SRM VALLIAMMAI ENGINEERING COLLEGE

(An Autonomous Institution)

SRM Nagar, Kattankulathur – 603 203

DEPARTMENT OF

ELECTRONICS AND COMMUNICATION ENGINEERING

QUESTION BANK

V - SEMESTER

1906503 – TRANSMISSION LINES AND RF SYSTEMS

Regulation – 2019

Academic Year 2022 – 2023 (Odd Semester)

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SUBJECT : 1906503 TRANSMISSION LINES AND RF SYSTEMS
SEM / YEAR: V/ III Year B.E.

UNIT I - TRANSMISSION LINE THEORY

General theory of Transmission lines - the transmission line - general solution - The infinite line - Wavelength, velocity of propagation - Waveform distortion - the distortion-less line - Loading and different methods of loading - Line not terminated in Z_0 - Reflection coefficient - calculation of current, voltage, power delivered and efficiency of transmission - Input and transfer impedance - Open and short circuited lines - reflection factor and reflection loss.

PART A (2 marks)

Q.No.	Questions	BT Level	Competence
1.	Define transmission line.	BTL 1	Remembering
2.	Mention the conditions for distortion less line.	BTL 1	Remembering
3.	Differentiate phase distortion and frequency distortion.	BTL 1	Remembering
4.	What are primary constants and secondary constants of a transmission line?	BTL 1	Remembering
5.	How to avoid the distortion that occurs in the line?	BTL 1	Remembering
6.	State the properties of an infinite line.	BTL 1	Remembering
7.	Sketch the equivalent circuit of a unit length of transmission line.	BTL 2	Understanding
8.	Infer the effect of inductance loading of telephone cable.	BTL 2	Understanding
9.	Obtain the relationship between characteristic impedance and propagation constant.	BTL 2	Understanding
10.	Express the general equation for the input impedance and transfer impedance of a transmission line.	BTL 2	Understanding
11.	Solve the maximum and minimum input impedances of a line with characteristic impedance of 100 ohms and Standing wave ratio S is 3.	BTL 2	Understanding
12.	Outline the purpose of equalizer in transmission line.	BTL 2	Understanding
13.	Write the voltage and current equations at any point on a uniform transmission line.	BTL 3	Applying
14.	Illustrate how practical lines made appear as an infinite line.	BTL 3	Applying
15.	Write down the equations for the phase constant and velocity of propagation for telephone cable.	BTL 3	Applying
16.	A transmission line has $Z_o = 745\angle{-12}°\Omega$ and is terminated in $Z_R=100\Omega$. Calculate reflection loss in dB.	BTL 3	Applying

17.	Find the attenuation and phase constant of a wave propagating along the line whose propagation constant is $1.048 \times 10^{-4} \angle 88.8°$.	BTL 3	Applying
18.	Determine the characteristic impedance of a transmission line if the following measurements have been made on the line $Z_{oc} = 550\angle -60° \Omega$ and $Z_{sc} = 500\angle 30° \Omega$.	BTL 3	Applying
19.	Analyze the expression for reflection coefficient and reflection loss.	BTL 4	Analyzing
20.	The open circuit and short circuit impedance of a transmission line at 1500 Hz are $800 \angle -30\ \Omega$ and $400 \angle -10\ \Omega$, respectively. Examine its propagation constant.	BTL 4	Analyzing
21.	Point out the expression for reflection factor.	BTL 4	Analyzing
22.	List out the applications of transmission line.	BTL 4	Analyzing
23.	Mention the reflection co-efficient values for various load termination.	BTL 4	Analyzing
24.	Identify the conditions in which the transmission line delivers maximum power to the load.	BTL 4	Analyzing

PART –B (13 marks)

1.		Obtain the true useful forms of equations for voltage and current at any point on a transmission line.	(13)	BTL 1	Remembering
2.		Derive the expression for the attenuation and phase constants after obtaining an expression for the characteristic impedance.	(13)	BTL 1	Remembering
3.		Discuss in detail about inductance loading of telephone cables and recall the attenuation constant, phase constant and velocity of signal transmission for the uniformly loaded cable.	(13)	BTL 1	Remembering
4.		Describe about the waveform distortion and derive the condition for distortion less line.	(13)	BTL 2	Understanding
5.	(i)	What is a loading? Specify the types of loading of lines.	(7)	BTL 1	Remembering
	(ii)	Write a short note on reflection factor and reflection loss and give its expressions.	(6)		
6.	(i)	Derive the expression for open and short-circuited impedance.	(6)	BTL 2	Understanding
	(ii)	Describe about the reflection on a line not terminated in its characteristic impedance.	(7)		
7.	(ii)	Draw and explain the reflection loss due to mismatch between source and load impedances.	(7)	BTL 2	Understanding
	(ii)	Illustrate the Z_0 and in terms of primary constants.	(6)		
8.		Explain the concept of secondary constants using R,L,G and C and find the velocity of propagation	(13)	BTL 2	Understanding
9.		Prove that infinite line equal to finite line, when it is terminated in its characteristic impedance.	(13)	BTL 3	Applying
10.	(i)	The constant of a transmission line are $R=6\Omega/Km$, $L=2.2mH/Km$, $C=0.005\mu F/Km$ and $G=0.25x10-3$ mho/Km, Calculate the characteristic impedance, attenuation constant	(7)	BTL 3	Applying

		and phase constant at 1000 Hz.			
	(ii)	For a cable, it is decided to provide lumped loading. The primary constants of the cable are R=40 Ω/km, L=1 mH/km, G=1 μmho/Km, C=0.05 μF/km. Find the new value of inductance required to achieve the distortion less condition. By what factor, the inductance is required to be raised?	(6)		
11.	(i)	The following measurement are made on a 25km line at a frequency of 796 Hz. Z_{SC} = 3220∠-79.29° Ω, Z_{OC} = 1301∠76.67° Ω. Determine the primary constants of the line.	(8)	BTL 3	Applying
	(ii)	Find the reflection coefficient of a 50 ohm line when it is terminated by a load impedance of 60+j 40 ohm.	(5)		
12.		A Communication line of length 100km has L=3.67 mH/Km, G=0.08x10-6 mho/Km, C=0.0083 μF/Km and R=10.4 Ω/Km. Find the characteristic impedance, propagation constant, phase constant and velocity of propagation for a given frequency f=1000 Hz.	(13)	BTL 3	Applying
13.	(i)	Examine the conditions (α, β) required for a distortion less line.	(7)	BTL 4	Analyzing
	(ii)	Illustrate the concept of attenuation and phase constant of an infinite line.	(6)		
14.	(i)	Classify the expressions for short circuited and open circuited impedance.	(6)	BTL 4	Analyzing
	(ii)	Analyze the propagation constant for a continuously loaded cable.	(7)		
15.	(i)	Justify why the R and G of a transmission line is maintained at smaller value for achieving minimal attenuation.	(3)	BTL 4	Analyzing
	(ii)	Simplify the expression for input impedance and transfer impedance of transmission lines.	(10)		
16.	(i)	Verify that the characteristic impedance of a distortion less line is purely real.	(7)	BTL 4	Analyzing
	(ii)	List out the advantages and disadvantages of the continuous loading of transmission line.	(6)		
17.		A 2 meter 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.	(13)	BTL 3	Applying
PART C (15 marks)					
1.	(i)	With necessary steps derive that the line will be distortion less if CR=LG.	(7)	BTL 1	Remembering
	(ii)	Connect the value of attenuation constant 'α' as **R/2** $\sqrt{C/L}$ **+ G/2**$\sqrt{L/C}$, when the series resistance R and shunt resistance G of the transmission line are small but not negligible.	(8)		

2.		Explain in detail about the primary constants and secondary constants of a transmission line and bring the relation between them.	(15)	BTL 2	Understanding
3.		A generator of 1V, 1000 Hz, supplies power to a 100 km open wire line terminated in Zo and having the following parameters R = 10.4 ohm per km, L = 0.00367 Henry per km, G = 0.8 x 10^{-6} mho per km, C = 0.00835 µF per km. Calculate Z_o α, β, λ, v. also find the received power.	(15)	BTL 3	Applying
4.		Open circuited and short circuited measurements at a frequency of 5KHz on a line of length 200km yielded the following results: Zoc = 570 ∠ -48^0 ohm , Zsc = 720∠ 34^0 ohm Evaluate Zo , α, β and primary constants, given that the approximate velocity of propagation to be 1.8×10^6 km/sec.	(15)	BTL 4	Analyzing
5.		A generator of 1V, 1KHz, supplies power to a 100 Km open wire line terminated in 200 Ω resistance. The line parameters are R = 10 Ω/Km, L = 3.8mH/Km, G =$1x10^{-6}$ mho/Km, C = 0.0085 µF/Km. Solve the impedance, reflection coefficient, power and transmission efficiency.	(15)	BTL 3	Applying

UNIT II - HIGH FREQUENCY TRANSMISSION LINES

Transmission line equations at radio frequencies - Line of Zero dissipation - Voltage and current on the Dissipation less line, Standing waves, Nodes, Standing wave ratio - Input impedance of the dissipation-less line - Open and short circuited lines - Power and impedance measurement on lines - Reflection losses - Measurement of VSWR and wavelength.

PART A (2 marks)

Q.No.	Questions	BT Level	Competence
1.	Define Skin effect.	BTL 1	Remembering
2.	List the assumptions to analyze the performance of the line at radio frequency.	BTL 1	Remembering
3.	Write down the formula for calculating the inductance of open wire line and coaxial line.	BTL 1	Remembering
4.	State the proper condition of attenuation constant and propagation constant for a dissipationless line.	BTL 1	Remembering
5.	What are nodes and antinodes in a wave propagation on a transmission line?	BTL 1	Remembering
6.	Find the nature and value of Z_0 for the dissipation less line.	BTL 1	Remembering
7.	Write the relation between standing wave ratio and magnitude of reflection co efficient.	BTL 2	Understanding
8.	Express reflection coefficient in terms of the E_{max} and E_{min} of a standing wave in a transmission line.	BTL 2	Understanding
9.	Obtain the expression for input impedance of RF transmission line.	BTL 2	Understanding
10.	How will you make standing wave measurements on co-axial lines?	BTL 2	Understanding
11.	Mention the conditions to be satisfied by a dissipationless line.	BTL 2	Understanding
12.	Specify the range of values of SWR and reflection co-efficient.	BTL 2	Understanding
13.	Illustrate the nature of input impedance of open circuited and short circuited and matched load condition for dissipation less line.	BTL 3	Applying
14.	Determine the terminating load impedance for a RF transmission line of	BTL 3	Applying

	length λ/8 with a characteristic impedance of 50Ω and SWR of 2.			
15.	Sketch the standing wave pattern on a line having short circuit termination.		BTL 3	Applying
16.	Infer the equations of an inductance and capacitance of an open wire line at high frequencies.		BTL 3	Applying
17.	A lossless transmission has a shunt capacitance of 100 pF/m and a series inductance of 4µH/m. Find its characteristic impedance		BTL 3	Applying
18.	A lossless transmission line has a shunt capacitance of 100pF/m and a series inductance of 4µH /m. Determine the characteristic impedance.		BTL 3	Applying
19.	Outline the effect of reflection in an unmatched line.		BTL 4	Analyzing
20.	Determine the expression for inductance of an open wire line and coaxial line.		BTL 4	Analyzing
21.	Point out the values of attenuation constant and characteristic impedance of a dissipationless line.		BTL 4	Analyzing
22.	Write the expression for the power flow in a voltage loop on a line with negligible losses.		BTL 4	Analyzing
23.	Justify that the point of voltage minimum is measured easily in a transmission line rather than the voltage maximum.		BTL 4	Analyzing
24.	When does the reflection occur in a transmission line?		BTL 4	Analyzing

PART B (13 marks)

1.		Identify the general expressions for voltage and current at any point on the radio frequency dissipationless line and draw the incident and reflected voltage wave for the successive instants of time.	(13)	BTL 1	Remembering
2.		Express the relation that permit easy measurement of power flow on the line of negligible losses.	(13)	BTL 1	Remembering
3.		Write in detail about the various parameters of open wire and co-axial line at radio frequencies.	(13)	BTL 1	Remembering
4.		Elaborate the line constants of different transmission lines used for radio signal transmission.	(13)	BTL 1	Remembering
5.		Explain the variation of input impedance along open and short circuit lines with relevant graphs.	(13)	BTL 2	Understanding
6.		Derive the measurement of power and impedance on the line of negligible losses.	(13)	BTL 2	Understanding
7.		Describe how the VSWR and wavelength are measured over a transmission line.	(13)	BTL 2	Understanding
8.		Derive the expression for the input impedance of its dissipation less line and find the maximum and minimum impedance.	(13)	BTL 2	Understanding
9.	(i)	A 30m long lossless transmission line with Z_0 = 50Ω operating at 2 MHz is terminated with a load Z_L =60+j40 Ω. If u=0.6c (c is velocity of light, u is phase velocity) on the line, Calculate (i) Reflection Coefficient, (ii) Standing wave ratio (iii) Input impedance.	(8)	BTL 3	Applying
	(ii)	Find the sending end impedance of a HF line having characteristic impedance of 50Ω. The line is of length 1.185 λ and is terminated in a load of 110+j80 Ω.	(5)		
10.	(i)	Apply the standing wave ratio in terms of the Maxima and minima voltage over a high frequency line.	(7)	BTL 3	Applying

	(ii)	Sketch the voltage and current on a dissipationless line for the conditions given (a) Open circuit (b) Short circuit (c) $R_R = R_0$	(6)		
11.	(i)	A line with zero dissipation has R=0.006 ohm per m, C=4.45 pF per m, L=2.5μH per m. If the line is operated at 10MHz, find Ro, α, β, λ, v.	(8)	BTL 3	Applying
	(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	(5)		
12.		The characteristic impedance of a transmission line at 8 MHz is (40-2j) ohm and the propagation constant is (0.01+j0.18) per meter. Find the primary constants.	(13)	BTL 3	Applying
13.	(i)	Sketch the impedance curve for a radio frequency line for the following terminations: (a) Open circuited load (b) Short circuited load (c) matched load	(7)	BTL 4	Analyzing
	(ii)	In a dissipationless line verify whether the reflection coefficient on a line is equal to [|Emax| - |Emin|] / [|Emax| +|Emin|].	(6)		
14.		Analyze the dissipationless line and derive the input impedance of the dissipation less line, also deduce the input impedance of an open and short circuited dissipation less line.	(13)	BTL 4	Analyzing
15.	(i)	Examine the voltage and currents at any point on the dissipation less line along with incident and reflected voltage wave phasor diagrams which should satisfy the conditions such as open circuit, short circuit and R_R=R_0.	(7)	BTL 4	Analyzing
	(ii)	Illustrate the behavior of the standing waves with neat diagram.	(6)		
16.	(i)	Summarize the effect of the reflections losses on power delivered to the load on an unmatched line.	(7)	BTL 4	Analyzing
	(ii)	Compare the characteristics of an open wire line and a co axial cable at high frequencies.	(6)		
17.		Compute the SWR on a uniform lossless line with Z_0 as characteristic impedance when it is terminated by the following loads (a) Short Circuit (b) Open Circuit (c) Z_0 (d) $2Z_0$	(13)	BTL 4	Analyzing
		PART C (15 marks)			
1.		Explain the theory of open and short circuited line with voltage and current distribution diagrams and also get the input impedance expression.	(15)	BTL 1	Remembering
2.		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.	(15)	BTL 2	Understanding
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	(15)	BTL 3	Applying

		when the line is excited by a source.			
4.	(i)	Formulate the expression for maximum and minimum impedances on the lossless line.	(5)	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.	(10)		
5.	(i)	Justify the reflection becomes undesirable in the transmission line. Why?	(5)	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 line.	(10)		

UNIT III - IMPEDANCE MATCHING IN HIGH FREQUENCY LINES

Impedance matching: Quarter wave transformer - Impedance matching by stubs - Single stub and double stub matching - Smith chart - Solutions of problems using Smith chart - Single and double stub matching using Smith chart.

PART A (2 marks)

Q.No.	Questions	BT Level	Competence
1.	What is the need for impedance matching?	BTL 1	Remembering
2.	List out the applications of transmission lines.	BTL 1	Remembering
3.	Express standing wave ratio in terms of reflection coefficient.	BTL 2	Understanding
4.	Mention about nodes and anti-nodes in a transmission line.	BTL 4	Analyzing
5.	Why do standing waves exist on transmission lines?	BTL 4	Analyzing
6.	Write the minimum and maximum value of SWR and reflection coefficient.	BTL 2	Understanding
7.	Calculate the standing wave ratio if the reflection co-efficient of a line is $0.3 \angle -66°$.	BTL 4	Analyzing
8.	A lossless line has a characteristic impedance of 400Ω. Determine the standing wave ratio if the receiving end impedance is 800Ω.	BTL 3	Applying
9.	Mention the applications of a quarter wave line.	BTL 4	Analyzing
10.	What is the use of eighth wave line?	BTL 1	Remembering
11.	Prove the statement - quarter wave lines are termed as impedance inverter.	BTL 3	Applying
12.	Why quarter wave line is called as copper insulator.	BTL 4	Analyzing
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.	BTL 3	Applying
14.	Express the equation to determine the characteristic impedance of the	BTL 3	Applying

		quarter wave transformer.			
15.		List out the advantages of Smith Chart.		BTL 1	Remembering
16.		Write the procedure to find the impedance from the given admittance using smith chart.		BTL 2	Understanding
17.		How would you determine the SWR from the smith chart?		BTL 3	Applying
18.		Examine why short, circuited stub is preferred to open circuited stub.		BTL 4	Analyzing
19.		What are the methods to determine the positon and the length of a single stub connected across the transmission line?		BTL 2	Understanding
20.		Write the equation to determine the length of the stub.		BTL 2	Understanding
21.		Compare single stub matching and double stub matching.		BTL 3	Applying
22.		Point out the difficulties in single stub matching?		BTL 2	Understanding
23.		What is the application of the quarter wave matching section?		BTL 1	Remembering
24.		Write the equation to determine the position of the stub.		BTL 1	Remembering
PART –B (13 Marks)					
1.	(i)	Examine the need of impedance matching devices in transmission line	(5)	BTL 2	Understanding
	(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.	(8)		
2.	(i)	Formulate the expression for input impedance of a quarter wave transformer and mention its significance in impedance matching.	(8)	BTL 3	Applying
	(ii)	Design a Quarter wave transformer to match a load of 200Ω to a source resistance of 500Ω which operates at the frequency of 200 MHz.	(5)		
3.		Explain the transmission line circle diagram by deriving the expression for constant S and constant βs circle.	(13)	BTL 1	Remembering
4.		The terminating load of UHF transmission line working at 300MHz is 50+j50 Ω. Evaluate the VSWR and the position of the voltage minimum nearest to the load if the characteristic impedance of the line is 50 Ω.	(13)	BTL 4	Analyzing
5.		Describe the impedance matching technique using single stub and obtain the expression for the stub location and stub length.	(13)	BTL 1	Remembering
6.		Find the input impedance and SWR for a 1.25 λ long transmission line at the sending end with a characteristic impedance Z0=50Ω and a load impedance ZL=30+j40Ω.	(13)	BTL 1	Remembering
7.		What is the procedure for double stub matching on a transmission line, explain with an example?	(13)	BTL 1	Remembering
8.		Consider the line with Z0= 100 Ω terminated by an unknown impedance. The swr =2.5 and first voltage minimum at 16cm from termination, when the frequency is 100 MHz. determine the terminating impedance by use of	(13)	BTL 2	Understanding

		smith chart assuming that the line is placed in free space.			
9.		A transmission line is terminated in $Z_{L.}$ Measurements indicate that the standing wave minima are 102 cm 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 R_0 = 250Ω. Determine frequency, wavelength, Real and reactive components of the terminating impedance. Also verify the results obtained from equations using the smith chart.	(13)	BTL 2	Understanding
10.		VSWR of a lossless line is found to be 5 and successive voltage minima are 40cm apart. The first voltage minima is observed to be 15cm from the load. The length of the line is 160cm and Z_o is 300 Ω. Apply the values in smith chart to find the load impedance and input impedance.	(13)	BTL 3	Applying
11.		A RF transmission line of length 1m, characteristic impedance of $Z_o=300\angle 0°$ Ω is terminated with an impedance of $100\angle 45°$Ω. This load is to be matched to the transmission line by using a short circuited stub. With the help of smith chart, determine the length and location of the stub.	(13)	BTL 4	Analyzing
12.		A 50 Ω transmission line feeds an inductive load 35+j35Ω. Determine the double stub tuner to match this load to the line using smith chart. Spacing between the two stubs is λ/4.	(13)	BTL 4	Analyzing
13.		Derive the expression of radius and center for constant R and X circles in Smith Chart.	(13)	BTL 4	Analyzing
14.		A 300 Ω transmission line is connected to a load impedance of (390+j600) Ω at 10MHz.Evaluate the position and length of a short circuited stub required to match the line using smith chart	(13)	BTL 3	Applying
15.		Find the sending end impedance of a line with negligible losses when Characteristic impedance is 55Ω, the load impedance is 115 + j75Ω and the length if the line is 1.183 λ by using smith chart	(13)	BTL 3	Applying
16.		A single stub is to match a 400 ohms line to a load of 200-j100 ohms. The wavelength is 3m. Determine the position and length of the short circuited stub.	(13)	BTL 4	Analyzing
17.		Design a single stub match for a load of 150+j225 Ω for a 75 Ω line a 500 MHz using smith chart.	(13)	BTL 3	Applying
PART – C (15 Marks)					
1.		Consider the transmission line with a characteristic impedance of 300 Ω and terminated in a load of		BTL 3	Applying

		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	(5) (5) (5)		
2.		Using double stub matching, match a complex load of Z_L=18.75+j56.25 Ω to a line with characteristic impedance Z_0=75 Ω.	(15)	BTL 3	Applying
3.	(i)	A line having characteristic impedance of 50 Ω is terminated in load impedance 75+j75Ω. Determine the reflection coefficient and voltage standard wave ratio.	(8)	BTL 2	Understanding
	(ii)	Mention the significance of smith chart and its application in transmission lines.	(7)		
4.		A UHF lossless transmission line of length 1m operating at 1GHz is connected to an unmatched line producing a voltage reflection coefficient of $0.5\angle 30°$. Calculate the length and position of the stub to match the line using formula. Verify the values using Smith Chart.	(15)	BTL 4	Analyzing
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.	(15)	BTL 4	Analyzing

UNIT IV - WAVE GUIDES

General Wave behavior along uniform guiding structures – Transverse Electromagnetic Waves, Transverse Magnetic Waves, Transverse Electric Waves – TM and TE Waves between parallel plates. Field Equations in rectangular waveguides, TM and TE waves in rectangular waveguides, Bessel Functions, TM and TE waves in Circular waveguides.

PART A (2 marks)

Q.No.	Questions	BT Level	Competence
1.	What are guided waves? Give examples for guiding structures.	BTL 1	Remembering
2.	Write Maxwell's equations in point form.	BTL 2	Understanding
3.	List out the characteristics of TE waves.	BTL 2	Understanding
4.	Find the significance of principal wave.	BTL 1	Remembering
5.	Define waveguide and write its applications..	BTL 1	Remembering
6.	Deduce the expression for cut off frequency when the wave is propagated in between two parallel plates.	BTL 4	Analyzing
7.	Examine the Characteristics of TEM waves.	BTL 3	Applying
8.	Justify, why TM_{01} and TM_{10} modes in a rectangular waveguide do not exists.	BTL 4	Analyzing
9.	Define wave impedance.	BTL 1	Remembering
10.	Write down the features of TM mode.	BTL 2	Understanding
11.	Mention about the dominant modes of a rectangular waveguide.	BTL 1	Remembering

12.	Calculate the cutoff wavelength for the TE_{11} mode in a standard rectangular waveguide if a = 4.5 cm.	BTL 3	Applying
13.	Write the relation between group velocity, phase velocity and free space velocity.	BTL 3	Applying
14.	Why rectangular waveguides preferred over circular waveguides?	BTL 4	Analyzing
15.	Identify the nature of the evanescent mode.	BTL 3	Applying
16.	Distinguish between TE and TM waves.	BTL 4	Analyzing
17.	Write the equation to find the cutoff wavelength and frequency of the TE_{10} mode in a rectangular waveguide	BTL 2	Understanding
18.	How would you categorize the modes as degenerate modes in a rectangular waveguide?	BTL 4	Analyzing
19.	Consider an air- filled rectangular waveguide with a cross – section of 5 cm × 3 cm. For this waveguide, deduce the cut off frequency (in MHz) of TE_{21} mode.	BTL 3	Applying
20.	Define the dominant mode in circular waveguide.	BTL 1	Remembering
21.	Express the Bessel's functions of first kind of order zero?	BTL 2	Understanding
22.	Calculate the cutoff wavelength of a rectangular waveguide whose inner dimensions are a= 2.3 cm and b=1.03 cm operating at TE_{10} mode.	BTL 3	Applying
23.	For a frequency of 6 GHz and plane separation of 3 cm, Find the group and phase velocities for the dominant mode.	BTL 4	Analyzing
24.	Write the expression for cutoff frequency in a circular waveguide.	BTL 2	Understanding

PART - B (13 marks)

1.		Obtain the expression for the field components of an electromagnetic wave propagating between a pair of perfectly conducting planes?	(13)	BTL 1	Remembering
2.		Derive the expression for the field strength for TE waves between parallel plates propagating in Z direction?	(13)	BTL 1	Remembering
3.	(i)	Explain about transverse electromagnetic waves between a pair of perfectly conducting planes?	(7)	BTL 1	Remembering
	(ii)	Determine the expression of wave impedance of TE, TM and TEM wave between a pair of perfectly conducting planes.	(6)		
4.		Illustrate the transmission of TM waves between two parallel perfectly conducting planes with necessary equations and diagram.	(13)	BTL 2	Understanding
5.		A pair of perfectly conducting plates is separated by 10cm in air and carries a signal frequency of 6 GHz in TE_{10} mode. Find cut-off frequency, cut-off wavelength and characteristic wave impedance along guiding walls.	(13)	BTL 3	Applying
6.		Derive the propagation of TE waves in a rectangular waveguide with necessary expressions for the field components.	(13)	BTL 2	Understanding
7.		Compute the field configuration, cut off frequency and velocity of propagation for TM waves in rectangular wave guides.	(13)	BTL 2	Understanding

8.		A rectangular air filled copper waveguide with dimension 0.9inch x 0.4inch cross section and 12 inch length is propagated at 9.2 GHz with a dominant mode. Find the cutoff frequency, guide wavelength, phase velocity and characteristic impedance.	(13)	BTL 4	Analyzing
9.		A rectangular waveguide measures 3 x 5 cm internally and has a 10 GHz signal propagated in it. Calculate the cut-off wavelength, the guide wavelength and the characteristic wave impedance for the TE_{10} mode.	(13)	BTL 4	Analyzing
10.		Describe the TM field components using Bessel equation in circular waveguides with necessary diagrams.	(13)	BTL 1	Remembering
11.		Calculate the cut-off wavelength, the guide wavelength and the characteristic wave impedance of a circular waveguide whose internal diameter is 4 cm for a 9 GHz signal propagated in it in the TE_{11} mode.	(13)	BTL 4	Analyzing
12.		Derive the expressions for the transmissions of TE wave's field components in a circular waveguide.	(13)	BTL 4	Analyzing
13.		A rectangular waveguide measuring a=4.5 cm and b=3 cm has a 9 GHz signal propagated in it. Calculate the guide wavelength, phase and group velocities for the dominant mode.	(13)	BTL 3	Applying
14.		Write a note on the features of a rectangular cavity resonator and derive the corresponding field components for TE and TM waves.	(13)	BTL 1	Remembering
15.		Calculate the cutoff wavelength, the guided wavelength and the characteristic wave impedance of a circular waveguide whose internal diameter is 4 cm for a 9 GHz signal propagated in the TE_{11} mode.	(13)	BTL 3	Applying
16.		An air-filled circular waveguide has a radius of 2 cm. Examine the cut off frequency and the phase constant for the dominant mode (p11' = 1.841 and p11 = 2.405.)	(13)	BTL 3	Applying
17.		Write short notes on (i) Characteristics of TE and TM waves between parallel plates (ii) Velocity of propagation and wave impedance	 (7) (6)	BTL 2	Understanding
		PART- C (15 marks)			
1.		A parallel plane waveguide consists of two sheets of good conductor separated by 10 cm. find the propagation constant at frequencies of 100 MHz and 10 GHz, when the waveguide is operated in TE_{10} mode. Does the propagation take place in each case? Justify your answer.	(15)	BTL 4	Analyzing
2.		Assume the plate separation is 10 cm find the propagation constant, phase velocity, group velocity and wave impedance at 6 GHz for TE_{10} mode.	(15)	BTL 4	Analyzing

3.		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 $(ha)_{11}$=1.842. (i) Find the cutoff frequency (ii) Find the guide wavelength for a frequency of 3 GHz. (iii) Determine the wave impedance in the guide	 (5) (5) (5)	BTL 3	Applying
4.		A rectangular waveguide having TE_{10} mode as dominant mode is having a cut off frequency of 18 GHz for the TE_{30} mode. Evaluate the inner broad – wall dimension of the rectangular waveguide.	(15)	BTL 2	Understanding
5.		An air filled circular waveguide having an inner radius of 1 cm is excited dominant mode at 10 GHz. Find the cutoff frequency of the dominant mode at 10 GHz, the guided wavelength and the wave impedance. Also find the wavelength for operation in the dominant mode only.	(15)	BTL 4	Analyzing

UNIT V - RF SYSTEM DESIGN CONCEPTS

Active RF components: Semiconductor basics in RF, bipolar junction transistors, RF field effect transistors, High electron mobility transistors Basic concepts of RF design, Mixers, Low noise amplifiers, voltage control oscillators, Power amplifiers, transducer power gain and stability considerations.

PART A (2 marks)

Q.No.	Questions	BT Level	Competence
1.	List some of the active RF components.	BTL 1	Remembering
2.	Point out the band gap energy for Si and Ge used for semiconductor diodes.	BTL 4	Analyzing
3.	List the characteristics of RF amplifiers.	BTL 2	Understanding
4.	Define BARITT diode.	BTL 1	Remembering
5.	What is TRAPATT diode? Write down its applications.	BTL 1	Remembering
6.	Classify RF field effect transistors based on physical construction.	BTL 2	Understanding
7.	Compare the enhancement type FET with Depletion type FET.	BTL 4	Analyzing
8.	What are the basic characteristics of mixers?	BTL 2	Understanding
9.	Mention the requirements and applications of low noise amplifiers.	BTL 3	Applying
10.	What is the use of HEMT?	BTL 3	Applying
11.	Enumerate the various types of mixers.	BTL 1	Remembering
12.	Summarize the basic steps in the design process of RF amplifier circuits.	BTL 3	Applying
13.	Name the parameters to be considered for the design of a suitable mixer.	BTL 2	Understanding
14.	Examine the importance of voltage controlled oscillator in RF system.	BTL 4	Analyzing
15.	List the basic parameters of RF amplifier.	BTL 2	Understanding
16.	Write the necessary and sufficient conditions for an amplifier to be unconditionally stable.	BTL 4	Analyzing
17.	Analyze the techniques of efficiency boosting in RF power amplifier	BTL 4	Analyzing

18.	Obtain the transducer power gain of a RF power amplifier.	BTL 3	Applying
19.	Mention the significance of negative resistance in oscillation of a circuit	BTL 4	Analyzing
20.	How the operation of single ended and differential ended LNA differs?	BTL 3	Applying
21.	What are stabilization methods?	BTL 1	Remembering
22.	Illustrate the typical output stability circle and input stability circle	BTL 3	Applying
23.	Define conversion loss of a mixer.	BTL 1	Remembering
24.	List the factors affecting amplifier performance?	BTL 2	Understanding

PART –B (13 Marks)

1.		Explain in detail about the operation and applications of Schottky diode.	(13)	BTL 1	Remembering
2.		Examine the structure and operation of PIN diode. Justify how it can be used as attenuator.	(13)	BTL 4	Analyzing
3.	(i)	Considering the electron concentration and hole concentration in a semiconductor as ***n*** and ***p*** respectively infer that $np = n_i^2$ where n_i is the intrinsic concentration.	(8)	BTL 3	Applying
	(ii)	For a Si PN junction the doping concentration are given as $N_A = 10^{18}$ cm^{-3} and $N_D = 10^{15}$ cm^{-3} with an intrinsic concentration of $n_i = 1.5 \times 10^{10} cm^{-3}$. Find the barrier voltages for $T = 300^o$ K.	(5)		
4.		Elaborate the construction and the functionality of the bipolar junction transistor.	(13)	BTL 1	Remembering
5.		Write in detail about the different operating modes of a bipolar junction transistor with appropriate diagram.	(13)	BTL 1	Remembering
6.		Derive the drain saturation voltage and maximum saturation current for a field effect transistor.	(13)	BTL 2	Understanding
7.	(i)	Explain the distinct features of high electron mobility transistors.	(8)	BTL 4	Analyzing
	(ii)	Compare the field effect transistor with the bipolar junction transistor	(5)		
8.		Explain the construction and functionality of RF Field effect transistors.	(13)	BTL 1	Remembering
9.	(i)	Discuss the steps involved to design a low noise amplifier	(7)	BTL 2	Understanding
	(ii)	Write a note on (a) Varactor Diode (b) IMPATT diode	 (3) (3)		
10.		Explain with necessary diagrams the various types of mixers and its principle of operation.	(13)	BTL 2	Understanding
11.		With reference to RF transistor amplifier, explain the considerations for stability and gain.	(13)	BTL 3	Applying
12.		Illustrate the design principles of RF amplifier and impedance matching with necessary diagrams	(13)	BTL 2	Understanding
13.	(i)	An RF channel with a center frequency of 1.89 GHz and bandwidth of 20 MHz is to be downconverted to an IF of 200 MHz. Select an appropriate f_{LO}. Find the quality factor	(7)	BTL 4	Analyzing

		Q of a band pass filter to select this channel if no downconversion is involved, and determine the Q of the band pass filter after downconversion.			
	(ii)	Explain the various stabilization methods for a RF amplifier circuit.	(6)		
14.		Derive the expression for unilateral power gain with necessary signal flow diagram.	(13)	BTL 3	Applying
15.		State and formulate the transducer power gain, available power gain and operating power gain of a microwave amplifier in terms of S parameters and different reflection coefficient.	(13)	BTL 4	Analyzing
16.		Explain about input and output stability circles in the complex Γ_L and Γ_S planes, also derive the condition for unconditional stability.	(13)	BTL 3	Applying
17.		A MESFET operated at 5.7GHz has the following S parameters: S_{11}=0.5∠-60°, S_{12}=0.02∠0°, S_{21}=6.5∠115° and S_{22}=0.6∠-35°. Determine if the circuit is unconditionally stable and Find the maximum power gain under optimal choice of reflection coefficients, assuming unilateral design (S_{12}=0).	(13)	BTL 4	Analyzing
PART – C (15 Marks)					
1.		An abrupt PN junction made of Si has the acceptor and donor concentration of $N_A = 10^{18}$ cm^{-3} and $N_D = 5 \times 10^{15}$ cm^{-3} , respectively .Assuming that the device operates at the room temperature , Formulate (a) the barrier voltage (b) the space charge width in the p- type and n- type semiconductors (c) the peak electric field across the junction (d) the junction capacitance for a cross sectional area of $10^{-4} cm^2$ and a relative dielectric constant of $\varepsilon_r = 11.7$	(15)	BTL 2	Understanding
2.		An RF amplifier has the following S-parameters. S_{11} = 0.3∠-70˚; S_{21} = 3.5∠85˚; S_{12} = 0.2∠-10˚; S_{22} = 0.4∠-45˚ furthermore, the input side of the amplifier is connected to a voltage source with V_S = 5V∠0˚ and source impedance Z_S = 40Ω. The output is utilized to drive an antenna which has an amplifier of Z_L = 73Ω. Assuming that the S-parameters of the amplifier are measured with reference to a 50Ω characteristics impedance. Find the transducer gain G_T, unilateral transducer gain G_{TU}, Available gain G_A, Operating power gain G, Power delivered to the load P_L, available power from source P_A and incident power to amplifier P_{inc}.	(15)	BTL 4	Analyzing

3.	(i)	A BJT with I_C = 10 mA and V_{CE} = 6 V is operated at a frequency of f = 2.4 GHz. The corresponding S-parameters are: $S_{11} = 0.3\angle 30^\circ$; $S_{21} = 2.5\angle -80^\circ$; $S_{12} = 0.2\angle -60^\circ$; $S_{22} = 0.2\angle -15^\circ$ Determine whether the transistor is unconditionally stable and find the values for source and load reflection coefficients that provide maximum gain.	(9)	BTL 1	Remembering
	(ii)	State the stability conditions for a microwave amplifier.	(6)		
4.	(i)	Derive the Expression for sustained oscillation of Voltage Controlled Oscillator with necessary Circuit diagrams.	(10)	BTL 3	Applying
	(ii)	A typical varactor diode has an equivalent series resistance of 45 Ω and a capacitance ranging from 10 pF to 30 pF for reverse voltages between 30 V and 2 V. Design a voltage controlled Clapp-type oscillator with center frequency of 300 MHz and ±10% tuning capability. Assume that the trans conductance of the transistor is constant and equal to g_m = 115 mS.	(5)		
5.	(i)	Compute the barrier voltage, depletion capacitance and space charge region width for a Schottky diode.	(9)	BTL 2	Understanding
	(ii)	A Schottky diode is created as an interface between a gold contact material and an n-type silicon semiconductor. The semiconductor is doped to $N_D = 10^{16}$ cm^{-3}, $N_C = 2.8\times10^{19}$ cm^{-3} and the work function V_M for gold is 5.1 V. Also, the affinity for Si is χ = 4.05V. Find the Schottky barrier V_d, space charge width d_S and capacitance C_J if the dielectric constant of silicon is ε_r = 11.9. Assume the cross-sectional diode area to be A = 10^{-4} cm^2 and the temperature equal to 300°K.	(6)		