SRM VALLIAMMAI ENGINEERING COLLEGE

(An Autonomous Institution)

SRM Nagar, Kattankulathur – 603 203

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

QUESTION BANK

VII SEMESTER

1906701 – ANTENNAS AND MICROWAVE ENGINEERING

Department of Electronics and Communication Engineering

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UNIT I - INTRODUCTION TO MICROWAVE SYSTEMS AND ANTENNAS

Microwave frequency bands, Physical concept of radiation, Fields and Power radiated by an antenna, Antenna pattern characteristics, Antenna Gain and Efficiency, Antenna Noise Temperature, Impedance matching, Friis transmission equation and Radar range equation, Link budget and link margin, Noise characterization of a microwave receiver.

PART – A

Q.No	Questions	CO	BT Level	Competence
1.	What is the purpose of using an antenna?	CO1	BTL 1	Remembering
2.	Define the term antenna.	CO1	BTL 1	Remembering
3.	List out the microwave frequency bands in electromagnetic spectrum	CO1	BTL 1	Remembering
4.	State the condition to be satisfied with respect to current and charge for emitting radiation.	CO1	BTL 1	Remembering
5.	Name the antenna parameters.	CO1	BTL 1	Remembering
6.	How the field regions of an antenna are classified?	CO1	BTL 1	Remembering
7.	Obtain the total power radiated by an antenna over an entire solid angle of 4π.	CO1	BTL 1	Remembering
8.	A radio link has a 15 W transmitter connected to an antenna of $2.5m^2$ effective aperture at 5 GHz. The receiving antenna has an effective aperture of $0.5\ m^2$ and is located at a 15 Km line-of-sight distance from the transmitting antenna. Assuming lossless, matched antennas, find the power delivered to the receiver.	CO1	BTL 1	Remembering
9.	Sketch the two dimensional radiation pattern of a directional antenna.	CO1	BTL 1	Remembering
10.	Mention the types of lobes that appear in the radiation pattern of an antenna.	CO1	BTL 1	Remembering
11.	The performance of a linearily polarized antenna are defined by the principal patterns- Justify.	CO1	BTL 1	Remembering
12.	Relate the gain and directivity of an antenna through an appropriate mathematical expression.	CO1	BTL 1	Remembering
13.	Differentiate Radian and Steradian.	CO1	BTL 2	Understanding
14.	Find the equation for antenna noise temperature with it's definition	CO1	BTL 2	Understanding
15.	If the noise figure of an antenna at room temperature is 2 dB, compute the effective noise temperature.	CO1	BTL 2	Understanding
16.	Discuss the significance of evaluating G/T in antenna systems.	CO1	BTL 2	Understanding
17.	Explore the need for impedance matching in antennas.	CO1	BTL 2	Understanding
18.	Summarize the different types of matching techniques	CO1	BTL 2	Understanding
19.	Write an equation that relates the received and transmitted power based on the distance between the antennas.	CO1	BTL 2	Understanding
20.	Mention the importance of Friis equation in communication.	CO1	BTL 2	Understanding
21.	Interpret the expression for the radar range equation.	CO1	BTL 2	Understanding
22.	Compare link budget and link margin in the field of antenna design	CO1	BTL 2	Understanding
23.	Outline the noise contribution of various components in a receiver.	CO1	BTL 2	Understanding
24.	Mention the need for noise characterization of a microwave receiver.	CO1	BTL 2	Understanding

PART – B						
1.		How radiation is accomplished using two wire antenna?	(13)	CO1	BTL3	Applying
2.		Mention the antenna parameters and explain any four parameters in detail.	(13)	CO1	BTL3	Applying
3.	(i)	Derive the power radiated from an antenna in terms of the radiation intensity.	(8)	CO1	BTL3	Applying
	(ii)	Find the power radiated by an antenna if the radiation intensity is given by Asinθ.	(5)	CO1		
4.		Explain the two dimensional normalized field pattern and power pattern of a linear array of an isotropic sources.	(13)	CO1	BTL3	Applying
5.		Summarize radiation pattern with a three dimension model. Also explain HPBW, FNBW and the other lobes.	(13)	CO1	BTL3	Applying
6.	(i)	An antenna has a field pattern given by $E(\theta)=\cos\theta\cos2\theta$ for $0^\circ \leq \theta \leq 90^\circ$. Compute (a) HPBW (b) FNBW.	(7)	CO1	BTL3	Applying
	(ii)	Interpret the concept of radiation pattern and directivity of an antenna.	(6)	CO1		
7.	(i)	Analyze the characteristics of omnidirectional, directional and an isotropic radiators.	(8)	CO1	BTL4	Analyzing
	(ii)	How the space around the antenna is subdivided?	(5)	CO1		
8.		Interpret the gain of an antenna and explain with mathematical expression about the relative gain and absolute gain of an antenna.	(13)	CO1	BTL3	Applying
9.		For a source with a radiation intensity U = 6cosθ, find the directivity and half power beamwidth when the radiation is unidirectional.	(13)	CO1	BTL4	Analyzing
10.	(i)	Considering the losses of an antenna determine the overall efficiency of an antenna.	(7)	CO1	BTL4	Analyzing
	(ii)	Explain the classification of polarization observed in the radiation of an antenna.	(6)	CO1		
11.		Describe the importance of the impedance matching in the transmission line involving antenna.	(13)	CO1	BTL4	Analyzing
12.		Mention the different types of impedance matching techniques available in the microwave frequency range applications, explain in detail.	(13)	CO1	BTL3	Applying
13.	(i)	Write a note on antenna noise temperature and deduce the noise equivalent temperature expression.	(8)	CO1	BTL4	Analyzing
	(ii)	If the noise figure of an antenna is 2 dB, what is the effective noise temperature?	(5)	CO1		
14.	(i)	Examine the Friis transmission equation relating the power received to the power transmitted between the antennas separated by a distance of 'R' units.	(7)	CO1	BTL4	Analyzing
	(ii)	Consider two similar dipoles of length 3 cm used as transmitting and receiving antennas. Find the power received if the receiving antenna is placed at a distance of 10 m from the transmitting antenna which is radiating 15 W average power at f = 1 GHz.	(6)	CO1		

15.		Generalize the radar range equation based on the transmitted power and delivered power to the load considering the conduction-dielectric losses.	(13)	CO1	BTL4	Analyzing
16.		Illustrate the concept of link budget and link margin with equation and suitable examples.	(13)	CO1	BTL3	Applying
17.		Analyze the noise characteristics of a microwave receiver front end with necessary diagram and mathematical expression.	(13)	CO1	BTL4	Analyzing

PART – C						
1.		Explain the radiation mechanism with different configurations of single wire as radiator.	(15)	CO1	BTL3	Applying
2.		An antenna receives a maximum power of 2 μW from a radio station. Estimate the maximum effective area if the antenna is located in the far field region of the station where $\|E\|$=50 mV/m.	(15)	CO1	BTL4	Analyzing
3.		Derive the relationship between gain of an antenna and the antenna aperture. Also analyse the significance of directivity gain of an antenna.	(15)	CO1	BTL4	Analyzing
4.		The normalized radiation intensity of an antenna is represented by $U(\theta)= \cos^2(\theta)\cos^2(3\theta)$, where $0^o\leq\theta\leq 90^o$, $0^o\leq \phi\leq 360^o$. Compute the half power beamwidth and first null beamwidth in radians and in degrees.	(15)	CO1	BTL3	Applying
5.	(i)	Outline the characteristics of the components required to build a microwave receiver.	(8)	CO1	BTL4	Analyzing
	(ii)	Draw the geometrical arrangement of a target and receiver and obtain the appropriate radar range equation.	(7)	CO1	BTL4	Analyzing

UNIT II - RADIATION MECHANISM AND DESIGN ASPECTS

Radiation mechanisms of Dipole/Monopole, Linear Wire, Loop and Slot antennas, Aperture antennas, Reflector antennas, Microstrip antennas and Frequency independent antennas, Wide Band Antennas, Design considerations and applications.

PART – A

Q.No	**Questions**		**BT Level**	**Competence**
1.	What does the term Hertzian dipole refer to in antenna theory?	CO2	BTL 1	Remembering
2.	How does the radiation occurs from the current element?	CO2	BTL 1	Remembering
3.	Define radiation resistance of an antenna.	CO2	BTL 1	Remembering
4.	A radiating element of 1 cm carries an effective current of 0.5 A at 3GHZ, calculate the power radiated by the element.	CO2	BTL 1	Remembering
5.	Under which condition, the radiation pattern of loop antenna is same as the Hertzian dipole antenna?	CO2	BTL 1	Remembering

6.	Mention the features of slot antenna.	CO2	BTL 1	Remembering
7.	Write the relationship between the terminal impedances of the slot antenna and the dipole.	CO2	BTL 1	Remembering
8.	State Babinet's principle.	CO2	BTL 1	Remembering
9.	Summarize the field equivalence approach.	CO2	BTL 1	Remembering
10.	Interpret the design considerations for an aperture antenna.	CO2	BTL 1	Remembering
11.	Outline the characteristics of corner reflector antenna.	CO2	BTL 1	Remembering
12.	List the advantages of cassegrain feed system.	CO2	BTL 1	Remembering
13.	Interpret how spillover happens during the reception of signal in an antenna.	CO2	BTL 2	Understanding
14.	Illustrate the nature of secondary antennas.	CO2	BTL 2	Understanding
15.	Analyze how the aperture blockage can be prevented in reflector antenna.	CO2	BTL 2	Understanding
16.	Summarize the advantages of microstrip antennas	CO2	BTL 2	Understanding
17.	Categorize the feeding methods of microstrip antenna.	CO2	BTL 2	Understanding
18.	Examine the applications of microstrip antenna.	CO2	BTL 2	Understanding
19.	Illustrate the expressions for design ratio, spacing factor of log periodic antenna.	CO2	BTL 2	Understanding
20.	Name the regions based on the length of dipole in LPDA.	CO2	BTL 2	Understanding
21.	What is the main idea of frequency independent antenna?	CO2	BTL 2	Understanding
22.	Classify the types of horn antennas.	CO2	BTL 2	Understanding
23.	Calculate the beam width of the pyramidal horn with the aperture dimension of 12 × 6 cm. Its operating frequency is given as 10 GHz.	CO2	BTL 2	Understanding
24.	Summarize the features of pyramidal horn antenna.	CO2	BTL 2	Understanding

PART – B						
1.		Interpret the electric and magnetic field quantities of an infinitesimal dipole and draw the radiation pattern.	(13)	CO2	BTL3	Applying
2.		What is a current element? Obtain the expression for the power radiated by the current element.	(13)	CO2	BTL4	Analyzing
3.		Show that the radiation resistance of a half wave dipole antenna is 73 Ω.	(13)	CO2	BTL3	Applying
4.		Obtain the radiation resistance and directivity of a small loop antenna.	(13)	CO2	BTL3	Applying
5.	(i)	Explain the radiation mechanism of a slot antenna.	(7)	CO2	BTL3	Applying
	(ii)	Find the dimensions and terminal resistance of a complementary slot for a cylindrical dipole with length to diameter ratio of 28 and length of 0.925	(6)	CO2		

		λ having terminal impedance of 710 + j 0 Ω.				
6.		Describe rectangular apertures and derive expressions for its uniform distribution on an infinite ground plane and space.	(13)	CO2	BTL3	Applying
7.	(i)	With field equivalence principle, explain radiation mechanism.	(6)	CO2	BTL4	Analyzing
	(ii)	A rectangular aperture with a constant field distribution, with a = 3 λ and b = 2 λ, is mounted on an infinite ground plane. Compute the FNBW and HPBW in the E-plane.	(7)	CO2		
8.		Elaborate the principle of parabolic reflector antenna with the neat diagram and explain the types of feed used.	(13)	CO2	BTL4	Analyzing
9.	(i)	Compare the flat reflector and corner reflector.	(7)	CO2	BTL3	Applying
	(ii)	Calculate the diameter of dish antenna that will form a beam having 0.5^{o} HPBW at a frequency of 8.2 GHz. Assume an efficiency constant of 0.6, calculate the antenna gain and effective aperture.	(6)	CO2		
10.	(i)	Describe the radiation pattern and fields on the axis of an E-plane and H-plane sectoral horns.	(6)	CO2	BTL3	Applying
	(ii)	A pyramidal horn antenna having aperture dimensions of a = 5.2 cm and b = 3.8 cm is used at a frequency of 10 GHz.Find its gain and HPBW.	(7)	CO2		
11.	(i)	With necessary sketches, explain in detail the radiation mechanism of a microstrip patch antenna.	(7)	CO2	BTL4	Analyzing
	(ii)	With suitable figures, explain the various feed techniques of a microstrip antenna.	(6)	CO2		
12.		Explain radiation mechanism of a microstrip antenna considering square microstrip antenna. Also draw the normalized patterns for the same.	(13)	CO2	BTL4	Analyzing
13.		Analyze the feeding techniques for the rectangular patch antenna with neat diagrams.	(13)	CO2	BTL4	Analyzing
14.		What are the different types of horn structures? Draw the radiation pattern of horn antenna and hence describe the radiation mechanism with neat diagram.	(13)	CO2	BTL4	Analyzing
15.		Identify the radiation resistance of a single turn and an eight-turn small circular loop when the radius of the loop is λ/20 and the medium is free space.	(13)	CO2	BTL4	Analyzing
16.		Design a 50 to 200 MHz log periodic dipole for antenna for gain corresponds to scale factor 0.8 and space factor 0.15. Assume the gap spacing at the smallest dipole is 3.6mm.	(13)	CO2	BTL3	Applying
17.		For transmission of signal with 2.4 GHz, design a microstrip patch antenna with an inset feed. Parameters for the design are : Operating frequency(f) : 2.4 GHz Dielectric constant of substrate(ε_r): 4.3 Height of the dielectric substrate(h): 1.6 mm Height of the conductor(t) : 0.035 mm	(13)	CO2	BTL3	Applying

PART – C						
1.		An electric field strength 10 μV/m is to be measured at an observation point $\theta = \pi/2$, 500 km from a half wave dipole antenna operating in air at 50 MHz (a) What is the length of dipole? (b) Calculate the current that must be fed to antenna (c) Find the average power radiated by antenna	(5) (5) (5)	CO2	BTL3	Applying
2.	(i)	Compare the field quantities and the other relevant parameter of a small loop antenna with a short dipole antenna.	(8)	CO2	BTL4	Analyzing
	(ii)	By applying the Poynting theorem determine the radiation resistance of a circular loop antenna.	(7)	CO2	BTL4	Analyzing
3.		The dimensions of an aperture of a pyramidal horn is given by 10 cm x 5 cm. When the horn is operated at 6 GHz frequency, find beamwidth, power gain and directivity.	(15)	CO2	BTL3	Applying
4.	(i) (ii)	Analyze the parabola geometry that makes it suitable for antenna reflectors. Design an antenna employing a parabolic reflector that is likely to be a highly directive receiving antenna.	(8) (7)	CO2	BTL4	Analyzing
5.		Draw the structure of log periodic dipole array and explain the operating principle and mention its applications.	(15)	CO2	BTL3	Applying

UNIT III - ANTENNA ARRAYS AND APPLICATIONS

Two-element array, Array factor, Pattern multiplication, Uniformly spaced arrays with uniform and non-uniform excitation amplitudes, Concept of phased arrays, Frequency scanning arrays, Smart antennas.

PART – A

Q.No	Questions		BT Level	Competence
1.	What do you understand by a uniform linear array?	CO3	BTL 1	Remembering
2.	Define phased array and frequency scanning array.	CO3	BTL 1	Remembering
3.	Write about pattern multiplication and its advantages.	CO3	BTL 1	Remembering
4.	List the features of smart antennas and where it is employed?	CO3	BTL 1	Remembering
5.	Draw the radiation pattern of isotropic point sources of same amplitude and opposite phase that are λ/2 apart along X-axis symmetric with respect to the origin.	CO3	BTL 1	Remembering
6.	How to eliminate minor lobes?	CO3	BTL 1	Remembering
7.	Interpret the meaning of array factor.	CO3	BTL 1	Remembering
8.	Summarize the advantages and disadvantages of binomial array.	CO3	BTL 1	Remembering
9.	Draw the radiation pattern for broad side and end fire array.	CO3	BTL 1	Remembering
10.	Write the basic principle of reconfigurable antennas.	CO3	BTL 1	Remembering
11.	Distinguish Binomial and Chebyshev distributions.	CO3	BTL 1	Remembering
12.	Write the expression that represents the pattern multiplication.	CO3	BTL 1	Remembering
13.	Mention the conditions to obtain end fire array antenna.	CO3	BTL 2	Understanding
14.	Identify the feed networks used in a phased array antenna.	CO3	BTL 2	Understanding

15.	Illustrate the meaning and need for the binomial array.	CO3	BTL 2	Understanding
16.	Identify the active antennas towards the wide interest for industrial applications.	CO3	BTL 2	Understanding
17.	Find the directivity of a broadside array of length 10 λ.	CO3	BTL 2	Understanding
18.	Mention the different types of antenna arrays.	CO3	BTL 2	Understanding
19.	Find the directivity of broadside forms of arrays when a uniform linear array contains 50 isotropic radiation with an inter element spacing of λ/2.	CO3	BTL 2	Understanding
20.	Classify smart antennas.	CO3	BTL 2	Understanding
21.	Explore the need for phase shifter in phased array antennas.	CO3	BTL 2	Understanding
22.	Compare beam steering and beamforming.	CO3	BTL 2	Understanding
23.	A linear end fire, uniform array of 10 elements has a separation of λ/4 between elements. Calculate the directivity of an array.	CO3	BTL 2	Understanding
24.	Inspect the angle where the transmitted power has dropped by from the maximum power in the direction at which the antenna array is directing.	CO3	BTL 2	Understanding

PART – B					
1.	Enumerate the principle of phased array antenna and frequency scanning arrays. Give account of beam forming networks for phased array antenna.	(13)	CO3	BTL 4	Analyzing
2.	Find the expression for the field and the radiation pattern produced by a N element array of infinitesimal with distance of separation λ/ 2 and currents of unequal magnitude and phase shift 180^0.	(13)	CO3	BTL 3	Applying
3.	(i) Derive the expression for field pattern of broad side array of N point sources.	(7)	CO3	BTL 3	Applying
	(ii)A linear broadside array consists of 4 equal isotropic in-phase point sources with λ/3 spacing. Identify the directivity and beamwidth.	(6)	CO3		
4.	For a 2 element linear antenna array separated by a distance d = 3λ/4, derive the field quantities and draw its radiation pattern for the phase difference of 45^o.	(13)	CO3	BTL 3	Applying
5.	Describe in detail about the resultant radiation pattern of two element array.	(13)	CO3	BTL 4	Analyzing
6.	Summarize the expression for the array factor of a linear array of four isotropic element spaced λ/2 apart fed with signals of equal amplitude and phase. Obtain the directions of maxima and minima.	(13)	CO3	BTL 4	Analyzing
7.	(i) Demonstrate the radiation mechanisms of broad side antenna array and end fire antenna array with neat sketches.	(7)	CO3	BTL 3	Applying
	(ii) What is binomial array? Draw the pattern of 10 elements binomial array with spacing between the elements of 3λ/4 and λ/2**.**	(6)	CO3		
8.	Analyze in details the concept, design principles and types of phased arrays.	(13)	CO3	BTL 4	Analyzing
9.	(i) Derive expression for directivity of end fire array.	(7)	CO3	BTL 3	Applying
	(ii) Write the properties of end fire array and frequency scanning arrays.	(6)	CO3		

10.	(i)Obtain the expression for the field produced by linear array and deduces it for an end fire array.	(7)	CO3	BTL 3	Applying
	(ii) Mention the properties of linear broadside array.	(6)	CO3		
11.	(i) Illustrate about the method of pattern multiplication.	(7)	CO3	BTL 3	Applying
	(ii)Deduce the expression for directions of pattern minima, pattern maxima, BWFN due to broad side array.	(6)	CO3		
12.	Derive the array factor of an uniform linear array. Explain the significance of array factor.	(13)	CO3	BTL 3	Applying
13.	Illustrate about the adaptive arrays and smart antennas.	(13)	CO3	BTL 4	Analyzing
14.	Examine how analog and digital beam forming is achieved with an antenna array with a neat diagram.	(13)	CO3	BTL 4	Analyzing
15.	(i)Analyze the working principle of phased array antenna with neat diagram.	(7)	CO3	BTL 4	Analyzing
	(ii)Describe the radiation mechanisms of binomial array with neat sketches and derive the expression for array factor.	(6)	CO3		
16.	Identify the direction of maximum and minimum radiation from the resultant radiation of two identical radiators which are spaced d = 3 λ/4 meters apart and fed with currents of equal magnitude but with 180^o phase difference.	(13)	CO3	BTL 4	Analyzing
17.	Determine the maxima, minima and half power directions if two point sources are fed with currents equal in magnitude but opposite in phase.	(13)	CO3	BTL 4	Analyzing

PART – C					
1.	Derive and draw the radiation pattern of 4 isotropic sources of equal amplitude and same phase.	(15)	CO3	BTL3	Applying
2.	Summarize in detail about the conditions for two-point sources with currents unequal in magnitude and with any phase.	(15)	CO3	BTL4	Analyzing
3.	For an end fire consisting of several half wave length isotropic radiator is to have a directive gain of 30^o. Formulate the array length and width of the major lobe. What will be these values for a broadside array?	(15)	CO3	BTL4	Analyzing
4.	(i) Deduce the directivity of a given linear broadside, uniform array of 10 isotropic elements with a separation of λ/4 between the elements.	(8)	CO3	BTL4	Analyzing
	(ii) A linear broadside array consists of four equal isotropic in-phase point sources with λ/3 spacing. Construct the directivity and beamwidth if the total length of the array is λ.	(7)	CO3		
5.	A uniform linear array consists of 16 isotropic point sources with a spacing of λ/4. If the phase difference is -90^o, Determine the directivity, HPBW, beam solid angle and effective apertures.	(15)	CO3	BTL3	Applying

UNIT IV - PASSIVE AND ACTIVE MICROWAVE DEVICES				
Microwave Passive components: Directional Coupler, Power Divider, Magic Tee, attenuator, resonator, Principles of Microwave Semiconductor Devices: Gunn Diodes, IMPATT diodes, Schottky Barrier diodes, PIN diodes, Microwave tubes: Klystron, TWT, Magnetron.				
PART – A				
Q.No	**Questions**		**BT Level**	**Competence**
1.	What are the main properties of power dividers?	CO4	BTL 1	Remembering
2.	Identify the use of matched termination in microwave communication setup.	CO4	BTL 1	Remembering
3.	Draw the equivalent circuit of a Gunn diode.	CO4	BTL 1	Remembering
4.	Write the effect of transit time.	CO4	BTL 1	Remembering
5.	What are the differences between TWTA and klystron amplifier?	CO4	BTL 1	Remembering
6.	List the basic parameters to measure the performance of a directional coupler?	CO4	BTL 1	Remembering
7.	Summarize sum and difference arm of magic Tee.	CO4	BTL 1	Remembering
8.	Write about attenuator and resonator.	CO4	BTL 1	Remembering
9.	Summarize the condition for oscillation and applications in reflex klystron.	CO4	BTL 1	Remembering
10.	State the principle of Faraday's rotation.	CO4	BTL 1	Remembering
11.	Distinguish between microwave passive components and ssemiconductor ddevices.	CO4	BTL 1	Remembering
12.	How the performance of directional coupler can be determined?	CO4	BTL 1	Remembering
13.	Outline the characteristics of Gunn diode and list the modes.	CO4	BTL 2	Understanding
14.	Exhibit the negative resistance property in Gunn diode.	CO4	BTL 2	Understanding
15.	Interpret about the Schottky barrier diodes.	CO4	BTL 2	Understanding
16.	Point out the various types of Tee used in microwave.	CO4	BTL 2	Understanding
17.	Show the features of power divider.	CO4	BTL 2	Understanding
18.	Illustrate the transferred electron effect.	CO4	BTL 2	Understanding
19.	Examine the factors reducing the efficiency of IMPATT diode.	CO4	BTL 2	Understanding
20.	Categorize the applications of magic-Tee.	CO4	BTL 2	Understanding
21.	Compare PIN and PN diode.	CO4	BTL 2	Understanding
22.	Why magnetron is called as cross field device?	CO4	BTL 2	Understanding
23.	Mention the purpose of slow wave structures in TWT.	CO4	BTL 2	Understanding
24.	Summarize the frequency pulling and frequency pushing in magnetrons.	CO4	BTL 2	Understanding

PART – B					
1.	With neat diagram explain the operation of attenuators in detail.	(13)	CO4	BTL 4	Analyzing
2.	Show the operation and properties of power divider. Derive their S parameters.	(13)	CO4	BTL 3	Applying
3.	(i) With the help of a neat diagram describe the magic Tee working principle.	(7)	CO4	BTL 4	Analyzing
	(ii) Find scattering matrix and applications of magic Tee.	(6)	CO4		
4.	(i) Write notes on high frequency limitations of conventional vacuum devices.	(7)	CO4	BTL 4	Analyzing

	(ii) What are the characteristics of travelling wave tube?	(6)	CO4		
5.	Describe the operation mechanism of two-cavity Klystron amplifier with neat sketch and write the expression for its output power.	(13)	CO4	BTL 3	Applying
6.	(i) From the first principles derive the scattering matrix of a multi hole directional coupler.	(7)	CO4	BTL 4	Analyzing
	(ii) Infer the characteristics of directional coupler in terms of S parameters and explain in detail two-hole directional coupler.	(6)	CO4		
7.	(i) Summarize the working principle of reflex klystron oscillator with necessary diagrams.	(7)	CO4	BTL 3	Applying
	(ii) Derive velocity modulation, transit time of reflex klystron oscillator.	(6)	CO4		
8.	(i) Elaborate the power output mode curve/frequency characteristics of reflex klystron.	(7)	CO4	BTL 4	Analyzing
	(ii) Draw the equivalent circuit and obtain the electronic spiral curve of reflex klystron.	(6)	CO4		
9.	Describe the working principle of Gunn diode oscillator and its modes.	(13)	CO4	BTL 3	Applying
10.	With neat diagrams, explain the operation of transmission line resonators and its application.	(13)	CO4	BTL 3	Applying
11.	Interpret the features of Schottky barrier diodes and its application in microwave communication.	(13)	CO4	BTL 3	Applying
12.	Illustrate with interaction region diagram the mechanism of operation of TWT amplifier, its applications and the expression for the gain of a TWT.	(13)	CO4	BTL 3	Applying
13.	(i) Determine the directivity in dB for a coupler if same power is applied in turn in to input and output of the coupler with output terminated in each case in a matched impedance. The auxiliary output readings are 450 mW and 0.710 μW.	(7)	CO4	BTL 3	Applying
	(ii) Calculate the operating frequency of a silicon based IMPATT diode with drift length of 2 μm and drift velocity of 10^7 cm/s.	(6)	CO4		
14.	Explain in detail about PIN diodes, control circuits and its applications.	(13)	CO4	BTL 4	Analyzing
15.	Analyze the working principle of Gunn diode as a transferred electron device with two valley model, also draw the structure, equivalent circuit and V-I characteristics of Gunn diode.	(13)	CO4	BTL 4	Analyzing
16.	(i) What are avalanche transit time devices? Explain the operation and construction of IMPATT diode.	(7)	CO4	BTL 4	Analyzing
	(ii) Explain mechanism of oscillation of IMPATT and as power amplifier.	(6)	CO4		
17.	Brief the following :			BTL 4	Analyzing
	(i) T-junction power divider.	(7)	CO4		
	(ii) Cylindrical Magnetron.	(6)	CO4		

PART – C					
1.	What is Circulator? With neat diagram, explain the working principle, construction, operation of four port circulator using magic-tee. Verify the circulator theory with necessary S-parameter equations.	(15)	CO4	BTL3	Applying
2.	With neat diagram, discuss the characteristics of series Tee and shunt Tee and derive the S matrix.	(15)	CO4	BTL4	Analyzing
3.	A TWT operates under the parameters: beam voltage = 3 KV, beam current = 30 mA, characteristics impedance of helix = 10 Ω, circuit length = 50, frequency = 10 GHz. Calculate gain parameter, output power gain in dB, four propagation constants.	(15)	CO4	BTL3	Applying
4.	Analyze the cross-sectional view of magnetron tube and explain how bunching occurs with equations of electron trajectory and derive the expression for Hull cut-off voltage.	(15)	CO4	BTL4	Analyzing
5.	With the help of two valley, explain how negative resistance can be created in Gunn diode and compare with tunnel diode.	(15)	CO4	BTL4	Analyzing

UNIT V - MICROWAVE DESIGN PRINCIPLES

Impedance transformation, Impedance Matching, Microwave Filter Design, RF and Microwave Amplifier Design, Microwave Power amplifier Design, Low Noise Amplifier Design, Microwave Mixer Design, Microwave Oscillator Design

PART – A

Q.No	Questions	CO	BT Level	Competence
1.	What is the need for impedance matching?	CO5	BTL 1	Remembering
2.	Define about a perfect filter.	CO5	BTL 1	Remembering
3.	List out the constraints of impedance matching.	CO5	BTL 1	Remembering
4.	What is the need of Rollet factor, K? Write its expressions.	CO5	BTL 1	Remembering
5.	Name the uses of microwave filters.	CO5	BTL 1	Remembering
6.	Identify the considerations in selecting a matching network.	CO5	BTL 1	Remembering
7.	State the significance of microstrip matching networks.	CO5	BTL 1	Remembering
8.	Draw typical output stability circle and input stability circle.	CO5	BTL 1	Remembering
9.	Distinguish single stub matching and double stub matching.	CO5	BTL 1	Remembering
10.	Write down the expression that relates the nodal quality factor (Q_n) with loaded quality factor (Q_L).	CO5	BTL 1	Remembering
11.	Summarize the filter realization steps in RF filter design.	CO5	BTL 1	Remembering
12.	Discuss the stability requirements in RF amplifier design.	CO5	BTL 1	Remembering
13.	Define about RF and microwave filter.	CO5	BTL 2	Understanding

14.	Outline the VSWR circle for the reflection coefficient equal to 1.	CO5	BTL 2	Understanding
15.	Define transducer power gain.	CO5	BTL 2	Understanding
16.	Calculate the VSWR of an amplifier if the amplifier has the reflection co-efficient 0.2533.	CO5	BTL 2	Understanding
17.	State the concept unilateral power gain.	CO5	BTL 2	Understanding
18.	Write necessary and sufficient conditions for an amplifier to be unconditionally stable.	CO5	BTL 2	Understanding
19.	Quote about low noise amplifier.	CO5	BTL 2	Understanding
20.	How is the noise voltage formula related to the noise figure?	CO5	BTL 2	Understanding
21.	Recall the concept of mixers with neat diagram.	CO5	BTL 2	Understanding
22.	Summarize the major components used in the mixer design.	CO5	BTL 2	Understanding
23.	Compare the diode and FET mixer design with neat diagram.	CO5	BTL 2	Understanding
24.	Formulate the conditions for oscillations of an amplifier.	CO5	BTL 2	Understanding

PART – B					
1.	Examine the transducer power gain, unilateral power gain, available power gain and operating power gain of a microwave amplifier using S parameters.	(13)	CO5	BTL 4	Analyzing
2.	Derive the expression for unilateral power gain with necessary signal flow diagram.	(13)	CO5	BTL 3	Applying
3.	Discuss about impedance matching using discrete component and formulate the conditions for impedance matching.	(13)	CO5	BTL 4	Analyzing
4.	Elaborate in detail about the concept of single ended, double-balanced and triple balanced mixer.	(13)	CO5	BTL 4	Analyzing
5.	Explain about microwave amplifier power design with the neat diagram of general amplifier system.	(13)	CO5	BTL 4	Analyzing
6.	Classify the methods to design the filter for microwave frequencies.	(13)	CO5	BTL 3	Applying
7.	Explain the concepts of T and Pi matching networks and comment the design issues for the same.	(13)	CO5	BTL 4	Analyzing
8.	(i) Interpret the steps involved to design a low noise amplifier	(7)	CO5	BTL 3	Applying
	(ii) Distinguish the power match and noise match in a low noise amplifier.	(6)	CO5		
9.	(i) Explain the significance of impedance matching and tuning.	(7)	CO5	BTL 3	Applying
	(ii) Design a microwave amplifier for maximum transducer power gain.	(6)	CO5		
10.	(i) Compare the different types of mixers.	(6)	CO5	BTL 3	Applying
	(ii) Show the distinction between the following parameters of Conversion gain, Linearity and isolation of a mixer.	(7)	CO5		
11.	(i) Describe the characteristics of amplifier. (ii) Discuss about the basic concepts of RF design.	(7)	CO5	BTL 3	Applying

12.	Elaborate about constant VSWR circles and different types of transducer power gain.	(13)	CO5	BTL 3	Applying
13.	Explain in detail about microwave filter design.	(13)	CO5	BTL 3	Applying
14.	Describe about RF mixer with neat diagram and list the mixers used in microwaves.	(13)	CO5	BTL 4	Analyzing
15.	Show that noise figure of three stage amplifier is $F=F_1+ (F_2-F_1)/(GA_1) + (F_3-F_1)/GA_2$ where F_1, F_2 and F_3 are noise figures and GA_1, GA_2 are power gains.	(13)	CO5	BTL 4	Analyzing
16.	Analyze about multistage low noise amplifier with neat diagram.	(13)	CO5	BTL 4	Analyzing
17.	Explain about one port negative resistance oscillator and RF transistor model.	(13)	CO5	BTL 4	Analyzing

PART – C					
1.	An RF amplifier has the following S parameters: $S_{11} = 0.3\angle{-70°}$, $S_{21}=3.5\angle{85°}$, $S_{12}=0.2\angle{-10°}$, $S_{22}=0.4\angle{-45°}$. Further $Vs=5V\angle 0°$, $Zs=40\ \Omega$ and $Z_L=73\ \Omega$. Assuming $Zo=50\ \Omega$. Evaluate G_T, G_{TU}, G_A and G.	(15)	CO5	BTL3	Applying
2.	An antenna is connected to a low-noise amplifier with a piece of coaxial transmission line. The amplifier bas a gain of 15 dB, a bandwidth of 100 MHz. and a noise temperature of 150 K. The coaxial line has an attenuation of 2 dB. Find the noise figure of the transmission line-amplifier cascade. What would be the noise figure if the amplifier wert placed at the antenna eliminating the transmission line. Assume all components are at an ambient temperature of T = 300 K.	(15)	CO5	BTL4	Analyzing
3.	Explain the different types of balanced microwave mixers with its operation.	(15)	CO5	BTL4	Analyzing
4.	(i)Explain RF and Microwave amplifier design parameters. (ii)Describe the stability considerations in microwave circuit design.	(8) (7)	CO5	BTL3	Applying
5.	Elaborate about low noise amplifier design process in detail.	(15)	CO5	BTL4	Analyzing