SRM VALLIAMMAI ENGINEERING COLLEGE
(An Autonomous Institution)

SRM Nagar, Kattankulathur – 603 203

DEPARTMENT OF

ELECTRONICS AND COMMUNICATION ENGINEERING

QUESTION BANK

V SEMESTER

EC3562 – TRANSMISSION LINES AND WAVEGUIDES

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Prepared by

Dr. N. Subhashini, *Associate Professor / ECE*

Dr. J. Premalatha, *Associate Professor /ECE*

Dr. K. Durgadevi, *Assistant Professor /ECE*

EC3562 TRANSMISSION LINES AND WAVEGUIDES

UNIT I - FUNDAMENTALS

Introduction - Types of transmission lines - General theory of transmission line - Line constants – Transmission line equation - Physical significance of the equations - The Infinite line - Distortion in a line - Distortion less line -Telephone cables - Loading of lines - Types of loading - Campbell's formula - General equation for line with any termination - Input impedance - Open and Short-circuited line.

PART A

Q.No	Questions	CO	BT Level	Competence
1.	Define transmission line.	CO1	BTL 1	Remembering
2.	Mention the conditions for distortion less line.	CO1	BTL 1	Remembering
3.	Differentiate phase distortion and frequency distortion.	CO1	BTL 1	Remembering
4.	What are primary constants and secondary constants of a transmission line?	CO1	BTL 2	Understanding
5.	How to avoid the distortion that occurs in the line?	CO1	BTL 2	Understanding
6.	State the properties of an infinite line.	CO1	BTL 2	Understanding
7.	Sketch the equivalent circuit of a unit length of transmission line.	CO1	BTL 1	Remembering
8.	Write about the effect of inductance loading in telephone cable.	CO1	BTL 1	Remembering
9.	State the relationship between characteristic impedance and propagation constant.	CO1	BTL 2	Understanding
10.	Express the general equation for the input impedance and transfer impedance of a transmission line.	CO1	BTL 1	Remembering
11.	Summarize the significance of Campbell's formula.	CO1	BTL 2	Understanding
12.	What is the main purpose of telephone cables?	CO1	BTL 2	Understanding
13.	Mention the voltage and current equations at any point on a uniform transmission line.	CO1	BTL 1	Remembering
14.	How practical lines can be considered to be equivalent to an infinite line?	CO1	BTL 1	Remembering
15.	Express the equations for the phase constant and velocity of propagation for telephone cable.	CO1	BTL 2	Understanding
16.	Interpret the significance of input impedance in transmission line?	CO1	BTL 2	Understanding
17.	Find the attenuation and phase constant of a wave propagating along the line whose propagation constant is $1.048 \times 10^{-4} \angle 88.8°$.	CO1	BTL 2	Understanding

18.	Identify the characteristic impedance of a transmission line if the following measurements have been made on the line $Zoc= 550\angle-60°\Omega$ and $Zsc= 500\angle30°\Omega$.		CO1	BTL 1	Remembering
19.	What is meant by loading of transmission lines? Why is it used in telephony?		CO1	BTL 1	Remembering
20.	The open circuit and short circuit impedance of a transmission line at 1500 Hz are $800\angle-30°$ Ω, $400\angle-10°$ Ω respectively. Find the propagation constant.		CO1	BTL 2	Understanding
21.	How to avoid the waveform distortion in transmission line?		CO1	BTL 1	Remembering
22.	List out the applications of transmission line.		CO1	BTL 1	Remembering
23.	State the distortion in a transmission line? What are the conditions for a distortion less line?		CO1	BTL 2	Remembering
24.	Explain the difference between amplitude distortion and phase distortion.		CO1	BTL 2	Understanding

PART B

1.	Obtain the expression for voltage and current at any point on the transmission line.	(16)	CO1	BTL 3	Applying
2.	(i) Analyze the general theory of transmission line with the equivalent diagram of transmission line. (ii) Describe the primary constants and the secondary constants of the transmission line.	(8) (8)	CO1	BTL 4	Analyzing
3.	(i) What is a loading? Specify the types of loading of lines. (ii) Derive the general expression for the input impedance of a lossless transmission line of length l, characteristic impedance Z_0, terminated with a load impedance Z_L.	(8) (8)	CO1	BTL 3	Applying
4.	(i) Solve the expression for open and short-circuited impedance. (ii) A lossless transmission line of characteristic impedance Z_0 and electrical length 'l' is either open-circuited or short-circuited at the load end. Derive the expressions for the input impedance in both cases.	(8) (8)	CO1	BTL 3	Applying
4.	(i) Elaborate the physical significance of a transmission line and how input impedance of line of infinite length can be determined.	(8) (8)	CO1	BTL 4	Analyzing

	(ii)Explain the general equation of a transmission line with any termination.				
5.	(i)Determine the expressions for short circuited and open circuited impedance. (ii) Analyze the propagation constant for a continuously loaded cable.	(8) (8)	CO1	BTL 4	Analyzing
6.	Obtain the expression for the attenuation and phase constants and characteristic impedance of a transmission line.	(16)	CO1	BTL 3	Applying
7.	(i)Prove that the characteristic impedance of a distortion less line is purely real and deduce the propagation constant (ii) List out the advantages and disadvantages of the continuous loading of transmission line.	(10) (6)	CO1	BTL 4	Analyzing
8.	(i) The following measurement are made on a 25km line at a frequency of 796Hz. $Z_{SC}=3220\angle-79.29°\Omega$, $Z_{OC} = 1301\angle76.67°\ \Omega$. Determine the primary constants of the line. (ii) Explain the waveform distortion in the transmission line with necessary expressions.	(8) (8)	CO1	BTL 3	Applying
9.	Open circuited and short-circuited measurements at a frequency of 5kHz on a line of length 200km yielded the following results: $Z_{oc} = 570 \angle -48^0\ \Omega$, $Z_{sc} = 720\angle 34^0\ \Omega$ Evaluate Z_o , α, β and primary constants, given that the approximate velocity of propagation to be 1.8×10^6 km/sec.	(16)	CO1	BTL 3	Applying
10.	A 2m long transmission line with characteristics impedance of 60+j40 ohm is operating at ω = 106 rad / sec has attenuation constant of 0.921 Np/m and phase shift constant of 0 rad /m. If the line is terminated by a load of 20+j50 ohm, compute the input impedance of this line.	(16)	CO1	BTL 3	Applying
11.	(i)With necessary steps derive that the line will be distortion less if LG = RC. (ii) Connect the value of attenuation constant 'α' as $\frac{R}{2}\sqrt{\frac{C}{L}}+\frac{G}{2}\sqrt{\frac{L}{C}}$, when the series resistance R and shunt resistance G of the transmission line are small but not negligible.	(8) (8)	CO1	BTL 4	Analyzing
12.	Examine in detail about the primary constants and secondary constants of a transmission line and obtain the relation between them.	(16)	CO1	BTL 3	Applying
13.	A generator of 1V, 1000 Hz, supplies power to a 100 km open wire line terminated in Zo and having the following	(16)	CO1	BTL 4	Analyzing

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	parameters R = 10.4 Ω/km, L = 0.00367 H/ km, G = 0.8 x 10^{-6} Ω^{-1}/km, C = 0.00835 µF/km. Calculate Z α, β, λ, v. also find the received power.				
14.	(i) Justify why the R and G of a transmission line is maintained at smaller value for achieving minimal attenuation. (ii) Simplify the expression for input impedance and transfer impedance of transmission lines.	(10) (6)	CO1	BTL 3	Applying
16.	Analyze the inductive loading in a transmission line and derive the Campbell's expression and the associated essential parameters.	(16)	CO1	BTL 4	Analyzing
17.	Explain in detail about inductance loading of telephone cables and derive the attenuation constant, phase constant and velocity of signal transmission for the uniformly loaded cable.	(16)	CO1	BTL 4	Analyzing

UNIT II RADIO FREQUENCY TRANSMISSION LINES

Line approximations - Parameters of open wire line at radio frequency, parameters of coaxial lines at radio frequencies, constants for the line of zero dissipation - Voltages and Currents on the dissipation-less lines - input impedance of a lossless line - Wavelength and velocity of propagation - Reflection phenomena - Line losses - Return loss - reflection loss- insertion loss - Reflection coefficient, Reflection factor, Standing wave ratio, Input impedance in terms of reflection coefficient.

PART A				
Q.No	Questions	CO	BT Level	Competence
1.	Define Skin effect.	CO2	BTL1	Remembering
2.	List the assumptions to analyze the performance of the line at radio frequency.	CO2	BTL1	Remembering
3.	Write the formula for calculating the inductance of open wire line and coaxial line.	CO2	BTL 1	Remembering
4.	State the condition of attenuation constant and propagation constant for dissipation less line.	CO2	BTL 1	Remembering
5.	Define nodes and antinodes in wave propagation on a transmission line.	CO2	BTL 2	Understanding
6.	Infer the conditions and value of Z_0 for the dissipation less line.	CO2	BTL 2	Understanding
7.	Summarize the features of nodes and antinodes in a standing wave.	CO2	BTL 2	Understanding

8.	Define Insertion loss in the transmission line.		CO2	BTL 1	Remembering
9.	Find the reflection coefficient of a 50 ohm line when it is terminated by a load impedance of 60+j 40 ohm.		CO2	BTL 2	Understanding
10.	How will you make standing wave measurements on co-axial lines?		CO2	BTL 1	Remembering
11.	List the conditions to be satisfied by dissipation less line.		CO2	BTL 1	Remembering
12.	Identify the range of values of SWR and reflection co-efficient.		CO2	BTL 2	Understanding
13.	Outline the input impedance of open circuited and short circuited and matched load condition for dissipation less line.		CO2	BTL 1	Remembering
14.	Find the terminating load impedance for a RF transmission line of length $\lambda/8$ with a characteristic impedance of 50Ω and SWR of 2.		CO2	BTL 2	Understanding
15.	Draw the standing wave pattern on a line having short circuit termination.		CO2	BTL 1	Remembering
16.	Infer the equations of an inductance and capacitance of an open wire line at high frequencies.		CO2	BTL 2	Understanding
17.	A lossless transmission has a shunt capacitance of 100 pF/m and a series inductance of 4μH/m. Find its characteristic impedance.		CO2	BTL 2	Understanding
18.	Calculate the values of SWR in the case of a) Z_R=0 b) $Z_R = Z_o$.		CO2	BTL 2	Understanding
19.	Outline the effect of reflection in an unmatched line.		CO2	BTL 2	Understanding
20.	Write the expression for inductance of an open wire line and coaxial line.		CO2	BTL 1	Remembering
21.	List out the values of attenuation constant and characteristic impedance of dissipation less line.		CO2	BTL 1	Remembering
22.	Write the expression for the power flow in a voltage loop on a line with negligible losses.		CO2	BTL 1	Remembering
23.	Exhibit the point of voltage minimum is measured easily in a transmission line rather than the voltage maximum.		CO2	BTL 2	Understanding
24.	How does the reflection occur in a transmission line?		CO2	BTL 2	Understanding
PART B					
1.	(i)Justify why the reflection becomes undesirable in the transmission line.	(8)	CO2	BTL 4	Analyzing
	(ii) A transmission line has following parameters per km R= 15 Ω , C = 15 μF, L=1 mH, G=1 μmho . Find the additional inductance to give distortion less line. Calculate α and β for this inductance added transmission.	(8)			

2.	(i)Formulate the expression for maximum and minimum impedances on the lossless line.	(8)	CO2	BTL 4	Analyzing
	(ii) Analyze the coaxial line for transmission of signal at high frequencies, write the necessary design equations. Plot the graph to show the variation of Ro with the radii ratio of a coaxial line.	(8)			
3.	The ratio of spacing 'd' to the radius 'a' of an open wire dissipation less line is 25 and the space between the conductors has a dielectric of relative permittivity of 8. Compute (i) the inductance (ii) the capacitance (iii) characteristic impedance (iv) velocity of wave propagation when the line is excited by a source.	(16)	CO2	BTL 3	Applying
4.	Solve the variation of input impedance along open and short circuited lines with relevant graphs.	(16)	CO2	BTL 4	Analyzing
5.	Express the measurement of power and impedance on the line of negligible losses.	(16)	CO2	BTL 3	Applying
6.	How the VSWR and wavelength are measured over a transmission line?	(16)	CO2	BTL 4	Analyzing
7.	(i)A line with zero dissipation has R=0.006 Ω/ m, C=4.45 pF/ m, L=2.5μH/ m. If the line is operated at 10MHz. Find R_o, α, β, λ, v.	(8)	CO2	BTL 4	Analyzing
	(ii) Solve for the standing wave ratio and reflection coefficient on a dissipation less line having Z_0=300 Ω and terminating impedance of Z_R=300+j400 Ω.	(8)			
8.	Evaluate the theory of open and short-circuited line with voltage and current distribution diagrams and also get the input impedance expression.	(16)	CO2	BTL 3	Applying
9.	Describe about the Standing waves, nodes, antinodes and standing wave ratio, also obtain the relation between the standing wave ratio S and the magnitude of the reflection coefficient.	(16)	CO2	BTL 3	Applying
10.	Examine the expression for the input impedance of its dissipation less line and find the maximum and minimum impedance.	(16)	CO2	BTL 3	Applying
11.	(i) Sketch the voltage and current waveform for a radio frequency line for the following terminations: (a)Open circuited load (b) Short circuited load (c)matched load	(8)	CO2	BTL 3	Applying
	(ii) In a dissipation less line verify whether the reflection coefficient on a line is equal to [|Emax| - |Emin|] / [|Emax| +|Emin|].	(8)			
12.	Examine in detail about the various parameters of open wire and co-axial line at radio frequencies.	(16)	CO2	BTL 3	Applying
13.	Explain the dissipation less line and derive the input impedance of the dissipation less line, also deduce the input	(16)	CO2	BTL 3	Applying

	impedance of an open and short-circuited dissipation less line.				
14.	(i) A 30m long lossless transmission line with $Z_0 = 50\Omega$ operating at 2 MHz is terminated with a load $Z_L = 60 + j40\ \Omega$. If $u = 0.6c$ (c is velocity of light, u is phase velocity) on the line, calculate (a) Reflection Coefficient, (b) Standing wave ratio (c) Input impedance. (ii) Find the sending end impedance of a HF line having characteristic impedance of 50Ω. The line is of length 1.185λ and is terminated with a load of $110 + j80\ \Omega$.	(8) (8)	CO2	BTL 4	Analyzing
15.	(i) Explain the concept of the reflection phenomena. (ii) Analyse the impact of insertion loss in the transmission line and obtain the appropriate expression for the same.	(8) (8)	CO2	BTL 4	Analyzing
16.	(i) Summarize the effect of the reflection losses on power delivered to the load on an unmatched line. (ii) Compare the characteristics of an open wire line and a coaxial cable at high frequencies.	(8) (8)	CO2	BTL 4	Analyzing
17.	Derive the general expressions for voltage and current at any point on the radio frequency dissipation less line and draw the incident and reflected voltage wave for the successive instants of time.	(16)	CO2	BTL 4	Analyzing

UNIT III TRANSMSSION LINE SECTIONS AND IMPEDANCE MATCHING TECHNIQUES				
Types of transmission line sections - Half wave line - Quarter wave line - Properties of quarter wave transformer - Impedance matching - Single and double stub matching- Smith chart and its Applications.				
PART A				
Q.No	Questions	CO	BT Level	Competence
1.	Mention the purpose of impedance matching in transmission line.	CO3	BTL 2	Understanding
2.	List out the types of transmission line sections.	CO3	BTL 1	Remembering
3.	Express the standing wave ratio in terms of reflection coefficient.	CO3	BTL 1	Remembering
4.	Summarize the characteristics of half wave line.	CO3	BTL 2	Understanding
5.	Why do standing waves exist on transmission lines?	CO3	BTL 1	Remembering
6.	Write the minimum and maximum value of SWR and reflection Coefficient.	CO3	BTL 2	Understanding
7.	A lossless transmission line of characteristic impedance $Z_0 = 50\ \Omega$ is terminated with a load $Z_L = 50\ \Omega$. If the line length is half-wavelength	CO3	BTL 2	Understanding

	(λ/2), what is the input impedance Zin seen at the input of the line?			
8.	State the condition for maximum power transfer in transmission lines.	CO3	BTL 1	Remembering
9.	Mention the applications of smith chart.	CO3	BTL 2	Understanding
10.	Interpret what happens to the impedance of a quarter-wave transformer if the load is short-circuited?	CO3	BTL 2	Understanding
11.	Define quarter wave lines are termed as impedance inverter.	CO3	BTL 2	Understanding
12.	Why quarter wave line is called as copper insulator?	CO3	BTL 1	Remembering
13.	A 75Ω lossless transmission line is to be matched to a resistive load impedance of Z_L =100Ω via a quarter wave section. Determine the input impedance of a quarter wave line.	CO3	BTL 1	Remembering
14.	Write the equation to determine the characteristic impedance of the quarter wave transformer.	CO3	BTL 1	Remembering
15.	List out the advantages of Smith Chart.	CO3	BTL 1	Remembering
16.	Write the procedure to find the impedance from the given admittance using smith chart.	CO3	BTL 2	Understanding
17.	Summarize the steps to find the SWR from the smith chart.	CO3	BTL 1	Remembering
18.	Why short circuited stub is preferred to open circuited stub?	CO3	BTL 2	Understanding
19.	What are the methods to determine the position and the length of a single stub connected across the transmission line?	CO3	BTL 1	Remembering
20.	Interpret the equation to determine the length of the stub.	CO3	BTL 2	Understanding
21.	Compare the single stub matching and double stub matching.	CO3	BTL 2	Understanding
22.	Summarize the pros and cons of single stub matching.	CO3	BTL 2	Understanding
23.	List the application of the quarter wave matching section.	CO3	BTL 1	Remembering
24.	Write the equation to determine the position of the single stub used for impedance matching.	CO3	BTL 1	Remembering
PART B				
1.	Consider the transmission line with a characteristic impedance of 300 Ω and terminated in a load of 175+j207 Ω. An electrical signal of 200MHz is transmitted along the line in free space. Determine the following: (i) Standing wave ratio (SWR) (ii) Load admittance (iii)Distance between load and the first voltage minimum along the transmission line.	(16)	CO3	BTL 4	Analyzing

2.	Using double stub matching, match a complex load of $Z_L=18.75+j56.25\ \Omega$ to a line with characteristic impedance $Z_0=75\ \Omega$.	(16)	CO3	BTL 4	Analyzing
3.	Using Single stub matching, match a complex load of $Z_L=20.75+j45.25\ \Omega$ to a line with characteristic impedance $Z_0=50\Omega$.	(16)	CO3	BTL 4	Applying
4.	The terminating load of UHF transmission line working at 300MHz is $50+j50\ \Omega$. Determine the VSWR and the position of the voltage minimum nearest to the load if the characteristic impedance of the line is $50\ \Omega$.	(16)	CO3	BTL 3	Applying
5.	Determine the SWR, characteristic impedance of a quarter wave transformer and the distance the transformer must be placed to achieve a smooth line with characteristic impedance $Z_0 = 50$ ohms with a load $Z_L = 75+j60$ ohms.	(16)	CO3	BTL 3	Applying
6.	(i)Explain the concept of a quarter-wave transmission line. Derive the equation for its input impedance and discuss impedance inversion. (ii)Design a quarter-wave transformer to match a 30Ω load to a 75Ω transmission line operating at a frequency of 1MHz.	(8) (8)	CO3	BTL 4	Analyzing
7.	An antenna as a load on a transmission line produces a standing wave ratio S=2.8, with a voltage minima at 0.12λ from the antenna terminals. Find the antenna impedance and the reflection coefficient and reflection factor if $R_o= 300\Omega$ for the line using the Smith chart and verify the answers using mathematical formula.	(16)	CO3	BTL 4	Analyzing
8.	The VSWR measured on UHF transmission line at a frequency of 300MHz is 2. If the distance between load and the voltage minimum is 0.8m, determine the normalized load impedance.	(16)	CO3	BTL 3	Applying
9.	A 70Ω lossless line is used at a frequency where wavelength equals 80 cm, terminated by a load of $140 +j91\Omega$. find the reflection coefficient, VSWR, input impedance using Smith chart.	(16)	CO3	BTL 3	Applying
10.	Analyze the procedure for double stub matching on transmission line, explain with an example.	(16)	CO3	BTL 4	Analyzing
11.	(i)Compare single-stub and double-stub matching techniques. List advantages, limitations, and applications of each. (ii) Using a Smith chart, explain the procedure for single-stub matching of a load to a transmission line.	(16)	CO3	BTL 3	Applying
12.	Design a short circuited single stub matching network for a transmission line functioning at 500MHz terminated with a load impedance $Z_L = 300 + j250\ \Omega$ and with the characteristic impedance of 100Ω . Determine the position and length of the stub.	(16)	CO3	BTL 3	Applying

13.	(i)Examine the need of impedance matching devices in transmission line. (ii) Determine the length and location of a single short-circuited stub to produce an impedance match on a transmission line with characteristic impedance of 600 Ω and terminated in 1800 Ω.	(6) (10)	CO3	BTL 3	Applying
14.	A transmission line is terminated in Z_L. Measurements indicate that the standing wave minima are 102cm apart and that the last minimum is 35 cm from the load end of the line. The value of standing wave ratio is 2.4 and Ro = 250Ω. Determine frequency, wavelength, Real and reactive components of the terminating impedance. Also verify the results obtained from equations using the smith chart	(16)	CO3	BTL 4	Analyzing
15.	Explain the impedance matching technique using single stub and obtain the expression for the stub location and stub length.	(16)	CO3	BTL 3	Applying
16.	A single stub is to match a 400 ohms line to a load of 200- j100Ω. The wavelength is 3m. Determine the position and length of the short-circuited stub.	(16)	CO3	BTL 4	Analyzing
17.	What is the procedure for double stub matching on a transmission line, explain with an example?	(16)	CO3	BTL 4	Analyzing

UNIT IV – WAVE PROPAGATION AND CHARACTERISTICS IN PARALLEL PLANES			
Waves between parallel planes - Transverse electric waves -Transverse magnetic waves - Characteristics of TE and TM waves - Transverse electromagnetic waves - Velocities of propagation - Attenuation in parallel plane waves - Wave impedance.			
PART A			
Q.No	Questions	CO	BT Level	Competence
1.	What is a waveguides?	CO4	BTL 1	Remembering
2.	Interpret the characteristics of a parallel plane waveguides.	CO4	BTL 2	Understanding
3.	What is the condition for wave propagation between two parallel planes?	CO4	BTL 1	Remembering
4.	Define a Transverse Electric (TE) wave.	CO4	BTL 1	Remembering
5.	Two perfectly conducting parallel planes are separated by 2 cm. Find the lowest cutoff frequency for TE waves.	CO4	BTL 2	Understanding
6.	Outline the features of Transverse Magnetic (TM) wave.	CO4	BTL 2	Understanding
7.	For a TM wave, if the cutoff frequency is 7 GHz and operating frequency is 10 GHz, calculate the guide wavelength.	CO4	BTL 2	Understanding
8.	List the conditions under which TM waves propagate.	CO4	BTL 1	Remembering

9.	Compare TE and TM waves in terms of their field orientations.	CO4	BTL 2	Understanding
10.	Summarize the concept of mode number in TE and TM waves.	CO4	BTL 2	Understanding
11.	What is meant by the dominant mode?	CO4	BTL 1	Remembering
12.	How does frequency affect the propagation of TE and TM waves?	CO4	BTL 2	Understanding
13.	In what way TEM waves differ from TE and TM waves?	CO4	BTL 2	Understanding
14.	List the cases based on the relationship between the operating frequency (f) and the cut off frequency(f_c).	CO4	BTL 1	Remembering
15.	In a waveguide , the phase velocity v_p is 2×10^8 m/s , calculate the group velocity v_g .	CO4	BTL 1	Remembering
16.	Mention the expression of phase velocity with definition.	CO4	BTL 2	Understanding
17.	What is group velocity in the wave propagating between two parallel plates.	CO4	BTL 1	Remembering
18.	If f = 8GHz and f_c = 4 GHz find the phase velocity in a parallel plate waveguide in TE mode.	CO4	BTL 1	Remembering
19.	Interpret the condition under which wave enters the evanescent mode.	CO4	BTL 2	Understanding
20.	Summarize about the characteristics of "attenuation" in the context of wave propagation,	CO4	BTL 2	Understanding
21.	Draw the attenuation versus frequency characteristics of waves guided between parallel conducting plates.	CO4	BTL 1	Remembering
22.	Name the primary factors that contribute to attenuation in parallel plate waveguides.	CO4	BTL 1	Remembering
23.	A TE wave has Ex = 3V/m, Hy =0.01 A/m , find the wave impedance.	CO4	BTL 2	Understanding
24.	Define wave impedance for a transmission line.	CO4	BTL 1	Remembering

PART B

1.	Consider the wave propagating in the z- direction between two parallel conducting plates, determine the electric field and magnetic field components.	(16)	CO4	BTL 3	Applying
2.	Derive the expressions for the electric and magnetic field components of TE modes in a parallel-plane waveguide.	(16)	CO4	BTL 4	Analyzing
3.	With the electric and magnetic fields distribution diagram in parallel plates waveguide for the TE$_{10}$ wave, deduce the corresponding field equations.	(16)	CO4	BTL 3	Applying
4.	Explain the characteristics of TE waves with necessary equations.	(16)	CO4	BTL 3	Applying

5.	Deduce the expressions for TM wave propagation between parallel conducting planes.	(16)	CO4	BTL 3	Applying
6.	(i) Compare TE and TM waves with respect to field components, cutoff conditions, and propagation. (ii) Explain the significance of the cut-off frequency in TE waves.	(10) (6)	CO4	BTL 4	Analyzing
7.	a) What is a mode? Explain dominant mode, higher order modes and mode patterns in TE and TM waves. b) Obtain the expression for phase velocity and group velocity in TE modes.	(8) (8)	CO4	BTL 3	Applying
8.	A parallel plate waveguide consists of two sheets of good conductor separated by 7 cm . Find the propagation constant, group velocity, phase velocity, cut off frequency for TE dominant mode for a frequency of 6GHz.	(16)	CO4	BTL 4	Analyzing
9.	Elaborate the characteristics of TEM waves. Compare TEM, TE, and TM waves based on field structure and propagation.	(16)	CO4	BTL 4	Analyzing
10.	(i) Determine the expressions for phase velocity and group velocity for TM waves in a waveguide. (ii) Show that $v_g v_p = c^2$ and explain its physical significance.	(8) (8)	CO4	BTL 4	Analyzing
11.	Consider a parallel plate waveguide with plate separation of 20 cm with the TE10 mode excited at 1GHz. Find the propagation constant , the cut off frequency and guide wavelength. Assuming $\varepsilon_r = 4$ for medium of propagation in the guide.	(16)	CO4	BTL 4	Analyzing
12.	Explain the characteristic of TEM wave with E field and H field diagram between the parallel plate	(16)	CO4	BTL 4	Analyzing
13.	Derive an expression for attenuation factor of transverse electric wave propagating between the parallel plate waveguide.	(16)	CO4	BTL 4	Analyzing
14.	Prove that the attenuation factor of TM wave is minimum when the operating frequency $f = \sqrt{f_c}$.	(16)	CO4	BTL 3	Applying
15.	For a frequency of 5GHz and plane separation of 8 cm in air, find cut off wavelength, wave impedance and phase constant for TM_{10} mode:	(16)	CO4	BTL 3	Applying
16.	Describe and obtain the expression for wave impedance of propagating TE mode in a parallel plate waveguide with a lossless dielectric medium.	(16)	CO4	BTL 4	Analyzing
17.	Compute the wave impedance of TM mode for various cases on comparing the frequency of operation with the cut off frequency.	(16)	CO4	BTL 3	Applying

UNIT V - GUIDED WAVES AND WAVE GUIDE THEORY

EC3562 TLWG Question bank 2025-26 (Odd Semester)

	Rectangular wave guides - TE and TM waves in rectangular wave guides - Dominant mode - Cut off frequency in wave guides - Impossibility of TEM waves in wave guides - Circular wave guides- TE and TM waves in circular wave guides - Attenuation factor and Q of wave guides			

	PART A			
Q.No	Questions	CO	BT Level	Competence
1.	Define a rectangular waveguide.	CO5	BTL 1	Remembering
2.	Compare TE and TM modes in rectangular waveguides	CO5	BTL 2	Understanding
3.	Name the field components present in TE modes.	CO5	BTL 1	Remembering
4.	State the condition for TM modes in a rectangular waveguide.	CO5	BTL 1	Remembering
5.	Mention the dominant mode in rectangular waveguides and imply why it is called so?	CO5	BTL 2	Understanding
6.	An air filled rectangular waveguide of cross section 5cm x 2 cm is used to propagate TM_{11} mode at 10 GHz. Determine cut-off wavelength and guide wavelength	CO5	BTL 2	Understanding
7.	What is meant by the "dominant mode" in a waveguide?	CO5	BTL 1	Remembering
8.	Why TE_{10} is preferred in practical waveguide applications?	CO5	BTL 1	Remembering
9.	Identify the cut off frequency for the dominant mode in a standard rectangular waveguide.	CO5	BTL 2	Understanding
10.	An air-filled waveguide has a cut-off frequency of 5 GHz for a specific mode. If a signal of 4.5 GHz is launched into the waveguide, will it propagate? Justify your answer.	CO5	BTL 2	Understanding
11.	If a signal of 8 GHz is propagating in an air-filled waveguide with a cut-off frequency of 6 GHz for the operating mode, calculate the waveguide wavelength (λg).	CO5	BTL 2	Understanding
12.	State the relationship between the operating frequency and the cut-off frequency for propagation to occur.	CO5	BTL 1	Remembering
13.	An air filled rectangular waveguide of inner dimension 2.286 x 1.016 in centimeters operates in the dominant TE10 modes. Calculate the cut-off frequency and phase velocity of a wave in the guide at a frequency of 7GHz	CO5	BTL 2	Understanding
14.	Justify, why TEM mode is impossible in a single-conductor waveguide	CO5	BTL 1	Remembering
15.	List the characteristics of TEM waves	CO5	BTL 1	Remembering
16.	Define a circular waveguide.	CO5	BTL 1	Remembering
17.	Name the dominant mode in a circular waveguide.	CO5	BTL 1	Remembering

No.	Question	Marks	CO	BTL	Level
18.	Mention the significance of Bessel functions in circular waveguide analysis.		CO5	BTL 2	Understanding
19.	Identify the modes supported in a circular waveguide.		CO5	BTL 2	Understanding
20.	Determine the size of the circular waveguide required to propagate TE_{11} mode if λc=8cm and ρ_{11}=1.842.		CO5	BTL 2	Remembering
21.	Interpret the attenuation factor in waveguides.		CO5	BTL 2	Understanding
22.	What is the quality factor (Q) of a waveguide?		CO6	BTL 1	Remembering
23.	List two primary causes of attenuation in waveguides.		CO5	BTL 1	Remembering
24.	How the Q-factor affects waveguide performance.		CO6	BTL 2	Understanding
PART B					
1.	Using the Maxwell's equation obtain the solution of wave equation in the rectangular waveguide.	(16)	CO5	BTL 3	Applying
2.	Describe the field component of a Transverse Electric wave in rectangular wave guides.	(16)	CO5	BTL 3	Applying
3.	(i)Analyze the behavior of field patterns in rectangular waveguides for higher-order modes. (ii)A rectangular waveguide operates at 9 GHz with dimensions 2.5 cm × 1 cm. Determine which TE modes can propagate.	(8) (8)	CO5	BTL 4	Analyzing
4.	Obtain the wave equations for TM modes and discuss the significance of each field component in guiding the wave.	(16)	CO5	BTL 3	Applying
5.	(i) A rectangular waveguide with dimensions a=8.5cm, b =4.8 cm is fed by 5GHz , Check whether TE_{11} mode will propagate in the waveguide? (ii) The cut off wavelength of rectangular waveguide are measured to be 8 cm and 4.8 cm for TE_{10} and TE_{11} mode respectively. Determine the waveguide dimensions.	(6) (10)	CO5	BTL 4	Analyzing
6.	Analyze the differences in field distribution and wave impedance for TE and TM modes. How does the wave impedance vary with frequency for both types of modes, and what are the practical implications of these variations?	(16)	CO5	BTL 4	Analyzing
7.	(i) Based on the cut off frequency analyze the behaviour of the propagation constant, guide wavelength and the velocity of propagation. (ii) With the field configuration of the TE wave in the rectangular waveguide, write the implications of the field equations.	(8) (8)	CO5	BTL 3	Applying
8.	Deduce the solution of the wave equation in the cylindrical coordinate system.	(16)	CO5	BTL 4	Analyzing
9.	Using Bessel differential equation derive the TM field components in circular waveguides.	(16)	CO5	BTL 3	Applying

10.	Describe the field components of TE modes in circular waveguides.	(16)	CO5	BTL 3	Applying
11.	(i)A TE_{11} wave is propagating through a circular waveguide. The diameter of the guide is 10 cm and the guide is air filled. Given X_{11} =1.842 Find the cut off frequency, the guide wavelength for a frequency of 3GHz and the wave impedance in the guide (ii)Summarize the dominant mode in circular waveguide for TE and TM waves.	(10) (6)	CO5	BTL 4	Analyzing
12.	Analyze the characteristics of TE and TM waves in circular waveguides.	(16)	CO5	BTL 4	Analyzing
13.	Categorize the Quality factor of the waveguides and determine the relationship between them.	(16)	CO6	BTL 4	Analyzing
14.	With rectangular waveguide as basis deduce the expression for the Quality factor.	(16)	CO6	BTL 3	Applying
15.	Explain the mode patterns and the role of Bessel functions in solving the wave equation for circular waveguides. An air-filled circular waveguide has an inner radius of 3 cm. Determine the cut-off frequency for the dominant TE_{11} mode. (Given: For TE_{11} mode, the first root of $J1'(x)=0$ is $x11'=1.842$).	(16)	CO5	BTL 3	Applying
16.	Determine the cut off frequencies of the first two propagating modes of a circular waveguide with a= 0.5cm and ε_r = 2.25 the guide is 50cm in length , operating at f = 13GHz. Determine the attenuation.	(16)	CO5	BTL 4	Analyzing
17.	Compare attenuation in rectangular vs circular waveguides for the same operating frequency. Identify which is more efficient and state the reason.	(16)	CO5	BTL 3	Applying

EC3562 TLWG Question bank 2025-26 (Odd Semester)