DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING
K.S.R. COLLEGE OF ENGINEERING: TIRUCHENGODE – 637 215.
COURSE / LESSON PLAN SCHEDULE

NAME: Dr. R.POORNIMA
CLASS/SEMESTER: III / V (A&B SEC)
SUBJECT:16EC514-TRANSMISSIONLINES AND WAVE GUIDES

A) Text Books:
1. John D.Ryder,"Networks, lines and fields", Prentice Hall of India, 2nd Edition, 2015.
2. E.C.Jordan, K.G. Balmain,"E.M.Waves& Radiating Systems", PHI,2nd Edition, 2011.

B) References:
1. Joseph Edminister,"Electromegnetics", Schaum's Series,TMH ,4th Edition , 2013.
2. G S N Raju, "Electromagnetic Field Theory and Transmission Lines",Pearson Education,2012.
3. S.F.Mahmoud, "Electromagnetic Waveguides Theory and Applications" Peter Peregrinus Ltd,1991.
4. B.Somanathan Nair, "Transmission Lines and wave guides", Pearson Education, 2011.

C. LEGEND:

L 1 -	Lecture 1	BB -	Black Board
T 1 -	Tutorial 1	OHP -	Over Head Projector
Tx 1 -	Text book 1	pp -	Pages
Tx 2 -	Text book 2	Rx 2 -	Reference 2
Rx 1 -	Reference 1	Rx 3 -	Reference 3

S.No.	Lecture Hour	Topics to be covered	Teaching Aid Required	Book No. / Page No.
UNIT-I		**FUNDAMENTAL OF FILTERS AND TRANSMISSION LINES**		
1	L1 & T1	The neper - The decibel - Characteristic impedance of symmetrical networks	BB	Tx 1/pp 138-146
2	L2	Current and voltage ratios - Propagation constant	BB	Tx 1/pp 146-149
3	L3	Properties of symmetrical networks	BB	Tx 1/pp 149-152
4	L4	Filter fundamentals – Pass and stop bands.	BB	Tx 1/pp 152-155
5	L5	A line of cascaded T sections	BB	Tx1/pp233-236
6	L6,L7& T2	General Solution of the transmission line	BB	Tx1/pp236-240 Tx2/pp 215-217 Rx 1/pp 15.1-15.3
7	L8&T3	Physical significance of the equations, The infinite line	BB	Tx1/pp240-245
8	L9	**Ex Topic: Behavior of the characteristic impedance**	BB	Tx 1/pp 155-157
UNIT II		**TRANSMISSION LINE THEORY**		
9	L10	Wavelength, Velocity of propagation	BB	Tx1/pp245-247 Rx 2/pp 7.16
10	L11& T4	Distortion line, Distortion less line condition	BB	Tx1/pp249-252
11	L12&L13	Loading, The telephone cable - Loaded telephone cable	BB	Tx1/pp252 - 254
12	L14	Campbell's formula	BB	Tx1/pp255
13	L15	Open and short circuited lines - Standing waves	BB	Tx1/pp264-271
14	L16&T5	Nodes - Standing wave ratio - Input impedance of open and short circuited lines	BB	Tx1/pp 291-294 Rx 1/pp 15.6
15	L17 & T6	Reflection on a line not terminated in Z_o- Reflection coefficient-Reflection factor and	BB	Tx1/pp256 – 260, 265 – 270

		reflection loss - Insertion loss.		
16	L18	**Ex Topic: T and π sections equivalent to lines**	BB	Tx1/pp271-274
UNIT III		**THE LINE AT RADIO FREQUENCY**		
17	L19	Parameters of open wire line and coaxial cable at RF	BB	Tx1/pp278-282
18	L20	Line constants for dissipation - voltages and currents on the dissipation less line	BB	Tx1/pp282-290
19	L21	Power and impedance measurement on lines	BB	Tx1/pp299-302
20	L22&T7	Section of transmission line: λ/2, λ/4, λ/8 line, Impedance matching	BB	Tx1/pp304-307 Tx 2/pp 224-231 Rx 1/pp 15.9, Rx 2/pp 7.22
21	L23	Single and double-stub matching	BB	Tx1/pp312-317 Rx1/pp15.10-15.12 Rx2/pp7.40-7.50
22	L24	**Ex Topic: Transients in loss less line**	BB	Rx-1 – 15.13 – 15.15
23	L25	Circle diagram	BB	Tx1/pp317-324,Tx2/pp 232-237, Rx 2/pp 7.40
24	L26&T8	Smith chart and its applications	LCD	Tx1/pp324-327, Tx2/pp 232-237, Rx 2/pp 7.40
25	L27 & T9	Stub matching problems solving using smith chart	LCD	Tx1/pp327-337
UNIT IV		**GUIDED WAVES BETWEEN PARALLEL PLANES**		
26	L28	Waves between parallel planes of perfect conductors	BB	Tx1/pp469-472, Rx2/pp 6.2
27	L29&L30	Field components of TM waves between parallel planes	BB	Tx1/pp473-478 Tx2/pp183-187, Rx2/pp 6.6
28	L31	Field components of TE & TEM waves between parallel planes	BB	Tx1/pp479-480 Tx2/pp180-183, Rx2/pp 6.8
29	L32&T10	Manner of wave travel	BB	Tx1/pp484-489 Tx 2/pp 189-192
30	L33&T11	Characteristics of TM, TE& TEM Waves	BB	Tx1/pp489-490
31	L34 &T12	Wave impedance	BB	Tx1/pp489-490
32	L35&L36	Attenuation factor of TM, TE & TEM Waves	BB	Tx1/pp490-495,Tx2/pp 192-200, 224-226
UNIT V		**WAVEGUIDES AND RESONANT CAVITIES**		
33	L37	Waves between rectangular waveguide	BB	Tx1/pp498-499, Rx2/pp 6.19
34	L38	TM and TE waves in rectangular waveguide	BB	Tx1/pp500-510 Tx 2/pp 244-249 Rx 1/pp 16.3-16.5
35	L39& T13	Bessel functions, Waves between circular waveguide, TM and TE waves in circular waveguide	BB	Tx1/pp 510-516 Tx 2/pp 257-261 Rx 2/pp 6.49
36	L40& T14	Characteristics of TM and TE wave in rectangular and circular wave guides	BB	Tx2/pp 185 - 188
37	L41& T15	Excitation of wave guides	BB	Tx1/pp 525-527 Rx2/pp 6.36
38	L42& L43	Resonant cavities -Rectangular resonant Cavity	BB	Tx1/pp527-532

				Rx2/pp 6.42
39	L44	Q factor of a rectangular cavity resonator for TE_{101} mode.	BB	Tx 1/pp 528 - 532 Tx 2/pp 269- 273
40	L45	**Ex Topic: Dielectric slab waveguide**	BB	Tx 2/pp 273-275

UNIT I FUNDAMENTAL OF FILTERS AND TRANSMISSION LINE

1. Define filters.(Remembering,CO1)

The reactive networks that will freely pass decide band of frequencies while almost totally suppressing other band of frequencies. Such reactive networks are called filters.

2. Define pass band, stop band and cut-off frequency of filter.(Remembering,CO1) (April/May 2019)

A filter network transmits or pass a desired frequency band without losses is called pass band, where it should stop or completely attenuate all undesired frequencies known as stop band.

The frequencies at which the network changes from a pass network to a stop network or vice-a-versa are called cut-off frequencies.

3. Define Neper. (Remembering,CO1)

The neper is defined as N nepers = $\ln\left|\frac{V_1}{V_2}\right| = \ln\left|\frac{I_1}{I_2}\right|$

Two voltages or currents differ by 1 neper when one of them is ε times as large as the other.

4. Define symmetrical network. (Remembering,CO1)

When the two series arms of T network are equal, or the shunt arms of π network are equal, the networks are said to be symmetrical.

5. Define Decibel. (Remembering,CO1) (June 2017)

The decibel is defines as db = 10 log (P_1/P_2), where P1 and P2 are input and output power respectively.

6. Compare lumped and distributed circuits? (Understanding,CO1) (Nov/Dec 2010)

The networks in which the Resistance, Inductance and Capacitance are individually connected at discrete points in the circuits are called lumped circuits.The networks in which the resistance, Inductance and Capacitance are distributed along the circuit are called distributed circuits.

7. Define the line parameters?(Remembering, CO1)

The parameters of a transmission line are:

(i) Resistance (R) (ii) Inductance (L) (iii) Capacitance (C) (iv) Conductance (G)

(i) Resistance (R) is defined as the loop resistance per unit length of the wire. Its unit is ohm/Km

(ii) Inductance (L) is defined as the loop inductance per unit length of the wire. Its unit is Henry/Km

(iii) Capacitance (C) is defined as the loop capacitance per unit length of the wire. Its unit is Farad/Km

(iv) Conductance (G) is defined as the loop conductance per unit length of the wire. Its unit is mho/Km

8. What are the secondary constants of a line? Why the line parameters are called distributed elements? (Remembering/understanding,CO1) (Nov /Dec 2003)

The secondary constants of a line are: (i) Characteristic Impedance (ii) 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.

9. Define Characteristic impedance. (Remembering, CO1) (Dec/Jan 2016) & (June 2016)

Characteristic impedance is the impedance measured at the sending end of the line. It is also defined as the ratio of voltage to the current at the sending side of the infinite line. It is given by

$Z_0 = \sqrt{Z/Y}$, where, $Z = R + j\omega L$ is the series impedance, $Y = G + j\omega C$ is the shunt admittance.

10. Define Propagation constant. (Remembering,CO1) (April /May 2017)

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.

11. What is a finite line? Write down the significance of this line? (Remembering,CO1)(Nov /Dec 2011)

A finite line is a line having a finite length on the line. It is a line, which is terminated, in its characteristic impedance ($Z_R = Z_0$), so the input impedance of the finite line is equal to the characteristic impedance ($Z_s=Z_0$).

12. What is an infinite line? (Remembering,CO1) (Apr /May 2019) (June 2017)

An infinite line is a line in which the length of the transmission line is infinite. The line length is infinite incident wave travels towards the end of the line and could not reach the load since the line length is infinite. Hence there is no reflection. Therefore an infinite line, the input impedance is equivalent to the characteristic impedance.

13. What are the properties of Infinite length? (Remembering,CO1) (June 2017) (Dec/Jan 2016)

1. As the line has an Infinite length, no waves will ever reach the receiving end and hence there is no possibility of the reflection at the receiving end. Thus there cannot be any reflected waves, returning to the sending end. The complete power applied at the sending end is absorbed by the line.

2. As the reflected waves are absent, the characteristic impedance Z_0 at the sending end will decide the current flowing, when a voltage is applied to the sending end. The current will not affect by the terminating impedance Z_R at the receiving end.

14. Calculate the characteristic impedance Z_0 for the following parameters. R = 10.4 ohms/km; G =0.8 x 10^{-6} mho/km; L = 0.00367 H/km; C = 0.00835 μf/km (Applying,CO1) (Nov /Dec 2004)

$Z = R + j\omega L =$ $Y = G + j\omega C =$ $Z_0 = \sqrt{Z/Y} =$

15. A lossless line has a shunt capacitance of 69 pF and a series inductance of 0.387μH, Calculate the characteristic impedance. (Applying, CO1) (Nov/Dec 2010 & 2013)

$Z_0 = \sqrt{Z/Y} = \sqrt{(0.387 \times 10^{-6}/69 \times 10^{-12})} = 74.83$ ohm

16. Define attenuation and phase constant?(Remembering,CO1) (May/June 2012)

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. Attenuation constant α defines the rate of decrease in amplitude of the voltage and current on the transmission line and Phase constant β defines the rate of change of phase with distance.

17. Write the relation between neper and decibel. (Understanding, CO1) (June 2017)

1 Neper = 8.686 db

is the relation between neper and decibel.

18. Obtain characteristic impedance in terms of Z_{OC} and Z_{SC}. (Understanding,CO1) (April/May 2019)

$Z_o = \sqrt{Z_{OC}.\, Z_{SC}}$

BIG QUESTIONS

1. Explain the properties and characteristics impedance of symmetrical networks.(Understanding,CO1) (June 2017)(June 2016)(Tx1: 143,149) (April/May2019)
2. Derive the general solutions of transmission line for voltage and current at any point on a line. (OR) Obtain the expressions for current and voltage at any point along a line, which is terminated in its Characteristic impedance. (Remembering/Understanding,CO1)(Tx 1:236)(Dec/Jan2016) (June 2017)
3. Explain in detail about the physical significance of the line equations and the infinite line. (June 2017)(Understanding, CO1) (Tx1:240)(Jan 2015)
4. An open wire transmission line has R =10 ohms per km, L = 0.0037 Henry per km, G=0.4 x 10^{-6} mhos per km and C=0.0083 x 10^{-6} Farad per km. Determine the characteristic impedance and propagation constant. Assume frequency as 1000 Hz. (Tx1:247) (Applying,CO1)(Dec/Jan2016)(June 2016)
5. Explain in detail about a line of cascaded T Section.(Understanding,CO1) (Tx 1:233)
6. A transmission line operating at 500 MHz has $Z_0 = 80\Omega$, $\alpha = 0.04$ Np/m, $\beta = 1.5$ rad/m. Find the line parameters series resistance (R Ω/m), series inductance (L H/m), shunt conductance (G mho/m) and

capacitance between conductors (C F/m).(Applying, CO1) (Tx 1:247) (May/June 2007)
7. The characteristics impedance of a uniform transmission line is 2309.6 ohm at 800Hz. At this frequency the propagation constant is 0.054 (0.0366+j0.999)/km. Determine R & L.(Applying, CO2) (Tx 1:247)
8. A Transmission lines has the following parameters per unit length parameters. L= 0.1μh, R = 5Ω, C = 300pf, G = 0.01 mho. Calculate the propagation constant and characteristic impedance of the of 500 MHz.(Applying, CO1) (Tx 1:247)(Nov/Dec 2012)(June 2017)
9. What are the different types of transmission line? Briefly comment on them? (Remembering/Understanding,CO1) (Tx 1:195) (Nov/Dec 2012)
10. Derive the condition for open and short circuited condition.(June 2016) (Tx1:144) (Understanding, CO1)
11. Obtain Propagation constant in terms of Z_{OC} and Z_{sc}. (April/May2019) (Tx1:145) (Understanding, CO1)

UNIT II TRANSMISSION LINE PARAMETERS

1.What is wavelength of a line? (Remembering,CO2) (Nov /Dec 2009) & (Jan 2015)

The distance the wave travels along the line while the phase angle is changingthrough 2π radians is called a wavelength.

2.What are the types of line distortions?(Remembering, CO2)

The distortions occurring in the transmission line are called waveformdistortion or line distortion. Waveform distortion is of two types:a) Frequency distortionb) Phase or Delay Distortion.

3.How frequency distortion occurs in a line? (Understanding, CO2)(June2009)&(May/June 2007)

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

4.How to avoid the frequency distortion that occurs in the line?(Understanding,CO2)

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 frequencydistortion. Equalizers are networks whose frequency and phasecharacteristics are adjusted to be inverse to those of the lines, which resultin a uniform frequency response over the desired frequency band, andhence the attenuation is equal for all the frequencies.

5.What is delay or phase distortion?(Remembering,CO2)(May / June 2006)(Dec 2014/Jan 2015)

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

6. How to avoid the phase distortion that occurs in the line?(Understanding, CO2)

In order to reduce phase frequency distortion occurring in the line,a) The phase constant β should be made independent of frequency.b) The velocity of propagation is independent of frequency.c) Also the delay distortion can be avoided by the use of co-axial cables.

7.What is a distortion less line? What is the condition for a distortion less line?(Remembering,CO2) (June 2016)(Nov /Dec 2009) (April/May 2019)

A line, which has neither frequency distortion nor phase distortion is called adistortion less line. The condition for a distortion less line is RC=LG. Also, a) The attenuation constant α should be made independent of frequency.b) The phase constant β should be made independent of frequency.
c) The velocity of propagation is independent of frequency.

8.What is the drawback of using ordinary telephone cables?(Remembering,CO2)

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

9. What is loading? &what are the types of loading?(Remembering,CO2)(June 2016) (June 2017)

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

a) 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.

b) Patch loading: It is the process of using sections of continuously loaded cables separated by sections of unloaded cables which increases the inductance value

c) 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

10.Define reflection coefficient. (Remembering, CO2) (Nov /Dec 2009) &(Jan 2015)

Reflection Coefficient can be defined as the ratio of the reflected voltage to theincident voltage at the receiving end of the line

Reflection Coefficient K=Reflected Voltage at load /Incident voltage at the load=Vr/Vi

11. Define reflection loss. (Remembering,CO2) (Dec/Jan 2016) &(Apr / May 2008)

Reflection loss is defined as the number of nepers or decibels by which thecurrent in the load under image matched conditions would exceed the current actuallyflowing in the load.

12.What is Impedance matching?(Remembering,CO2)

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

13. Define the term insertion loss.(Remembering,CO2) (Nov /Dec 2006)&(May/June 2007)

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 thenetwork/Current flowing in the load with insertion of the network

14.When reflection occurs in a line?(Understanding,CO2)

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 thereceiving end to absorb all the power transmitted from the source end. Hence all thepower incident on the load gets completely reflected back to the source causingreflections in the line. When the line is terminated in its characteristic impedance, theload will absorb some power and some will be reflected back thus producing reflections.

15.What are the conditions for a perfect/Flat line? What is a smooth line? (Nov /Dec 2012), (Nov/Dec 2013) (Remembering,CO2)

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

16. How much inductive loading is required to make a 16 gauge cable distortion less? The line Parameters are R =42.1 ohm /Km, G = 1.5 μ mho/km, C = 0.062 μ f / km and L =1mH / km. (Applying,CO2)(Nov /Dec 2006)

The condition for distortion lessline :$\frac{L}{C}=\frac{R}{G}$ => L = $\frac{RC}{G}$ =1.74 h

Inductive loading = 1.74 – 0.001 = 1.739 H /km

17. Find the reflection coefficient of a 50 Ω transmission line when it is terminated by a load impedance of 60 + j40 Ω. (Applying,CO2) (April/May 2017)&(Nov/Dec 2013)

$Z_0 = 50\ \Omega$,Z_L 6 + j 40 Ω, Reflection coefficient = $\frac{60+j40-50}{60+j40+50}$ =0.35 < 55.98° = 0.196 + j0.29

18. Calculate the characteristic impedance of a transmission line if the following parameters have been made on the line Z_{OC} =550 < -60° Ω and Z_{SC} =500 < 30° Ω. (Applying,CO2)(April/May 2011)

$Z_0 = \sqrt{(Z_{0C}Z_{sc})}$ = 524. 4< -15° Ω

19. What are the disadvantages of open wire lines?(Remembering, CO2)

1) Exposed to atmosphere so affected by atmospheric conditions.
2) Need towers and posts to install.
3) Initial cost is high.
4) Short circuit chances due to flying objects.

20. Calculate the load reflection coefficient of an open and short circuited line.(Applying, CO2) (May /June 2007)

When the line is short circuited, K= $\frac{0-Z0}{0+Z0}$ = -1=1<180°,

When the line is open circuited, K= $\frac{1-\frac{Z0}{ZR}}{1+\frac{Z0}{ZR}}$=1=1<0°

21. What is phase velocity and group velocity?(Remembering,CO2) (Nov/Dec09),(Nov /Dec 2010)

The velocity of the waves along the line decided by ω and phase constant β is called phase velocity.

$v = \omega / \beta$.

The velocity with which a signal produced by variation of a steady state wave or by introduction of a group of frequencies, travels through the system is called group velocity.$v_g = d\omega / d\beta$

22. Define wavelength of a transmission line?How is it related to the phase velocity? (Remembering/Understanding,CO2)(Apr/May 2005)(June 2017)

The distance between the two points along the line at which currents or voltages differ in phase by 2π radians is called 1 wavelength of a line. It is given as, $\lambda = 2\pi / \beta$

The velocity of the waves along the line decided by ω and phase constant β is called phase velocity.

$v = \omega / \beta = 2\pi f / \beta = \lambda . f$

Therefore the wavelength λ is related to phase velocity.

23. What do you understand by loading of transmission lines?(Remembering,CO2) (April/May 2017)

To get distortion less line (free from frequency and delay distortions)

To meet condition of $\frac{L}{C} = \frac{R}{C}$, loading is done.

24. Define Return loss. (Remembering,CO2) (Apr /May 2004)

The ratio of power at the receiving end due to the incident wave and power due to reflected wave by the load is called return loss. Return loss = 20log $\left|\frac{ZR+Z0}{ZR-Z0}\right|$db

25. Differentiate wavelength and period of a sine wave.(Understanding, CO2) (Nov /Dec 2008)

Distance covered by emf wave of one cycle is called wavelength.

Time taken to have a phase change of 360^0 is called period of sine wave.

26. Give the relationship between the input impedance and characteristic impedance of an infinite line. (Remembering,CO2) (Nov/Dec 2012)

$\mathbf{Z_S = Z_0}$,Fora infinite line input impedance is equal to the characteristic impedance.

27. Write the equations for velocity of propagation and the attenuation constant of a telephone cable. (Remembering,CO2) (Dec 2014/Jan 2015) (Nov/Dec 2012)

Attenuation constant = $\sqrt{\frac{\omega CR}{2}}$ Velocity of propagation = $\sqrt{\frac{2\omega}{CR}}$

28. For a transmission line with incident voltage of 5V and reflected voltage of 3V, determine the reflection coefficient and SWR. (Applying,CO2) (May/June 2013)

Reflection coefficient K = $\frac{Incident\ Voltage}{Reflected\ Voltage} = \frac{5}{3}$ = 1.67

SWR = $\frac{1+|K|}{1-|K|}$ =3.98

29. For a given length of coaxial cable with a distributed capacitance C = 48.3 pF/m, a distributed inductance L = 241.56 nH/m and a relative dielectric constant ε_r = 2.3, determine the velocity of propagation. (Applying,CO2) (May/June 2013)

v = $\frac{1}{\sqrt{LC}}$ = 2.92*10^8m/sec.

30. A 50 Ω line is terminated in load Z_R = 90 + j60 Ω . Determine the reflection coefficient. (Applying,CO4) (Nov /Dec 2014) (Dec/Jan 2016)

K = $\frac{ZR - Z0}{ZR + Z0}$ = 0.473 < 33°

31. Determine the reflection coefficient of a transmission line when Z_R = 200 Ω and Z_0 =692 <-12° Ω (Applying,CO2) (Nov /Dec 2010)

K = $\frac{ZR - Z0}{ZR + Z0}$ = $\frac{200-692<-12}{200+692<-12}$ =0.55<-153.6

32. A transmission line with a characteristic impedance of 300 ohm is fed by a generator of impedance 100 ohm. The line is 100 m and is terminated by a resistive load of 200 ohm. Calculate the refection loss in db.(Applying,CO2)

Zg = 100 Ohm, Zo = 300 Ohm, Zr = 200 Ohm

Reflection loss = 20 log ((Zr + Zo)/(2(Zr+Zo)$^{1/2}$)

R = 0.18db.

BIG QUESTIONS

1. Explain in detail about the waveform distortion. Derive the condition for a distortion less line? (Understanding, CO2) (Tx1:249-251)(Dec/Jan2016) (May/June 2013), (June 2017), (June 2016)
2. Derive the input impedance of a transmission line. Also find the input impedance of open and short Circuited lines. (Understanding,CO2) (Tx1:263-265)(May/June 2013), (Nov/Dec 2013) (April/May2019)
3. Derive the expression for transfer impedance of a Transmission line. (Understanding, CO2) (Tx1:263-264) (June 2016)
4. Derive the equations for attenuation and phase constant of a transmission line in terms of the line parameters.(Understanding, CO2) (Tx1:246) (Apr/May 2008)
5.Explain in detail about the reflection on a line not terminated in its characteristic impedance(Z_o). (Understanding, CO2) (Tx1:256-260) (June 2017) (April/May2019) & (Jan 2015)
6. State and explain the Campbell's equation formula for the loading cables.(Dec/Jan2016) (April/May 2019) (Remembering/Understanding, CO2) (Tx1:252-256)(April/May 2011)
7. Write short notes on Insertion loss.(Remembering,CO2) (Tx1:267-271))(Dec/Jan2016)(June 2016)
8. A parallel wire transmission line is having (R = 2.59 x 10^{-3} Ω /m), series inductance (L = 2μH / m), shunt conductance (G = 0 ohm /m) and capacitance between conductors (C = 5.56 pF / m) . Find the characteristics impedance, attenuation constant (α Np /m), phase shift constant (β rad /m), velocity of propagation and wavelength.(Applying,CO2) (Tx1:247)(Apr/May 2008) (Jan 2015)
9. A 2 meter long transmission line with characteristics impedance of 60 + j40 Ω is operating at (ω) 10^6 rad /sec has attenuation constant of 0.921 Np/m and phase shift constant of 10 rad/m . If the line is terminated by a load of 20 + j 50 Ω, determine the input impedance of this line. (Applying,CO2) (Tx1:261) (Apr/May 2008)
10. Acable has the following parameters: R = 48.75 Ω/km, L = 1.09 mH/km, G = 38.75µmho/km and C=0.059 µf/km. Determine the characteristic impedance, propagation constant and wavelength for a source of f = 1600 Hz and Es =1.0 volts.(Applying,CO2) (Tx1:247)(April/May 2011) (June 2016)
11. A cable has been uniformly loaded by an inductance such that ωl>> R. Assuming leakage conductance to be nil, deduce an expression for attenuation and phase constant without neglecting R. (Applying, CO2) (Tx1:252-254) (April/May 2019) (April/May 2011) &(Nov/Dec 2007)
12. The characteristic impedance of a 805 m –long transmission line is 94<-23.12° Ω, the attenuation

constant is 74.5 x 10^{-6}Np/m and the phase shift constant is 174 x 10^{-6} rad/m at 5KHz. Calculate the line parameters R, L, G and C per meter and the phase velocity on the line. (Applying,CO2)(Tx1:247) (Nov/Dec 2008)

13. A generator of 1V, 1 kHz supplies power to a 100 km transmission line terminated in 200 Ω resistance.The line parameters are R = 10 Ω/km, L = 3.8 mH/km, G = 1μmho/km and C= 0.0085 μf/km.Calculate the input impedance and reflection coefficient.(Applying, CO2) (Tx1:261-263) (May/June 2009)

14. A transmission line has the following parameters per km R = 15 Ω, C = 15Mf, L = 1mH, G = 1 μmho. Find the additional inductance to give distortion less transmission. Calculate α and β for this loaded line. (Applying,CO2) (Tx1:251) (Nov/Dec 2011) &(Nov/Dec 2010)

15. A transmission line has the following parameters: R = 6 Ω/km, L = 2.2 mH/km, C = 0.005μF/km and G = 0.05 x 10^{-6} mho/km. Determine the attenuation and phase shift in traduced by the line to a signal at a frequency of 1kHz, if the line length is 100 km. (Applying,CO2) (Tx1:247)(May/June 2013)

16. The attenuation on a 50 Ω distortion less line is 0.01 dB/m. The line has a capacitance of 0.1nF/m. Determine the resistance, inductance and conductance of the line.(Applying,CO2) (Tx1:250-251) (May/June 2013)

17. What is SWR? Derive SWR in terms of reflection Coefficient? (Applying, CO2)(Tx1:291-292) (June 2017) (Nov/Dec 2011)

18. A transmission line has Z_0 = 745 <12 degree and is terminated in Zr = 200 ohm. Calculate the reflection loss and reflection loss in db.(Applying,CO2) (Tx1:266) (May/June 2013)

19.The characteristics impedance of a TL is (40-2j) ohms at a frequency of 8MHz the propagation constant is(0.01 + 0.18j) per meter, determine the primary constants. (Jan 2015) (Applying,CO2)

20. Obtain the expression for current and voltages at any point along a line are terminated in Zo. (Nov /Dec 2014) (Applying,CO2)

UNIT III THE LINE AT RADIO FREQUENCY

1. State the assumptions for the analysis of the performance of the radio frequencyline. (Remembering,CO3)(Dec 2014/Jan 2015)(Nov /Dec 2009)

1) Due to the skin effect,the currents are assumed to flow on the surface of theconductor. The internal inductance is zero. 2)The resistance R increases with √ f while inductance L increases with f. Hence ωL>>R. 3)The leakage conductance G is zero.

2.State the expressions for inductance L of a open wire line and coaxial line.(Remembering,CO3) (Apr/May 2005) (Nov/Dec 2014)

For open wire line ,L=9.21*10^{-7}(μ/μ_r +4ln d/a)=10^{-7}(μ_r+9.21log d/a) H/m

For coaxial line,L = 4.60*10^{-7}[log b/a]H/m

3.State the expressions for the capacitance of a open wire line.(Remembering,CO3)(Apr/May 2005)

For open wire line,C=(12.07)/(ln d/a)$\mu\mu_f$/m

4.What is dissipationless line?(Remembering,CO3)

A line for which the effect of resistance R is completely neglected is calleddissipationless line.

5.What is the nature and value of Z_0 for the dissipation less line?(Remembering,CO3)

For the dissipation less line, the Z_0 is purely resistive and given by,Z_0=R_0 = √ L/C

6.State the values of α and β for the dissipation less line.(Remembering,CO3)(Nov/Dec 2015)

α=0 and β= ω √LC

7.What are nodes and antinodes on a line? (Remembering,CO3) (Nov/Dec 2005)

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

8.What is standing wave ratio?(Remembering,CO3)(May / June 2006), (Nov/ Dec 2009)

The ratio of the maximum to minimum magnitudes of voltage or current on aline having standing waves called standing waves ratio. S = $\frac{|Emax|}{|Emin|}$ = $\frac{|Imax|}{|Imin|}$

9.What is the range of values of standing wave ratio and reflection coefficient?(Remembering,CO3)

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

The range of values of reflection coefficient is theoretically 0 to 1.

10.State the relation between standing wave ratio and reflection coefficient.(Remembering,CO3) (April/May 2017)

$S = \frac{|1+K|}{|1-K|}$, Also $|k| = \frac{S-1}{S+1}$

11.What are standing waves? (Remembering,CO3) (Apr/May 2005)&(Nov /Dec 2006)

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

12.Give the input impedance of dissipationless line? (Remembering,CO3) (May / June 2006)

The input impedance of a dissipationless line is given by,$Z_s = \frac{Es}{Is} = R_0 \frac{1+k<\phi-2\beta s}{1-k< \phi-2\beta s}$

13.Give the maximum and minimum input impedance of the dissipation less line. (Remembering,CO3)

Maximum input impedance,$R_{max} = R_0 \left(\frac{1+|k|}{1-|k|}\right) = S R_0$

Minimum input impedance,$R_{min} = R_o\left(\frac{1+|k|}{1-|k|}\right) = \frac{R0}{S}$

14.Give the input impedance of open and short circuited lines.(Remembering,CO3)(May / June 2007)

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

15. What is the use of eighth wave line?(Remembering,CO3) (Nov /Dec 2006)

An eighth wave line is used to transform any resistance to impendence with amagnitude equal to $R_o$of the line or to obtain a magnitude match between a resistance ofany value and a source of R_o internal resistance.

16. Give the input impendence of eighth wave line terminated in a pure resistance Rr? (Remembering,CO6)

The input impendence of eighth wave line terminated in a pure resistance Rr isgiven by $Zs = (Z_R+jR_o)/ (R_o+jZ_R)$ .From the above equation it is seen that$|Zs| = R_o$.

17. Why is a quarter wave line called as impendence inverter? (Understanding,CO3)(Nov /Dec 2003)

A quarter wave line may be considered as an impendence inverter because it cantransform a low impendence in to ahigh impendence and vice versa.

18. What are the applications of the quarter wave matching section? (Understanding,CO3)(Nov /Dec2012)&(April/May 2017)

An important application of the quarter wave matching sectionis to a couple atransmission line to a resistive load such as an antenna .The quarter wave matchingsection then must be designed to have a characteristic impendence R_o so chosen that theantenna resistance R_a is transformed to a value equal to the characteristic impendence $R_0$of the transmission line.The characteristic impendence R_o of the matching sectionthen should be$R_o' = \sqrt{R_a R_o}$

19. State the use of half wave line? (Remembering,CO3)(Apr /May 2004)& (May/June 2007)

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.

20. Explain impendence matching using stub?(Understanding,CO3) (June2016) (Nov/Dec 2012)

In the method of impendence matching using stub,an open or closed stub line ofsuitable length is used as a reactance shunted across the transmission line at a designateddistance from the load,to tune the length of the line and the load to resonance with ananti-resonant resistance equal to R_o.

21. Give reasons for preferring a short- circuited stub when compared to an open-circuited stub? (Understanding,CO3)(Apr/ May 2004)

A short circuited stub is preferred to an open circuited stub because ofgreater ease in constructions and because of the inability to maintain high enoughinsulation resistance at the open -circuit point to ensure that the stub is really opencircuited.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 fieldpropagation.

22.What are the two independent measurements that must be made to find thelocation and length of the stub?(Remembering,CO3)

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

23.What is the use of a circle diagram?(Understanding,CO3)

The circle diagram may be used to find the input impendence of a lineof anychosen length.

24. How is the circle diagram useful to find the input impendence of short and opencircuited lines? (Understanding,CO3)

An open circuited line has s =α ,the correspondent circle appearing as the verticalaxis .The input impendence is then pure reactance, with the value for various electricallengths determined by the intersections of the corresponding βs circles with the verticalaxis.

A short circuited line may be solved by determining its admittance .The S circle isagain the vertical axis, and susceptance values may be read off at appropriate intersectionof the βs circles with the vertical axis.

25. List the applications of the smith chart.(Remembering,CO3)(Nov /Dec 2009) &(June 2017)

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 aline then follows a spiralpath towards the chart center, due to attenuation.(iii) In single stub matching, smith chart is used to find the length of the stub and also find distance between stub and load.

26. What are the difficulties in single stub matching? (Understanding,CO3)(Nov/Dec2015)(May2005)

The difficulties of the smith chart are(i)Single stub impedance matching requires the stub to be locatedat a definite point on the line. This requirement frequently callsfor placement of the stub at an undesirable place from amechanical view point.(ii) For a coaxial line, it is not possible to determine the location ofa voltage minimum without a slotted line section, so thatplacement of a stub at the exact required point is difficult.(iii) In the case of the single stub it was mentioned that twoadjustments were required,these being location and length ofthe stub.

27. What is double stub matching?(Remembering,CO3) (Nov/Dec2015)

Impedance matching is to use two stubs in which thelocations of the stub are arbitrary,the two stub lengths furnishing the requiredadjustments.The spacing is frequently made λ /4.This is called double stub matching.

28. What are constant ‘S’ circles? (Remembering,CO3) (June 2009)

The input impedance equation for dissipation less line if expressed in terms of standing wave ratio S, results in the form of a circle. These circles are called as constant S circle. Since the minimum value of S is unity, S circles surround the 1, 0 point.

29. Why Double stub matching is preferred over single stub matching.(Understanding,CO3) (Nov/Dec 2012)

Double stub matching is preferred over single stub due to followingdisadvantages of single stub.

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

30. What is the need for stub matching in transmission lines? (Remembering,CO3)(Nov /Dec 2004)

When Z_R not equal to Z_0, reflection occurs at the load, resulting in loss of energy. To set maximum power absorption thereby making $Z_R = Z_0$ stubs are used.

31.Design a quarter wave transformer to match a load of 200 Ω to a source resistance of 500 Ω. The operating frequency is 200 MHz.(Applying,CO3) (April/May 2019) (Nov /Dec 2006)

$R_0 = \sqrt{Z_S Z_R} = \sqrt{500 \times 200} = 316.22\Omega$

$\lambda = C/f = 1.5$ m $\lambda/4 = 0.375$ m .

32. Why do standing waves exist on transmission lines?(Understanding, CO6) (Nov /Dec 2010)

Standing waves are due to Z_R not equal to Z_0 , both incident and reflected waves are present standstill along the lines .

33. Give the analytical expression for input impedance of a dissipationless line.(Remembering,CO3)

The input impedance of a dissipationless line is $Z_S = R_0 \left\{\frac{ZR + j\, R0 \tan\beta\, s}{R0 + j\, ZR \tan\beta\, s}\right\}$

34. When a line is said to be in zero dissipation? (Understanding,CO3) (June 2009)

Any line the value of resistance is neglected completely, then such a line is called zero dissipation line.

35. Write the value of SWR of the following loads. a) open circuit b) short circuit c) matched load. (Remembering,CO3) (Nov /Dec 2010)

a) For Open circuit: $Z_R = \infty$, SWR = ∞

b) For Short circuit: $Z_R = 0$, SWR = 0 c) For matched load: $Z_R = Z_0$, SWR = 1

36. Define skin effect. (Remembering,CO3) (May/June 2010)

The current is flowing on the surface of the conductor in a skin of very small depth, the effect is called skin effect.

37.Write down the expression to determine the position of the stub & Length of the Stub? (Remembering,CO3)(Apr/May 2011)

$Ls = (\lambda/2\pi) \tan^{-1}(\sqrt{Zr/Zo})$

$Lt = (\lambda/2\pi) \tan^{-1}(\sqrt{(ZrZo)}/(Zr+Zo)$

Where Lt = Length of the Stub

Ls = Position of the Stub

Zr = Receiving end Impedance (or Load Impedance)

Z0 = Characteristic Impedance of the Line

38. Find the characteristic impedance for a quarter wave transformer that is used to match a 75 Ω line to a 60 Ω resistive load. (Applying,CO3) (Dec/Jan2016) (Nov /Dec 2012)

$Z_0 = \sqrt{75 \times 60} = 67.08\ \Omega$

39. How can smith chart be used as admittance chart.(Understanding,CO3) (Nov /Dec 2012)

The smith chart is used an admittance chart, the R and X become g and b axes, with the usual implications that the capacitance susceptance positive about and inductive susceptance is positive below the real axes. The point at the left of the conductive axes represents zero conductance or open circuit, while the point at extreme right represents infinite conductance or short circuits.

40. Give the names of circles on Smith chart. (Remembering, CO3) (June 2016)

- Constant R circles
- Constant X circles

BIG QUESTIONS

1.What are impedance matching devices?Write short notes on eighth line and half line.(Tx1:304-307) (Nov/Dec 2012) (Remembering,CO3)

2. Write short notes on quarter wave line and write its applications.(Remembering,CO3) (Tx1:305-306) (Dec/Jan2016)(Nov /Dec 2010), (May/June 2009), (Jan 2015) &(April/May 2019)

3. Derive the parameters of open wire line and coaxial line at high frequencies. (Understanding,CO5) (Tx1:278-282) (Nov/Dec 2012)

4.(i)Explain in detail about single stub matching and double stub matching. (Understanding, CO3)

(Tx1:312-317) (Tx1:333-334) (June 2017) (May/June 2009)
(ii)Explain the concept of power and impedance measurement on line. (Understanding,CO3)
(Dec/Jan2016)(Tx1:299 - 302) (Nov/Dec 2012)
5. Discuss the applications of smith chart with suitable illustrations. (Understanding, CO3)(Tx1:327-331)
(Apr/May 2008)
6. Derive an expression for the voltage and current on the dissipation less line. (Understanding,CO3)
(June 2017) (June 2016) (Tx1:285 - 290)
7.Deduce the expression for constant –S circle for the dissipation less line.(Understanding,CO6)
(Tx1:317 - 320) (Nov/Dec 2007)
8. Derive an expression for the input impedance of the dissipation less line. (Understanding,CO3)
(Tx1:295-297)(Apr/May 2008)
9. A 70Ω lossless line is used at a frequency where wavelength (λ) equals 80 cm terminated by a load of (140 + j91) Ω. Find the reflection coefficient, VSWR and input admittance using SMITH chart.
(Applying, CO3) (Tx1:330) (Apr/May 2008)
10. A 75Ω lossless line is to be matched with a 100 –j 80 Ω load using single stub. Calculate the stub length and its distance from the load corresponding to the frequency of 30 MHz using SMITH chart.
(Applying,CO3) (Tx1:332) (Apr/May 2008)
12. (i) A 75Ω lossless line is to be matched to a resistive load impedance of Z_L = 100Ω via a quarter –wave section. Find the characteristic impedance of the quarter wave transformer. (Applying, CO3) (Tx1:358), (Nov/Dec 2008)
(ii) A 50Ω lossless transmission line is terminated in a load impedance of Z_L=(25 +j50)Ω. Use the SMITH chart to find (1) Voltage reflection coefficient, (2) VSWR (3) input impedance of the line, given that the line is 3.3λ long and (4) input admittance of the line. (Applying, CO3)(Tx1:328-329)
(Nov/Dec 2008)(Jan 2015)
13. A 50Ω lossless feeder line is to be matched to an antenna with Z_L =(75–j 20)Ω at 100MHz using single shorted stub. Calculate the stub length and distance between the antenna and stub using SMITH chart.(Applying,CO3) (Tx1:330)(Dec/Jan2016)(Nov/Dec 2014), (Nov/Dec 2013)(Jan 2015)
14. A transmission line is terminated in Z_L. Measurements indicate that the standing wave minima are 102 cm apart and that the minimum is 35cm from the load end of the line. The value of standing wave ratio is 2.4 and R_o = 250 ohm. Determine wavelength and load impedance. (Applying, CO3)
(June 2016)(Tx1:359), (Nov/Dec 2007)
15. Determine the length and location of a single short circuited stub to produce an impedance match on a transmission line with R_o of 600Ω and terminated in 1800Ω.(Applying,CO3) (Tx1:332)(Nov/Dec 2007)
16. Explain with relevant diagrams and equations of the location of the single stub for impedance matching.
(Understanding,CO3) (Tx1:312 - 316) (May/June 2007)
17. A 30 m long lossless transmission line with characteristic impedance (Z_0) of 50 Ω is terminated by a load impedance (Z_L) =60 + j40 Ω. The operating wavelength is 90m. Find the reflection coefficient, standing wave ratio and input impedance using smith chart. (Applying,CO3)(Tx1:328-330)
(May/June 2007)
18. A 50 Ω transmission line is connected to a load impedance (Z_L)= 60 +j80 Ω. The operating frequency is 300 MHz. A DOUBLE –stub tuner spaced an eighth of a wave length apart is used to match the load to the line. Find the lengths of the short circuited stubs using SMITH chart. (Tx1:335)
(Applying,CO3) (May/June 2007)
19. An antenna as a load on a transmission line produces a standing wave ratio of 2.8 with a voltage minimum 0.12 λ from the antenna terminals. Find the antenna impedance, reflection factor and reflection loss at the antenna of R_0 = 300 ohms for the line. (Applying, CO3) (Tx1:360)(Nov/Dec 2013)
20. A load (50-j100)ohms is connected across a 50 Ω line. Design a short circuited stub to provide matching between the two at a signal frequency of 30 MHz.(Applying,CO3)(Tx1:332) (Nov/Dec 2010)

21. A certain transmission line, working at radio frequencies has following constants, L= 9µH/m, C=10Pf/m, the line is terminated in a resistive load of 1000 ohm. Find the reflection coefficient and standing wave ratio.(Applying,CO3)(Tx1:292) (June 2009)

22. A line of Z_0= 300 Ω is connected to a load of 73 Ω for a frequency of 40Mhz. Find the length and location of the nearest load of the single stub to produce an impedance match. (Applying,CO3) (Tx1:332) (Nov/Dec 2012)

23. A transmission line of length of 0.4 λ has a characteristic impedance of 100Ω and is terminated in a load impedance of 200 + j180Ω, Find (1) Voltage reflection coefficient (2) VSWR (3) input impedance of the line.(Applying, CO3)(Tx1:328 - 330) (Nov/Dec 2012)

24. Discuss the principle of double stub matching with neat diagram and expressions. (Understanding,CO3) (Tx1:333) (Nov/Dec 2013)(Jan 2015)

25. Explain the characteristics of SMITH CHART? (Understanding,CO6)(Tx1:304-307)(Nov/Dec 2013)

26. Derive the smith chart Equations? (Understanding,CO3) (Tx1:304-307) (Nov/Dec 2013)

27. A SWR on a loss less line is found to be 5 and the successive voltage minimum is 40cm apart. The first voltage minimum is observed to be 15cm from the load. The length of the line is 160cm and the characteristics impedance 300 ohm. Using smith chart determine (i)The load impedance. (ii) The sending end impedance. (Applying,CO3)

28.A lossless line has a characteristics impedance of 75 ohm. Determine the standing wave ratio of it is terminated with a load impedance of ohms. (Applying,CO3) (Dec 2014/Jan 2015)

29. Explain the parameters of open wire line and coaxial cable at RF .Mention the standard assumption made for radio frequency line. (Nov /Dec 2014) (Understanding,CO3)

30. A lossless transmission line has a load of Z_R/R_0=(1+j1.2). Design Double Stub matching with a distance between two stubs are 3/8λ. Find location and length of stub1 and stub2 using smith chart. (Applying, CO3) (Dec/Jan2016) (April/May 2019)

UNIT IV-GUIDED WAVES BETWEEN PARALLEL PLANES

1. What are guided waves? Give examples.(Remembering,CO4)

The electromagnetic waves that are guided along or over conducting ordielectric surface are called guided waves.Examples: Parallel wire, transmission lines.

2. What is TE wave or H wave?(Remembering,CO4) (Nov /Dec 2009)

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

3. What is TH wave or E wave?(Remembering,CO4)

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

4. What is a TEM wave or principal wave?(Remembering,CO4)(Nov/Dec 2012&2013) &(June 2016)

TEM wave is a special type of TM wave in which an electric field Ealong the direction of propagation is also zero. The TEM waves are waves in which bothelectric and magnetic fields are transverse entirelyi.eno components of Ez and Hz. It is also referred to as the principal wave.

5. What is a dominant mode? (Remembering,CO4) (June 2009) &(Nov/Dec 2010)

The modes that have the lowest cut off frequency or highest cut off wavelength are called the dominantmode.

6. Give the dominant mode for TE and TM waves in parallel plates.(Remembering,CO4)

(Nov/Dec 2010) Dominant mode: TE_{10} and TM_{11}

7. Define cut off frequency?What is the value of cutoff frequency for TEM wave in parallel plate guide?(Remembering,CO4)(Nov/Dec 2010)(Dec 2014/Jan 2015)

The frequency at which the wave motion ceases is called cut-off frequencyof the waveguide. Cut-off frequency is the frequency at which propagation constant γ =0.

For TEM wave, the cut-off frequency, fc = m / 2a ($\sqrt{\mu\varepsilon}$) = 0

8. What is cut-off wavelength? (Remembering,CO4) (Nov /Dec 2009)

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

9. Mention the characteristics of TEM waves. (Understanding,CO4)(Nov/Dec 2009) &(June 2017)

a) It is a special type of TM wave b) It doesnot have either E or H component

c) Its velocity is independent of frequencyd) Its cut-off frequency is zero.

10. Define attenuation factor. Give the relation between the attenuation factor for TE waves and TM waves in parallel plates.(Understanding,CO4) (June 2017) (June 2009)

Attenuation factor = (Power lost/ unit length)/(2 x power transmitted)$\alpha_{TE} = \alpha_{TM}$ (fc/f)^2

11.Define wave impedance.(Remembering,CO4)(Dec /Jan 2016) (Dec 2014/Jan 2015) (April/May 2019)

Wave impedance is defined as the ratio of electric to magnetic field strength$Z_{xy}= E_x/ H_y$ in the positive direction, $Z_{xy}= -E_x/ H_y$ in the negative direction

12. Write down the relation between guide wavelength and cutoff wavelength. (Remembering,CO3)

$$\lambda_g = \frac{\lambda_0}{\sqrt{1-\left(\frac{\lambda_0}{\lambda_c}\right)^2}}$$ **(April/May 2017)**

13.Mention the applications of wave guides.(Remembering,CO4)

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

14. What are the characteristics of principal wave?(Remembering,CO4)

f_c =0, $E_Z= H_Z= 0$, $\gamma = j\omega \sqrt{\mu_u \varepsilon u}$, $v = \frac{1}{\sqrt{\mu u \varepsilon u}} = 0$ $\lambda=2\pi/\beta$

15. Differentiate TE and TM waves. (Understanding,CO4) (Nov/Dec 2012)& (June 2016)

	TE	TM
1.	Electric field strength E is entire transverse.	Magnetic field strength E is entire transverse.
2.	It has Z component of magnetic field H_z.	It has Z component of electric field E_z.
3.	It has no Z component of electric field E_z	It has no Z component of magnetic field H_z

16. A wave guide can be called as high pass filter. Why?(Understanding,CO4)(Nov/Dec 10)

In a wave guide, the lower frequencies are attenuated completely, with no propagation; while the higher frequencies are allowed to propagate with phase shift only, so the wave guide called as high pass filter.

17. How do you account for the finite conductivity of the conductors forming wave guide? (Understanding,CO4)(Apr/May 2011)

Finite conductivity of the conductance is taken into account while forming the waveguides. Attenuation of signal transmission in metallic waveguide occurs due to ohmic losses in the highly conductive guide walls because of finite conductivity or non-zero surface resistance Rs = $\sqrt{(w\mu/2\sigma)}$. Attenuation is proportional to the surface resistance.

18. What is the significance of Maxwell's equation? (Understanding,CO4) (Nov/Dec 2012)

Maxwell's equation defines the general conditions necessary for the propagation of EM wave in any medium. To apply the Maxwell's equation to a particular problem to a confined region, certain boundary conditions are to be imposed on the equation.

19. What is meant by group and phase velocities? (Remembering,CO4)(Nov/Dec 2012)

The velocity with which the energy propagates along guide is called group velocity.The phase velocity is defined as velocity of propagation of equiphase surfaces along a guide.

Group velocity, $V_g = \frac{d\omega}{d\beta}$Phase velocity, $V_p = \frac{\omega}{\beta}$

20.A wave is propagated in a parallel plane wave guide.The frequency is 6 GHz and the plane separation is 3cm.Determine the group and phase velocities for the dominant mode.(Applying,CO4) (Nov/Dec 2013)

$v_p = \frac{v_1}{\sqrt{1-\frac{f_c^2}{f^2}}}$ = 5.45x10^8 m/sec $v_g = \frac{v2}{vp}$ =1.65 x10^8m/sec

21. What is the necessity of guiding waves?(Remembering,CO4) (May/June2012)

In many applications it is necessary to confine and guide the wave energy by guided structures. In such cases the transmitting power or fields are confined by the boundaries of a guided structures which is made up of a material that of the transmission path or media. The wave directed by the guided structures is called guided waves.

22. **A wave is propagating at 6GHz between parallel planes with separation of 3cm in the dominant mode. Calculate the characteristic wave impedance.(Applying,CO4)**

Z_{TE} = ή /(1-$(fc/f)^2)^{1/2}$

fc = (m/2a) * v = 5GHz

Z_{TE} = 682 Ohm

BIG QUESTIONS

1. Derive the field component of the wave propagating between parallel planes?(Understanding,CO4) (Tx1: 469)
2. Derive the expression for the field strengths for TE waves between a pair of parallel perfectly Conductingplanes of infinite extent in the 'Y' and 'Z' directions. The planes are separated in 'X' direction by "a" meter. (Understanding,CO4)(Tx:1 473) (Nov/Dec 2014) (Dec/Jan2016)(Jan 2015)
3. Derive the expressions for the field components of TM waves between parallel plates, propagating in Z direction.(Understanding,CO4) (Tx1:474) (Nov/Dec 2012)& (Nov/Dec 2013) (June 2017) (April/May2019)
4. Derive the electromagnetic field expressions for TEM waves guided by a parallel conducting plane? (Applying,CO4)(Tx1:481 (May /June 2009)
5.Discuss the characteristics of TE, TM and TEM waves between parallel conducting planes. And also derive the cut-off frequency and phase velocity from the propagation constant. (Understanding,CO4) (Tx1:473)Apr/May 2008)
6. Describe the velocity of propagation of wave between a pair of perfectly conducting plates. (Tx1:484) (Understanding,CO4) (June 2016)
7. Derive the expression for the attenuation constant of TE waves in between two parallel conducting planes. (Applying,CO4)(Tx1:494) (Nov/Dec 2010) &(Nov/Dec 2012,2013)
8. Define attenuation. Obtain the expression for attenuation constant of TE, TM andTEM waves in parallel plane wave guides. (Tx1:493(Applying,CO4)(June 2017)& (Nov/Dec 2013, Jan 2015)
9. Explain wave impedance and obtain the expressions of wave impedance for TE and TM waves guided along parallel planes. Also sketch the variation of wave impedance with frequency. (Understanding,CO4) (Tx:490) (Dec/Jan2016)(Nov/Dec 2012) (June 2017) (April/May 2019)
10. A pair of perfectly conducting plates are separated by 3 cm in air and carries a 10 GHz signal in TM_1 mode. Find the cut off frequency, phase constant and cut off wave length. (Tx1: 478) (Applying,CO4) (Apr/May 2008)
11. A parallel perfectly conducting plates are separated by 5 cm in air and carries a signal with frequency of 10 GHz in TM_{11} mode. Find the cut-off frequency and cut-off wavelength. (Applying,CO4) (Tx1:478) (Nov/Dec 2008)
12. (i)For a frequency of 5 GHz and plane separation of 8 cm in air, find the following for TM_{10} mode (1) Cut-off wave length (2) Characteristic impedance (3) Phase constant.(Applying,CO4) (June2016)
(ii) For a frequency of 10 GHz and plane separation of 5 cm in air, find the cutoff wavelength, phase velocity and group velocity of the wave. (Applying,CO4) (Tx1:478) (May /June 2009)

13. (i) A parallel perfectly conducting plates are separated by 7 cm in air and carries a signal with frequency of 6GHz in TE_1 mode. Find (1) the cut-off frequency (2) Phase constant (3) Attenuation constant and phase constant for f = 0.8 fc and (4) cut-off wavelength. (Applying,CO4) (Tx1:480) (May /June 2007)

(ii) A pair of perfectly conducting planes is separated by 3.6 cm in air. For TM_{10} mode determine the cut-off frequency and cut-off wavelength,if the operating frequency is 5GHz. (Applying,CO4) (Tx1:478)(May /June 2009)

14. If the plate separation is 10 cm, Find the propagation constant, phase velocity, group velocity and wave impedance at 6 GHz for TE_{10} mode. (Applying,CO4) (Tx1:480) (Nov/Dec 2010)

15. The parallel plate waveguide has plate separation 1 cm and filled with a perfect dielectric of dielectric Constant 9. Find the cut-off frequencies and next higher TM modes. (Applying,CO4)(Tx1:489) (Nov/Dec13)

16. Give an account of characteristics of Uniform plane waves. (Understanding,CO4)(Tx1:473)(Nov/Dec 13)

17. List the properties of TEM Waves. (Remembering,CO4)(Tx1:481)

18. Prove $V_p * V_g = C^2$ (Applying,CO4) (Tx1:484) (May/June 2012)

19.A TEM wave at 1MHz propagates in the region between conducting planes which is filled dielectric material of with μ_r= 1 and ε_r=2.Find the phase constant and characteristics wave impedance.(Jan 2015) (Applying,CO4)

20. Explain the following i)Attenuators ii) Characteristics impedance (Understanding,CO4) (Nov/Dec 2011) (Understanding,CO4)

UNIT V- WAVEGUIDES AND RESONANT CAVITIES

1.Why is circular or rectangular form used as waveguide?(Remembering,CO5)

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

2. What is an evanescent mode?(Remembering, CO5)

When the operating frequency is lower than the cut-off frequency, the propagationconstant becomes real i.e, $\gamma = \alpha$. The wave cannot be propagated. This non- propagatingmode is known as evanescent mode.

3.What is the dominant mode for the TE waves and TM waves in the rectangular waveguide? (Remembering,CO5)(Nov /Dec 2012)

The lowest mode for TE wave is TE_{10} (m=1, n=0)The lowest mode for TM wave is TM_{11} (m=1, n=1)

4. What is the dominant mode for the rectangular waveguide?(Remembering,CO5) (Dec/Jan2016)

The lowest mode for TE wave is TE_{10} (m=1, n=0) whereas the lowest mode forTM wave is TM_{11}(m=1, n=1). The TE_{10} wave has the lowest cut off frequencycompared to the TM_{11} mode. Hence the TE_{10} (m=1, n=0) is the dominant mode of arectangular waveguide.Because the TE_{10} mode has the lowest attenuation of all modes ina rectangular waveguide and its electric field is definitely polarized in one directioneverywhere.

5.Which are the non-zero field components for the for the TE_{10} mode in a rectangularwaveguide?

H_x, H_z and E_y.**(Remembering,CO5)(Nov /Dec 2012)**

6. Which are the non-zero field components for the for the TM_{11} mode in arectangular waveguide?

H_x, H_y ,E_y and E_z.**(Remembering,CO5)(Nov /Dec 2012)**

7. Define characteristic impedance in a waveguide.(Remembering,CO5)

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

8.Why TEM mode is not possible in a rectangular waveguide?(Understanding,CO5) (Nov/Dec 2010)&(May/June 2007)) (Nov /Dec 2014)

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

9.Explain why TM_{01} and TM_{10} modes in a rectangular waveguide do not exist.(Understanding,CO5) (Nov/Dec 2010)

For TM modes in rectangular waveguides, neither m or n can be zero becauseall 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 nofields are present. Hence TM_{01} and TM_{10} modes in a rectangular waveguide do not exist.

10. What are degenerate modes in a rectangular waveguide? (Remembering,CO5)(Nov/Dec 2010)

Some of the higher order modes, having the same cut off frequency, arecalled degenerate modes. In a rectangular waveguide, TE_{mn} and TM_{mn} modes (both m not= 0 and n not= 0) are always degenerate.

11. A rectangular waveguide has the following dimensions l = 2.54 cm, b = 1.27 cm waveguide thickness = 0.127 cm. Calculate the cut-off frequency for TE_{11} mode.(Applying,CO5)(Nov /Dec 2006)

A rectangular waveguide has the following dimensions:

a = 2.54 cm, b = 1.27 cm waveguide thickness = 0.127 cm.

$f_c = \frac{1}{2\pi\sqrt{\mu\varepsilon}}\sqrt{(\frac{m\pi}{a})^2 + (\frac{n\pi}{b})^2}$ = 16.15 GHz

a = 2.54 -2 x 0.127 = 0.02286 m   b = 1.27 – 2 x 0.127 = 0.01016 m

12. What is the significance of propagation constant being imaginary, zero and real? (Remembering,CO5)(Nov/Dec 2010)

For frequencies below cutoff frequencies the propagation constant is real.

For frequencies above cutoff frequencies the propagation constant is imaginary.

For frequencies equal to cutoff frequencies the propagation constant is zero.

13.Write down the expression for phase velocity for rectangular wave guides?(Remembering,CO5) (Nov/Dec 2010)

$$v_p = \frac{v_1}{\sqrt{1 - \frac{f_c^2}{f^2}}}$$

14.Write a brief note on excitation of modes in rectangular wave guides?(Remembering,CO5) (Apr/May 2008)

In order to launch a particular mode a type of probe I chosen which will produce a lines of E & H that are roughly parallel to the lines of E&H for that mode? TE10, TE11, TE20 and TM11 are the modes normally used to excite in rectangular wave guides. It is possible for several modes to exist simultaneously in a wave guide, if the frequency is above cutoff for those particular modes. However the wave guide dimensions are often chosen so that the only the dominant can exist.

15. What is a circular waveguide?(Remembering,CO5)

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

16. Why circular waveguides are not preferred over rectangular waveguides? (Understanding,CO5) (June 2009)

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.

17. Mention the applications of circular waveguide. (Remembering,CO5) (Nov /Dec 2012)

Circular waveguides are used as attenuators and phase-shifters

18. What are the root values for the TM modes?(Remembering,CO5)

The root values for the TM modes are:

$(ha)_{01}$ = 2.405 for TM_{01} $(ha)_{02}$ = 5.53 for TM_{02} $(ha)_{11}$ = 3.85 for TM_{11} $(ha)_{12}$ = 7.02 for TM_{12}

19. What are the root values for the TE modes?(Remembering,CO5)

The root values for the TE modes are:

$(ha)_{01}$ = 3.85 for TE_{01} $(ha)_{02}$ = 7.02 for TE_{02} $(ha)_{11}$ = 1.841 for TE_{11} $(ha)_{12}$ = 5.53 for TE_{12}

20. What is the dominant mode for TE and TM waves in a circular waveguide? (Nov /Dec 2014) (Remembering,CO5)

The dominant mode for TE waves in a circular waveguide is the TE_{11} because it has the lowest root value of 1.841. The dominant mode for TM waves in a circular waveguide is the TM_{01} because it has the lowest rootvalue of 2.405.Since the root value of TE_{11} is lower than TM_{01}. So TE_{11} is the dominant or the lowest order mode for a circular waveguide.

21. Why is TM_{01} mode preferred to the TE_{01} mode in a circular waveguide?(Understanding,CO5) (Nov /Dec 2012)

TM_{01} mode is preferred to the TE_{01} mode in a circular waveguide, since it requires a smaller diameter for the same cut off wavelength.

22. What are the performance parameters of microwave resonator?(Remembering,CO10)

(i) Resonant frequency (ii) Quality factor (iii) Input impedance

23. What is resonant frequency of microwave resonator?(Remembering,CO5)(June 2009)

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.

24. Define quality factor of a resonator. (Remembering,CO5) (April/May 2019) (Dec/Jan2016)

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

25. What is a resonator? (Nov /Dec 2012)(Remembering,CO5)

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.

26. What are the disadvantages if the resonator is made using lumped elements at high frequencies? (Remembering,CO5) (Nov /Dec 2012)

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

27. What are the methods used for constructing a resonator?(Remembering,CO5)

The resonators are built by (a) using lumped elements like L and C for low frequencies (<300MHz) (b) using distributed elements like sections of coaxial lines (c) using rectangular or circular waveguide.

28. What are the applications of cavity resonators?(Remembering,CO5)(Dec 2014/Jan 2015) (June 2017)(April/May 2017)

The cavity resonators are used as tuned circuits. Also used in UMF tubes, klystron amplifier, oscillators, duplexes of radar. The circular cavity resonators are also used in microwave frequency meter.

- Used in microwave generation and amplification
- Used in light house tube,VHF range of frequency
- Used in RADAR as TR tubes and ATR tubes
- Used for measurement of microwave signals with cavity wave meter.

29. Find Cutoff wavelength for a standard rectangular waveguide for TE_{11} mode?(Applying,CO5) (May/June 2012)) (Nov /Dec 2014)$2/ \{(1/a)^2 + (1/b)^2\}^{1/2}$

30. Calculate the cutoff wavelength for dominant mode in a rectangular waveguide whose a = 3cm. (May/June 2012)(Dec 2014/Jan 2015)(Applying,CO5)(Dec/Jan2016)

Cutoff wavelength $\lambda c = 2a/m = (2 * 3cm) / 1 = 6cm$

31. What is the dominant mode of cavity resonator?(Remembering,CO5)(May/June 2012)

The dominant mode of rectangular resonator depends on the dimensions of the cavity. b<a<d the dominant mode is $TE_{101.}$

32. An air filled rectangular waveguide of dimensions a = 7cm and b = 3.5 cm operates in the dominant mode. Determine the guide wavelength at a frequency of 3.5 GHz.(Applying,CO5) (Nov/Dec 2013)

$\lambda c = 2a/m = 14$cm.

$f_c = c/\lambda c = 2.14$GHz.

$\lambda g = \lambda 0/(1-(fc/f)^2)^{1/2} = 0.11$m.

33. Determine the group velocity of TE_{11} mode in a rectangular waveguide with a = 7.2 cm and b = 3.2 cm at 6GHz.(Applying,CO5) (May/June 2013)

$Fc = v/2\ ((m/a)^2 + (n/b)^2)^{½} = 5.1$GHz

$V_g = v\ (1-(f_c/f)^2)^{1/2} = 1.86X10^8$ m/sec.

34. List the salient features of circular wave guide.(Remembering,CO5)(Nov/Dec 2013)

Circular waveguide s used as attenuators and phase shifters.

35. What is the relationship between loaded, unloaded and external Q of a cavity resonator? (Nov/Dec 2010)(Remembering,CO5)

$$1/Q_L = 1/Q_0 + 1/Q_e$$

$Q_{L=}$ Loaded quality factor

$Q_{0=}$ Unloaded quality factor

$Q_{e=}$ External quality factor

BIG QUESTIONS

1. Obtain the solution of electric and magnetic fields of TM waves guided along rectangular wave guide. (Applying,CO5)(Dec 2014/Jan 2015) (Nov/Dec 2009) & (Nov/Dec 2012) (Tx1:500)

2. Determine the solution of electric and magnetic fields of TE waves guided along rectangular wave guide. (Applying,CO5) (Tx1:505) (June 2017) &(Nov/Dec 2012)

3. Derive the field configuration, cut off frequency and velocity of propagation for TE waves in a rectangular waveguide. (Applying,CO5) (Tx1:508) (Nov/Dec 2008)

4. Derive the field configuration, cut off frequency and velocity of propagation for TM waves in rectangular wave guide. (Applying,CO5)(Tx1:502) (Apr/May 2008)

5. TEM wave cannot exist in a single –conductor waveguide – Justify the statement using Maxwell's equation. (Understanding,CO5)(Nov/Dec 2012)&(Apr/May 2008)

6. Explain wave impedance of a rectangular wave guide and derive the expression for the wave impedance of TE and TM waves. (Tx1:507)(Applying,CO5) (May/June 2009) &(Nov/Dec 2006)

7. A TE_{10} wave at 10GHz propagates in a X-band copper rectangular wave guide whose inner Dimensions are 'a' =2.3 cm and 'b' = 1cm, which is filled with Teflon $\varepsilon_r = 2.1$, $\mu_r = 1$. Calculate thecut-off frequency, velocity of propagation, Phase velocity, Phase constant, Guide wave length and Wave impedance. (Applying,CO5)(Tx1:502(Nov/Dec 2012)

8. A X- band air filled rectangular waveguide has inner dimensions of 'a' =2.3 cm and 'b' = 1cm. Calculate the cut-off frequencies in the following modes: TE_{10}, TE_{20}, TM_{11}, TM_{12}. Also check which of the modes will propagate along the wave guide when the signal frequency is 10GHz. (Applying,CO5) (May 2008) (Tx1:508)

9. A rectangular wave guide measures 3 x4.5 cm internally and has a 10GHz signal propagated in it. Calculate the cutoff wavelength, guide wavelength and the characteristic wave impedance for the TE_{10} mode. (Applying,CO5) (Tx1:502) (Nov/Dec 2007)

10. What are the dimensions of a waveguide with the following specifications? (1) At a frequency of 9959.5 MHz, the guide wavelength for TE_{10} mode is 87.57% of the cutoff wavelength (2) TE_{30} and TE_{12} mode has the same cutoff frequency. (Applying,CO5) (Nov/Dec 2007) (Tx1:506)

11. An air filled rectangular wave guide with dimensions of 'a' =8.5 cm and 'b' = 4.3cm is fed by a 4GHz carrier from co-axial cable. Determine the cutoff frequency, Phase velocity and group velocity for TE_{11} mode. (Applying,CO5)(Tx1:508) (Nov/Dec 2006)

12. The cutoff wave lengths of a rectangular wave guide are measured to be 8cm and 4.8cm for TE_{10} and TE_{11} mode respectively. Determine waveguide dimensions. (Applying,CO5) (April/May2019) (Dec/Jan 2016) (Tx1:502)

13. An air filled rectangular copper wave guide with dimensions of ‘a’ =2.28 cm and ‘b’ = 1.01cm is operated at 9.2 GHz in dominant mode. Determine the cut off frequency,guide wave length, phase velocity and characteristics impedance (Applying,CO5)(Nov/Dec 2010) (Nov/Dec 2014) (Tx1:502)
14. Find the broad wall dimension of a rectangular waveguides when the cut-off frequency for TE_{10} modes (i) 3 GHz (ii) 30 GHz. (Applying,CO5)(Tx1:502)(Nov/Dec 2012)
15. A hollow rectangular waveguide operates at 1 GHz and it has the dimensions of 5 x 2 cm. Check whether TE_{21} mode operates or not.(Applying,CO5) (Tx1:508)(Nov/Dec 2012)
16. Determine the solution of electric and magnetic fields of TM waves guided along circular wave guide (Dec/Jan2016)(Applying,CO5) (Tx1:513)(Nov/Dec 12)
17. Determine the solution of electric and magnetic fields of TE waves guided along circular wave guide. (Applying,CO5) (Nov/Dec 2012) (Tx1:512)
18. Derive the expressions for cutoff frequency, phase shift constant and velocity of propagation of waves in circular wave guide. (Tx1:514)(Applying,CO5)(Nov/Dec 2006) (April/May2019)
19. Sketch the electric and magnetic fields configuration for TE_{01} mode in a circular wave guide. (Understanding,CO5) (Nov/Dec 2006) (Tx1:516)
20. Write a brief notes on excitation of mode in circular wave guides. (Nov/Dec 2010) &(June 2017) (Remembering,CO5) (Tx1:526)
21. What is meant by cavity resonator? Derive the expression for the resonant frequency of the rectangular cavity resonator. (Understanding,CO5) (Tx1:530) (June2016)(Nov/Dec 2012) (April/May2019)
22. Derive the equation for Q factor of rectangular cavity resonator for TE_{101} mode. (Applying,CO5) (Nov/Dec 2008) (Tx1:532)
23. Calculate resonant frequency of an air filled rectangular resonator of dimensions a = 2cm, b = 4cm and d = 6cm operating in TE_{101} mode. (Applying,CO5) (Tx1:530) (Dec/Jan2016) (Apr/May 2008)
24. A circular wave guide has an internal diameter of 4cm. For a 10GHz signal propagated in it in the TE_{11}mode, Calculate cutoff wavelength, guide wavelength and characteristic impedance[$(ha)^1_{11}$= 1.84] (Tx1:514)(Applying,CO5)(June 2016)(Nov/Dec 2007)
25. Given a circular wave guide of an internal diameter 12 cm operating with 8GHz signal propagating TM_{22}. Calculate λ_1, λ_C, λ_g and η_g [$(ha)_{22}$ =8.42]. (Applying,CO5)(Tx1:514) (Nov/Dec 2006)
26. A rectangular cavity resonator excited by TE_{101} mode, at 20GHz have the dimension a =2cm and b =1cm. Calculate the length of the cavity. (Applying,CO5) (Tx1:529) (Nov/Dec 2006)
27. Explain the concept of excitation of waveguides. (Nov/Dec 2014) (Understanding,CO5) (Tx1:526)
28. Discuss the structure advantages and disadvantages of resonant cavities.(Understanding,CO5) (Tx1:526)(Nov/Dec 2012)
29. A copper walled rectangular cavity resonator is structured by 3 x 1 x 4 cm and operates at the dominant modes of TE and TM. Find the resonant frequency and Quality factor. The conductivity of copper is 5.8 x 10^7 mho/m. There is air inside the cavity. (Applying,CO5)(Tx1:53) (Nov/Dec 2012)
30. Explain the principle and operation of rectangular cavity resonators and discuss the TE_{mnp} modes in a rectangular cavity resonator with relevant expressions. (Understanding, CO5) (Nov/Dec 2012)
31. Mathematically prove the dominant mode for circular waveguide is TE 11? (Applying,CO5) (Nov/Dec 2013) (Tx1:530)
32.An circular waveguide having inner diameter of 6cm is excited at 9GHz in dominant mode. Find (1) Cutoff frequency (2) Wave impedance (3) Cutoff wave length. (Applying,CO5)(Nov/Dec 2010) (Tx1:514)
33. Give a brief note on the dominant mode in circular waveguide? (Tx1:516) (May/June 2013) (Understanding,CO5)
34.A rectangular waveguide measuring a=7cm and b=4cm internally has a 3GHz signal propagated in it, Withdielectric constant 3. Determine all the modes which will propagate inside the guide. (Dec 2014/Jan 2015) (Tx1:514) (Applying,CO5)

16EC514-Transmission Lines and Waveguides

CYCLE TEST – 1

Part A (5 x 2 =10)

1. What do you meant by lumped and distributed circuits? (Remembering)(CO1)
2. Define Neper and Decibel. (Remembering)(CO1)
3. Construct the equivalent circuit of transmission line. (Applying)(CO1)
4. Summarize the properties of infinite line? (Understanding) (CO1)
5. Calculate the characteristic impedance of a transmission line if the following parameters have been made on the line Z_{OC}= Ω and Z_{SC} = Ω

Part B (15 marks)

6. Define the Zo and derive the expression for Zo of symmetrical T network terminated by Z_0.(Remembering)(CO1)
7. Explain the general solutions of transmission line for voltage and current at any point on a line.(Understanding) (CO1)

16EC514- Transmission Lines and Waveguides

CYCLE TEST – 2

Part A (5 x 2 =10)

1. What is the drawback of using ordinary telephone cables? (Remembering) (co2)
2. Define reflection loss and reflection factor. (Analyzing) (co2)
3. Define Nodes, Antinodes and SWR. (Understanding) (co2)
4. What do you meant by loading? Write its types. (Remembering) (co2)
5. Determine the reflection coefficient of a transmission line when Z_R = Ω and Z_0 =692 <-12° **Ω.** (Evaluating) (co2)

Part B

6. Explain in detail about waveform distortion. Write the condition for the distortion less line? (10m)(Applying) (co2)
7. Explain in detail about the input impedance of transmission line.Also find the input impedance of open and short circuited lines. (5m) (Understanding) (co2)

16EC514Transmission Lines and Waveguides

Cycle Test – 3

PART A (5X2=10)

1. State the assumptions for the analysis of the performance of the radio frequency line. (R) (Co3)
2. List the applications of quarter wave line. (U)(co3)
3. What is the use of half wave line?(R) (Co3)
4. Give reasons for preferring a short- circuited stub when compared to an open-circuited stub? (ANA) (co3)
5. List the applications of Smith chart. (U) (co3)

PART B(2X7.5=15)

6. Explain in detail the parameters of open wire and coaxial cables. (R) (co3)
7. A ----Ω lossless transmission line is terminated in a load impedance of ZL =(25 +j50)Ω. Use the SMITH chart to find (1) Voltage reflection coefficient, (2) VSWR (3) input impedance of the line, given that the line is 3.3λ long and (4) input admittance of the line. (E) (co3)

16EC514Transmission Lines and Waveguides

Cycle Test – 4

1. What are guided waves? Give examples.
2. Define wave impedance. Write wave Impedance of TE, TM waves.
3. What is meant by group and phase velocities?
4. Define cutoff frequency and cutoff wavelength.
5. Write the relation between guide wavelength, cutoff wavelength and free space wavelength..

6. Derive the expression for field components of TM waves in parallel conducting planes. (7.5)
7. Define attenuation. Obtain the expression for α of TM waves in parallel plane wave guides. (7.5)

16EC514 Transmission Lines and Waveguides

Cycle Test – 5

1. What is the dominant mode for the rectangular waveguide?
2. What are degenerate modes in a rectangular waveguide?
3. Why circular waveguides are not preferred over rectangular waveguides?
4. Write the Bessel's function of first kind of order zero.

5. An air filled rectangular waveguide of dimensions a = 7cm and b = 3.5 cm operates in the dominant mode. Determine the guide wavelength at a frequency of 2.5 GHz.

6. Derive the expression for field components of TE waves in rectangular waveguides. (7.5)

7. Derive the expression for field components of TM waves in circular waveguides (7.5)