Base Equations

$$\frac{e_3}{R_5} = i_1' + \frac{e_1 - (e_3 + V)}{R_3} + \beta i_1' + i_2$$

$$I + \frac{e_1 - e_2}{R_2} = i_1'$$

$$\frac{e_1 - \alpha i_2'}{R_1} + \frac{e_1 - e_2}{R_2} = \frac{e_3 + V - e_1}{R_3}$$

Substituting

$$i_1' = \frac{e_2 - e_3}{R_4} \qquad i_2' = -\frac{V + e_3}{R_6}$$

$$\frac{1}{R_5} e_3 = \frac{1+\beta}{R_4} e_2 - \frac{1+\beta}{R_4} e_3 + \frac{1}{R_3} e_1 - \frac{1}{R_3} e_3 + \frac{V}{R_3} - \frac{V}{R_6} - \frac{1}{R_6} e_3$$

$$\left(\frac{1}{R_5} + \frac{1+\beta}{R_4} + \frac{1}{R_3} + \frac{1}{R_6}\right) e_3 - \frac{1+\beta}{R_4} e_2 - \frac{1}{R_3} e_1 = V\left(\frac{1}{R_3} - \frac{1}{R_6}\right)$$

$$\frac{1}{R_2} e_1 - \frac{1}{R_2} e_2 = \frac{1}{R_4} e_2 - \frac{1}{R_4} e_3 - I$$

$$\frac{1}{R_4} e_3 - \left(\frac{1}{R_4} + \frac{1}{R_2}\right) e_2 + \frac{1}{R_2} e_1 = -I$$

$$\left(\frac{1}{R_1} + \frac{1}{R_2}\right) e_1 - \frac{1}{R_2} e_2 + \frac{\alpha V}{R_1 R_2} + \frac{\alpha}{R_1 R_2} e_3 = \frac{1}{R_3} e_3 + \frac{V}{R_3} - \frac{1}{R_3} e_1$$

$$\left(\frac{\alpha}{R_1 R_2} - \frac{1}{R_3}\right) e_3 - \frac{1}{R_2} e_2 + \left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right) e_1 = V\left(\frac{1}{R_3} - \frac{\alpha}{R_1 R_2}\right)$$