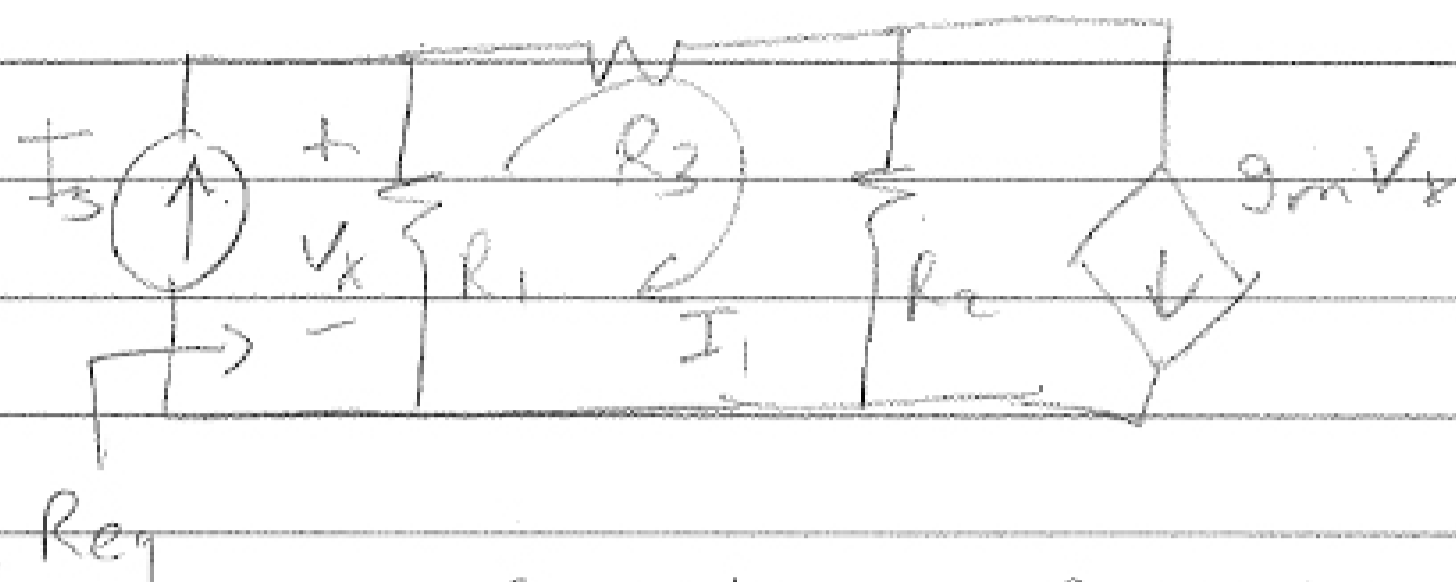


3-40



$$R_1 = 1 \text{ k}\Omega, \quad R_2 = 5 \text{ k}\Omega, \quad R_3 = 4 \text{ k}\Omega$$

$$I_s = 100 \text{ mA}, \quad g_m = 4 \times 10^{-4} \text{ S}$$

KVL around center loop:

$$-V_x + I_1 R_3 + (I_1 - g_m V_x) R_2 = 0$$

Ohm's Law, Resistor R_1 , $V_x = (I_s - I_1) R_1$

$$-V_x (1 + g_m R_2) + I_1 (R_3 + R_2) = 0$$

$$V_x + I_1 R_1 = I_s R_1$$

$$-V_x (1 + 2) + I_1 (9 \text{ k}\Omega) = 0$$

$$\rightarrow -V_x + 3 \text{ k}\Omega I_1 = 0$$

$$V_x + (1 \text{ k}\Omega) I_1 = 100 \text{ V}$$

$$3 \text{ k}\Omega I_1 + 1 \text{ k}\Omega I_1 = 4 \text{ k}\Omega I_1 = 100 \text{ V}$$

$$I_1 = 25 \text{ mA}$$

$$V_x = 3 \text{ k}\Omega I_1 = 75 \text{ V} = V_x$$

$$(b) \quad R_{eq} = \frac{V_x}{I_s} = \frac{75 \text{ V}}{100 \text{ mA}} = 750 \Omega$$

$$(c) \quad P_{g_m V_x} = -IV$$

$$I = g_m V_x = (0.4 \text{ mS}) 75 \text{ V} = 30 \text{ mA}$$

$$V = R_3 (I_1 - 30 \text{ mA}) = -25 \text{ V}$$

$$P = - (30 \text{ mA}) (-25 \text{ V}) = +0.75 \text{ W}$$

Problem 42

(a)

The following loop equations can be written,

$$21 - 20I_1 - 80(I_1 - I_2) = 0$$

$$24 + 80I_2 - 80(I_1 - I_2) = 0$$

$$\Rightarrow I_1 = 0.15 \text{ A}$$

$$I_2 = -0.075 \text{ A}$$

$$V_{R_3} = (I_1 - I_2)R_3$$

$$= 0.225 \times 80 = 18 \text{ V}$$

$$P_{R_3} = 18(0.225) = 4.05 \text{ W}$$

(b)

Again, writing the loop equations,

$$21 - (I_1 + I_2)20 - 80I_2 - 24 = 0$$

$$21 - (I_1 + I_2)20 - 80I_1 = 0$$

$$\Rightarrow I_1 = 0.225 \text{ A}$$

$$I_2 = -0.075 \text{ A}$$

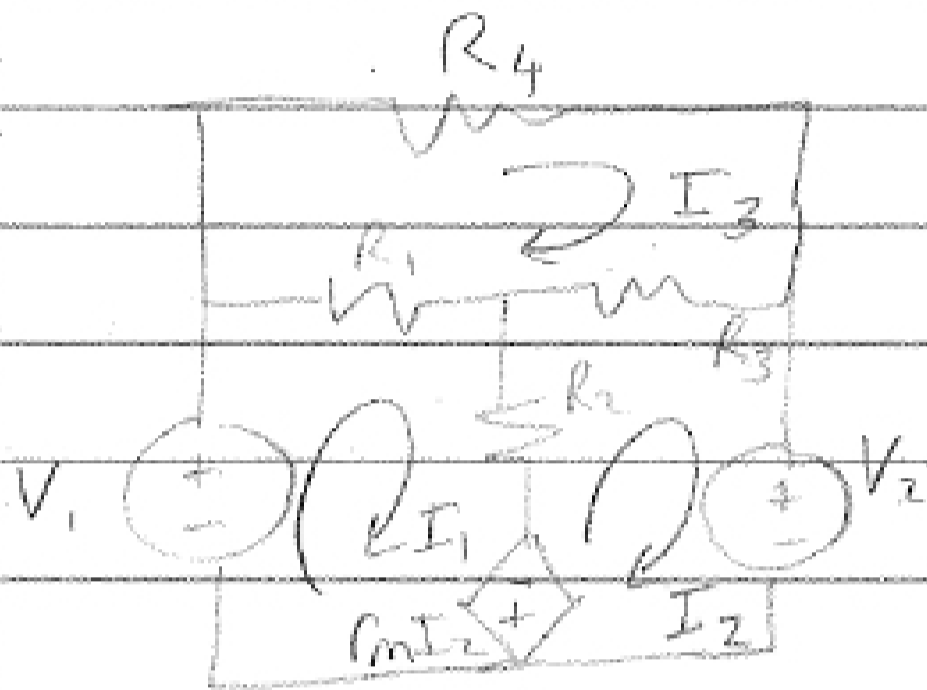
$$V_{R_3} = I_1 R_3$$

$$= 0.225 \times 80 = 18 \text{ V}$$

$$P_{R_3} = 18(0.225) = 4.05 \text{ W}$$

3-44

$$\begin{bmatrix} 40 & -80 & -10 \\ -30 & 130 & -50 \\ -10 & -50 & 70 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} V_1 \\ -V_2 \\ 0 \end{bmatrix}$$



KVL, L1:

$$-V_1 + (I_1 - I_3)R_1 + (I_1 - I_2)R_2$$

$$-g_m I_2 = 0$$

$$I_1(R_1 + R_2) + I_2(-R_2 - g_m)$$

$$-I_3 R_1 = V_1$$

$$\therefore R_1 + R_2 = 40\Omega, \quad R_2 + g_m = 80\Omega$$

$$R_1 = 10\Omega$$

$$\text{KVL, L2: } g_m I_2 + (I_2 - I_1)R_2 + (I_2 - I_3)R_3 + V_2 = 0$$

$$-I_1 R_2 + I_2(g_m + R_2 + R_3) - I_3 R_3 = -V_2$$

$$\therefore R_2 = 30\Omega, \quad g_m + R_2 + R_3 = 130\Omega, \quad R_3 = 50\Omega$$

$$\text{KVL, L3: } I_3 R_4 + (I_3 - I_2)R_3 + (I_3 - I_1)R_1 = 0$$

$$-I_1 R_1 - I_2 R_3 + I_3(R_4 + R_3 + R_1) = 0$$

$$R_1 = 10\Omega, \quad R_3 = 50\Omega, \quad R_1 + R_3 + R_4 = 70\Omega$$

$$10\Omega + 50\Omega + R_4 = 70\Omega$$

$$R_4 = 10\Omega$$

$$R_2 + g_m = 80\Omega$$

$$g_m = 80\Omega - R_2 = 80\Omega - 30\Omega = 50\Omega = g_m$$