Two Port Networks

1. Two Two-port networks are connected in cascade. The combination is to the represented as a single two – port network, by multiplying the individual
   (a) z-parameter matrices
   (b) h-parameter matrices
   (c) y-parameter matrices
   (d) ABCD parameter

[GATE 1991: 2 Marks]

Soln. **ABCD parameters relate the voltage and current at one port to voltage and current at the other port**

Option (d)

2. For a 2-port network to be reciprocal,
   (a) $z_{11} = z_{22}$
   (b) $y_{21} = y_{12}$
   (c) $h_{21} = -h_{12}$
   (d) AD – BC = 0

[GATE 1992: 2 Marks]

Soln. $\boldsymbol{y_{21} = y_{12}}$

$\boldsymbol{h_2 = -h_{12}}$

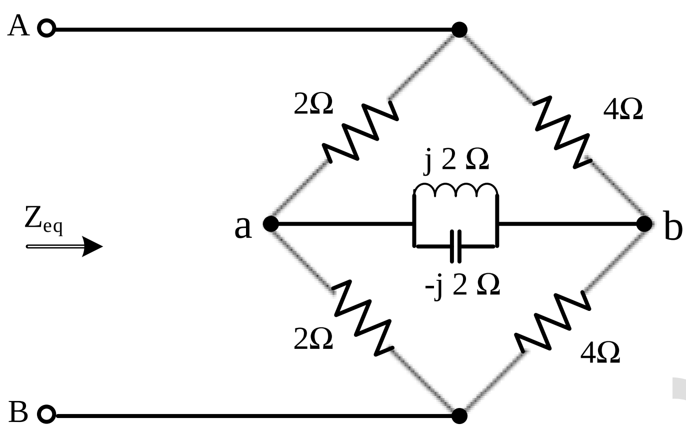
Option (b) & (c)

3. The condition, that a 2-port network is reciprocal, can be expressed in terms of its ABCD parameters as…….

[GATE 1994: 1 Mark]

Soln. **AD – BC = 1**

4. In the circuit of figure, the equivalent impedance seen across terminals A, B is



(a) (16/3) Ω
(b) (8/3) Ω
(c) (8/3 + 12j) Ω
(d) None of the above

[GATE 1997: 2 Marks]

Soln. **The product of the opposite arms are equal, so the bridge is balanced.**

The point a and b are at the same potential

$$\boldsymbol{Z_{eq} = (2 \| 4) + (2 \| 4)}$$

$$\boldsymbol{= \frac{4}{3} + \frac{4}{3} = \frac{8}{3}}$$

Option (b)

5. The short-circuit admittance matrix of a two-port network is

$$\begin{bmatrix} 0 & -1/2 \\ 1/2 & 0 \end{bmatrix}$$

The two – port network is

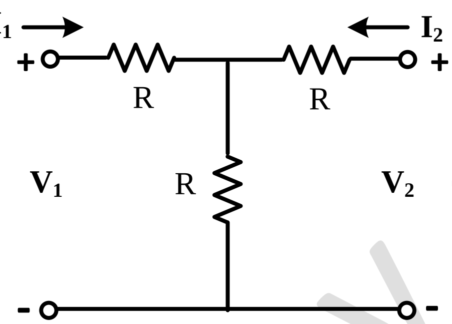
(a) non – reciprocal and passive
(b) non – reciprocal and active
(c) reciprocal and passive
(d) reciprocal and active

[GATE 1998: 1 Marks]

Soln. $y_{12} \neq y_{21}$ **so the network is nonreciprocal. And active networks are nonreciprocal**

Option (b)

6. A 2-port network is shown in the figure. The parameter h_{21} for this network can be given by



(a) -1/2
(b) +1/2
(c) -3/2
(d) +3/2

[GATE 1999: 1 Mark]

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

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

$h_{21} = \frac{I_1}{I_2}|_{V2=0}$

$V_2 = RI_2 + R(I_1 + I_2)$

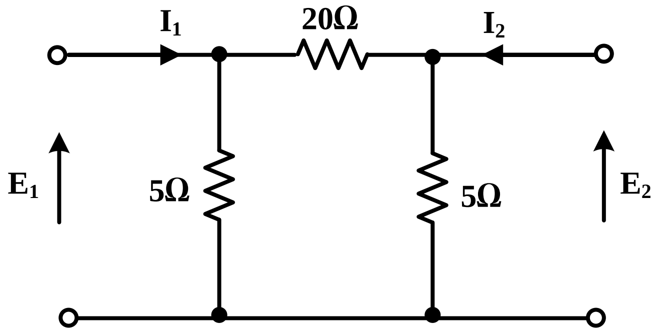
Or $2RI_2 + RI_1 = V_2$

When $V_2 = 0, \; 2RI_2 + RI_1 = 0$

So, $\frac{I_2}{I_1} = \frac{-R}{2R} = -\frac{1}{2}$

Option (a)

7. The admittance parameter Y_{12} in the 2-port network in figure is



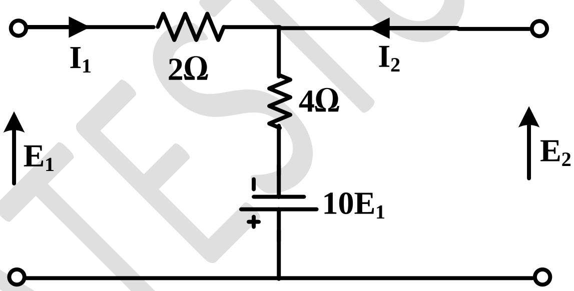
(a) -0.2 nho
(b) 0.1 mho
(c) -0.05 mho
(d) 0.05 mho

[GATE 2001: 1 Mark]

Soln. $$y_{12} = -\frac{1}{20} = -0.05\ mhos$$

Option (c)

8. The Z parameters Z_{11} and Z_{21} for the 2-port network in the figure are



(a) $Z_{11} = \frac{-6}{11}\Omega, Z_{21} = \frac{16}{11}\Omega$
(b) $Z_{11} = \frac{6}{11}\Omega, Z_{21} = \frac{4}{11}\Omega$
(c) $Z_{11} = \frac{6}{11}\Omega, Z_{21} = \frac{-16}{11}\Omega$
(d) $Z_{11} = \frac{4}{11}\Omega, Z_{21} = \frac{4}{11}\Omega$

[GATE 2001: 2 Marks]

Soln. **For z – parameters**

$$E_1 = Z_{11}I_1 + Z_{12}I_2$$

$$E_2 = Z_{21}I_1 + Z_{22}I_2$$

Writing KVL in LHS loop

$$E_1 = 2I_1 + 4I_1 + 4I_2 - 10E_1$$

Or $$11E_1 = 6I_1 + 4I_2 ----(I)$$

$$Z_{11} = \frac{E_1}{I_1}|_{I_2=0} = \frac{6}{11}\Omega$$

$$Z_{12} = \frac{E_1}{I_2}|_{I_1=0} = \frac{4}{11}\Omega$$

Writing KVL in RHS Loop

$$E_2 = 4(I_1 + I_2) - 10E_1 ------(II)$$

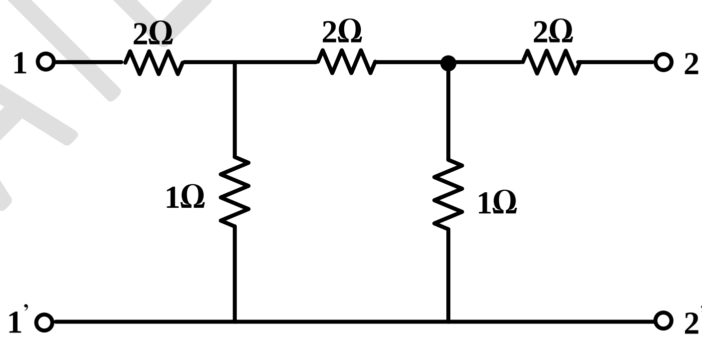
Substituting $E_1 = \frac{6I_1+4I_2}{11}$ $in\ equation --(III)$

$$E_2 = 4(I_1 + I_2) - \frac{10(6I_1+4I_2)}{11}$$

$$Z_{21} = \frac{E_2}{I_1}|_{I_2=0} = \frac{-16}{11}\Omega$$

Option (c)

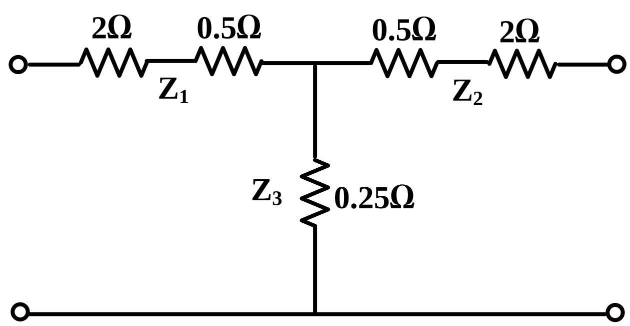
9. The impedance parameters Z_{11} and Z_{12} of the two-port network in the figure are



(a) $Z_{11} = 2.75\Omega\ and\ Z_{12} = 0.25\ \Omega$
(b) $Z_{11} = 3\ \Omega\ and\ Z_{12} = 0.5\Omega$
(c) $Z_{11} = 3\ \Omega\ and\ Z_{12} = 0.25\Omega$
(d) $Z_{11} = 2.25\Omega\ and\ Z_{12} = 0.5\ \Omega$

[GATE 2003: 2 Marks]

Soln. **Using $\Delta - Y$ conversion, the circuit reduces to**



$$Z_{11} = Z_1 + Z_3$$

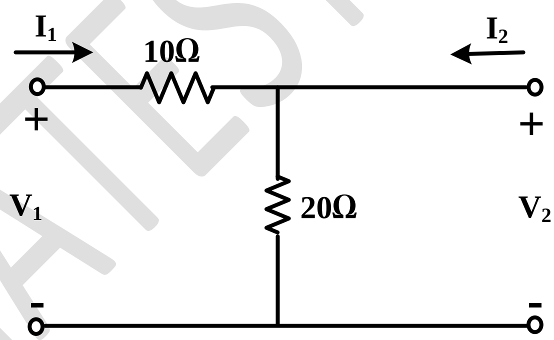
$$= 2.5 + 0.25$$

$$= 2.75\Omega$$

$$Z_{12} = Z_3 = 0.25\Omega$$

Option (a)

10. The h parameter of the circuit shown in the figure are



(a) $\begin{bmatrix} 0.1 & 0.1 \\ -0.1 & 0.3 \end{bmatrix}$

(b) $\begin{bmatrix} 10 & -1 \\ 1 & 0.05 \end{bmatrix}$

(c) $\begin{bmatrix} 30 & 20 \\ 20 & 30 \end{bmatrix}$

(d) $\begin{bmatrix} 10 & 1 \\ -1 & 0.05 \end{bmatrix}$

[GATE 2005: 2 Marks]

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

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

Writing KVL in LHS and RHS Loop

$V_1 = 10I_1 + 20(I_1 + I_2) - - - - - - -(i)$

$V_2 = 20(I_2 + I_1) - - - - - - -(ii)$

Or $V_1 = 10I_1 + V_2$

$h_{11} = \frac{V_1}{I_1}|_{V_2=0} = 10$

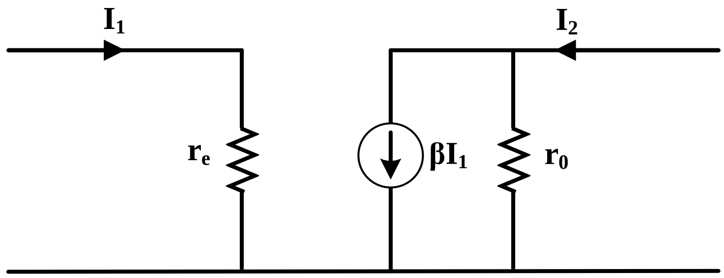
$h_{21} = \frac{I_2}{I_1}|_{V_2=0} = -1$

$h_{12} = \frac{V_1}{V_2}|_{I_1=0} = 1$

$h_{22} = \frac{I_2}{V_2}|_{I_1=0} = \frac{1}{20} = 0.05\Omega$

Option (d)

11. In the two network shown in the figure below Z_{12} and Z_{21} are, respectively



(a) r_e and βr_0

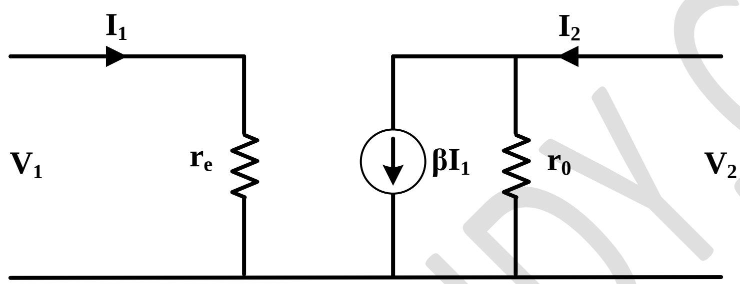
(b) 0 $and - \beta r_0$

(c) 0 and βr_0

(d) r_e $and -\beta r_0$

[GATE 2006: 1 Mark]

Soln.



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

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

$$Z_{12} = \frac{V_1}{I_2}|_{I_1=0}$$

When $I_1 = 0, V_1 = 0, \quad so \quad Z_{12} = 0$

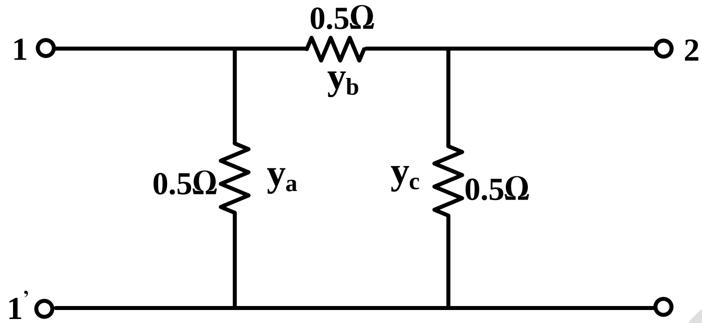
$$Z_{21} = \frac{V_2}{I_1}|_{V_2=0}$$

When $I_2 = 0, V_2 = -\beta I_1 r_0$

$$Z_{21} = -\beta r_0$$

Option (b)

12. For the two-port network shown, the short-circuit admittance parameter matrix is



(a) $\begin{bmatrix} 4 & -2 \\ -2 & 4 \end{bmatrix} S$

(b) $\begin{bmatrix} 1 & -0.5 \\ -0.5 & 4 \end{bmatrix} S$

(c) $\begin{bmatrix} 1 & -0.5 \\ 0.5 & 1 \end{bmatrix} S$

(d) $\begin{bmatrix} 4 & 2 \\ 2 & 4 \end{bmatrix} S$

[GATE 2010: 1 Mark]

Soln. The short circuit admittance parameters of a two port π network:

$$y_{11} = y_a + y_b = \frac{1}{0.5} + \frac{1}{0.5} = 4\Omega$$

$$y_{12} = y_{21} = -y_b = -\frac{1}{0.5} = -2\Omega$$

$$y_{22} = y_b + y_c = \frac{1}{0.5} + \frac{1}{0.5} = 4\Omega$$

Option (a)

13. If the scattering matrix [S] of a two port network is

$[S] = \begin{bmatrix} 0.2\angle 0^0 & 0.9\angle 0^0 \\ 0.9\angle 0^0 & 0.1\angle 0^0 \end{bmatrix}$

Then the network is

(a) Lossless and reciprocal

(b) Lossless but not reciprocal

(c) Not lossless but reciprocal

(d) Neither lossless not reciprocal

[GATE 2010: 1 Mark]

Soln. For the reciprocal network $|S_{12}| = |S_{21}|$

For a loss less network $|S_{11}|^2 + |S_{12}|^2 = 1$

$$(0.2)^2 + (0.9)^2 \neq 1$$

The network is lossy and reciprocal.

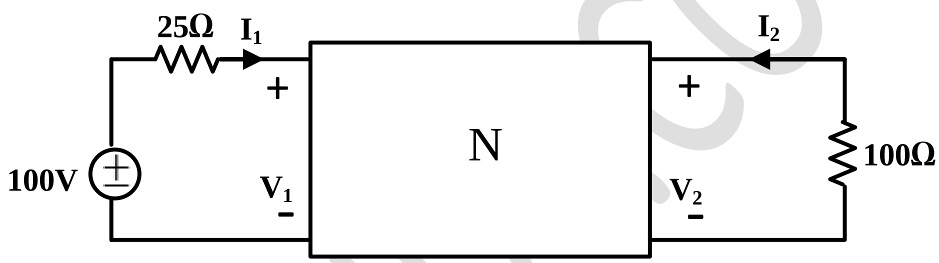
Option (c)

14. In the circuit shown below, the network N is described by the following Y matrix:
$Y = \begin{bmatrix} 0.1S & -0.01S \\ 0.01S & 0.1S \end{bmatrix}$ The voltage gain $\frac{V_2}{V_1}$ is

(a) 1/90
(b) -1/90
(c) -1/99
(d) -1/11

[GATE 2011: 2 Marks]

Soln.



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

$$= 0.01\, V_1 + 0.1\, V_2 - - - - - - - - (i)$$

$$V_2 = -I_2 R_L = -100 I_2$$

$$I_2 = \frac{-V_2}{100}$$

Substituting the value of I_2 in equation (i)

$$\frac{-V_2}{100} = 0.01V_1 + 0.1V_2$$

Or $\frac{V_2}{V_1} = \frac{-1}{11}$

Option (d)