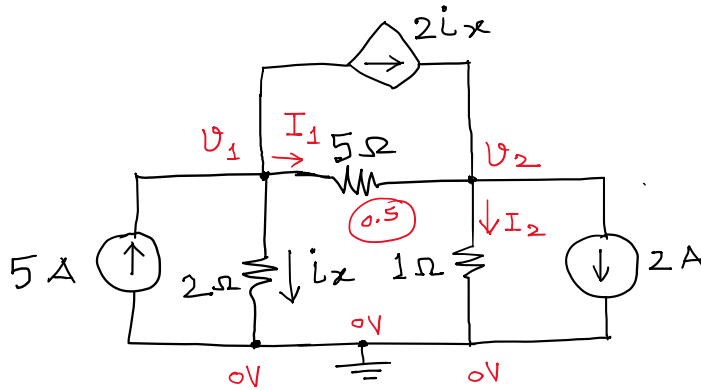Marks = 5   Time = 20 minutes

1. In the following circuit, determine node voltages using nodal analysis.

SOLUTION :

$i_x = \dfrac{v_1}{2}$;

$I_1 = \dfrac{v_1 - v_2}{5}$;

$I_2 = \dfrac{v_2}{1} = v_2$;

KCL at node 1, $i_x + I_1 + 2i_x = 5$

⟹ $3i_x + I_1 = 5$

⟹ $3 \times \dfrac{v_1}{2} + \dfrac{v_1 - v_2}{5} = 5$

$(\times 10)$ ⟹ $15v_1 + 2v_1 - 2v_2 = 50$

⟹ $17v_1 - 2v_2 = 50$ ⋯⋯⋯ (i)

KCL at node 2, $I_1 + 2i_x = I_2 + 2$

⟹ $\dfrac{v_1 - v_2}{5} + 2 \times \dfrac{v_1}{2} - v_2 = 2$

$(\times 5)$ ⟹ $v_1 - v_2 + 5v_1 - 5v_2 = 10$

⟹ $6v_1 - 6v_2 = 10$ ⋯⋯⋯ (ii)

$(i) \times 3$ ⟹ $51v_1 - 6v_2 = 150$

$(-)$ $-45v_1 = -140$ ⟹ $v_1 = \dfrac{28}{9}$ V

⟹ $\boxed{v_1 = 3.11 \text{ V}}$

(ii) ⟹ $v_1 - v_2 = \dfrac{10}{6} = \dfrac{5}{3}$

⟹ $v_2 = v_1 - \dfrac{5}{3} = \dfrac{28}{9} - \dfrac{5}{3} = \dfrac{28 - 15}{9} = \dfrac{13}{9}$ V

⟹ $\boxed{v_2 = 1.44 \text{ V}}$