CIRCUIT SIX

GENERAL EQUATION

$$R_t = [(R_5 + R_3 // R_4) // R_2] + R_1$$

$$\therefore R_t = [(10k\Omega + 12k\Omega // 12k\Omega) // 34k\Omega] + 10k\Omega$$

$$= [(10k\Omega + 6k\Omega) // 34k\Omega] + 10k\Omega$$

[used $R_{eq} = \frac{R}{n}$]

$$= [16k\Omega // 34k\Omega] + 10k\Omega$$

$$= 10.88k\Omega + 10k\Omega$$

[used $R_{eq} = \frac{R_1 \cdot R_2}{R_1 + R_2}$]

$$= \frac{(16)(34)(k\Omega)^2}{(16+34)k\Omega}$$

$$= \left(\frac{544}{50}\right)k\Omega$$

$$R_{eq} = 10.88k\Omega$$

$$\boxed{R_t = 20.88k\Omega}$$

$$I_t = \frac{V_t}{R_t}$$

$$\therefore I_t = \frac{20V}{20.88k\Omega}$$

$$I_t \approx 958\mu A$$

Now $V_a = V_1 - V_{R2}$

$= V_1 - I_t R_1$

$= 20V - 958\mu A \cdot 10k\Omega$

$\boxed{V_a \simeq 10.42V}$

$V_b = V_a - V_{ab}$

$= V_a - (I_2)\cdot(R_3 \parallel R_4)$; $I_2 = I_t - I_1$

$= V_a - (I_t - I_1)(R_3 \parallel R_4)$

$= V_a - (I_t - \frac{V_a}{R_2})(R_3 \parallel R_4)$

$= 10.42V - (958\mu A - \frac{10.42V}{34k\Omega})(12k\Omega \parallel 12k\Omega)$

$= 10.42V - (652\mu A)(6k\Omega)$ [used $\frac{R}{n}$]

$= 10.42V - 3.912V$

$\boxed{V_b \simeq 6.51V}$

$V_{ab} = I_2 \cdot R_3 \parallel R_4$

$= (I_t - I_1)(R_3 \parallel R_4)$

$= (I_t - \frac{V_a}{R_2})(R_3 \parallel R_4)$

$\boxed{V_{ab} = 3.912V}$ (as calculated in V_b equation)

OR

$V_{ab} = V_a - V_b$

$= 10.42V - 6.51V$

$\boxed{V_{ab} = 3.91V}$

I_5

$$I_5 = \frac{V_b}{R_5}$$

$$= \frac{6.51\,V}{10\,k\Omega}$$

$$\boxed{I_5 = 651\,\mu A}$$

Working backward that $I_5 = I_2$

$$I_2 = \frac{V_a}{(R_3 \,||\, R_4) + R_5}$$

$$= \frac{10.42\,V}{(12k\Omega \,||\, 12k\Omega) + 10k\Omega}$$

$$= \frac{10.42\,V}{6k\Omega + 10k\Omega} \qquad [\text{and } R_{eq} = \frac{R}{n}]$$

$$= \frac{10.42\,V}{16k\Omega}$$

$$I_2 = 651\,\mu A \;\checkmark$$