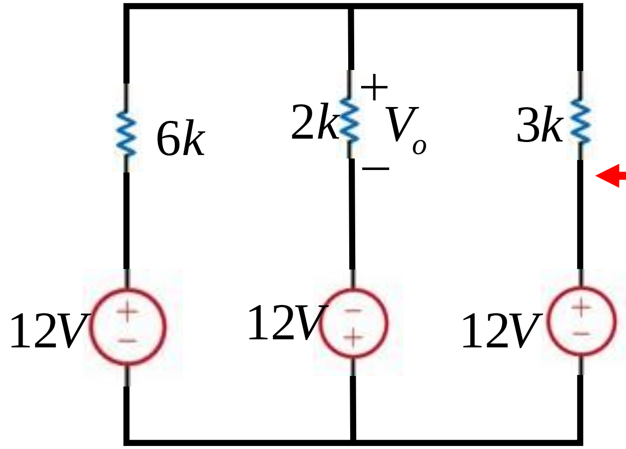
$$I_o = 1.6m \times \frac{5}{5+3} = 1mA$$

3. Please using source transformation to find V_0 in Fig. 3.







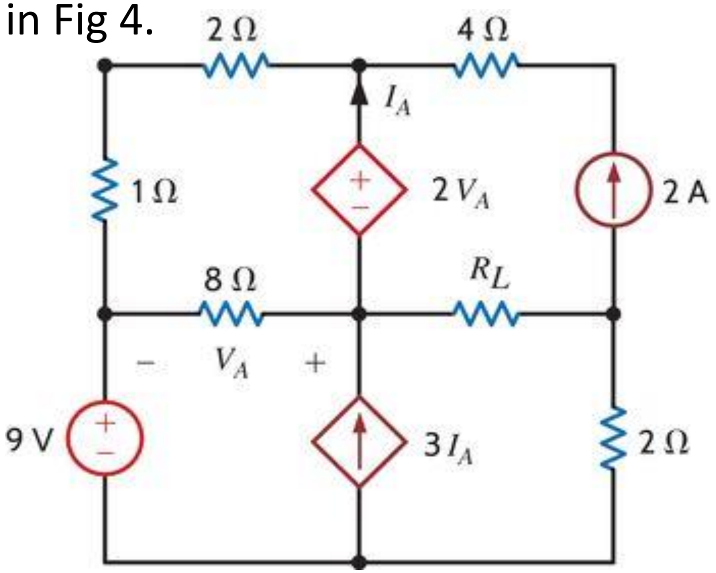


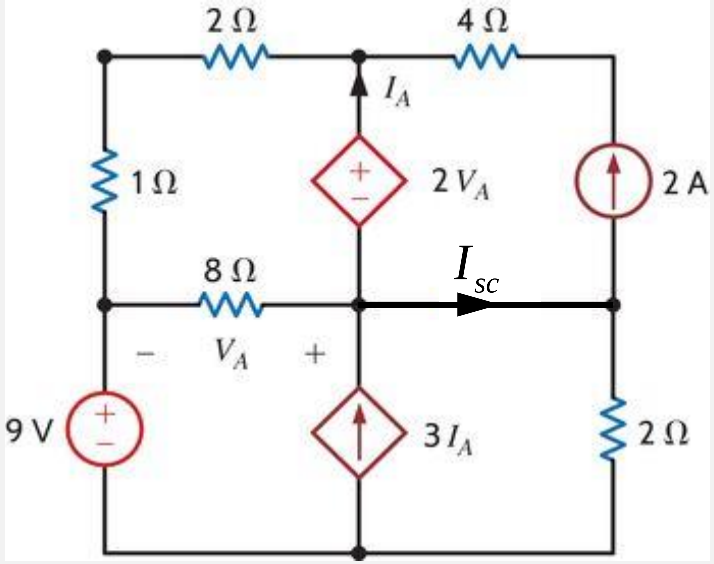
$$KCL: \frac{V_x-12}{6k}+\frac{V_x-(-12)}{2k}+\frac{V_x-12}{3k}=0$$

$$\Rightarrow V_x=0$$

所以$V_0 = V_x-(-12)=12V$

4.(20%) Please find for maximum power transfer and the maximum power transferred to this load in Fig 4.





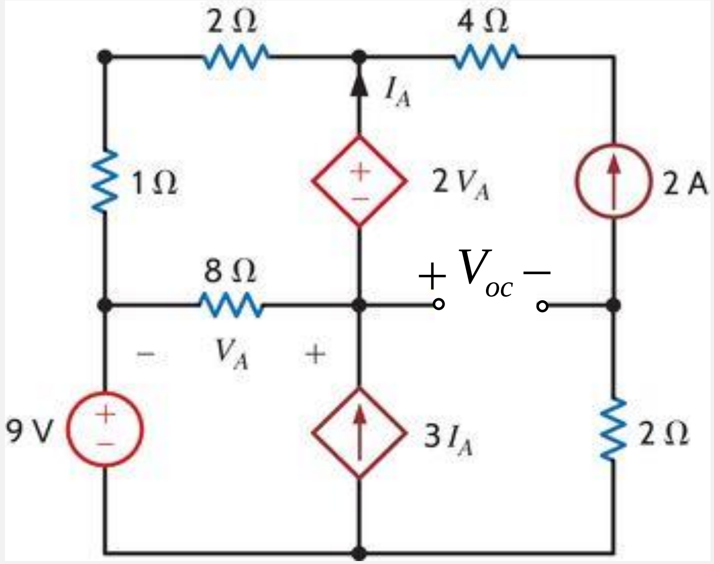
$$I_A = V_A - 2$$

$$I_{sc} = 3I_A - \frac{V_A}{8} - I_A$$

$$\Rightarrow I_{sc} = \frac{15}{8} V_A - 4$$

$$I_{sc} = 2 + \frac{V_A + 9}{2} = \frac{V_A}{2} + 6.5$$

$$\Rightarrow I_{sc} = \frac{227}{22}, I_A = \frac{62}{11}, V_A = \frac{84}{11}$$



$$16 I_A = V_A$$

$$3(I_A + 2) = 3V_A$$

$$\Rightarrow I_A = V_A - 2$$

$$I_A = \frac{2}{15}, V_A = \frac{32}{15}$$

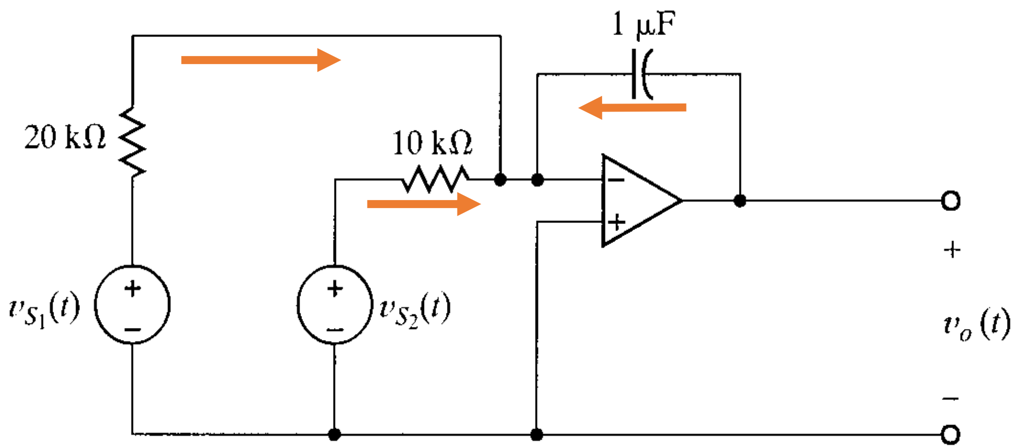
$$V_{oc} = 2 \times 2 + 9 + V_A = 13 + \frac{32}{15} = \frac{227}{15}$$

$$R_{TH} = \frac{V_{oc}}{I_{sc}} = \frac{22}{15} \Omega$$

$$R_L = \frac{22}{15} \Omega$$

$$P_{max} = \frac{1}{4} \frac{V^2}{R_L} = \frac{51529}{1320} W$$

5.(15%) If the sources are given as $v_{s1}(t) = 80\cos 400t$ and $v_{s2}(t) = 40\cos 400t$, please determine the expression of the output voltage in Fig. 5.



$$\frac{v_{s1}(t)}{20k} + \frac{v_{s2}(t)}{10k} = -C\frac{dv_0(t)}{dt}$$

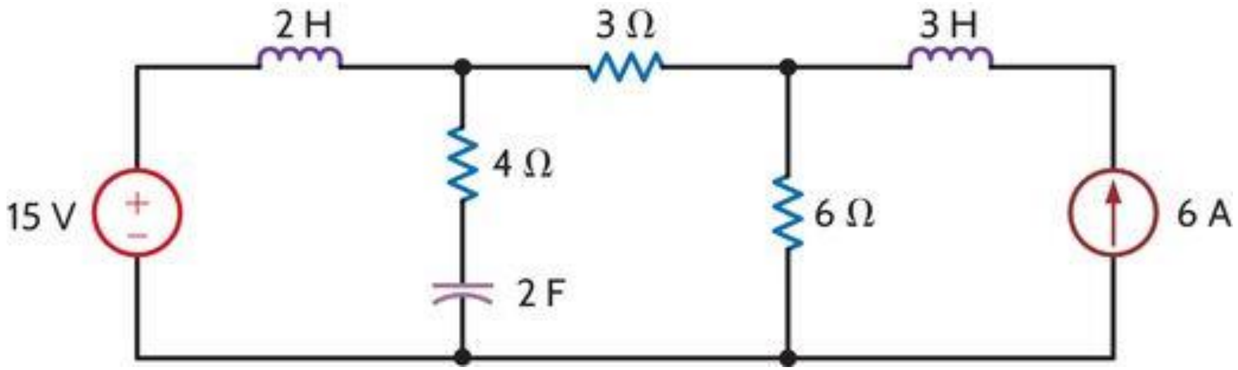
$$\Rightarrow v_0(t) = -50\int (V_{s1} + 2V_{s2})dt$$

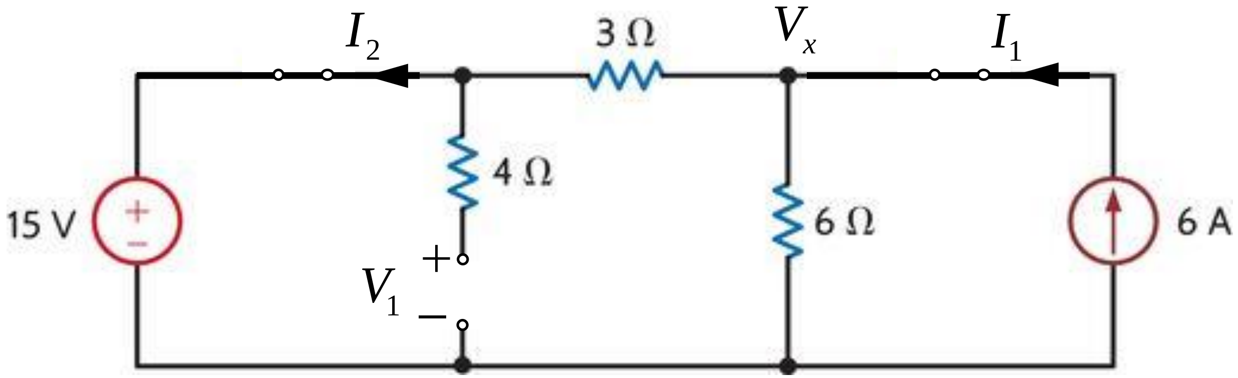
$$v_0(t) = -50\int (80\cos 400t + 2\times 40\cos 400t)dt$$

$$= -50\int (160\cos 400t)dt$$

$$= -20\sin 400t$$

6.(15%) Please find the energy stored in the circuit in Fig. 6.





$$I_1 = 6\text{A}, V_1 = 15\text{V}$$

$$\frac{V_x - 15}{3} + \frac{V_x}{6} = 6 \Rightarrow V_x = 22\text{V}$$

$$I_2 = \frac{V_x - 15}{3} = \frac{7}{3}\text{A}$$

$$\therefore Energy - stored$$

$$W_{2H} = \frac{1}{2} L_1 I_2^2 = \frac{1}{2} \times 2 \times (\frac{7}{3})^2 = \frac{49}{9} J$$

$$W_{1F} = \frac{1}{2} C V_1^2 = \frac{1}{2} \times 2 \times 15^2 = 225 J$$

$$W_{3H} = \frac{1}{2} L_2 I_1^2 = \frac{1}{2} \times 3 \times 6^2 = 54 J$$

$$W = W_{2H} + W_C + W_{3H} = \frac{2560}{9} J$$