EC 6701 -RF & MICROWAVE ENGINEERING

UNIT III

ACTIVE AND PASSIVE MICROWAVE DEVICES

PART A

1. What are the two types of terminations?
   Matched load
   Variable short circuit

2. What are ferrites and give its properties?
Ferrites are ceramic like materials. These are maby by sintering a mixture of metallic oxides
Properties Specific resistivity's may be used as much as 1014 greater than that of metals
Dielectric constants around 10to 15 or greater Relative permeability is 1000

3. Give some examples of ferrite devices?
   Isolator Circulator Phase shifters, Modulators, Power limiters

4. List two microwave devices using Faraday rotation
      principles Isolator, Circulator

5. What are powered dividers?
    Power dividers are used to divide the input power into a number of smaller amounts of power
for exciting the radiating elements in an array antenna

6. What is the S-matrix of 3 port circulators?
   Anticlockwise [S]= 0 1 0
                      0 0 1
                      1 0 0
   Clockwise [S]= 0 0 1
                  1 0 0
                  0 1 0

7. Give the differences between Isolator and Circulator

Si.no	Isolator	Circulator
1	It is a 2 port device	It is a 3 port device
2	It cannot be used as circulator	It is used as isolator by terminating one port

3	If input is given in port 1,output is obtained at port 2 and vice versa	Each terminal is connected only to the next terminal

8. What is the S-matrix for 4 port circulators?
Clockwise

[S]= 0 0 0 1
　　 1 0 0 0
　　 0 1 0 0
　　 0 0 1 0

Anticlockwise

[S] = 0 1 0 0
　　　0 0 1 0
　　　0 0 0 1
　　　0 0 1 0

9. Give the S-matrix of E-plane Tee.
　　 [S] = 0.5 0.5 0.707
　　　　　 0.5 0.5 -0.707
　　　　　 0.5 -0.707 0

10. Give the S-matrix of H-plane Tee
　　 [S] = 0.5 -0.5 0.707
　　　　　 -0.5 0.5 0.707
　　　　　 0.707 0.707 0

11. Give the S-matrix of Magic Tee
　　 [S] = 0 0 0.707 0.707
　　　　　 0 0 0.707 -0.707
　　　　　 0.707 0.707 0 0
　　　　　 0.707 -0.707 0 0

12. Give the Smatrix of directional coupler
　　　 [S] = 0 P 0 jq
　　　　　　 P 0 jq 0
　　　　　　 0 jq 0 P
　　　　　　 Jq 0 P 0

13. Give an example for a two port MW device
　　 Isolator is an example for a 2 port MW device

14. Give the applications of directional coupler
　　 1. Unidirectional power measurement
　　 2. SWR measurement

3. Unidirectional wave launching
4. Reflectometer
5. Balanced duplexer

15. What is Faraday's rotation law?

If a circularly polarized wave is made to pass through a ferrite rod which has been influenced by an axial magnetic field B, then the axis of polarization gets tilted in clockwise direction and amount of tilt depends upon the strength of magnetic field and geometry of the ferrite.

16. Define VSWR

Voltage standing wave ratio is defined as the ratio of maximum voltage to the minimum voltage. VSWR=Vmax/Vmin

17. What is Gyrator?

Gyrator is a two port device which provides a relative phase shift of 180 degree for transmission from port 1 to port 2 as compared to the phase for transmission from Port2 to port1.

18. What is the principle of Microwave phase shifter?

When a wave propagates on a line,a phase difference prevails between any two arbitrary points along its paths. The phase difference between two points,

19. What are junctions? Give some examples

A microwave circuit consists of several microwave devices connected in some way to achieve the desired transmission of MW signal.The interconnection of two or more microwave may be regarded as MW junction.
Eg:Magic Tee,Hybrid Ring

20. What is Tee junction?Give two examples

In MW circuits a wave guide or coaxial junction with three independent ports is referred to as tee junction.
Eg: E- Plane Tee,H-plane Tee

21.What is the other name for magic TEE?
Hybrid Tee

22. What is hybrid ring?

Hybrid ring consists of an annular line of proper electrical length to sustain standing waves, to which four arms are connected at proper intervals by means of series or parallel junctions.

23. What is the other name for Hybrid ring?
Rat-race circuit.

24. Name some wave guide components used to change the direction of the guide through an arbitrary angle.

Wave guide corner, Bend and twist

25. What are the different types of Directional coupler?
1. Two hole directional coupler
2. Be the hole directional coupler
3. Four hole directional coupler

26. What are hybrid couplers?

Hybrid couplers are interdigitated micro strip couplers consisting of four parallel strip lines with alternate lines tied together, It has four ports. This type of coupler is called Lange hybrid coupler.

27. What are nonreciprocal devices? Give two examples

The devices which are having the property that the forward characteristics are not equal to the reverse characteristics are called non reciprocal devices.

28. Why isolators are called uniline?

An ideal isolator completely absorbs the power for propagation in one direction and provides lossless transmission in the opposite direction. Thus isolators are called unline.

29. Give some coupling parameters of directional coupler?
Coupling coefficient, Directivity, Insertion loss, Isolation

30. Mention the different types of directional coupler.
a)Two-hole directional coupler   b)Four-hole directional coupler
c)Reverse-coupling directional coupler   d)Bethe-hole directional coupler

31. Define isolator.

An isolator or uniline is a two-port non-reciprocal devices which produces a minimum attenuation to wave in one direction and very high attenuation in the opposite direction.

32. What is circulator?

A circulator is a multi port junction in which the wave can travel from one port to next immediate port in one direction only. They are useful in parametric amplifier, Tunnel diode, Amplifier and duplexer in radar.

33. What is H-Plane Tee?

An H-Plane Tee is a waveguide tee in which the axis of its side arm is shunting the E yield or parallel to the H-field of the main guide.

34. What is E-plane Tee?

An E-plane tee is a waveguide tee in which the axis of its side arm is parallel to the E-field of the main guide.

PART B

1. a). A three port circulator has an insertion loss of 1db, isolation of 20 db, VSWR =1.2when all ports are matched terminated. Find S matrix and output power at port 2and 3 for an input power of 100mw at port. (6)

    b). Explain the principle of operation of magic Tee and derive the S matrix of Magic Tee. (10).

2. From the first principles derive the S matrix parameters of Directional coupler. (16)

3. a) Is it possible to match all the 3 ports of a lossless reciprocal microwave component? Prove the same. (10)

    b) Explain with diagrams waveguide corner, bends, twists. (6)

4. a) What is an isolator? Write down S parameters. (4)

    b) A signal of power 32mw is fed into one of the collinear ports of a lossless H plane tee. Determine the powers in the remaining ports when other ports are terminated by means of matched load. (12)

5. With relevant equations, explain the properties of S-matrix with corresponding proof. (16)

6. A four port network has the scattering matrix shown below

$$
\begin{array}{cccc}
0.1 \lfloor 90° & 0.8 \lfloor -45° & 0.3 \lfloor 45° & 0 \\
0.8 \lfloor -45° & 0 & 0 & 0.4 \lfloor 45° \\
0.3 \lfloor -45° & 0 & 0 & 0.6 \lfloor -45° \\
0 & 0.4 \lfloor 45° & 0.6 \lfloor -45° & 0
\end{array}
$$

S =

   (i) Is this network lossless? (2)

   (ii) Is this network reciprocal? (2)

   (iii) What is the return loss at port1 when all other ports are terminated with matched loads? (4)

   (iv) What is the insertion loss and phase dialog between ports 2 and ports 4, when all other ports are terminated with matched loads? (4)

   (v) What is the reflection coefficient seen at port1 in a short circuit is placed at the terminal plane of port 3, and all other ports are terminated with matched loads?(4)

7. Discuss the structure and principle of operation of

(i) Isolator (8) (ii)
Circulator (8)

8. (a).Derive scattering matrix of E – plane tee using S – parameter theory. (8)

    (b). what is hybrid ring? With the help of a neat diagram explain its working principle.(8)

9. What do you mean by S parameters? Why do we require S parameters? Draw the diagram of a Directional coupler and explain the working. Derive S matrix of a directional coupler. (16)

10. (a).Derive scattering matrix of H – plane tee using S – parameter theory. (8)

     (b). with neat diagrams explain waveguide corners, bends and twists. (8)

11. (a).Derive scattering matrix of E – plane tee using S – parameter theory. (8)
    (b). draw and explain the concept of N port scattering matrix. (8)

12. What are ferrites devices? Explain in detail the different ferrite devices.(16)