SRM VALLIAMMAI ENGINEERING COLLEGE

(An Autonomous Institution)

SRM Nagar, Kattankulathur – 603 203.

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

QUESTION BANK

SUBJECT : EC8651 TRANSMISSION LINES AND RF SYSTEMS
SEM / YEAR: VI/ 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.	List the conditions for distortion less line.	BTL 1	Remembering
3.	State 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.	Choose the properties of infinite line.	BTL 1	Remembering
7.	Write the expressions for the phase constant and velocity of propagation.	BTL 2	Understanding
8.	Discuss the effect of inductance loading of telephone cable.	BTL 2	Understanding
9.	Deduce the relationship between characteristic impedance and propagation constant.	BTL 2	Understanding
10.	Conclude the general equation for the input impedance and transfer impedance of a transmission line.	BTL 2	Understanding
11.	Build the voltage and current equations at any point on a uniform transmission line.	BTL 3	Applying
12.	Illustrate how practical lines made appear as infinite lines.	BTL 3	Applying
13.	Sketch the equivalent circuit of a unit length of transmission line.	BTL 3	Applying
14.	Analyze the expression for reflection coefficient and reflection loss.	BTL 4	Analyzing
15.	The open circuit and short circuit impedance of a transmission line at 1500 Hz are 800 $\angle$-30 Ω and 400 $\angle$-10 Ω respectively, Examine its propagation constant.	BTL 4	Analyzing
16.	Assess the expression for reflection factor.	BTL 4	Analyzing
17.	Prove that 1 neper=8.686dB.	BTL 5	Evaluating

18.		Estimate the reflection coefficient of a 50ohm transmission line when it is terminated by a load impedance of 60+j40Ω.		BTL 5	Evaluating
19.		Formulate the equation to find the relation between characteristic impedance and primary constants of a transmission line.		BTL 6	Creating
20.		Design Campbell's formula for a uniformly loaded line.		BTL 6	Creating
PART –B (13 marks)					
1.		Obtain the general transmission line equation for the voltage and current at any point on a transmission line.	(13)	BTL 1	Remembering
2.	(i)	Outline the expression for the attenuation and phase constants after obtaining an expression for the characteristic impedance.	(7)	BTL 1	Remembering
	(ii)	How to solve the Campbell's equation for the loading cables?	(6)		
3.	(i)	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.	(7)	BTL 1	Remembering
	(ii)	Describe about the reflection on a line not terminated in its characteristic impedance.	(6)		
4.	(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 expressions.	(6)		
5.	(i)	Explain in detail about the waveform distortion and also derive the condition for distortion less line.	(7)	BTL 2	Understanding
	(ii)	Predict the expression for open and short circuited impedance.	(6)		
6.	(i)	Identify the conditions (α, β) required for a distortion less line.	(7)	BTL 2	Understanding
	(ii)	A distortion less transmission line has attenuation constant α=1.15×10-2 Np/m, and capacitance of 0.01 nF/m. the characteristic resistance L/C=50Ω. Identify the resistance, inductance and conductance per more of the line.	(6)		
7.	(i)	A telephone line has parameters of R = 6.5 Ω/km, L= 0.4 mH/km, C=0.05μF/km and G=0.5 μmho/km. Extend the calculation for finding the input impedance of the line at a frequency of 500 Hz given that the line is very long.	(7)	BTL 2	Understanding
	(ii)	A lossless transmission line with Z_0 = 75ohm and electrical length l= 0.3 λ is terminated with a complex load impedance of Z_R = 40+j20ohm. Estimate reflection	(6)		

		coefficient and VSWR of the line.			
8.	(i)	The characteristic impedance of a certain transmission line is 682.5-j195.7 ohm. The frequency of operation is 1 KHz. At this frequency, the attenuation constant in the line was observed to be 0.01 neper/km and phase constant 0.035 radians /km. Prepare the line constants R, L, G and C per km of the line.	(8)	BTL 3	Applying
	(ii)	Draw and explain the reflection loss due to mismatch between source and load impedances.	(5)		
9.	(i)	An open wire line having R=10.15 ohm/km, L = 3.93 mH/km, G=0.29 μmho/km and C=0.00797 μF/km is 100 km long and terminated in Z_0. Solve Z_0, α, β and γ.	(7)	BTL 3	Applying
	(ii)	Illustrate the Zo and in terms of primary constants.	(6)		
10.	(i)	Connect the value of attenuation constant 'α' as $\mathbf{R/2}\sqrt{C/L} + \mathbf{G/2}\sqrt{L/C}$, when the series resistance R and shunt resistance G of the transmission line are small but not negligible.	(7)	BTL 4	Analyzing
	(ii)	Demonstrate the concept of attenuation and phase constant of an infinite line.	(6)		
11.	(i)	Analyze the expressions for short circuited and open circuited impedance.	(6)	BTL 4	Analyzing
	(ii)	Point out the propagation constant of continuously loaded cable.	(7)		
12.	(i)	A 2 meter long transmission line with characteristic impedance of 60+j40 is operating at $=10^6$ rad/sec has attenuation constant of 0.921 Np/m and phase shift constant of 0 rad/miff the line is terminated by a load of 20+j50,find the input impedance of this line.	(7)	BTL 4	Analyzing
	(ii)	Simplify the expression for input impedance and transfer impedance of transmission lines.	(6)		
13.	(i)	Summarize how an infinite line equal to finite line terminated in its characteristic impedance.	(6)	BTL 5	Evaluating
	(ii)	The characteristics impedance of a 805m-long transmission line is 94 angle $-23.2^0\Omega$, the attenuation constant is 74.5×10^{-6} Np/m. and the phase shift constant is 174×10^{-6} rad/m at 5KHz. Assess the line parameters R,L,G and C per meter and the phase	(7)		

		velocity on the line.			
14.		The constants of a transmission line are R= 6Ω/km, L=2.2mH/km, C=0.005×10^{-6}F/km and G=0.25×10^{-6} mho/km. calculate at the frequency of 800 HZ, Design (a) The terminating impedance for which no reflection will be setup in the line, (b) The attenuation in dB suffered by the signal after travelling a distance of 50Km when the line is properly terminated and the phase velocity with which the signal would travel.	(6) (7)	BTL 6	Creating
PART C (15 marks)					
1.	(i)	Adapt the condition for minimum attenuation in a distortion less line	(7)	BTL 6	Creating
	(ii)	Develop and derive the relation between primary constants and secondary constants.	(8)		
2.		A 100 km long line is terminated in its characteristic impedance. A generator of internal impedance of 600 ohm and a voltage of 5 volts operating at frequency of 800 Hz is connected at the input end of the line. The characteristic impedance of the line is 550 ∠ -15^0 and the propagation constant γ = 0.045 +j0.0825 per km. Observe the parameter such as (a) Primary Constants (b)Sending end current and sending end voltage (c)Receiving end current and Receiving end Voltage (d) Sending end power and Receiving end power.	(15)	BTL 6	Creating
3.		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 EvaluateZo , α, β and primary constants given that the approximate velocity of propagation to be 1.8 *10^6 km/sec.	(15)	BTL 5	Evaluating
4.	(i)	An open wire line is 200 km long is correctly terminated. The generator at the sending end has Es = 10 V, f = 1 KHz and internal impedance of 500 ohm. At that frequency Zo=683-j138 and γ= 0.0074+j0.0356 per km. Measure the sending and receiving end voltage, current and power.	(10)	BTL 5	Evaluating
	(ii)	A cable has α = 0.01 nepers /km and β = 0.0018/km and having length of 100 km.Estimate the receiving end voltage when the line is terminated in its characteristic impedance and Es = 5V.	(5)		
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.	Label the assumptions made for the analysis of performance of the line at radio frequency.	BTL 1	Remembering
3.	Compare the values of SWR for $Z_R = 0$ and $Z_R = Z_0$.	BTL 1	Remembering
4.	Recognize the dissipationless line with the proper condition.	BTL 1	Remembering
5.	What are nodes and antinodes on a line?	BTL 1	Remembering
6.	Find the nature and value of Z0 for the dissipation less line.	BTL 1	Remembering
7.	Give the relation between standing wave ratio and magnitude of reflection co efficient.	BTL 2	Understanding
8.	Express reflection coefficient in terms of SWR.	BTL 2	Understanding
9.	Predict the expression for input impedance of RF line.	BTL 2	Understanding
10.	Indicate the minimum values and maximum values of SWR and reflection coefficient.	BTL 2	Understanding
11.	Relate the nature of input impedance of open circuited and short circuited and matched load condition for dissipation less line.	BTL 3	Applying
12.	Solve the terminating load for a certain R.F transmission line which has the characteristic impedance of the line 1200 Ω and the reflection co-efficient was observed to be 0.2.	BTL 3	Applying
13.	Sketch standing waves on a line having open or short circuit termination.	BTL 3	Applying
14.	Deduce an expression for inductance of an open wire line and coaxial line.	BTL 4	Analyzing
15.	Analyze the line with dissipationless line and find the values of attenuation constant and characteristic impedance.	BTL 4	Analyzing
16.	Explain the concept of dissipation less line.	BTL 4	Analyzing
17.	How would you justify that the point of voltage minimum is measured rather than the voltage maximum?	BTL 5	Evaluating
18.	A lossless transmission has a shunt capacitance of 100 pF/m and a series inductance of 4μH/m. Evaluate the characteristic impedance.	BTL 5	Evaluating
19.	Can you predict the range of values of standing wave ratio?	BTL 6	Creating
20.	Adapt the condition for open and short circuited line.	BTL 6	Creating
PART B (13 marks)			

1.		Derive the expressions for voltage and current at any point on the radio frequency dissipation less line. Obtain the expressions for the same for different receiving end conditions.	(13)	BTL 1	Remembering
2.	(i)	Brief notes on Standing waves, nodes, standing wave ratio also make relation between the standing wave ratio S and the magnitude of the reflection coefficient.	(7)	BTL 1	Remembering
	(ii)	State the condition for the open wire line at high frequencies and derive the parameters.	(6)		
3.	(i)	Explain the parameters of open wire line and co axial at RF. Mention the standard assumptions made for radio frequency line. Label the Line constants for zero dissipation.	(7)	BTL 1	Remembering
	(ii)	Enumerate the voltage and current equation on dissipation less line.	(6)		
4.	(i)	Discuss the reflection coefficient of different transmission lines.	(6)	BTL 1	Remembering
	(ii)	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. Recognize (a)Inductance (b) Capacitance (c) Characteristic impedance	(7)		
5.	(i)	Compare the features of open wire and co axial cable at high frequencies.	(7)	BTL 2	Understanding
	(ii)	Outline the variation of input impedance along open and short circuit lines with relevant graphs.	(6)		
6.	(i)	Describe the various parameters of open wire and co axial lines at radio frequency.	(7)	BTL 2	Understanding
	(ii)	Summarize the concept of Standing wave ratio.	(6)		
7.		Explain how the VSWR and wavelength of the line measured in detail.	(13)	BTL 2	Understanding
8.	(i)	Derive the line constants of a zero dissipation less line.	(7)	BTL 3	Applying
	(ii)	Sketch the voltages and currents on dissipation less line for the conditions given below. (a) Open circuit (b) Short circuit (c) $R_r = R_0$	(6)		
9.	(i)	A low loss transmission line of 100Ω characteristic impedance is connected to a load of 200Ω.Apply the formula to calculate the voltage reflection coefficient and the standing wave ratio.	(7)	BTL 3	Applying

	(ii)	Solve the standing wave ratio and reflection co – efficient on a line having Z_0 =300ohm and terminated in Z_R=300+j400	(6)		
10.	(i)	Draw the standing wave pattern for (a) Open circuited load (b) Short circuited load (c) matched load	(7)	BTL 4	Analyzing
	(ii)	Predict that the reflection coefficient [|Emax| - |Emin|] / [|Emax| +|Emin|].	(6)		
11.		Explain the expressions for the input impedance of the dissipation less line. Deduce the input impedance of open and short circuited dissipation less line.	(13)	BTL 4	Analyzing
12.	(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, R_R=R_0.	(7)	BTL 4	Analyzing
	(ii)	Analyze the standing waves with neat diagram.	(6)		
13.	(i)	Summarize the relation between standing wave ratio (S) and magnitude of relation co – efficient.	(7)	BTL 5	Evaluating
	(ii)	Find the reflection coefficient and voltage standing wave ratio of a line having Ro = 100 ohm, Zr = 100 – j100 ohm.	(6)		
14.		Formulate the following parameters (a) Standing waves (b) Standing wave ratio (c) Relation between SWR and K (d) Nodes and Antinodes	(13)	BTL 6	Creating
PART C (15 marks)					
1.		A Dissipation less co-axial cable has an inner copper conductor of radius 3mm and an outer copper conductor of radius 15mm. It is filled with dielectric material of relative permittivity ε_r. When it is excited at one end by an a.c. source, the phase velocity of the wave was observed to be 1.5 X 10 ^{8} m/s. The other end is terminated in a load resistance Z_R = R_R which produces standing wave ratio of 3.8. What would you recommend the values for following parameters? (a) Characteristic impedance Zo = Ro		BTL 5	Evaluating

		(b) Dielectric constant (c) Load resistance $Z_R = R_R$ (d) Reflection Coefficient K	(4) (4) (3) (4)		
2.		Generalize the expressions for voltage and current at any point on the radio frequency dissipation less line. Obtain the expressions for the same for different receiving end conditions.	(15)	BTL 5	Evaluating
3.		How could you adapt the length of dissipationless line to obtain an inductance of 15µH at 60 MHz frequency with open circuit termination? Given that characteristic impedance of the line is 400 ohm.	(15)	BTL 6	Creating
4.	(i)	How would you make up the expression for maximum and minimum impedances on the line for a lossless line as R_oS and R_o/S respectively?	(8)	BTL 6	Creating
	(ii)	What way would you design the coaxial line at high frequencies? Design a graph to show the variation of R_o for a coaxial line.	(7)		

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 the requirements of a better transmission line	BTL 1	Remembering
3.	Interpret the effect of impedance mismatching.	BTL 2	Understanding
4.	Express standing wave ratio in terms of reflection coefficient.	BTL 2	Understanding
5.	Discuss about nodes and anti nodes in a transmission line.	BTL 4	Analyzing
6.	Why do standing waves exist on transmission lines?	BTL 1	Remembering
7.	Give the minimum and maximum value of SWR and reflection coefficient.	BTL 1	Remembering

8.	Calculate the standing wave ratio if the reflection co-efficient of a line is 0.3 ∠-66°.	BTL 3	Applying
9.	A lossless line has a characteristic impedance of 400Ω. Determine the standing wave ratio if the receiving end impedance is 800+j0Ω	BTL 5	Evaluating
10.	List the application of a quarter wave line.	BTL 1	Remembering
11.	Justify the statement - quarter wave lines are termed as impedance inverter.	BTL 5	Evaluating
12.	Analyze 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.	BTL 6	Creating
14.	Determine the characteristic impedance of the quarter wave transformer.	BTL 2	Understanding
15.	Mention the advantages of Smith Chart.	BTL 2	Understanding
16.	Illustrate the procedure to find the impedance from the given admittance using smith chart.	BTL 3	Applying
17.	Define the term Stub used in transmission line.	BTL 1	Remembering
18.	Examine why short circuited stub is preferred to open circuited stub.	BTL 3	Applying
19.	Generalize the method to determine the positon and the length of a single stub connected across the transmission line.	BTL 6	Creating
20.	Compare single stub matching and double stub matching.	BTL 3	Applying

PART –B (13 Marks)

1.	(i)	Examine the operation and application of quarter wave transformer.	(7)	BTL 2	Understanding
	(ii)	Consider a line with a load of Z_R/R_O =2.6+j, which is 28° long. Find the input impedance.	(6)		
2.	(i)	Deduce the expression for input impedance of a quarter wave transformer and mention its applications.	(8)	BTL 6	Creating
	(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.		Analyze the transmission line circle diagram by deriving the expression for constant S and constant βs circle.	(13)	BTL 4	Analyzing
4.		A lossless line with Z_O =70Ω is terminated with Z_R =115-80jΩ. Wavelength of transmission is 2.5 λ. Using smith chart evaluate the VSWR, reflection coefficient, input impedance and input admittance	(13)	BTL 5	Evaluating
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.		Consider a line of R_O = 55 ohms terminated with 115+j75 ohms. If the total length of the line is 1.183λ, find the reflection coefficient, VSWR, input impedance and admittance	(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.		A UHF lossless transmission line working at 1 GHz is connected to an unmatched line producing a voltage reflection coefficient of 0.5(0.866+j 0.5). Calculate the length and position of the stub to match the line using corresponding equations verify the values using Smith Chart.	(13)	BTL 2	Understanding
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 with $Z_o=300\angle 0°$ Ω is terminated in 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. Analyze and design a double stub tuner to match this load to the line using smith chart. Spacing between the two stubs is λ/4.	(13)	BTL 1	Remembering
13.		Derive the expression of radius and center for constant R and X circles in Smith Chart.	(13)	BTL 4	Analyzing
14.		Examine the transmission line to provide an impedance matching using a stub. Obtain the length and location of the stub to provide an impedance match on a line of 600 ohms terminated with 200 ohms. Assuming that the stub is short circuited at one end.	(13)	BTL 3	Applying
PART – C (15 Marks)					
1.	(i)	Determine length and location of a single short circuited stub to produce an impedance match on a transmission line with characteristic impedance of 600 ohm and terminated in 1800 ohm.	(8)	BTL 5	Evaluating
	(ii)	A 300 Ω transmission line is connected to a load impedance of (450-j600) Ω at 10MHz.Evaluate the position and length of a short circuited stub required to match the line using	(7)		

		smith chart.			
2.		For a normalized load impedance of 0.8+j1.2 design a double stub tuner with the distance between them as 3λ/8. Considering the stubs are short circuited determine the length of the stubs and the position of the first stub from the load. Verify the answer using Smith Chart.	(15)	BTL 6	Creating
3.	(i)	A line having characteristic impedance of 50 Ω is terminated in load impedance [75+j75] Ω. Determine the reflection coefficient and voltage standard wave ratio.	(8)	BTL 5	Evaluating
	(ii)	Mention the significance of smith chart and its application in transmission lines.	(7)		
4.	(i)	Develop the expression for the input impedance of the dissipation less line and thus obtain the expression for the input impedance of the quarter wave line. Also discuss the application of the quarter wave line.	(10)	BTL 6	Creating
	(ii)	Design a single stub match for a load of 150+j225 Ω for a 75 Ω line a 500 MHz using smith chart.	(5)		

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.	Interpret the characteristics of E wave and H wave.	BTL 2	Understanding
3.	Write about Principal wave.	BTL 1	Remembering
4.	Express the dominant mode in the wave propagating in the waveguide.	BTL 2	Understanding
5.	Deduce the expression for cut off frequency when the wave is propagated in between two parallel plates.	BTL 4	Analyzing
6.	Examine the Characteristics of TEM waves.	BTL 3	Applying
7.	Justify, why TM_{01} and TM_{10} modes in a rectangular waveguide do not exists.	BTL 5	Evaluating
8.	Define cutoff frequency of a waveguide.	BTL 1	Remembering
9.	Illustrate the features of TE and TM mode.	BTL 2	Understanding
10.	Mention about the dominant mode of a rectangular waveguide.	BTL 1	Remembering
11.	Discuss about the dominant mode and degenerate modes in rectangular	BTL 5	Evaluating

	waveguide.		
12.	Explore the relation between group velocity, phase velocity and free space velocity.	BTL 3	Applying
13.	Why rectangular waveguides preferred over circular waveguides?	BTL 1	Remembering
14.	Exhibit the nature of the evanescent mode.	BTL 3	Applying
15.	Analyze why TM_{01} and TM_{10} modes in a rectangular waveguide do not exist	BTL 4	Analyzing
16.	How would you categorize the modes as degenerate modes in a rectangular waveguide?	BTL 4	Analyzing
17.	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 6	Creating
18.	List the dominant mode in circular waveguide.	BTL 1	Remembering
19.	Write Bessel's functions of first kind of order zero?	BTL 2	Understanding
20.	Formulate the size of the circular waveguide required to propagate TE_{11} mode if λc=8cm and p'_{11}=1.841.	BTL 6	Creating

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 6	Creating
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 6GHz in TE1 mode. Find Cut-off frequency, Angle of incidence on planes, Phase velocity, group velocity, Phase constant, Cut-off wavelength, characteristic wave impedance, and wavelength along guiding walls. Is it possible to propagate TE_3 mode.	(13)	BTL 3	Applying
6.	(i)	Interpret the propagation of TE waves in a rectangular waveguide with necessary expressions for the field components.	(6)	BTL 2	Understanding
	(ii)	Summarize the characteristics of TE and TM waves and also derive the cutoff frequency and phase velocity from	(7)		

		propagation constant.			
7.		Analyze the field configuration, cut off frequency and velocity of propagation for TM waves in rectangular wave guides.	(13)	BTL 4	Analyzing
8.		A rectangular air filled copper waveguide with dimension 0.9inch x 0.4inch cross section and 12inch length is propagated at 9.2GHz with a dominant mode. Find the cutoff frequency, Guide wavelength, Phase velocity, characteristic impedance and the loss.	(13)	BTL 5	Evaluating
9.		An air filled rectangular waveguide of 5cm x 2 cm cross section is operating in the TE_{10} mode at a frequency of 4GHz. Determine (a)the group velocity (b)the guide wavelength (c) the attenuation to be expected at a frequency which is 0.95 times the cut off frequency (assuming the guide walls is made of perfect conductors).	(3) (4) (6)	BTL 2	Understanding
10.		Using Bessel differential equation Obtain the TM field components in circular waveguides.	(13)		
11.		A TE_{11} wave is propagating through a circular waveguide. The diameter of the guide is 10cm and the guide is air-filled. Given p'_{11}=1.842 (a)Find the cut off frequency (b)Find the wavelength λg in the guide for a frequency of 3GHz. (c)Determine the wave impedance in the guide.	(4) (4) (5)	BTL 4	Analyzing
12.		Analyze the expressions for the transmissions of TE waves in a circular waveguide conducting planes for the field components.	(13)	BTL 4	Analyzing
13.		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
14.		Obtain the field distribution of transverse and longitudinal components of the electric and magnetic fields in circular waveguide with necessary equations.	(13)	BTL 1	Remembering
		PART C (15 marks)			
1.	(i)	A hollow rectangular waveguide is to be used to transmit signals at a carrier frequency of 6GHz. Choose its dimensions so that the cut off frequency of the dominant TE mode is lower than the carier by 25 % and that of the next mode is atleast 25 % higher than the carrier.	(8)	BTL 6	Creating
	(ii)	Evaluate the ratio of the area of a circular waveguide to that of a rectangular one if both are to have the same cut off frequency for dominant mode.	(7)		

2.	(i)	The interior of *a* 20/3 *cm* × 20/4 *cm* rectangular waveguide is completely filled with a dielectric of $\varepsilon_r = 4$. Waves of free space wave – length shorter than which can be propagated in the TE_{11} mode.	(8)	BTL 5	Evaluating
	(ii)	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.	(7)		
3.		Determine the cut off frequencies of the first two propagating modes of a circular waveguide with a=0.5cm and $\varepsilon_r = 2.25$ the guide is 50cm in length operating at f=13GHz. Determine the cut off wavelength and propagation constant.	(15)	BTL 5	Evaluating
4.		A TE wave propagating in a dielectric filled waveguide of unknown permittivity has dimensions a=5 cm and b = 3cm.If the x – components of the electric field is given by Ex=36cos(40πx)sin(100πy)sin(2.4π×1010t−52.9πz) (V/m). Devise (a) ε_r of the material in the guide, (b) the cutoff frequency, (c) the expression for H_y.	 (5) (4) (6)	BTL 6	Creating

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.	Enumerate the band gap energy for Si and Ge used for semiconductor diodes.	BTL 4	Analyzing
3.	Draw the cross section of multifinger Bipolar Junction Transistor	BTL 1	Remembering
4.	What is called as HBTs ?	BTL 1	Remembering
5.	Define reverse active mode in bipolar junction transistor.	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 3	Applying
8.	Outline the characteristics of modulation doped field effect transistor	BTL 1	Remembering
9.	Illustrate the generic RF amplifier design.	BTL 2	Understanding
10.	Mention the various types of mixers.	BTL 1	Remembering
11.	Summarize the basic steps in the design process of RF amplifier circuits.	BTL 5	Evaluating
12.	Distinguish between oscillator and Mixer	BTL 4	Analyzing
13.	Examine the importance of voltage controlled oscillator in RF system.	BTL 2	Understanding
14.	Interpret the basic parameters of RF amplifier.	BTL 2	Understanding

15.		Generalize the concept of unconditional stability of an amplifier.		BTL 6	Creating
16.		Analyze the techniques of efficiency boosting in RF power amplifier		BTL 4	Analyzing
17.		Evaluate the significance of negative resistance in oscillation of a circuit		BTL 5	Valuating
18.		Devise the operation of single ended and differential ended LNA.		BTL 5	Creating
19.		Deduce the transducer power gain of a RF power amplifier.		BTL 3	Applying
20.		Demonstrate typical output stability circle and input stability circle		BTL 3	Applying
PART –B (13 Marks)					
1.		Outline the process to compute the junction capacitance and the space charge region length of a *pn* junction semiconductor device.	(13)	BTL 1	Remembering
2.	(i)	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.	(7)	BTL 5	Evaluating
	(ii)	Considering the electron concentration and hole concentration in a semiconductor as ***n*** and ***p*** respectively infer that $\boldsymbol{np} = \mathbf{n_i}^2$ where ni is the intrinsic concentration.	(6)		
3.		Elaborate the construction and the functionality of the bipolar junction transistor.	(13)	BTL 3	Applying
4.		Discuss about the different operating modes of a bipolar junction transistor with appropriate diagram.	(13)	BTL 3	Applying
5.		Derive the drain saturation voltage and maximum saturation current for a field effect transistor.	(13)	BTL 6	Creating
6.	(i)	Compare the field effect transistor with the bipolar junction transistor	(6)	BTL 4	Analyzing
	(ii)	Explain the distinct features of high electron mobility transistors.	(7)		
7.	(i)	Analyze the steps involved to design a low noise amplifier	(6)	BTL 4	Analyzing
	(ii)	Distinguish power match and noise match in a Low Noise Amplifier.	(7)		
8.	(i)	Interpret the various types of mixers with its principle of operation	(6)	BTL 2	Understanding
	(ii)	Examine the following parameters of Conversion gain, Linearity and isolation of a mixer.	(7)		
9.		Illustrate the design principles of RF amplifier and impedance matching.	(13)	BTL 2	Understanding
10.	(i)	Write about the method used to design an integer N frequency synthesizer.	(7)	BTL 1	Remembering
	(ii)	Determine the transfer function of a voltage controlled oscillator.	(6)		
11.		Obtain the expression for unilateral power gain with necessary signal flow diagram.	(13)	BTL 1	Remembering
12.		Describe the various power gain for a two port RF network	(13)	BTL 1	Remembering

		considering the stability of the amplifier involved.			
13.		Discuss about input and output stability circles in the complex Γ_L and Γ_S planes, also derive the condition for unconditional stability.	(13)	BTL 2	Understanding
14.		A MESFET operated at 5.7GHz ha the following S parameters: $S_{11}=0.5\angle-60°$, $S_{12}=0.02\angle0°$, $S_{21}=6.5\angle115°$ and $S_{22}=0.6\angle-35°$. 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- 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 6	
2.		An RF amplifier has the following S parameters: $S_{11}=0.3\angle-70°$, $S_{21}=3.5\angle85°$, $S_{12}=0.2\angle-10°$, $S_{22}=0.4\angle-45°$. Further $Vs=5V\angle0°$, $Zs=40\Omega$ and $Z_L=73\Omega$. Assuming $Zo=50\Omega$. Find GT, GTU, GA and G. Also find Power delivered to the load PL, available power from source PA and incident power to amplifier Pinc.	(15)	BTL 5	Evaluating
3.		Consider a Si bipolar junction transistor whose emitter, base , collector are uniformly doped with the following concentrations $N^E_D = 10^{21}$ cm^{-3} , $N^B_A = 2 \times 10^{19} cm^{-3}$, $N^C_D = 10^{19}$ cm-3. Assume that the base emitter voltage is 0.75 and the collector –emitter potential is set to 2 V. The cross sectional area of both junctions is 10-4 cm2 and the emitter, base and collector thickness are $d_E = 0.8\mu m$, $d_B = 1.2\mu m$ and $d_C = 2\mu m$ respectively. Assuming that the device is operated at room temperature : (a) Find the space charge region extents for both junctions. (b) Compute the base, emitter and collector currents (c) Calculate the forward and reverse current gains	(5) (5) (5)	BTL 5	Evaluating
4.	(i)	Generelize the homodyne and heterodyne architecture of RF system	(8)	BTL 6	Creating
	(ii)	Devise the various stabilization methods for a RF amplifier circuit.	(7)		