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

Regulation – 2019

Academic Year 2022 – 2023

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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**	**BT Level**	**Competence**
1.	What is the need of an antenna?	BTL 1	Remembering
2.	Define the term antenna.	BTL 1	Remembering
3.	List out the microwave frequency bands in electromagnetic spectrum	BTL 1	Remembering
4.	State the condition to be satisfied with respect to current and charge for emitting radiation.	BTL 1	Remembering
5.	Categorize the antenna parameters.	BTL 4	Analyzing
6.	How the field regions of an antenna are classified?	BTL 4	Analyzing
7.	Obtain the total power radiated by an antenna over an entire solid angle of 4π.	BTL 3	Applying
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.	BTL 3	Applying
9.	Sketch the two dimensional radiation pattern of a directional antenna.	BTL 1	Remembering
10.	Name the radiation pattern lobes of an antenna.	BTL 1	Remembering
11.	The performance of a linearily polarized antenna are defined by the principal patterns- Justify.	BTL 4	Analyzing
12.	Relate the gain and directivity of an antenna through an appropriate mathematical expression.	BTL 3	Applying
13.	Differentiate Radian and Steradian.	BTL 4	Analyzing
14.	Find the equation for antenna noise temperature with it's definition	BTL 3	Applying
15.	If the noise figure of an antenna at room temperature is 2 dB, compute the effective noise temperature.	BTL 3	Applying
16.	Illustrate the significance of G/T calculation.	BTL 3	Applying
17.	Explore the need for impedance matching in antennas.	BTL 4	Analyzing
18.	Summarize the different types of matching techniques	BTL 2	Understanding
19.	Write an equation that relates the received and transmitted power based on the distance between the antennas.	BTL 2	Understanding
20.	Mention the importance of Friis equation in communication.	BTL 2	Understanding
21.	Interpret the expression for the radar range equation.	BTL 4	Analyzing
22.	Compare link budget and link margin in the field of antenna design	BTL 2	Understanding
23.	Outline the noise contribution of various components in a receiver.	BTL 2	Understanding
24.	Discuss the need for noise characterization of a microwave receiver.	BTL 2	Understanding

PART - B					
1.		How radiation is accomplished using two wire antenna?	(13)	BTL1	Remembering
2.		List the antenna parameters and explain any four parameters in detail.	(13)	BTL1	Remembering
3.	(i)	Derive the power radiated from an antenna in terms of the radiation intensity.	(8)	BTL3	Applying
	(ii)	Find the power radiated by an antenna if the radiation intensity is given by $A\sin\theta$.	(5)	BTL3	Applying
4.		Explain the two dimensional normalized field pattern and power pattern of a linear array of an isotropic sources.	(13)	BTL2	Understanding
5.		Summarize radiation pattern with a three dimension model. Also explain HPBW, FNBW and the other lobes.	(13)	BTL2	Understanding
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)	BTL3	Applying
	(ii)	Interpret the concept of radiation pattern and directivity of an antenna.	(6)	BTL3	Applying
7.	(i)	Analyze the characteristics of omnidirectional, directional and an isotropic radiators.	(8)	BTL4	Analyzing
	(ii)	Examine how the space around the antenna is subdivided.	(5)	BTL4	Analyzing
8.		Define gain of an antenna. Explain with mathematical expression about the relative gain and absolute gain of an antenna.	(13)	BTL2	Understanding
9.		For a source with a radiation intensity $U = 6\cos\theta$, find the directivity and half power beamwidth when the radiation is unidirectional.	(13)	BTL3	Applying
10.	(i)	Considering the losses of an antenna determine the overall efficiency of an antenna.	(7)	BTL2	Understanding
	(ii)	Explain the classification of polarization observed in the radiation of an antenna.	(6)	BTL2	Understanding
11.		Describe the importance of the impedance matching in the transmission line involving antenna.	(13)	BTL1	Remembering
12.		Mention the different types of impedance matching techniques available in the microwave frequency range applications, explain in detail.	(13)	BTL1	Remembering
13.	(i)	Write a note on antenna noise temperature and deduce the noise equivalent temperature expression.	(8)	BTL1	Remembering
	(ii)	If the noise figure of an antenna is 2 dB, what is the effective noise temperature?	(5)	BTL1	Remembering
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)	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)	BTL4	Analyzing

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

PART - C					
1.		Explain the radiation mechanism with different configurations of single wire as radiator.	(15)	BTL2	Understanding
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)	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)	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)	BTL3	Applying
5.	(i)	Outline the characteristics of the components required to build a microwave receiver.	(8)	BTL1	Remembering
	(ii)	Draw the geometrical arrangement of a target and receiver and obtain the appropriate radar range equation.	(7)	BTL1	Remembering

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 is meant by Hertzian dipole?	BTL1	Remembering
2.	How does the radiation occurs from the current element?	BTL1	Remembering
3.	Define radiation resistance of an antenna.	BTL1	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.	BTL3	Applying
5.	Under which condition, the radiation pattern of loop antenna is same as the Hertzian dipole antenna?	BTL4	Analyzing
6.	Mention the features of slot antenna.	BTL2	Understanding

7.	Write the relationship between the terminal impedances of the slot antenna and the dipole.	BTL1	Remembering
8.	State Babinet's principle.	BTL1	Remembering
9.	Summarize the field equivalence approach.	BTL2	Understanding
10.	Interpret the design considerations for an aperture antenna.	BTL3	Applying
11.	Outline the characteristics of corner reflector antenna.	BTL2	Understanding
12.	List the advantages of cassegrain feed system.	BTL1	Remembering
13.	Interpret how spillover happens during the reception of signal in an antenna.	BTL3	Applying
14.	Illustrate the nature of secondary antennas.	BTL3	Applying
15.	Analyze how the aperture blockage can be prevented in reflector antenna.	BTL4	Analyzing
16.	Summarize the advantages of microstrip antennas	BTL2	Understanding
17.	Categorize the feeding methods of microstrip antenna.	BTL4	Analyzing
18.	Examine the applications of microstrip antenna.	BTL4	Analyzing
19.	Illustrate the expressions for design ratio, spacing factor of log periodic antenna.	BTL3	Applying
20.	Name the regions based on the length of dipole in LPDA.	BTL2	Understanding
21.	What is the main idea of frequency independent antenna?	BTL2	Understanding
22.	Classify the types of horn antennas.	BTL4	Analyzing
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.	BTL3	Applying
24.	Generalize the features of pyramidal horn antenna.	BTL4	Analyzing

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

		length to diameter ratio of 28 and length of 0.925 λ having terminal impedance of $710 + j\,0\ \Omega$.			
6.		Describe rectangular apertures and derive expressions for its uniform distribution on an infinite ground plane and space.	(13)	BTL 2	Understanding
7.	(i)	With field equivalence principle, explain radiation mechanism.	(6)	BTL 4	Analyzing
	(ii)	A rectangular aperture with a constant field distribution, with $a = 3\lambda$ and $b = 2\lambda$, is mounted on an infinite ground plane. Compute the FNBW and HPBW in the E-plane.	(7)	BTL 4	Analyzing
8.		Elaborate the principle of parabolic reflector antenna with the neat diagram and explain the types of feed used.	(13)	BTL 2	Understanding
9.	(i)	Compare the flat reflector and corner reflector.	(7)	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)	BTL3	Applying
10.	(i)	Describe the radiation pattern and fields on the axis of an E-plane and H-plane sectoral horns.	(6)	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)	BTL3	Applying
11.	(i)	With necessary sketches, explain in detail the radiation mechanism of a microstrip patch antenna.	(7)	BTL 1	Remembering
	(ii)	With suitable figures, explain the various feed techniques of a microstrip antenna.	(6)	BTL 1	Remembering
12.		Explain radiation mechanism of a microstrip antenna considering square microstrip antenna. Also draw the normalized patterns for the same.	(13)	BTL 1	Remembering
13.		Analyze the feeding techniques for the rectangular patch antenna with neat diagrams.	(13)	BTL 4	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)	BTL 1	Remembering
15.		Identify the radiation resistance of a single turn and an eight-turn small circular loop when the radius of the loop is $\lambda/20$ and the medium is free space.	(13)	BTL 1	Remembering
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)	BTL 4	Analyzing
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)	BTL 4	Analyzing

PART – C					
1.		An electric field strength 10 µV/m is to be measured at an observation point θ = π/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)	BTL 3	Applying
2.	(i)	Compare the field quantities and the other relevant parameter of a small loop antenna with a short dipole antenna.	(8)	BTL 4	Analyzing
	(ii)	By applying the Poynting theorem determine the radiation resistance of a circular loop antenna.	(7)	BTL 4	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)	BTL 4	Analyzing
4.		Derive the parabola geometry that makes it a suitable for antenna reflectors. Design an antenna employing a parabolic reflector that is likely to be a highly directive receiving antenna.	(15)	BTL 2	Understanding
5.		Draw the structure of log periodic dipole array and explain the operating principle and mention its applications.	(15)	BTL 1	Remembering

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 is mean by uniform linear array?	BTL 1	Remembering
2.	Define phased array and frequency scanning array.	BTL 1	Remembering
3.	Write about pattern multiplication and its advantages.	BTL 1	Remembering
4.	List the features of smart antennas and where it is employed?	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.	BTL 1	Remembering
6.	How to eliminate minor lobes?	BTL 1	Remembering
7.	Interpret the meaning of array factor.	BTL 2	Understanding
8.	Summarize the advantages and disadvantages of binomial array.	BTL 2	Understanding
9.	Draw the radiation pattern for broad side and end fire array.	BTL 2	Understanding
10.	Enumerate the basic principle of reconfigurable antennas.	BTL 2	Understanding
11.	Distinguish Binomial and Chebyshev distributions.	BTL 2	Understanding
12.	Write the expression that represents the pattern multiplication.	BTL 2	Understanding
13.	Show the conditions to obtain end fire array antenna.	BTL 3	Applying
14.	Identify the feed networks used in a phased array antenna.	BTL 3	Applying
15.	Illustrate the meaning and need for the binomial array.	BTL 3	Applying
16.	Select the active antennas towards the wide interest for industrial applications.	BTL 3	Applying
17.	Solve the directivity of a broadside array of length is 10 λ.	BTL 3	Applying
18.	Classify different types of antenna arrays.	BTL 3	Applying

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.	BTL 4	Analyzing
20.	Classify smart antennas.	BTL 4	Analyzing
21.	Explore the need for phase shifter in phased array antennas.	BTL 4	Analyzing
22.	Compare beam steering and beamforming.	BTL 4	Analyzing
23.	A linear end fire, uniform array of 10 elements has a separation of λ/4 between elements. Calculate the directivity of an array.	BTL 4	Analyzing
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.	BTL 4	Analyzing

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)	BTL 1	Remembering
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)	BTL 1	Remembering
3.	(i) Quote and derive the expression for field pattern of broad side array of N point sources.	(7)	BTL 1	Remembering
	(ii)A linear broadside array consists of 4 equal isotropic in-phase point sources with λ/3 spacing. Identify the directivity and beamwidth.	(6)		
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°.	(13)	BTL 1	Remembering
5.	Describe in detail about the resultant radiation pattern of two element array.	(13)	BTL 1	Remembering
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)	BTL 2	Understanding
7.	(i) Demonstrate the radiation mechanisms of broad side antenna array and end fire antenna array with neat sketches.	(7)	BTL 2	Understanding
	(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)		
8.	Discuss in details the concept, design principles and types of phased arrays.	(13)	BTL 2	Understanding
9.	(i) Derive expression for directivity of end fire array.	(7)	BTL 2	Understanding
	(ii) Write the properties of end fire array and frequency scanning arrays.	(6)		
10.	(i) Show the expression for the field produced by linear array and deduces it for an end fire array.	(7)	BTL 3	Applying
	(ii) Express the properties of linear broadside array.	(6)		
11.	(i) Illustrate about the method of pattern multiplication.	(7)	BTL 3	Applying
	(ii) Solve the expression for directions of pattern minima, pattern maxima, BWFN due to broad side array.	(6)		
12.	Derive array factor of an uniform linear array. Explain the	(13)	BTL 3	Applying

	significance of array factor.			
13.	Illustrate about the adaptive arrays and smart antennas.	(13)	BTL 3	Applying
14.	Examine how analog and digital beam forming is achieved with an antenna array with a neat diagram.	(13)	BTL 4	Analyzing
15.	(i)Analyze the working principle of phased array antenna with neat diagram.	(7)	BTL 4	Analyzing
	(ii)Describe the radiation mechanisms of binomial array with neat sketches and derive the expression for array factor.	(6)		
16.	Identify the direction of maximum and minimum radiation from the resultant radiation of two identical radiators which are spaced d = 3 $\lambda/4$ meters apart and fed with currents of equal magnitude but with 180^o phase difference.	(13)	BTL 4	Analyzing
17.	Inspect the maxima, minima and half power directions if two point sources are fed with currents equal in magnitude but opposite in phase.	(13)	BTL 4	Analyzing

PART - C				
1.	Derive and draw the radiation pattern of 4 isotropic sources of equal amplitude and same phase.	(15)	BTL 1	Remembering
2.	Summarize in detail about the conditions for two-point sources with currents unequal in magnitude and with any phase.	(15)	BTL 2	Understanding
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)	BTL 3	Applying
4.	(i) Deduce the directivity of a given linear broadside, uniform array of 10 isotropic elements with a separation of $\lambda/4$ between the elements.	(8)	BTL 4	Analyzing
	(ii) A linear broadside array consists of four equal isotropic in-phase point sources with $\lambda/3$ spacing. Construct the directivity and beamwidth if the total length of the array is λ.	(7)		
5.	A uniform linear array consists of 16 isotropic point sources with a spacing of $\lambda/4$. If the phase difference is -90^o, Determine the directivity, HPBW, beam solid angle and effective apertures.	(15)	BTL 4	Analyzing

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.	Outline the properties of power dividers with examples.	BTL 1	Remembering
2.	Identify the use of matched termination in microwave communication setup.	BTL 1	Remembering
3.	Draw the equivalent circuit of a Gunn diode.	BTL 1	Remembering
4.	Write the effect of transit time.	BTL 1	Remembering
5.	What are the differences between TWTA and klystron amplifier?	BTL 1	Remembering

6.	List the basic parameters to measure the performance of a directional coupler?	BTL 1	Remembering
7.	Summarize sum and difference arm of magic Tee.	BTL 2	Understanding
8.	Discuss about attenuator and resonator.	BTL 2	Understanding
9.	Summarize the condition for oscillation and applications in reflex klystron.	BTL 2	Understanding
10.	Review the principle of Faraday's rotation.	BTL 2	Understanding
11.	Distinguish between microwave passive components and ssemiconductor ddevices.	BTL 2	Understanding
12.	How the performance of directional coupler can be determined?	BTL 2	Understanding
13.	Demonstrate Gunn diode and list the modes.	BTL 3	Applying
14.	Exhibit the negative resistance property in Gunn diode.	BTL 3	Applying
15.	Interpret about the Schottky barrier diodes.	BTL 3	Applying
16.	Pointout the various types of Tee used in microwave.	BTL 3	Applying
17.	Show the features of power divider.	BTL 3	Applying
18.	Illustrate the transferred electron effect.	BTL 3	Applying
19.	Examine the factors reducing the efficiency of IMPATT diode.	BTL 4	Analyzing
20.	Categorize the applications of magic-Tee.	BTL 4	Analyzing
21.	Compare PIN and PN diode.	BTL 4	Analyzing
22.	Why magnetron is called as cross field device?	BTL 4	Analyzing
23.	Determine the purpose of slow wave structures in TWT.	BTL 4	Analyzing
24.	Inspect the frequency pulling and frequency pushing in magnetrons.	BTL 4	Analyzing

PART - B				
1.	With neat diagram explain the operation of attenuators in detail.	(13)	BTL 1	Remembering
2.	Show the operation and properties of power divider. Derive their S parameters.	(13)	BTL 1	Remembering
3.	(i) With the help of a neat diagram describe the magic Tee working principle.	(7)	BTL 1	Remembering
	(ii) Find scattering matrix and applications of magic Tee.	(6)		
4.	(i) Write notes on high frequency limitations of conventional vacuum devices.	(7)	BTL 1	Remembering
	(ii) What are the characteristics of travelling wave tube?	(6)		
5.	Examine the operation mechanism of two-cavity Klystron amplifier with neat sketch and write the expression for its output power.	(13)	BTL 1	Remembering
6.	(i) From the first principles derive the scattering matrix of a multi hole directional coupler.	(7)	BTL 2	Understanding
	(ii) Infer the characteristics of directional coupler in terms of S parameters and explain in detail two-hole directional coupler.	(6)		
7.	(i) Discuss the working principle of reflex klystron oscillator with necessary diagrams.	(7)	BTL 2	Understanding
	(ii) Derive velocity modulation, transit time of reflex klystron oscillator.	(6)		
8.	(i) Summarize the power output mode curve/frequency characteristics of reflex klystron.	(7)	BTL 2	Understanding
	(ii) Draw the equivalent circuit and obtain the electronic spiral	(6)		

	curve of reflex klystron.			
9.	Discuss the working principle of Gunn diode oscillator and its modes.	(13)	BTL 2	Understanding
10.	With neat diagrams, explain the operation of transmission line resonators and its application.	(13)	BTL 3	Applying
11.	Demonstrate the Schottky barrier diodes and its application in microwave communication.	(13)	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)	BTL 3	Applying
13.	(i) Solve 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)	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)		
14.	Explain in detail about PIN diodes, control circuits and its applications.	(13)	BTL 4	Analyzing
15.	Discuss 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)	BTL 4	Analyzing
16.	(i) What are avalanche transit time devices? Explain the operation and construction of IMPATT diode.	(7)	BTL 4	Analyzing
	(ii) Explain mechanism of oscillation of IMPATT and as power amplifier.	(6)		
17.	Discuss the following :		BTL 4	Analyzing
	(i) T-junction power divider.	(7)		
	(ii) Cylindrical Magnetron.	(6)		

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)	BTL 1	Remembering
2.	With neat diagram, discuss the characteristics of series Tee and shunt Tee and derive the S matrix.	(15)	BTL 2	Understanding
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)	BTL 3	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)	BTL 4	Analyzing
5.	With the help of two valley, explain how negative resistance can be created in Gunn diode and compare with tunnel diode.	(15)	BTL 4	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**	**BT Level**	**Competence**
1.	Why impedance matching is required?	BTL 1	Remembering
2.	Define about a perfect filter.	BTL 1	Remembering
3.	List out the constraints of impedance matching.	BTL 1	Remembering
4.	What is the need of Rollet factor, K? Write its expressions.	BTL 1	Remembering
5.	Name the uses of microwave filters.	BTL 1	Remembering
6.	Identify the considerations in selecting a matching network.	BTL 1	Remembering
7.	State the significance of microstrip matching networks.	BTL 2	Understanding
8.	Draw typical output stability circle and input stability circle.	BTL 2	Understanding
9.	Distinguish single stub matching and double stub matching.	BTL 2	Understanding
10.	Write down the expression that relates the nodal quality factor (Q_n) with loaded quality factor (Q_L).	BTL 2	Understanding
11.	Summarize the filter realization steps in RF filter design.	BTL 2	Understanding
12.	Discuss the stability requirements in RF amplifier design.	BTL 2	Understanding
13.	Define about RF and microwave filter.	BTL 3	Applying
14.	Outline the VSWR circle for the reflection coefficient equal to 1.	BTL 3	Applying
15.	Define transducer power gain.	BTL 3	Applying
16.	Calculate the VSWR of an amplifier if the amplifier has the reflection co-efficient 0.2533.	BTL 3	Applying
17.	State the concept unilateral power gain.	BTL 3	Applying
18.	Write necessary and sufficient conditions for an amplifier to be unconditionally stable.	BTL 3	Applying
19.	Quote about low noise amplifier.	BTL 4	Analyzing
20.	Correlate the formula for noise voltage and noise figure.	BTL 4	Analyzing
21.	Recall the concept of mixers with neat diagram.	BTL 4	Analyzing
22.	Summarize the major components used in the mixer design.	BTL 4	Analyzing
23.	Compare the diode and FET mixer design with neat diagram.	BTL 4	Analyzing
24.	Formulate the conditions for oscillations of an amplifier.	BTL 4	Analyzing

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)	BTL 1	Remembering
2.	Derive the expression for unilateral power gain with necessary signal flow diagram.	(13)	BTL 1	Remembering
3.	Discuss about impedance matching using discrete component and formulate the conditions for impedance matching.	(13)	BTL 1	Remembering
4.	Elaborate in detail about the concept of single ended, double-balanced and triple balanced mixer.	(13)	BTL 1	Remembering
5.	Explain about microwave amplifier power design with the neat diagram of general amplifier system.	(13)	BTL 1	Remembering
6.	Classify the methods to design the filter for microwave frequencies.	(13)	BTL 2	Understanding
7.	Explain the concepts of T and Pi matching networks and comment the design issues for the same.	(13)	BTL 2	Understanding
8.	(i) Interpret the steps involved to design a low noise amplifier	(7)	BTL 2	Understanding
	(ii) Distinguish the power match and noise match in a low noise amplifier.	(6)		
9.	(i) Explain the significance of impedance matching and tuning.	(7)	BTL 2	Understanding
	(ii) Design a microwave amplifier for maximum transducer power gain.	(6)		
10.	(i) Compare the different types of mixers.	(6)	BTL 3	Applying
	(ii) Show the distinction between the following parameters of Conversion gain, Linearity and isolation of a mixer.	(7)		
11.	(i) Describe the characteristics of amplifier. (ii) Discuss about the basic concepts of RF design.	(7)	BTL 3	Applying
12.	Elaborate about constant VSWR circles and different types of transducer power gain.	(13)	BTL 3	Applying
13.	Explain in detail about microwave filter design.	(13)	BTL 3	Applying
14.	Describe about RF mixer with neat diagram and list the mixers used in microwaves.	(13)	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)	BTL 4	Analyzing
16.	Analyze about multistage low noise amplifier with neat diagram.	(13)	BTL 4	Analyzing
17.	Explain about one port negative resistance oscillator and RF transistor model.	(13)	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 $V_s=5V\angle 0°$, $Z_s=40\ \Omega$ and $Z_L=73\ \Omega$. Assuming $Z_o=50\ \Omega$. Evaluate G_T, G_{TU}, G_A and G.	(15)	BTL 1	Remembering
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	(15)	BTL 2	Understanding

	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.			
3.	Explain the different types of balanced microwave mixers with its operation.	(15)	BTL 3	Applying
4.	(i)Explain RF and Microwave amplifier design parameters. (ii)Discuss about stability considerations in microwave circuit design.	(8) (7)	BTL 4	Analyzing
5.	Elaborate about low noise amplifier design process in detail.	(15)	BTL 4	Analyzing