UNIT II GUIDED WAVES

1. What are guided waves? Give examples

The electromagnetic waves that are guided along or over conducting or dielectric surface are called guided waves.

Examples: Parallel wire, transmission lines

2. What is TE wave or H wave?

Transverse electric (TE) wave is a wave in which the electric field strength E is entirely transverse. It has a magnetic field strength Hz in the direction of propagation and no component of electric field Ez in the same direction.

3. What is TH wave or E wave?

Transverse magnetic (TM) wave is a wave in which the magnetic field strength H is entirely transverse. It has a electric field strength Ez in the direction of propagation and no component of magnetic field Hz in the same direction.

4. What is a TEM wave or principal wave?

TEM wave is a special type of TM wave in which an electric field E along the direction of propagation is also zero. The TEM waves are waves in which both electric and magnetic fields are transverse entirely but have no components of Ez and Hz

.It is also referred to as the principal wave.

5. What is a dominant mode?

The modes that have the lowest cut off frequency is called the dominant mode.

6. Give the dominant mode for TE and TM waves

Dominant mode: TE_{10} and TM_{10}

7. What is cut off frequency?

The frequency at which the wave motion ceases is called cut-off frequency of the waveguide.

8. What is cut-off wavelength?

It is the wavelength below which there is wave propagation and above which there is no wave propagation.

9. Write down the expression for cut off frequency when the wave is propagated in between two parallel plates.

The cut-off frequency, fc = mC/ 2a

10. Mention the characteristics of TEM waves.

a) It is a special type of TM wave

b) It doesn't have either e or H component
c) Its velocity is independent of frequency
d) Its cut-off frequency is zero.

11. Define attenuation factor

Attenuation factor = (Power lost/ unit length)/(2 x power transmitted)

12. Give the relation between the attenuation factor for TE waves and TM waves

$\alpha TE = \alpha TM (fc/f)2$

13. Define wave impedance

Wave impedance is defined as the ratio of electric to magnetic field strength Zxy= Ex/ Hy in the positive direction
Zxy= -Ex/ Hy in the negative direction

14. What is a parallel plate wave guide?

Parallel plate wave guide consists of two conducting sheets separated by a dielectric material.

15. Why are rectangular wave-guides preferred over circular wave-guides?

Rectangular wave-guides preferred over circular wave guides because of the following reasons.

a) Rectangular wave guide is smaller in size than a circular wave guide of the same operating frequency
b) It does not maintain its polarization through the circular wave guide
c) The frequency difference between the lowest frequency on dominant mode and the next mode of a rectangular wave-guide is bigger than in a circular wave guide.

16. Mention the applications of wave guides

The wave guides are employed for transmission of energy at very high frequencies where the attenuation caused by wave guide is smaller. Waveguides are used in microwave transmission.Circular waveguides are used as attenuators and phase shifters

RECTANGULAR WAVEGUIDES

1. Why is circular or rectangular form used as waveguide?

Waveguides usually take the form of rectangular or circular cylinders because of its simpler forms in use and less expensive to manufacture.

2. What is an evanescent mode?

When the operating frequency is lower than the cut-off frequency, the propagation constant becomes real i.e., The wave cannot be propagated. This non- propagating mode is known as evanescent mode.

3. What is the dominant mode for the TE waves in the rectangular waveguide?

The lowest mode for TE wave is TE_{10} (m=1 , n=0)

4. What is the dominant mode for the TM waves in the rectangular waveguide?

The lowest mode for TM wave is TM_{11}(m=1 , n=1)

5. What is the dominant mode for the rectangular waveguide?

The lowest mode for TE wave is TE_{10} (m=1, n=0) whereas the lowest mode for TM wave is TM_{11}(m=1 , n=1). The TE_{10} waves have the lowest cut off frequency compared to the TM11 mode. Hence the TE_{10} (m=1, n=0) is the dominant mode of a rectangular waveguide. Because the TE_{10} mode has the lowest attenuation of all modes in a rectangular waveguide and its electric field is definitely polarized in one direction everywhere.

6. Which are the non-zero field components for the for the TE_{10} mode in a rectangular waveguide?

H_x, H_z and E_y.

7. Which are the non-zero field components for the for the TM_{11} mode in a rectangular waveguide?

H_x, H_y ,E_y. and E_z.

8. Define characteristic impedance in a waveguide.

The characteristic impedance Z_o can be defined in terms of the voltage-current ratio or in terms of power transmitted for a given voltage or a given current. Z_o (V,I) = V/I

9. Why TEM mode is not possible in a rectangular waveguide?

Since TEM wave do not have axial component of either E or H ,it cannot propagate within a single conductor waveguide

10. Explain why TM_{01} and TM_{10} modes in a rectangular waveguide do not exist.

For TM modes in rectangular waveguides, neither m or n can be zero because all the field equations vanish (i.e., H_x, H_y ,E_y. and E_z.=0). If m=0,n=1 or m=1,n=0 no fields are present. Hence TM_{01} and TM_{10} modes in a rectangular waveguide do not exist.

11. What are degenerate modes in a rectangular waveguide?

Some of the higher order modes, having the same cut off frequency, are called degenerate Modes. In a rectangular waveguide, TE_{mn} and TM_{mn} modes

CIRCULAR WAVE GUIDES AND RESONATORS

1. What is a circular waveguide?

A circular waveguide is a hollow metallic tube with circular cross-section for propagating the electromagnetic waves by continuous reflections from the surfaces or walls of the guide

2. Why circular waveguides are not preferred over rectangular waveguides?

The circular waveguides are avoided because of the following reasons:

a) The frequency difference between the lowest frequency on the dominant mode and the next mode is smaller than in a rectangular waveguide, with b/a= 0.5

b) The circular symmetry of the waveguide may reflect on the possibility of the wave not maintaining its polarization throughout the length of the guide.

c) For the same operating frequency, circular waveguide is bigger in size than a rectangular waveguide.

3. Mention the applications of circular waveguide.

Circular waveguides are used as attenuators and phase-shifters

4. Which mode in a circular waveguide has attenuation effect decreasing with increase in frequency?

TE01

5. What are the possible modes for TM waves in a circular waveguide?

The possible TM modes in a circular waveguide are: TM01, TM02, TM11, and TM12

6. Define dominant mode for a circular waveguide.

The dominant mode for a circular waveguide is defined as the lowest order mode having the lowest root value.

7. What are the possible modes for TE waves in a circular waveguide?

The possible TE modes in a circular waveguide are: TE01, TE02, TE11, and TE12

8. What are the root values for the TE modes?

The root values for the TE modes are: (ha)01 = 3.85 for TE01

(ha)02 = 7.02 for TE02 (ha)11 = 1.841 for TE11 (ha)12 = 5.53 for TE12

9. What is the dominant mode for TE waves in a circular waveguide?

The dominant mode for TE waves in a circular waveguide is the TE11 because it has the lowest root value of 1.841

10. What is the dominant mode for TM waves in a circular waveguide?

The dominant mode for TM waves in a circular waveguide is the TM01 because it has the lowest root value of 2.405.

11. What is the dominant mode in a circular waveguide?

The dominant mode for TM waves in a circular waveguide is the TM01 because it has the root value of 2.405. The dominant mode for TE waves in a circular waveguide is the TE11 because it has the root value of 1.841. Since the root value of TE11 is lower than TM01, TE11 is the dominant or the lowest order mode for a circular waveguide.

12. Mention the dominant modes in rectangular and circular waveguides

For a rectangular waveguide, the dominant mode is TE01
For a circular waveguide, the dominant mode is TE11

13. Why is TM01 mode preferred to the TE01 mode in a circular waveguide?

TM01 mode is preferred to the TE01 mode in a circular waveguide, since it requires a smaller diameter for the same cut off wavelength.

14. What are the performance parameters of microwave resonator?

The performance parameters of microwave resonator are:
(i) Resonant frequency
(ii) Quality factor
(iii) Input impedance

15. What is resonant frequency of microwave resonator?

Resonant frequency of microwave resonator is the frequency at which the energy in the resonator attains maximum value. i.e., twice the electric energy or magnetic energy.

16. Define quality factor of a resonator.

The quality factor Q is a measure of frequency selectivity of the resonator. It is defined as
Q = 2 _ x Maximum energy stored / Energy dissipated per cycle = _ W/ P
Where W is the maximum stored energy

P is the average power loss

17. What is a resonator?

Resonator is a tuned circuit which resonates at a particular frequency at which the energy stored
in the electric field is equal to the energy stored in the magnetic field.

18. How the resonator is constructed at low frequencies?

At low frequencies upto VHF (300 MHz), the resonator is made up of the reactive elements or the lumped elements like the capacitance and the inductance.

19. What are the disadvantages if the resonator is made using lumped elements at high frequencies?

1) The inductance and the capacitance values are too small as the frequency is increased beyond the VHF range and hence difficult to realize.

20. What are the methods used for constructing a resonator?

The resonators are built by
a) using lumped elements like L and C

b) using distributed elements like sections of coaxial lines c) using rectangular or circular waveguide

21. What is a transmission line resonator or coaxial resonator?
Transmission line resonator can be built using distributed elements like sections of coaxial lines. The coaxial lines are either opened or shunted at the end sections thus confining the electromagnetic energy within the section and acts as the resonant circuit having a natural resonant frequency.

22. Why transmission line resonator is not usually used as microwave resonator? At very high frequencies transmission line resonator does not give very high quality factor Q due to skin effect and radiation loss. So, transmission line resonator is not used as microwave resonator

23. What are cavity resonators?
Cavity resonators are formed by placing the perfectly conducting sheets on the rectangular or circular waveguide on the two end sections and hence all the sides are surrounded by the conducting walls thus forming a cavity. The electromagnetic energy is confined within this metallic enclosure and they acts as resonant circuits.

24. What are the types of cavity resonators?
There are two types of cavity resonators. They are:
a) Rectangular cavity resonator
b) Circular cavity resonator

25. Why rectangular or circular cavities can be used as microwave resonators?
Rectangular or circular cavities can be used as microwave resonators because they have natural resonant frequency and behave like a LCR circuit.

26. How the cavity resonator can be represented by a LCR circuit?
The electromagnetic energy is stored in the entire volume of the cavity in the form of electric and magnetic fields. The presence of electric field gives rise to a capacitance value and the presence of magnetic field gives rise to a inductance value and the finite conductivity in the walls gives rise to loss along the walls giving rise to a resistance value. Thus the cavity resonator can be represented by a equivalent LCR circuit and have a natural resonant frequency

27. Name the three basic configurations of coaxial resonators.
The basic configurations of coaxial resonators are:
d) Quarter wave coaxial cavity
e) Half wave coaxial cavity
f) Capacitance end coaxial cavity

28. What is the dominant mode for rectangular resonator?
The dominant mode of a rectangular resonator depends on the dimensions of the cavity. For b<a<d, the dominant mode is TE101

29. What is the dominant mode for circular resonator?

The dominant mode of a circular resonator depends on the dimensions of the cavity. Ford< 2a, the dominant mode is TM010

30. When a medium is said to be free- space.

A free-space medium is one in which there are no conduction currents and no charges.