Unit I Transmission Line Theory

Part - A Questions

1. What is meant by distortion less line?

A line, which has neither frequency distortion nor delay distortion is called a distortion less line.

2. Find the reflection coefficient of a 200Ω transmission line when it is terminated by a load impedance of 692∟12ºΩ. **[May/June 2014]**

Given: Zr=200Ω and Z0=692∟12ºΩ = 678.878-j143.87 Reflection
coefficient K= (Zr-Z0)/Zr+Z0
K=200-(678.878-j143.87)/200+(678.878-j143.87)
K=(- 467.878+j143.87)/878.878-j143.87)
K=(498.1∟163.21)/890.57∟-9.29
K=0.559∟172.5º

3. What are the line parameters and define it?

The parameters of a transmission line are:
Resistance (R) Inductance (L) Capacitance (C) Conductance (G)
Resistance (R) is defined as the loop resistance per unit length of the wire. Its unit is ohm/Km
Inductance (L) is defined as the loop inductance per unit length of the wire. Its unit is Henry/Km
Capacitance (C) is defined as the loop capacitance per unit length of the wire. Its unit is Farad/Km
Conductance (G) is defined as the loop conductance per unit length of the wire. Its unit is mho/Km

4. What are the secondary constants of a line? Why the line parameters are called distributed elements?

The secondary constants of a line are: Characteristic Impedance Propagation Constant Since the line constants R, L, C, G are distributed through the entire length of the line, they are called as distributed elements. They are also called as primary constants.

5. What is a finite line? Write down the significance of this line?

A finite line is a line having a finite length on the line. It is a line, which is terminated, in its characteristic impedance (ZR=Z0), so the input impedance of the finite line is equal to the characteristic impedance (Zs=Z0).

6. What is an infinite line?

An infinite line is a line in which the length of the transmission line is infinite. A finite line, which is terminated in its characteristic impedance, is termed as infinite line. So for an infinite line, the input impedance is equivalent to the characteristic impedance.

7. What is wavelength of a line? [May/June 2014, Nov/Dec 2017]

The distance the wave travels along the line while the phase angle is changing through 2Π radians is called a wavelength.

8. What are the types of line distortions?

The distortions occurring in the transmission line are called waveform distortion or line distortion.
Waveform distortion is of two types:

a) Frequency distortion
b) Phase or Delay Distortion.

9. How frequency distortion occurs in a line? [May/June 2014]

When a signal having many frequency components are transmitted along the line, all the frequencies will not have equal attenuation and hence the received end waveform will not be identical with the input waveform at the sending end because each frequency is having different attenuation. This type of distortion is called frequency distortion.

10.How to avoid the frequency distortion that occurs in the line?

In order to reduce frequency distortion occurring in the line,

a) The attenuation constant α should be made independent of frequency. b) By using equalizers at the line terminals which minimize the frequency distortion. Equalizers are networks whose frequency and phase characteristics are adjusted to be inverse to those of the lines, which result in a uniform frequency response over the desired frequency band, and hence the attenuation is equal for all the frequencies.

11.What is delay distortion?

When a signal having many frequency components are transmitted along the line, all the frequencies will not have same time of transmission, some frequencies being delayed more than others. So the received end waveform will not be identical with the input waveform at the sending end because some frequency components will be delayed more than those of other frequencies. This type of distortion is called phase or delay distortion.

12. What is a distortion less line? What is the condition for a distortion less line? [May/June 2014]

A line, which has neither frequency distortion nor phase distortion is called a distortion less line. The condition for a distortion less line is RC=LG. Also,

- The attenuation constant α should be made independent of frequency.

- The phase constant β should be made dependent of frequency.
- The velocity of propagation is independent of frequency.

13. What is the drawback of using ordinary telephone cables? [April/May 2015]

In ordinary telephone cables, the wires are insulated with paper and twisted in pairs, therefore there will not be flux linkage between the wires, which results in negligible inductance, and conductance. If this is the case, there occurs frequency and phase distortion in the line.

14. How the telephone line can be made a distortion less line?

For the telephone cable to be distortion less line, the inductance value should be increased by placing lumped inductors along the line.

15. What is loading?

Loading is the process of increasing the inductance value by placing lumped inductors at specific intervals along the line, which avoids the distortion.

16. What are the types of loading?

a) Continuous loading b) Patch loading c) Lumped loading

17. What is continuous loading?

Continuous loading is the process of increasing the inductance value by placing a iron core or a magnetic tape over the conductor of the line.

18. What is patch loading?

It is the process of using sections of continuously loaded cables separated by sections of unloaded cables which increases the inductance value.

19. What is lumped loading?

Lumped loading is the process of increasing the inductance value by placing lumped inductors at specific intervals along the line, which avoids the distortion.

20. Define reflection coefficient. [April/May 2017]

Reflection Coefficient can be defined as the ratio of the reflected voltage to the incident voltage at the receiving end of the line Reflection Coefficient K=Reflected Voltage at load /Incident voltage at the load $K=V_r/V_i$

21. When reflection occurs in a line?

Reflection occurs because of the following cases:

1) when the load end is open circuited

2) when the load end is short-circuited
3) when the line is not terminated in its characteristic impedance
When the line is either open or short circuited, then there is not resistance at the receiving end to absorb all the power transmitted from the source end. Hence all the power incident on the load gets completely reflected back to the source causing reflections in the line. When the line is terminated in its characteristic impedance, the load will absorb some power and some will be reflected back thus producing reflections.

22. What are the conditions for a perfect line? What is a smooth line?
For a perfect line, the resistance and the leakage conductance value were neglected. The conditions for a perfect line are R=G=0.A smooth line is one in which the load is terminated by its characteristic impedance and no reflections occur in such a line. It is also called as flat line.

23. Define reflection loss. **[May/June 2016]**
Reflection loss is defined as the number of nepers or decibels by which the current in the load under image matched conditions would exceed the current actually flowing in the load

24. Define the term insertion loss. **[April/May 2015]**
The insertion loss of a line or network is defined as the number of nepers or decibels by which the current in the load is changed by the insertion. Insertion loss=Current flowing in the load without insertion of the network/Current flowing in the load with insertion of the network

Part-B

1. Derive the general solution of a transmission line terminated with any load impedance ZR.
[April/May 2016, Nov/Dec 2017]
2. Obtain the expression for voltage and current along a parallel wire transmission line.
[May/June 2013, May 2014, Nov/Dec2016, May 2017]
3. A transmission line has the following constants R= 10.4Ω, L=3.666mH, G=0.08μmho and C=0.8351μf. Calculate characteristic impedance, attenuation and phase constant and velocity at10MHZ.
[Nov/Dec2011,May 2013, Nov/Dec 2016]
4. What are the types of waveform distortions introduced by the transmission line? Derive the condition for distortion less operation of transmission line.
[Nov/Dec2011, April/May 2014, May 2015, April/May 2016]
5. Derive (a) open and short circuit impedance (b) condition required for a distortion less line (c) reflection coefficient (d) reflection loss and reflection factor.
[May/June 2014, April/May 2015, Nov/Dec 2016]

6. At 8 Mhz the characteristic Impedance is 40-j2 ohms and propagation constant 0.01+j0.18 parameter. Find the primary constants

[April/May 2014, Nov/Dec 2015, April/May 2016]

7. A line has R = 8.4 ohm/km, L = 2.67 mH/km, G = 1.8 μ mho/km and C = .00835μF/km. Determine Zo for f = 1000 Hz. Vs = 4.0 volts and length = 100 km.

[May/June 2014, April/May2016, Nov/Dec 2016]

8. A transmission line has characteristic impedance of (683-j138)Ω. The propagation constant is (0.0075+j0.0356) per Km. Determine the values of 'R' and 'L' of this line at 1000Hz.

[April/May 2013, Nov/Dec 2015, April/May 2016]

9. The constants of transmission lines are R=6Ω/Km, L=2.2 mH/Km, C=0.005 μF/Km and G= (0.25 m) mhos/Km. Calculate the attenuation constant and phase constant at 1000Hz.

[April/May 2014, Nov/Dec 2015, April/May 2017]

10. Derive equation of attenuation and phase constant of line, and derive an expression for the input impedance of a transmission line**.**

[May/June 2013, April/May 2014, Nov/Dec 2016]

Unit II High Frequency Transmission Line

Part - A Questions

1. For the line of zero dissipation, what will be the values of attenuation constant and characteristic impedance? [May/June 2014]

Attenuation constant: $\alpha=0$,
Phase constant: $\beta=\omega\sqrt{(LC)}$
Characteristic impedance: $Z0=\sqrt{(L/C)}$

2. State the assumptions for the analysis of the performance of the radio frequency line. [May/June 2016]

i).Due to the skin effect ,the currents are assumed to flow on the surface of the conductor. The internal inductance is zero.
ii).The resistance R increases with Ö f while inductance L increases with f . Hence wL>>R.
iii).The leakage conductance G is zero

3. State the expressions for inductance L of a open wire line and coaxial line.

i) For open wire line,
L=9.21*10-7(μ/μr +4ln d/a)=10-7(μr+9.21log d/a) H/m
ii) For coaxial line,
L = 4.60*10-7[log b/a]H/m

4. State the expressions for the capacitance of a open wire line.

For open wire line,
C=(12.07)/(ln d/a) μf/m

5. What is dissipationless line? [April/May 2015]

A line for which the effect of resistance R is completely neglected is called dissipationless line

6. What is the nature and value of Z0 for the dissipation less line? [May/June 2014]

For the dissipation less line, the Z0 is purley resistive and given by, $Z0=R0 = \sqrt{L/c}$

7. State the values of α and β for the dissipation less line. [May/June 2014]

$\alpha=0$ and $\beta=\omega\sqrt{LC}$

8. What are nodes and antinodes on a line?

The points along the line where magnitude of voltage or current is zero are called nodes while the the points along the lines where magnitude of voltage or current first maximum are called antinodes or loops.

9. What is the range of values of standing wave ratio?

The range of values of standing wave ratio is theoretically 1 to infinity.

10. What are standing waves?

If the transmission is not terminated in its characteristic impedance, then there will be two waves traveling along the line which gives rise to standing waves having fixed maxima and fixed minima.

11. What is called standing wave ratio? [May/June 2013, April/May 2014]

The ratio of the maximum to minimum magnitudes of current or voltage on a line having standing wave is called the standing-wave ratio S. That is, $S = | E_{max} / E_{min} | = | I_{max} / I_{min} |$

12.State the relation between standing were ratio S and reflection co-efficient k.

[May/June 2016, April/May 2015]

The relation between standing wave ratio S and reflection co-efficient k is,

1+ k /1- k also K= S-1/ S+1

13.How will you make standing wave measurements on coaxial lines?

For coaxial lines it is necessary to use a length of line in which a longitudinal slot, one half wavelength or more long has been cut. A wire probe is inserted into the air dielectric of the line as a pickup device, a vacuum tube voltmeter or other detector being connected between probe and sheath as an indicator. If the meter provides linear indications, S is readily determined. If the indicator is non linear, corrections must be applied to the readings obtained.

14.Give the maximum and minimum input impedance of the dissipationless line.

Maximum Input impedance, $R_{max} = SR_o$

Minimum input impedance, $R_{min} = R_o / S$

15. Give the input impedance of open and short circuited lines.

The input impedance of open and short circuited lines are given by, $Z_{sc} = jR_o \tan 2\beta s$

16. Why the point of voltage minimum is measured rather than voltage maximum?

The point of a voltage minimum is measured rather than a voltage maximum because it is usually possible to determine the exact point of minimum voltage with greater accuracy.

17. What is the use of eighth wave line?

An eighth wave line is used to transform any resistance to an impendence with a magnitude equal to Roof the line or to obtain a magnitude match between a resistance of any value and a source of Ro internal resistance.

18. What do you mean by copper insulators?

An application of the short circuited quarter wave line is an insulator to support an open wire line or the center conductor of a coaxial line .This application makes se of the fact that the input impendence of a quarter –wave shorted line is very high, such lines are sometimes referred to as copper insulators.

Part-B

1. Elaborate various parameters of open-wire and co-axial lines at radio frequency and for high frequency propagation. **[April/May 2014, Nov/Dec 2015, Nov/Dec 2016]**
2. Derive and explain in detail about the voltages and current when radio frequency propagates in the transmission line under dissipation less condition. **[April/May 2013, April/May 2014, Nov/Dec 2016, Nov/Dec 2017]**
3. Write the brief note on impedance and VSWR measurement on transmission line. **[April/May 2014, Nov/Dec 2015, April/May 2016]**

A 30m long loss less transmission line with Z0=50Ω operating at 2MHz is terminated with a load ZL=(60+j40) Ω. If U=0.6C on the line, find (i) Reflection coefficient (K)(ii) Standing wave ratio (S) (iii) Input impedance (ZS). **[April/May 2013, April/May 2014, Nov/Dec 2017]**

4. Derive expression for input impedance of short and open circuited lines. **[April/May 2013, Nov/Dec 2015, Nov/Dec 2016]**
5. Explain (a) standing wave (b) nodes(c) antinodes (c) reflection loss. **[April/May 2014, Nov/Dec 2016]**
6. Explain power and impedance measurement on transmission lines. **[Nov/Dec 2017]**

Unit III Impedance Matching In High Frequency Transmission Line

Part - A Questions

1. What is Impedance matching?

If the load impedance is not equal to the source impedance, then all the power that are transmitted from the source will not reach the load end and hence some power is wasted. This is called impedance mismatch condition. So for proper maximum power transfer, the impedances in the sending and receiving end are matched. This is called impedance matching.

2. Distinguish between single stub and double stub matching. [May/June 2014]

Single stub matching Double stub matching

i) It has one stub to match the transmission line impedance

ii) Stub should be placed on a definite place on a line

iii) It necessities both length and location of stub to be altered for matching.

Double stub matching:

i) It requires two stubs for impedance matching

ii) Location of stub is arbitrary.

iii) It alter the length of stubs for matching

3. Why is a quarter wave lines called as impendence inverter? [May/June 2016]

A quarter wave line may be considered as an impendence inverter because it can transform a low impendence value to a high impendence and vice versa.

4. List the application of the quarter wave line? [May/June 2015]

An important application of the quarter wave matching section is to a couple a transmission line to a resistive load such as an antenna.

The quarter –wave matching section then must be designed to have a characteristic impendence Ro so chosen that the antenna resistance Ra is transformed to a value equal to the characteristic impendence R_0 of the transmission line.

5. Explain impendence matching using stub. [May/June 2016]

In the method of impendence matching using stub, an open or closed stub line of suitable length is used as a reactance shunted across the transmission line at a designated distance from the load, to tune the length of the line and the load to resonance with an anti resonant resistance equal to Ro.

6. Give reasons for preferring a short- circuited stub when compared to an open – circuited stub.

A short circuited stub is preferred to an open circuited stub because of greater ease in constructions and because of the inability to maintain high enough insulation resistance at the open –circuit point to ensure that the stub is really open circuited .A shorted stub also has a lower loss of energy due to radiation, since the short – circuit can be definitely established with a large metal plate ,effectively stopping all field propagation.

7. What are the two independent measurements that must be made to find the location and length of the stub?

The standing wave ratio S and the position of a voltage minimum are the independent measurements that must be made to find the location and length of the stub.

8. Give the formula to calculate the length of the short circuited stub.

The formula to calculate the length of the short circuited stub is,

L=_/2_tan-1(s/(s-1))

This is the length of the short – circuited stub to be placed d meters towards the load from a point at which a voltage minimum existed before attachment of the stub.

9.Give reason for an open line not frequently employed for impedance matching.

An open line is rarely used for impedance matching because of radiation losses from the open end, and capacitance effects and the difficulty of a smooth adjustment of length.

10.State the use of half wave line.

The expression for the input impendence of the line is given by Zs = Zr. Thus the line repeats is terminating impedance .Hence it is operated as one to one transformer .Its application is to connect load to a source where they cannot be made adjacent.

11. Why Double stub matching is preferred over single stub matching.

Double stub matching is preferred over single stub due to following disadvantages of single stub.

1. Single stub matching is useful for a fixed frequency. So as frequency changes the location of single stub will have to be changed.
2. The single stub matching system is based on the measurement of voltage minimum .Hence for coxial line it is very difficult to get such voltage minimum, without using slotted line section

12.List the applications of the smith chart. [April/May 2016]

The Applications of the smith chart are,

(i) It is used to find the input impendence and input admittance of the line.

(ii) The smith chart may also be used for lossy lines and the locus of points on a line then follows a spiral path towards the chart center, due to attenuation.

(iii) In single stub matching

13.Give reason for an open line not frequently employed for impedance matching.

An open line is rarely used for impedance matching because of radiation losses from the open end, and capacitance effects and the difficulty of a smooth adjustment of length.

14. State the use of half wave line.

The expression for the input impendence of the line is given by Zs = Zr. Thus the line repeats is terminating impedance .Hence it is operated as one to one transformer .Its application is to connect load to a source where they cannot be made adjacent.

15. What are the difficulties in single stub matching? [May/June 2017]

The Difficulties of the smith chart are

(i) Single stub impedance matching requires the stub to be located at a definite point on the line. This requirement frequently calls for placement of the stub at an undesirable place from a mechanical view point.

(ii) For a coaxial line, it is not possible to determine the location of a voltage minimum without a slotted line section, so that placement of a stub at the exact required point is difficult.

(iii) In the case of the single stub it was mentioned that two adjustments were required, these being location and length of the stub.

16. What is double stub matching?

Another possible method of impedance matching is to use two stubs in which the locations of the stub are arbitrary, the two stub lengths furnishing the required adjustments. The spacing is Frequently made $\lambda/4$.This is called double stub matching.

17. Give the equation for the radius of a circle diagram.

The equation for the radius of a circle diagram is R=(S2-1)/2S and C = (S2+1)/2S Where C is the shift of the center of the circle on the positive Ra axis.

18. What is the use of a circle diagram?

The circle diagram may be used to find the input impendence of a line m of any chosen length.

Part-B

1.Explain single stub matching on a line. Deduce the expression for the length and location of single stub tuner for impedance matching.

[April/May 2014, April/May 2015, Nov/Dec 2016, Nov/Dec 2017]

2. Single stub is to match a 300Ω line to a load of 450-j600Ω at 1MHZ. Determine the shortest distance from the load to the stub location and proper length of the short circuited stub using relevant formula.

[April/May 2015, April/May 2016, Nov/Dec 2017]

3. A loss less line 0.4375λ long has an input impedance of 1.2+j0.95. Using smith chart, find the load impedance, reflection coefficient and standing wave ratio.

[April/May 2013, April/May 2015, Nov/Dec 2016]

4. Determine the stub length and distance from load. Given that a complex load 50- j100 is to be matched to a 75 ohms transmission line using short circuited stub.

[April/May 2015, Nov/Dec 2016]

5. A load having an impedance of (450-j600) ohms at 10MHz is connected to a 300ohms line. Calculate the position and length of a short circuited stub to match this load to the line using Smith chart.

[April/May 2014, April/May 2017]

6. A 100 Ω, 200 m long lossless transmission line operators at 10MHz and is terminated into an impedance of 50 –j 200Ω .The transit time of the line is 1 μs. Determine the length and location of a short circuited stub line. **[April/May 2014, April/May 2015, Nov/Dec 2016]**

Derive length and location of single stub matching. **[Nov/Dec 2015, April/May 2017]**

7. Derive the expression for the input impedance of the quarter wave line and discuss the applications of it. [**April/May 2014, Nov/Dec 2015, April/may 2016]**

8. Discuss the principle of double stub matching with neat diagram and expressions.

[April/May 2015, Nov/Dec 2016]

9. Design a single stub match for a load of (150+j225) Ω for 75Ω line a 500 MHz using smith chart.

[Nov/Dec 2015]

Unit IV Passive Filters

Part - A Questions

1. Define Characteristic impedance. [May/June 2016, May/June 2015]

Characteristic impedance is the impedance measured at the sending end of the line. It is given by $Z0 = Z/Y$, where $Z = R + j\omega L$ is the series impedance $Y = G + j\omega C$ is the shunt admittance.

2. Define Neper. [May/June 2012]

The natural logarithmic of the ratio of input current or voltage to the output current or voltage is expressed in neper.

$N=\ln [v1/v2]=\ln[I1/I2]$.

3. Define Propagation constant. [May/June 2013, May/June 2015]

Propagation constant is defined as the natural logarithm of the ratio of the sending end current or voltage to the receiving end current or voltage of the line. It gives the manner in the wave is propagated along a line and specifies the variation of voltage and current in the line as a function of distance. Propagation constant is a complex quantity and is expressed as $\gamma = \alpha + j \beta$.

The real part is called the attenuation constant α whereas the imaginary part of propagation constant is called the phase constant β.

4. What is symmetrical network?

A network is said to be symmetrical if the two series arms of a T network or shunt arms of a Π network are equal.

5. If the short circuit impedance is 100Ω and open circuit impedance 400Ω, What is the characteristic impedance of symmetrical network.

Given: $Zsc=100\Omega$ and $Zoc=400\Omega$

$Z0=\sqrt{(Zsc.Zoc)} =\sqrt{(100*400)}=200\Omega$

6. Define cut-off frequency of a filter.

The frequency at which the network changes from a pass band to a stop band or vice-versa is called cut-off frequency.

7. What are the disadvantages of constant K prototype filters? [April/May 2015]

Attenuation does not increase rapidly beyond cut-off frequencies ii) Characteristic impedance varies widely in the pass band from its desired value.

8. What is the condition for occurrence of cut-off frequency of a filter?

i) Z1/(4 Z2)=0 i.e, Z1=0
ii) Z1/(4 Z2)= -1 i.e Z1= -4 Z2

9. What is constant k filters. [Nov/Dec 2016]
A filter in which the series arm impedance Z1 and arm shunt arm impedance Z2 satisfy the relationship between Z1.Z2=RK. Is called constant k filter, where Rk is a real constant independent of frequency.

10. What is importance of terminating half section?
1. Terminating half section are normally added to any filter to provide uniform terminated and matching characteristics.
2. They provide a point of high attenuation at a frequency 1.25 times that of cut off. Thus improving the attenuation the attenuation characteristic of the filter.

11. Why constant k filters are also known as proto type filters? [Nov/Dec 2014]
Constant k filters are also known as proto type filters because other complicated networks can be derived from it.

12. Mention the advantages of m-derived filters. [May/June 2015]
i) Attenuation rises near cut-off frequency and its slope is adjustable by varying f ∞.
ii) The characteristic impedance will be uniform in the pass band when m-derived half section having m=0.6 is connected at the ends.

13. What are composite filters? [May/June 2016]
A Composite filter is a combination of constant K filters, m-derived filters and m-derived half section.

14. What is low pass filter?
Low pass filter is a network which allows only low frequencies at below cut-off frequency and attenuates high frequencies.

Part –B

1. Derive an expression for the input impedance of a symmetrical T and π network terminated by characteristic impedance, also give for short circuit & open circuit.
[Nov/Dec 2013, April/May 2014, Nov/Dec 2015, Nov/Dec2016]

2. Explain the properties and characteristic impedance of symmetrical networks.
[Nov/Dec 2012, May/June 2013]

3. Design constant-k low pass and high pass filters with suitable filter sections.
[April/May 2014, Nov/Dec 2015, Nov/Dec2017]

4. Find L and C of a low pass T section constant-k filter having a cutoff frequency of 1.8 KHz and load of 500ohms. **[Nov/Dec 2014, April/May 2015, Nov/Dec 2016, May/June 2017]**

5. Design a constant K LPF for the cutoff frequency of 6 KHz and design impedance of 500 Ω.
[April/May 2013, April/May 2014, May/June 2015, April/May 2016]

6. Design T and π section low pass filter which has series inductance 80 mH and shunt capacitance 0.022μf. Find the cutoff frequency and design impedance.
[April/May 2013, April/May 2014, Nov/Dec 2015, Nov/Dec2016]

7. Derive the expression for design impedance, cut-off frequency attenuation constant and phase constant for proto type high pass filter. **[Nov/Dec 2015, April/May 2017]**

8. Obtain the design equation for constant – K band pass filter. [**April/May 2015, May/June 2016]**

9. Design a constant K BPF having a design impedance of 600 ohms and cutoff frequencies of 1 Khz and 4 Khz. **[May/June 2012, April/May 2014, May/June 2015, Nov/Dec 2015, Nov/Dec2016]**

10. Design a m-derived T section low pass filter having a cutoff frequency of 5000 hz and a design impedance of 600 ohms. The frequency of infinite attenuation is 1.5fc
[April/May 2014, Nov/Dec 2015, May/June 2016, Nov/Dec2016]

11. Draw and explain the design and operation of m-derived T-section HPF with necessary equations and diagrams. **[April/May 2013, April/May 2014, May/June 2015]**

12.Derive and draw the characteristics of m-derived T section for high pass filter.
[Nov/Dec 2012, April/May 2013, May/June 2015, Nov/Dec2016]

Unit V Waveguides and Cavity Resonators

Part - A Questions

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. 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.

4. 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.

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

The lowest mode for TE wave is TE10 (m=1 , n=0)

6. What is the dominant mode for the TM waves in the rectangular waveguide? [April/May 2015]

The lowest mode for TM wave is TM11(m=1, n=1)

7. What is the dominant mode for the rectangular waveguide? [May/June 2015, Nov/Dec 2016]

The lowest mode for TE wave is TE10 (m=1, n=0) whereas the lowest mode for TM wave is TM11(m=1 , n=1). The TE10 wave have the lowest cut off frequency compared to the TM11 mode. Hence the TE10 (m=1 , n=0) is the dominant mode of a rectangular waveguide. Because the TE10 mode has the lowest attenuation of all modes in a rectangular waveguide and its electric field is definitely polarized in one direction everywhere.

8. Which are the non-zero field components for the for the TM11 mode in a rectangular waveguide?

Hx, Hy ,Ey. and Ez

9. Define characteristic impedance in a waveguide

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

10. 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

11. Explain why TM01 and TM10 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., Hx, Hy ,Ey. and Ez.=0). If m=0,n=1 or m=1,n=0 no fields are present. Hence TM01 and TM10 modes in a rectangular waveguide do not exist.

12. 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, TEmn and TMmn modes (both m _ 0 and n _ 0) are always degenerate.

13. 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

14. 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.

15. What is a dominant mode?

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

16. Give the dominant mode for TE and TM waves Dominant mode: TE10 and TM10

17. What is cut off frequency?

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

18. What is cut-off wavelength? [April/May 2015]

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

19. Write down the expression for cut off frequency when the wave is propagated inbetween two parallel plates.

The cut-off frequency, fc = m/ (2a (μE)1/2)

20. Mention the characteristics of TEM waves. [May/June 2014, April/May 2017]

It is a special type of TM wave

a) It doesn't have either e or H component

b) Its velocity is independent of frequency

c) Its cutoff frequency is zero.

21. Define attenuation factor

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

22. 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

23. What is a parallel plate wave guide?

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

24.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.

25. Mention the applications of wave guides [May/June 2016]

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

26. 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.

27.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.

28. Mention the applications of circular waveguide. [May/June 2014]

Circular waveguides are used as attenuators and phase-shifters

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

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

30. What are the root values for the TM modes?

The root values for the TM modes are:

(ha)01 = 2.405 for TM01 (ha)02 = 5.53 for TM02 (ha)11 = 3.85 for TM11 (ha)12 = 7.02 for TM12

31. 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.

32.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.

33. 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

34. 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

35. 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.

36. 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.

37. 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

38.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.

39. Define quality factor of a resonator. [May/June 2012]

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

40. 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.

41.How the resonator is constructed at low frequencies? [May/June 2016]

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.

42.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.

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

[May/June 2016, May/June 2014]

a) using lumped elements like L and C
b) using distributed elements like sections of coaxial lines
c) using rectangular or circular waveguide

Part-B

1. Derive the expression for the field strength for the TE waves between parallel plates propagating in z direction. **[May/June 2014, April/May 2015, Nov/Dec 2016, Nov/Dec 2017]**
2. Derive the field components of the TM wave propagation between parallel plates. **[April/May 2014, Nov/Dec 2015, April/May 2016]**
3. Derive the characteristics of TE, TM and TEM waves for parallel plates. **[May/June 2012, April/May 2014, Nov/Dec 2015]**
4. Obtain the expression for the field components of an electromagnetic wave propagating between a pair of perfectly conducting planes? **[April/May 2013, April/May 2014, Nov/Dec 2015]**
5. Explain the transmission of TM waves in Rectangular waveguide with neat diagram and derivation. **[May/June 2012, April/May 2013, Nov/Dec 2015, Nov/Dec 2016, May/June 2017]**
6. An air filled rectangular waveguide with dimensions of a = 8.5 cm and b = 4.3 cm is fed by a 4 GHz carrier from co-axial cable. Determine the cut-off frequency, phase velocity and group velocity forTE11 mode. **[Nov/Dec 2015, Nov/Dec 2016]**
7. Obtain TE wave component of circular waveguide Using Bessel function **[April/May 2014, Nov/Dec 2015, Nov/Dec 2016]**