Assignment - 1

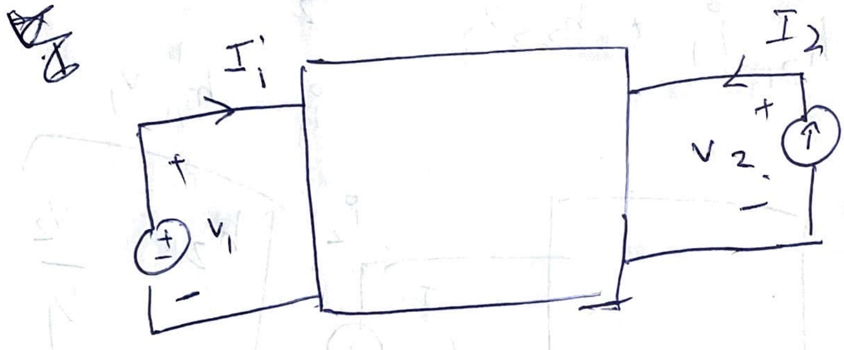
Analog Electronics

Q1 VCVS

The parameter is g-parameter

The Dependent sources are (I_1, V_2)

and independendent sources are (V_1, I_2)



$$I_1 = g_{11} V_1 + g_{12} I_2$$

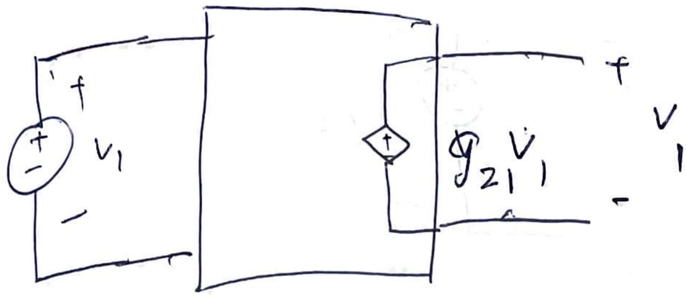
$$V_2 = g_{21} V_1 + g_{22} I_2$$

when $I_2 = 0$ [acts like VCVS circuit]

$$I_1 = g_{11} V_1 \quad ; \quad V_2 = g_{21} V_1$$

$$\boxed{g_{11} = \frac{I_1}{V_1}\Big|_{I_2=0}} \qquad \boxed{g_{21} = \frac{V_2}{V_1}}$$

~~when~~ $V_1 = 0$



when $V_1 = 0$

$I_1 = g_{12} I_2$; $V_2 = g_{22} I_2$

$g_{12} = \frac{I_1}{I_2} = 0$; $g_{22} = \frac{V_2}{I_2} = 0$

$$G = \begin{bmatrix} \frac{I_1}{V_1} & \frac{I_1}{I_2} \\ \frac{V_2}{V_1} & \frac{V_2}{I_2} \end{bmatrix} \Rightarrow \begin{bmatrix} i_1 \\ V_2 \end{bmatrix} = G \begin{bmatrix} V_1 \\ i_2 \end{bmatrix}$$

$g_{11}, g_{12}, g_{22} = 0$ since it is a VCVS

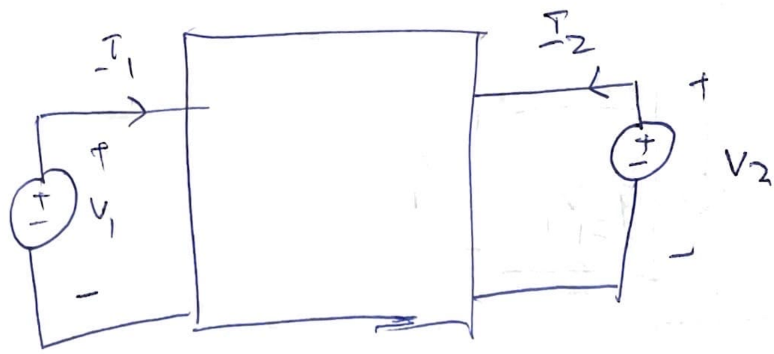
$$G = \begin{bmatrix} 0 & 0 \\ \frac{V_2}{V_1} & 0 \end{bmatrix}$$

VCCS

The para peter is Y- parameter ,
The Dependent sources are (I_1, I_2) and independent sources are (V_1, V_2)

$I_1 = Y_{11} V_1 + Y_{12} V_2$

$I_2 = Y_{21} V_1 + Y_{22} V_2$.



when $V_1 = 0$

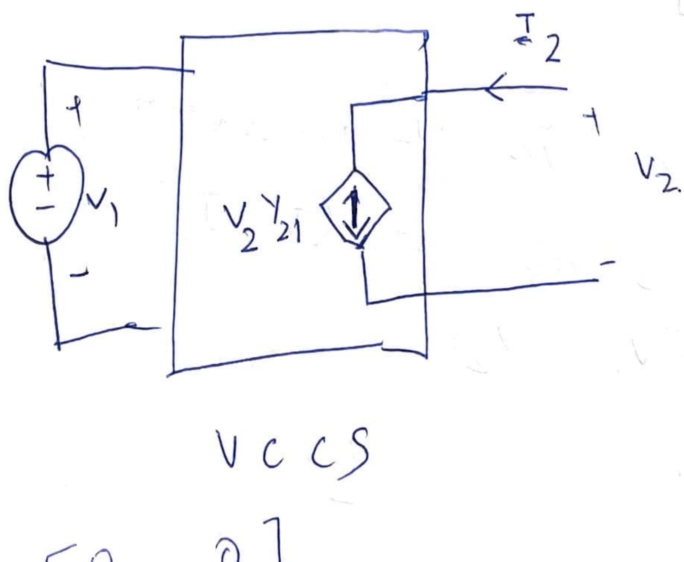
$I_1 = Y_{12} V_2 \Rightarrow Y_{12} = \frac{I_1}{V_2} = 0$

$I_2 = Y_{22} V_2 \Rightarrow Y_{22} = \frac{I_2}{V_2} = 0$

when $V_2 = 0$

$I_1 = Y_{11} V_1$; $I_2 = Y_{21} V_1$

$Y_{11} = \frac{I_1}{V_1} = 0$; $Y_{21} = \frac{I_2}{V_1}$



VCCS

$$Y = \begin{bmatrix} 0 & 0 \\ \frac{I_2}{V_1} & 0 \end{bmatrix}$$

CCVS

The parameter is Z - parameters. The dependent sources are $\overline{I}(V_1, V_2)$ and independent sources are (I_1, I_2)

$$V_1 = Z_{11} I_1 + Z_{12} I_2$$

$$V_2 = Z_{21} I_1 + Z_{22} I_2$$

when $I_1 = 0$

$$V_1 = \cancel{Z_{11}} Z_{12} I_2 \; ; \; V_2 = Z_{22} I_2$$

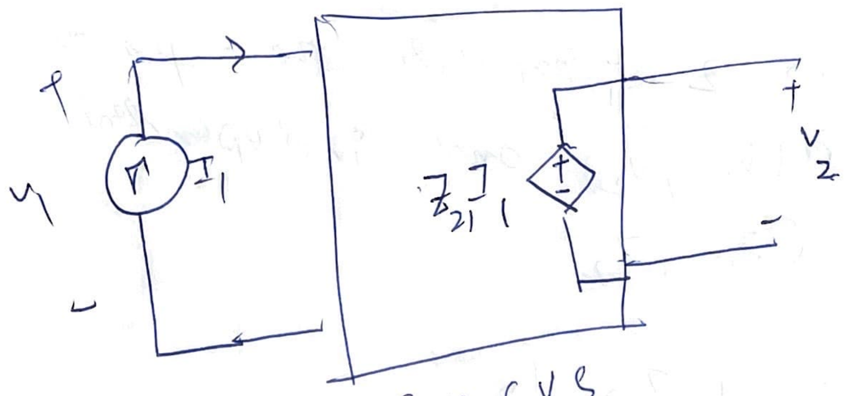
$$Z_{12} = \frac{V_1}{I_2} = 0 \; ; \; Z_{22} = \frac{V_2}{I_2} = 0$$

when $I_2 = 0$

$$V_1 = Z_{11} I_1 \Rightarrow Z_{11} = \frac{V_1}{I_1} = 0$$

$$V_2 = Z_{21} I_1 \Rightarrow Z_{21} = \frac{V_2}{I_1}$$

$$Z = \begin{bmatrix} \frac{V_1}{I_1} & \frac{V_1}{I_2} \\ \frac{V_2}{I_1} & \frac{V_2}{I_2} \end{bmatrix} = \begin{bmatrix} 0 & 0 \\ \frac{V_2}{I_1} & 0 \end{bmatrix}$$

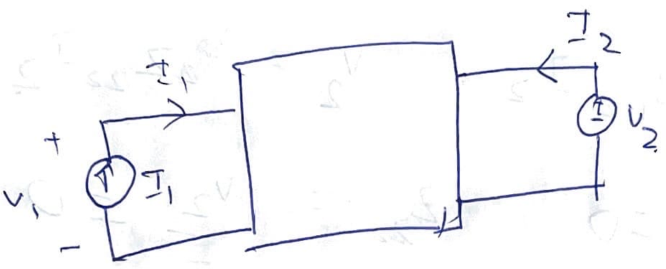


~~B~~ CCVS

CCCS

The parameters used is h-parameters

~~the~~



$V_1 = h_{11} I_1 + h_{12} V_2$

$I_2 = h_{21} I_1 + h_{22} V_2$

when $I_1 = 0$

$V_1 = h_{12} V_2$; $I_2 = h_{22} V_2$

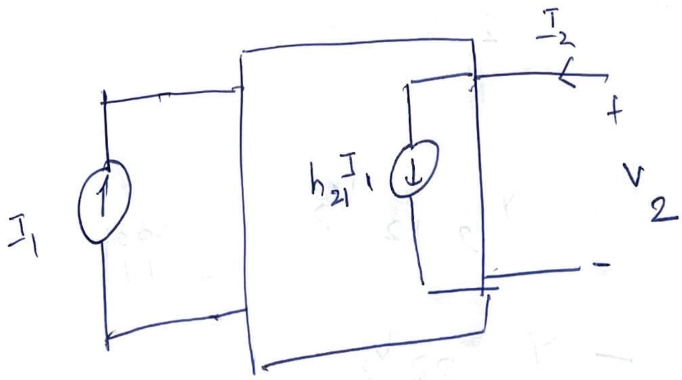
$h_{12} = \frac{V_1}{V_2} = 0$; $h_{22} = \frac{I_2}{V_2} = 0$

when $V_2 = 0$

$V_1 = h_{11} I_1$; $I_2 = h_{21} I_1$

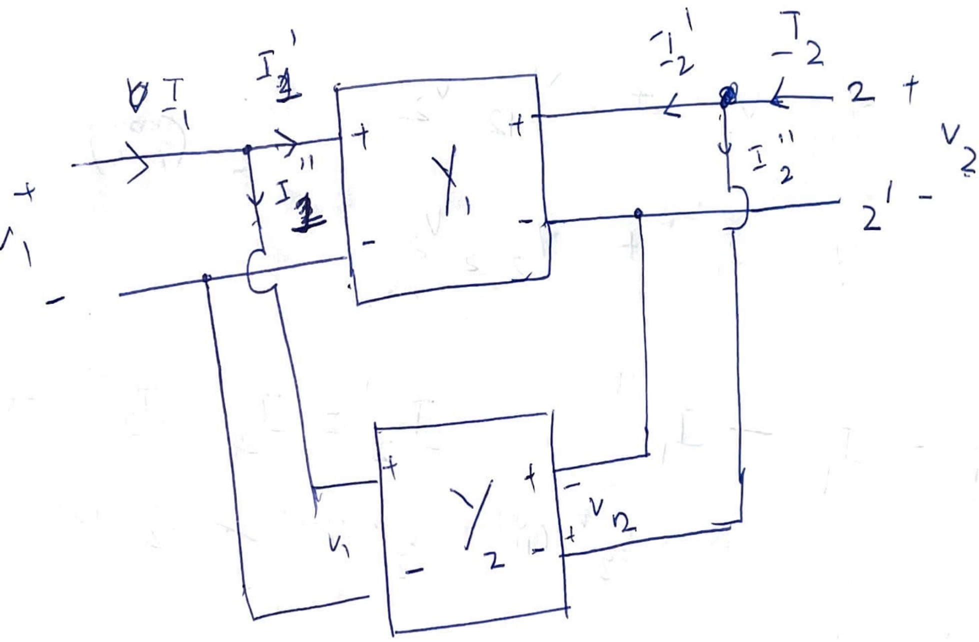
$h_{11} = \frac{V_1}{I_1} = 0$; $h_{21} = \frac{I_2}{I_1}$

$$H = \begin{bmatrix} \frac{V_1}{I_1} & \frac{V_1}{V_2} \\ \frac{I_2}{I_1} & \frac{I_2}{V_2} \end{bmatrix} = \begin{bmatrix} 0 & 0 \\ \frac{I_2}{I_1} & 0 \end{bmatrix}$$



C CCS

(2)



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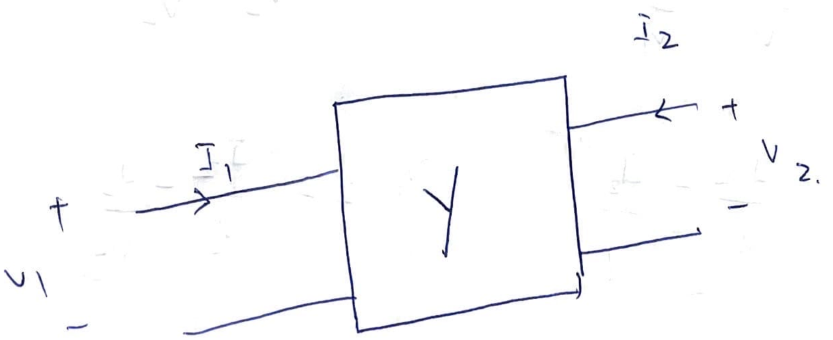

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$$I_1' = Y_{1,11} V_1 + Y_{1,12} V_2 \quad \text{— (i)}$$

$$I_2' = Y_{1,21} V_1 + Y_{1,22} V_2$$

$$I_1'' = Y_{2,11} V_1 - Y_{2,12} V_2 \quad \text{— (ii)}$$

$$-I_2'' = Y_{2,21} V_1 - Y_{2,22} V_2$$

$$I_1 = Y_{11} V_1 + Y_{12} V_2 \quad \text{— (iii)}$$

$$I_2 = Y_{21} V_1 + Y_{22} V_2$$

$$I_1' = I_1 - I_1'' \qquad I_2' = I_2 - I_2'' \quad \text{— (iv)}$$

solving eq^n (i), eq^n (ii), eq^n (iii) & eq^n (iv)

$$Y_{1,11} = \frac{I_1}{V_1} - \frac{I_1''}{V_1} \qquad Y_{1,12} = \frac{I_1}{V_2} - \frac{I_1''}{V_2}$$

$$Y_{1,21} = \frac{I_2}{V_1} - \frac{I_2''}{V_1} \qquad Y_{1,22} = \frac{I_2}{V_2} - \frac{I_2''}{V_2}$$

$$Y_{2,11} = \frac{I_1''}{V_1}, \qquad Y_{2,12} = -\frac{I_1''}{V_2}$$

$$Y_{2,21} = -\frac{I_2''}{V_1} \qquad Y_{2,22} = \frac{I_2''}{V_2}$$

$$Y_{1,11} = \frac{I_1'}{V_1} - Y_{2,11} \qquad Y_{1,12} = \frac{I_1}{V_2} + Y_{2,12}$$

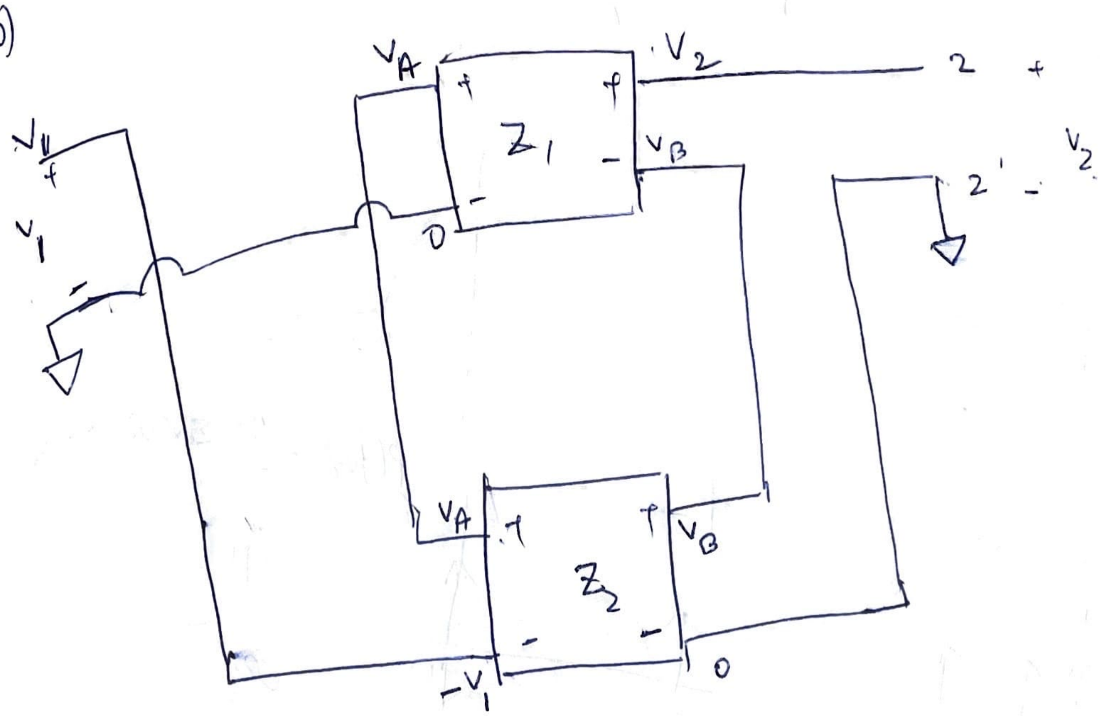
$$Y_{1,21} = \frac{I_2}{V_1} + Y_{2,21} \qquad Y_{1,22} = \frac{I_2}{V_2} - Y_{2,22}$$

$$Y_{1,11} + Y_{2,11} = \frac{I_1}{V_1} \qquad Y_{1,12} - Y_{2,12} = \frac{I_1}{V_2}$$

$$Y_{1,21} - Y_{2,21} = \frac{I_2}{V_1} \qquad Y_{1,22} + Y_{2,22} = \frac{I_2}{V_2}$$

$$\boxed{\begin{aligned} Y_{11} &= Y_{1,11} + Y_{2,11} \\ Y_{12} &= Y_{1,12} - Y_{2,12} \\ Y_{21} &= Y_{1,21} - Y_{2,21} \\ Y_{22} &= Y_{1,22} + Y_{2,22} \end{aligned}}$$

(b)



for Z_1 the input voltage is V_A and output voltage is $(V_2 - V_B)$

for Z_2 the input voltage is $(V_A - V_1)$ and output voltage is V_B

for Z_1

$$V_A - 0 = Z_{1,11} I_1 + Z_{1,12} I_2 \quad \text{— (i)}$$

$$V_2 - V_B = Z_{1,21} I_1 + Z_{1,22} I_2$$

for Z_2

$$V_A - V_1 = -Z_{2,11} I_1 + Z_{2,12} I_2 \quad \text{— (ii)}$$

$$V_B = -Z_{2,21} I_1 + Z_{2,22} I_2$$

for Z

$$V_1 = Z_{11} I_1 + Z_{12} I_2 \quad \text{-(iii)}$$

$$V_2 = Z_{21} I_1 + Z_{22} I_2$$

On solving Eqⁿ (i), (ii) & (iii)

$$V_2 = \cancel{Z_{1,12}}\, Z_{1,21} I_1 + Z_{1,22} I_2 + V_B$$

$$V_2 = Z_{1,21} I_1 + Z_{1,22} I_2 - Z_{2,21} I_1 + Z_{2,22} I_2$$

$$V_2 = (Z_{1,21} - Z_{2,21}) I_1 + (Z_{1,22} + Z_{2,22}) I_2$$

$$V_1 = Z_{2,11} I_1 - Z_{2,12} I_2 + V_A$$

$$V_1 = Z_{2,11} I_1 - Z_{2,12} I_2 + Z_{1,11} I_1 + Z_{1,12} I_2$$

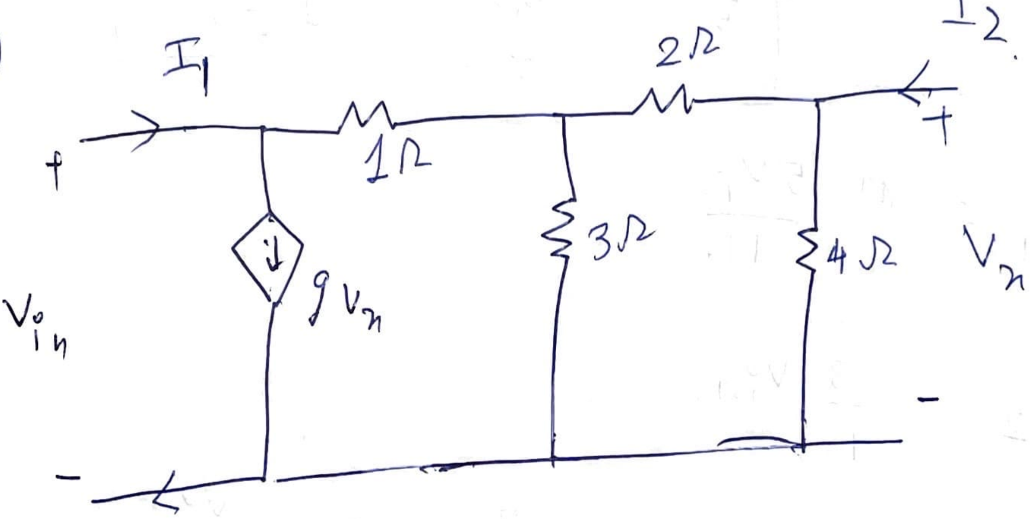
$$V_1 = (Z_{2,11} + Z_{1,11}) I_1 + (Z_{1,12} - Z_{2,12}) I_2$$

$$\therefore \boxed{\begin{aligned} V_1 &= (Z_{2,11} + Z_{1,11}) I_1 + (Z_{1,12} - Z_{2,12}) I_2 \quad \text{-(iv)} \\ V_2 &= (Z_{1,21} - Z_{2,21}) I_1 + (Z_{1,22} + Z_{2,22}) I_2 \quad \text{-(v)} \end{aligned}}$$

on comparing eq^n (iv) and (v) with (iii)

$$\boxed{\begin{aligned} Z_{11} &= Z_{1,11} + Z_{2,11} \\ Z_{12} &= Z_{1,12} - Z_{2,12} \\ Z_{21} &= Z_{1,21} - Z_{2,21} \\ Z_{22} &= Z_{1,22} + Z_{2,22} \end{aligned}}$$

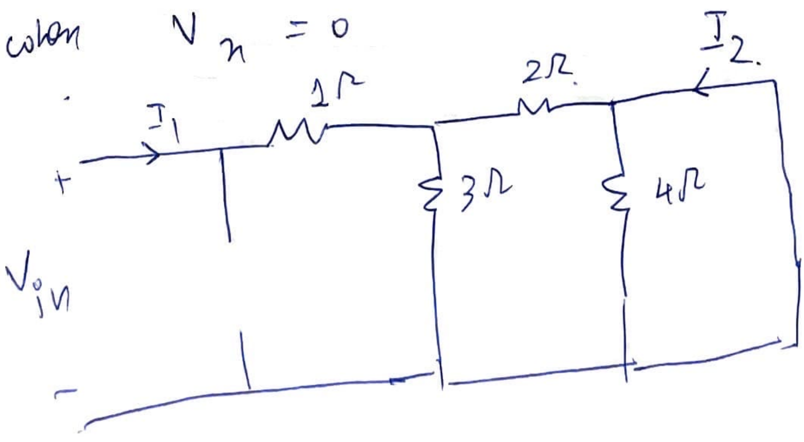
(3)
(a)

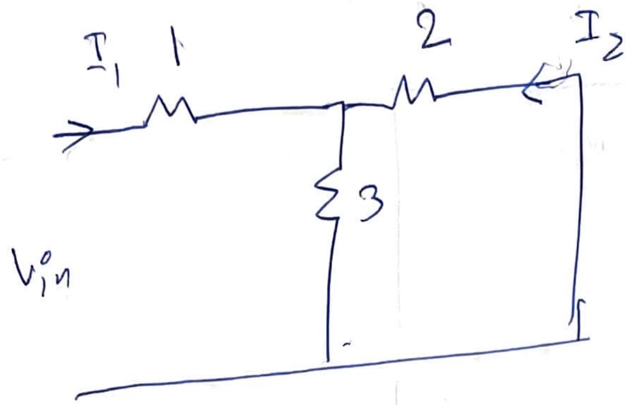


$$I_1 = Y_{11} V_{in} + Y_{12} V_x$$

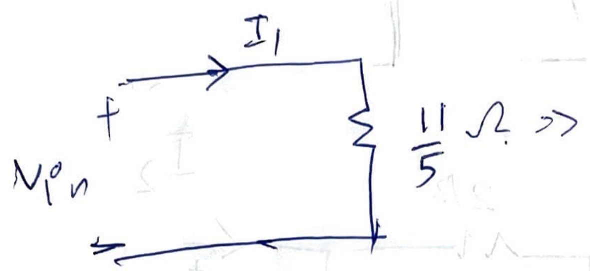
$$I_2 = Y_{21} V_{in} + Y_{22} V_x$$

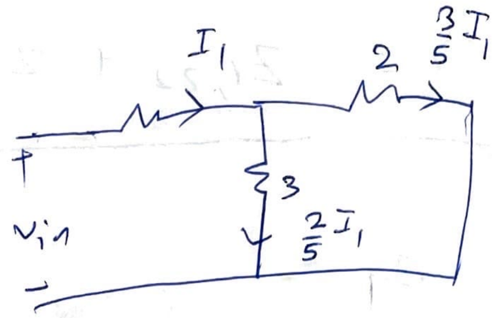
when $V_x = 0$





y





$$I_1 = \frac{5V_{in}}{11}$$

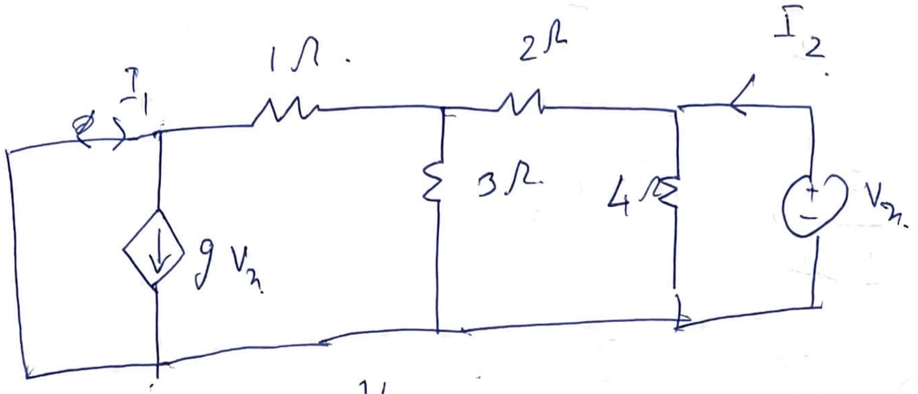
$$I_2 = -\frac{3}{11}V_{in}$$

$I_1 = y_{11}V_{in}$ & $I_2 = y_{21}V_{in}$

$\frac{5}{11}V_{in} = y_{11}V_{in}$; $\frac{3}{11}V_{in} = y_{21}V_{in}$

$$\boxed{y_{11} = \frac{5}{11} \; ; \; y_{21} = \frac{3}{11}}$$

when $V_{in} = 0$



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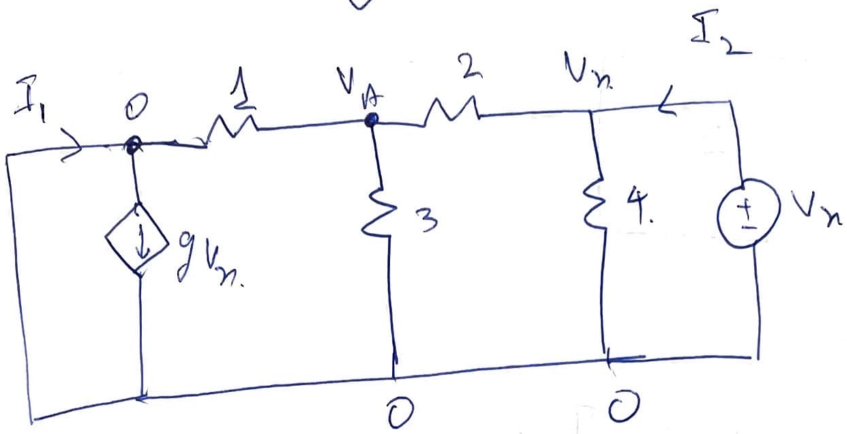


$$\frac{V_A}{3} + \frac{V_A}{1} + \frac{V_A - V_x}{2} = 0 \quad \text{(i)}$$

$$\frac{V_x - V_A}{2} + \frac{V_x}{4} = I_2 \quad \text{(ii)}$$

$$\frac{0 - V_A}{1} + g V_x = I_1 \quad \text{(iii)}$$

$$\frac{V_A}{3} + V_A + \frac{V_A}{2} = \frac{V_x}{2} \Rightarrow \frac{11 V_A}{6} = \frac{V_x}{2}$$

$$\Rightarrow \frac{11}{3} V_A = \frac{V_x}{1} \Rightarrow \boxed{V_A = \frac{3 V_x}{11}}$$

$$\frac{V_n}{2} + \frac{V_n}{4} - \frac{V_A}{2} = I_2$$

$$\frac{3V_n}{4} - \frac{3V_n}{22} = I_2$$

$$\frac{\overset{27}{\cancel{54}} V_n}{\underset{2}{\cancel{4}} \times 22} = I_2$$

$$I_2 = \frac{27}{44} V_n.$$

$$-V_A + g V_n = I_1$$

$$-\frac{3}{11} V_n + g V_n = I_1$$

$$I_1 = V_n \left[g - \frac{3}{11} \right]$$

$$I_1 = Y_{12} V_n \quad \Rightarrow \quad Y_{12} = g - \frac{3}{11}$$

$$I_2 = Y_{22} V_n \qquad Y_{22} = \frac{27}{44}$$

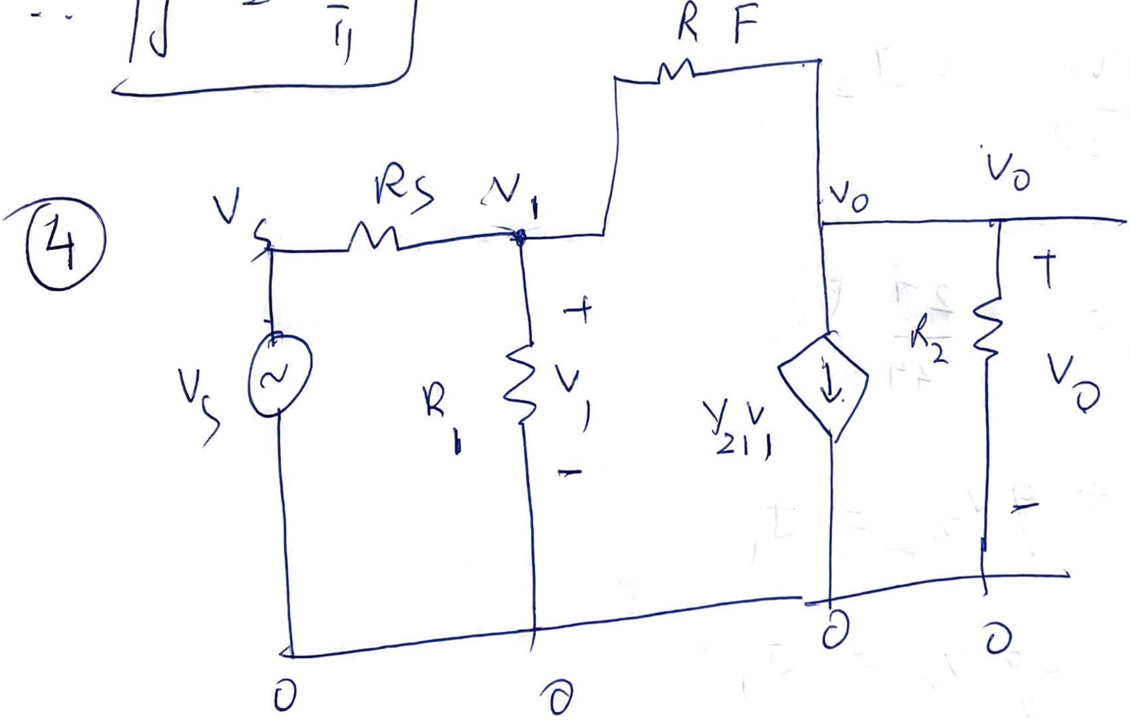
$$Y = \begin{bmatrix} \frac{5}{11} & g - \frac{3}{11} \\ \frac{3}{11} & \frac{27}{44} \end{bmatrix}$$

(b) for the ~~system to be~~ network to be ~~and~~ unilateral one of the off diagonal elements ~~sto~~ should be zero

so Y_{12} or Y_{21} need to be zero

$$\therefore \boxed{g = \frac{3}{11}}$$

(4)



Nodal analysis

$$\frac{V_1}{R_1} + \frac{V_1 - V_S}{R_S} + \frac{V_1 - V_o}{R_F} = 0$$

$$\frac{V_0 - V_1}{R_F} + Y_{21} V_1 + \frac{V_0}{R_2} = 0$$

$$\frac{V_0}{R_F} + \frac{V_0}{R_2} = \frac{V_1}{R_F} + Y_{21} V_1 = 0$$

$$\frac{V_0}{R_F} + \frac{V_0}{R_2} = V_1 \left[\frac{1}{R_F} - Y_{21} \right]$$

$$V_0 \left[\frac{1}{R_F} + \frac{1}{R_2} \right] = V_1 \left[\frac{1}{R_F} - Y_{21} \right]$$

$$\frac{V_1}{R_1} + \frac{V_1}{R_S} + \frac{V_1}{R_F} = \frac{V_S}{R_S} + \frac{V_0}{R_F}$$

$$V_1 \left[\frac{R_S R_F + R_1 R_F + R_1 R_S}{R_1 R_S R_F} \right] = \frac{V_S}{R_S} + \frac{V_0}{R_F}$$

$$\frac{V_0 [R_F + R_2]}{R_2 [1 - R_F Y_{21}]} \frac{[R_S R_F + R_1 R_F + R_1 R_S]}{R_1 R_S R_F} - \frac{V_0}{R_F} = \frac{V_S}{R_S}$$

$$V_0 \frac{[R_F + R_2][R_S R_F + R_1 R_F + R_1 R_S] - [1 - R_F Y_{21}] R_1 R_S R_F}{R_2 [1 - \overset{1}{\cancel{R_F}} Y_{21}] R_1 \cancel{R_S}} = \frac{V_S}{\cancel{R_S}}$$

(a) $$\frac{V_o}{V_s} = \frac{R_2\left[1 - R_F Y_{21}\right] R_1}{\left[R_F + R_2\right]\left[R_S R_F + R_S R_1 + R_F R_1\right] - R_2\left[1 - Y_{21}\right] R_1 R_S}$$

(b) $$\frac{V_o}{V_s} = \frac{Y_{21}\left[R_2\left(\frac{1}{Y_{21}} - R_F\right)\right] R_1}{Y_{21}\left[\frac{\left[R_F + R_2\right]\left[R_S R_F + R_S R_1 + R_F R_1\right]}{Y_{21}}\right] - R_2 Y_{21}\left[\frac{1}{Y_{21}} - 1\right] R_1 R_S}$$

$$\lim_{Y_{21} \to \infty} \frac{V_o}{V_s} = \frac{R_2\left[\cancel{\frac{1}{Y_{21}}}^{0} - R_F\right] R_1}{\frac{\left[R_F + R_2\right]\left[R_S R_F + R_S R_1 + R_F R_1\right]}{Y_{21}} - R_2\left[\cancel{\frac{1}{Y_{21}}}^{0} - 1\right] R_1 R_S}$$

$$= \frac{-\cancel{R_2 R_F R_1}}{+\cancel{R_F R_1 R_S R_F}} =$$

$$\frac{-R_2 R_F R_1}{R_S R_L R_1} = \boxed{\frac{-R_F}{R_S}}$$