

**EC 2403 -RF & MICROWAVE ENGINEERING  
BRANCH/YEAR/: ECE/IV**

**UNIT – I**

**TWO PORT RF NETWORKS- CIRCUIT REPRESENTATION**

**PART A**

1. Define s-matrix

Scattering matrix is a square matrix which gives all the combination of power relationships between the various input and output port of a microwave junction.

2. What is the .Properties of s-matrix?

1. It possess symmetric property  $s_{ij} = s_{ji}$
2. It possess unitary property  $[s][s]^* = [I]$

3. Why is s-matrix used in MW analysis?

S matrix is used in MW analysis to overcome the problems which occurs when H, Y, & Z parameters are used in high frequencies.

1. Equipment is not readily available to measure total voltage & total current at the ports of the network.
2. Short and open circuits are difficult to achieve over a broad band of frequencies.
3. Active devices, such as power transistor & tunnel diodes, frequently won't have stability for a short or open circuit.

4. Give ABCD matrix for a two port network

$$\begin{matrix} V_1 = A & B & V_2 \\ I_1 = C & D & -I_2 \end{matrix}$$

5. What is ABCD matrix?

ABCD matrix is a transmission matrix. These parameters express voltage and current at output in terms of those at input port.

$$\begin{matrix} V_1 = A V_2 - B I_2 \\ I_1 = C V_2 - D I_2 \end{matrix}$$

6. What are the advantages of ABCD matrix?

1. They are used in power transmission lines.
2. They are very helpful in the case of cascade networks.

7. What is the Scattering matrix for N port device?

$$[S] = \begin{matrix} S_{11} & S_{12} & S_{13} & \dots & S_{1n} \\ S_{21} & S_{22} & \dots & \dots & S_{2n} \\ S_{31} & S_{32} & \dots & \dots & S_{3n} \\ \dots & \dots & \dots & \dots & \dots \end{matrix}$$

$S_{m1} S_{m2} \dots S_{mm}$

8. Give the properties of impedance [x]&admittance[y] matrix?

1. For a lossless junctionary y and z are symmetric.
2.  $[y]=[z]^{-1}$
3. Elements of matix [Z] &matrix [Y] are Frequency dependent.

9. What are the properties of scattering matrix for a lossless junctoion?

1. The product of any column of the S-matrix with conjugate of this column equals unity.
2. The product of any column of the scattering matrix with the complex conjugate of any other column is zero.

10. What is transmission matrix?

When a number of microwave devices are connected in cascade. Each junction is represented by a transmission matrix which gives the output quantities in terms of input quantities.

11. Define one port circuit. Give two examples.

A one port circuit is a circuit for which power can enter or leave through a single wave Guide or transmission line.

Examples:

1. Short-circuited co-axial line

12. Write the voltage matrix for an N-port microwave circuits.

$$\begin{matrix} V_1 & Z_{11} & Z_{12} & \dots & Z_{1N} & I_1 \\ V_2 & Z_{21} & Z_{22} & \dots & Z_{2N} & I_2 \\ \vdots & \vdots & \vdots & \dots & \vdots & \vdots \\ V_N & Z_{N1} & Z_{N2} & \dots & Z_{NN} & I_N \end{matrix}$$

Where  $Z_{ij}$ =Elements of impedance matrix.

[Z]=Impedance matrix

17. Give two examples for two port junctions.

1. The junction of two rectangular guides of unequal height
2. A symmetrical junction consisting of two similar rectangular guides joined by an Intermediate guide of greater width.

18. State the unique property of scattering matrix?

Unitary Property: the row of a scattering matrix multiplied by the complex conjugate of the same row of the scattering matrix is one.

19. State the reciprocity theorem.

The theorem state that when some amount of electromotive force is applied at one point in a passive linear network that will produce the current at any point. The same amount of current is produced when the same electromotive force is applied in the new location: that is

$$V_k/i_m = v_m/i_k$$

20. Mention the many forms of wire.
- (i) Wire wound resistors
  - (ii) Wire wound inductors
  - (iii) Leaded capacitors
  - (iv) Element to element interconnect applications
21. Mention the purpose of resistors.
- (i) In transistor bias networks, to establish an operating point
  - (ii) In attenuators, to control the flow of power
  - (iii) In signal combiners, to produce a higher output power
  - (iv) In transmission lines, to create matched conditions
22. Write the application of inductors.
1. Resonance circuits
  2. Filters
  3. Phase shifters
  4. Delay networks
  5. RF chokes.

### PART-B

1. (a) A shunt impedance  $Z$  is connected across a transmission line with characteristic Impedance  $Z_0$ . Find the S matrix of the junction. (8)  
(b) List and explain the properties of S parameters. (8)
2. The S parameters of a two port network are given by
- $$\begin{matrix} S_{11} = 0.2 & \left| & 0, & S_{22} = 0.1 & \left| & 0 \\ S_{12} = 0.6 & \left| & 90^\circ, & S_{21} = 0.6 & \left| & 90^\circ, \end{matrix}$$
- (i) Prove that the network is reciprocal but not lossless. (8)  
(ii) Find the return loss at port 1 when port 2 is short circuited. (8)
3. Derive the formulation of the S – parameters. (16)
4. Derive the S – matrix representation of multiport network. (16)
5. Write short notes on
1. Reciprocal networks and lossless networks (8)
  2. The transmission (ABCD) Matrix (8)
6. A). Compare the relationship between [S][Z] and [Y] matrices. (8)  
B). Explain about LF parameters. (8)
7. A). Explain the interrelationship between LF & HF parameters. (8)  
B). Explain about RF basic components and application of RF. (8)