SOLUTION
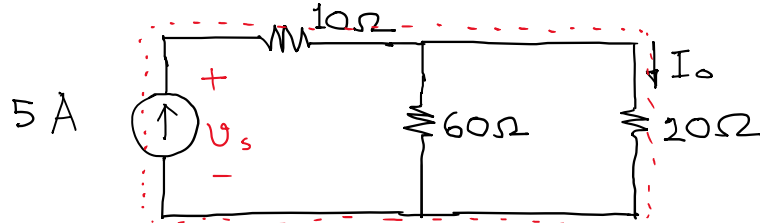
Marks = 30   Time = 1 hour 15 minutes

1.   (a) Calculate I_0 in the following circuit.   [8]
      (b) Calculate the power supplied by the source and absorbed by the 10-Ω resistor.

SOLUTION :   (a)

$$I_0 = \frac{5 \times 60}{60 + 20} = \boxed{3.75\ A}$$

(2)

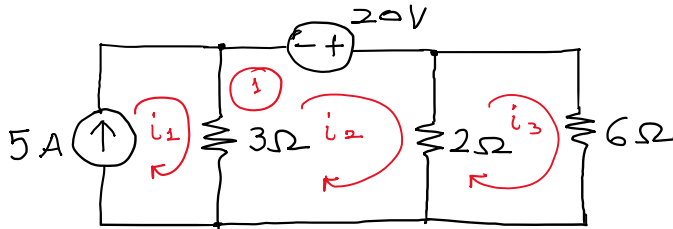(b) (2) $P_R = 5^2 \times 10 = \boxed{250\ W}$

(2) KVL at the outer loop.

$-U_s + 5 \times 10 + 3.75 \times 20 = 0 \Rightarrow U_s = 125\ V$

(2) $P_s = 125 \times 5 = \boxed{625\ W}$

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2.   In the following circuit, find the mesh currents using the mesh analysis.   [10]

SOLUTION : $\boxed{i_1 = 5\ A}$ (1)

KVL at mesh #2,

(3) $3(i_2 - i_1) - 20 + 2(i_2 - i_3) = 0$

$\Rightarrow -3i_1 + 5i_2 - 2i_3 = 20$

$\Rightarrow \boxed{5i_2 - 2i_3 = 35}$ ……(i)

KVL at mesh #3,

(3) $2(i_3 - i_2) + 6i_3 = 0$

$\Rightarrow 8i_3 - 2i_2 = 0$

$\Rightarrow \boxed{4i_3 - i_2 = 0}$ ……(ii)

(ii) $\Rightarrow i_2 = 4i_3$ in (i) $\Rightarrow 20i_3 - 2i_3 = 35$

$\Rightarrow 18i_3 = 35$ (2)

$\Rightarrow \boxed{i_3 = 1.94\ A}$ $\boxed{i_2 = 7.78\ A}$

3. Calculate the node voltages in the following circuit, using nodal analysis. [12]
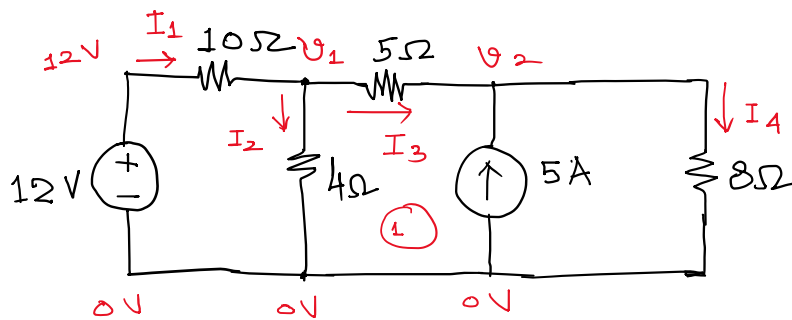
$$I_1 = \frac{12 - V_1}{10} \quad ; \quad I_2 = \frac{V_1}{4} \quad ;$$

$$I_3 = \frac{V_1 - V_2}{5} \quad ; \quad I_4 = \frac{V_2}{8} \quad ;$$

KCL at node 1, $\quad I_1 = I_2 + I_3$

④

$$\Rightarrow \quad \frac{12 - V_1}{10} = \frac{V_1}{4} + \frac{V_1 - V_2}{5}$$

$(\times 20) \Rightarrow 24 - 2V_1 = 5V_1 + 4V_1 - 4V_2$

$$\Rightarrow 11V_1 - 4V_2 = 24 \quad \cdots ⓘ$$

③

ⓘ $\times 13 \Rightarrow 143V_1 - 52V_2 = 312$

ⓘ $\times 4 \Rightarrow 32V_1 - 52V_2 = -800$

$(-) \quad 111 V_1 = 1112 \quad \Rightarrow \quad \boxed{V_1 = 10.02V}$

KCL at node 2, $\quad I_3 + 5 = I_4$

④

$$\Rightarrow \quad \frac{V_1 - V_2}{5} + 5 = \frac{V_2}{8}$$

$(\times 40) \Rightarrow 8V_1 - 8V_2 + 200 = 5V_2$

$$\Rightarrow 8V_1 - 13V_2 = -200 \quad \cdots ⓘⓘ$$

ⓘ $\Rightarrow \boxed{V_2 = 21.55 V}$

END