SRM VALLIAMMAI ENGINEERING COLLEGE

(An Autonomous Institution)

SRM Nagar, Kattankulathur – 603 203

DEPARTMENT OF

ELECTRONICS AND COMMUNICATION ENGINEERING

QUESTION BANK

VI SEMESTER

EC3663 – ANTENNAS AND WAVE PROPAGATION

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Prepared by

Dr. S. Ramesh, *Professor /ECE*

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

Dr. G. Sathish Kumar, *Assistant Professor(Sel.G) /ECE*

EC3663 – ANTENNAS AND WAVE PROPAGATION

Unit I - ANTENNA BASICS AND LINEAR WIRE ANTENNAS				
Definition of antenna parameters – Radiation Resistance, Antenna Polarization, Radiation Patterns, Beam Width, Radiation Intensity, Beam Area, Directivity, Gain, Antenna Aperture, Effective length, Bandwidth, Antenna Temperature, Reciprocity in Antennas, Friis Transmission Formula, Radiation from oscillating dipole, Half wave dipole, Quarter Wave Monopole.				
PART – A				
Q.No	**Questions**	**CO**	**BT Level**	**Competence**
1.	Define antenna.	CO1	BTL 1	Remembering
2.	List the antenna parameters.	CO1	BTL 1	Remembering
3.	Write the significance of radiation resistance.	CO1	BTL 1	Remembering
4.	Draw the 3D pattern of a directional antenna with maximum in z- direction at $\theta = 0^\circ$.	CO1	BTL 1	Remembering
5.	Define the term Half Power Beam Width.	CO1	BTL 1	Remembering
6.	What is an elementary dipole and how does it differ from the infinitesimal dipole?	CO1	BTL 1	Remembering
7.	Name the types of an antenna.	CO1	BTL 1	Remembering
8.	Relate the Gain and Directivity of an antenna through proper expression.	CO1	BTL 2	Understanding
9.	Write about retarded potential in antenna.	CO1	BTL 1	Remembering
10.	Define Radiation pattern	CO1	BTL 1	Remembering
11.	What are the two types of radiation pattern. Field pattern	CO1	BTL 1	Remembering
12.	A radio link has a 15W transmitter connected to an antenna of 2.5 m^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, estimate the power delivered to receiver.	CO1	BTL 2	Understanding
13.	An antenna has a field pattern described by $E\varphi=Cos^2\varphi$ for $0^\circ \leq \varphi \leq 90^\circ$. Find the Half Power Beam Width (HPBW) of the antenna.	CO1	BTL 2	Understanding
14.	Interpret dB and dBi in antenna measurements.	CO1	BTL 2	Understanding
15.	Draw the E plane and H plane radiation pattern of a dipole	CO1	BTL 1	Remembering
16.	Differentiate between antenna directivity and gain.	CO1	BTL 2	Understanding
17.	The radial component of the radiated power density of an antenna is given by $W_{rad} = W_r\hat{a}r = A_o\sin\theta / r^2 \ \hat{a}r$ (W/m^2) where A_o is the peak value of the power density, θ is the usual spherical coordinate and $\hat{a}r$ is the radial unit vector. Determine the total radiated power of the antenna.	CO1	BTL 2	Understanding
18.	An antenna element is placed in an electric field of strength 2 V/m and an induced voltage of 0.7 V is obtained. Calculate the effective length of the antenna element.	CO1	BTL 2	Understanding
19.	An antenna has a radiation resistance of 65 Ω and a loss resistance of 10 Ω. Determine the antenna efficiency and express it in decibels (dB).	CO1	BTL 2	Understanding
20.	The radiation resistance of an antenna is 72 Ohms and the	CO1	BTL 1	Remembering

	loss resistance is 8 Ohms. What is the directivity (in dB), if the power gain is 15?			
21.	Write the importance of antenna bandwidth.	CO1	BTL 2	Understanding
22.	Compare half-wave dipole and quarter-wave monopole antennas in terms of radiation characteristics	CO1	BTL 2	Understanding
23.	Outline the working of a quarter-wave monopole antenna.	CO1	BTL 2	Understanding
24.	Why a half-wave dipole commonly used?	CO1	BTL 2	Understanding

PART – B

1.	Explain the terms "Radiation Resistance", "gain", "directivity", and "polarization" of an antenna	(16)	CO1	BTL 3	Applying
2.	How radiation is accomplished using two wire antenna?	(16)	CO1	BTL 3	Applying
3.	(i) An antenna has a field pattern given by $E(\theta)=\cos\theta\cos2\theta$ for $0^\circ \le \theta \le 90^\circ$. Compute (a) HPBW (b) FNBW.	(8)	CO1	BTL 3	Applying
	(ii) Interpret the concept of radiation pattern and directivity of an antenna.	(8)			
4.	Write short notes on (i)Vector Potential (ii)Polarization (iii)Retarded Potential (iv)Radiation Pattern	(16)	CO1	BTL 4	Analyzing
5.	Elaborate in detail about the radiation from a small oscillating current element with the required E and H field quantities and diagrams.	(16)	CO1	BTL 4	Analyzing
6.	Explain the structure of a folded dipole antenna and find the radiation resistance and the admittance of the folded dipole.	(16)	CO1	BTL 3	Applying
7.	Illustrate the radiated fields of a center fed $\lambda/2$ dipole antenna with an appropriate expression. Sketch the radiation pattern.	(16)	CO1	BTL 4	Analyzing
8.	Summarize the principle of radiation from an oscillating electric dipole. Derive the near field and far field expressions.	(16)	CO1	BTL 3	Applying
9.	Show that the directivity of an antenna depends on the power radiated. Using the expression obtained for directivity determine the maximum directivity of the antenna for an infinitesimal linear dipole of length $l << \lambda$ for which the radial component of the power density is $W_{av} = W_r = A_o (\sin^2 \theta / r^2)$ (W/m^2)	(16)	CO1	BTL 3	Applying
10.	Derive the expression for the field quantities radiated from a $\lambda/2$ dipole and prove that the radiation resistance to be 73 Ω .	(16)	CO1	BTL 4	Analyzing
11.	(i) Examine the Friis transmission equation relating the power received to the power transmitted between the antennas separated by a distance of 'R' units.	(8)	CO1	BTL 4	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.	(8)			
12.	Analyze the electric and magnetic field components of a finite length dipole antenna and show its current distribution with respect to its length in terms of the wavelength.	(16)	CO1	BTL 4	Analyzing

13.	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	(16)	CO1	BTL 3	Applying
14.	Determine the field equations for a Hertzian dipole to produce the purely resistive intrinsic impedance.	(16)	CO1	BTL 4	Analyzing
15.	Prove that the radiation resistance of a half wave dipole antenna is 73 Ω.	(16)	CO1	BTL 3	Applying
16.	Deduce an expression for the power radiated by the current element and calculate the radiation resistance	(16)	CO1	BTL 3	Applying
17.	Explain Hertzian dipoles and find the electric and magnetic field quantities of infinitesimal and radiation pattern	(16)	CO1	BTL 4	Analyzing

UNIT II ANTENNA ARRAYS

N element linear array, Pattern multiplication, Broadside and End fire array – Concept of Phased arrays, Adaptive array, Basic principle of antenna Synthesis-Binomial array, Tchebyshev distribution.

PART – A

Q.No	Questions	CO	BT Level	Competence
1.	What is meant uniform linear array?	CO2	BTL 1	Remembering
2.	Define phased array.	CO2	BTL 1	Remembering
3.	Write about pattern multiplication and its advantages.	CO2	BTL 1	Remembering
4.	Outline the features of the adaptive array and specify where it is employed.	CO2	BTL 2	Understanding
5.	Draw the radiation pattern of an isotropic point sources of same amplitude and opposite phase that are λ/2 apart along X-axis symmetric with respect to the origin.	CO2	BTL 1	Remembering
6.	How to eliminate minor lobes?	CO2	BTL 1	Remembering
7.	Interpret the meaning of linear array and point source.	CO2	BTL 2	Understanding
8.	Summarize the advantages and disadvantages of binomial array.	CO2	BTL 2	Understanding
9.	Draw the radiation pattern for broad side and end fire array.	CO2	BTL 1	Remembering
10.	Summarize the basic principle of pattern multiplication.	CO2	BTL 2	Understanding
11.	Show the conditions to obtain end fire array antenna.	CO2	BTL 2	Understanding
12.	Identify the feed networks used in a phased array antenna .	CO2	BTL 2	Understanding
13.	Illustrate the concept of binomial array.	CO2	BTL 1	Remembering
14.	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.	CO2	BTL 1	Remembering
15.	Write about antenna arrays.	CO2	BTL 1	Remembering
16.	List the need for phase shifter in phased array antennas.	CO2	BTL 1	Remembering
17.	Differentiate Binomial and Chebyshev distributions.	CO2	BTL 2	Understanding
18.	Compare end fire and broad side array.	CO2	BTL 2	Understanding
19.	State the basic objective of antenna synthesis.	CO2	BTL 1	Remembering

20.	How antenna synthesis helps in controlling radiation pattern?	CO2	BTL 2	Understanding
21.	A linear end fire, uniform array of 10 elements has a separation of λ/4 between elements. Find the directivity of an array.	CO2	BTL 1	Remembering
22.	Illustrate the relative excitation levels of a binomial array of 2 and 3 elements.	CO2	BTL 2	Understanding
23.	Define Tchebyshev (Chebyshev) distribution.	CO2	BTL 1	Remembering
24.	Why Tchebyshev distribution is preferred over binomial distribution in practical arrays?	CO2	BTL 2	Understanding

PART – B

1.	Obtain 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 degree. (16)	(16)	CO2	BTL 3	Applying
2.	(i)Quote and derive the expression for field pattern of broad side array of N point sources. (ii)A linear broadside array consists of 4 equal isotropic in-phase point sources with λ/3 spacing. Identify the directivity and beamwidth.	(8) (8)	CO2	BTL 4	Analyzing
3.	For a 2 element linear antenna array separated by a distance d = 3 λ/4 , derive the field quantities and draw its radiation pattern for the phase difference of 45°.	(16)	CO2	BTL 4	Analyzing
4.	Review how does the directivity of an array represent the figure of merit on the operation of the system? Derive expressions for the directivity of broadside array and end fire array.	(16)	CO2	BTL 4	Analyzing
5.	(i)Research the radiation mechanisms of broad side antenna array and End fire antenna array with neat sketches. (ii) What is binomial array? Draw the pattern of 10 element binomial array with spacing between the elements of 3λ/4 and λ/2**.**	(8) (8)	CO2	BTL 3	Applying
6.	Discuss and derive the expressions for directivity of the following N element linear array antennas. (i) Broad side array (ii) End fire array (iii) Phased array(iv) Tapered array	(16)	CO2	BTL 4	Analyzing
7.	(i) Show the expression for the field produced by linear array and deduce it for an end fire array. (ii) Express the properties of linear broadside array.	(8) (8)	CO2	BTL 3	Applying
8.	(i)Illustrate about the method of pattern multiplication. (ii)Solve the expression for directions of pattern minima, pattern maxima, BWFN due to broad side array.	(8) (8)	CO2	BTL 3	Applying
9.	(i)Analyze the working principle of phased array antenna with neat diagram. (ii)Describe the radiation mechanisms of binomial array with neat sketches and derive the expression for array factor.	(8) (8)	CO2	BTL 4	Analyzing
10.	Identify the direction of maximum and minimum radiation from the resultant radiation of two identical radiators which	(16)	CO2	BTL 4	Analyzing

	are spaced d = 3 λ/4 meters apart and fed with currents of equal magnitude but with 180° phase difference.				
11.	Derive an expression for the far field of a continuous array of point sources of uniform amplitude and phase. Summarize and prove mathematically for finding directions of pattern nulls of the array.	(16)	CO2	BTL 3	Applying
12.	Design a broadside Dolph-Tschebyschev array of 10 elements withy spacing 'd' between the elements and with a major to minor lobe ratio of 26 db. Find the excitation coefficients and form the array factor.	(16)	CO2	BTL 3	Applying
13.	(i)Analyze the directivity of a given linear broadside, uniform array of 10 isotropic elements with a separation of λ/4 between the elements. (ii) A linear broadside array consists of four equal isotropic inphase point sources with λ/3 spacing. Construct the directivity and beamwidth.	(8) (8)	CO2	BTL 4	Analyzing
14.	A uniform linear array consists of 16 isotropic point sources with a spacing of λ/4. If the phase difference is -90 ^{o}, Evaluate the directivity, HPBW, beam solid angle and effective apertures.	(16)	CO2	BTL 4	Analyzing
15.	For an end fire consisting of several half wave length isotropic radiator is to have a directive gain of 30 ^{o}. Evaluate the array length and width of the major lobe. What will be these values for a broadside array.	(16)	CO2	BTL 4	Analyzing
16.	A broadside array operating at 100 cm wavelength consists of four halfway dipoles spaced 50 cm. Each element carries radio frequency current in the same phase and magnitude of 0.5 amp. Calculate radiated power, half width of major lobe. (16)	(16)	CO2	BTL 3	Applying
17.	A 7-element uniform linear array has an element spacing of d=λ/2 and is required to have a maximum side-lobe level of 25 dB.. Develop the array factor of the array using Tchebyshev polynomial method	(16)	CO2	BTL 3	Applying

UNIT III - APERTURE ANTENNAS				
Radiation from Rectangular, Uniform and Tapered aperture, Horn antennas, Slot antenna, Reflector antennas- Aperture blockage, Feeding structures, Applications of aperture antennas.				
PART – A				
Q.No	**Questions**	**CO**	**BT Level**	**Competence**
1.	Define the field equivalence principle.	CO3	BTL 1	Remembering
2.	State Huygen's principle.	CO3	BTL 1	Remembering
3.	Interpret the design considerations for an aperture antenna.	CO3	BTL 1	Remembering
4.	How the concept of aperture applied in an antenna?	CO3	BTL 1	Remembering
5.	Identify the examples for uniform and tapered apertures.	CO3	BTL 1	Remembering
6.	Why radiation pattern of a rectangular aperture is represented by sinc functions in both principal planes?	CO3	BTL 1	Remembering

7.	Interpret why the radiation pattern is symmetric in slot antenna.	CO3	BTL 2	Understanding
8.	Mention the features of slot antenna.	CO3	BTL 1	Remembering
9.	Write the relationship between the terminal impedances of the slot antenna and the dipole.	CO3	BTL 1	Remembering
10.	What are the applications of aperture antennas?	CO3	BTL 1	Remembering
11.	Outline the characteristics of corner reflector antenna.	CO3	BTL 1	Remembering
12.	List the advantages of Cassegrain feed system.	CO3	BTL 1	Remembering
13.	Interpret how spillover happens during the reception of signal in an antenna.	CO3	BTL 2	Understanding
14.	What is the nature of secondary antennas?	CO3	BTL 2	Understanding
15.	How the aperture blockage can be prevented in reflector antenna?	CO3	BTL 2	Understanding
16.	Compare uniform and tapered apertures.	CO3	BTL 2	Understanding
17.	Classify the types of horn antennas.	CO3	BTL 2	Understanding
18.	Calculate the beam width of the pyramidal horn with the aperture dimension of 12 × 6 cm. Its operating frequency is given as 10 GHz.	CO3	BTL 2	Understanding
19.	Summarize the features of pyramidal horn antenna.	CO3	BTL 2	Understanding
20.	List the merits of offset feed reflector antenna.	CO3	BTL 1	Remembering
21.	Find the significance of F/D ratio in reflector antenna.	CO3	BTL 2	Understanding
22.	Outline the principle of Babinet used in slot antenna.	CO3	BTL 2	Understanding
23.	A parabolic antenna having a circular mouth is to have power gain of 1000 at λ= 10 cm. Estimate the diameter of mouth and HPBW of the antenna.	CO3	BTL 2	Understanding
24.	Exhibit the concept of spill over in parabolic reflector.	CO3	BTL 2	Understanding

PART – B

1.	Derive the radiation components of field from a rectangular aperture with an illustration of field equivalence principle.	(16)	CO3	BTL 4	Analyzing
2.	What are the different types of horn structures? Draw the radiation pattern of horn antenna and hence describe the radiation mechanism with neat diagram.	(16)	CO3	BTL 4	Analyzing
3.	With field equivalence principle, explain radiation mechanism.	(8)	CO3	BTL 3	Applying
	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.	(8)	CO3		
4.	Explain the radiation mechanisms of slot antenna with diagram.	(16)	CO3	BTL 3	Applying
5.	Elaborate the principle of parabolic reflector antenna with the neat diagram and explain the types of feed used.	(16)	CO3	BTL 4	Analyzing
6.	Describe rectangular apertures and derive expressions for its uniform distribution on an infinite ground plane and space.	(16)	CO3	BTL 4	Analyzing
7.	(i) Compare the flat reflector and corner reflector.	(8)	CO3	BTL 3	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.	(8)	CO3		

8.	With suitable diagrams, compare uniform and tapered aperture illumination in terms of radiation pattern, directivity, sidelobe suppression, and practical applications.	(16)	CO3	BTL 4	Analyzing
9.	(i) Describe the radiation pattern and fields on the axis of an E-plane and H-plane sectoral horns.	(8)	CO3	BTL 3	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.	(8)	CO3		
10.	(i) Define aperture blockage and identify its major sources.	(8)	CO3	BTL 3	Applying
	(ii) List the types of reflector feeding methods with diagram.	(8)	CO3		
11.	"A horn antenna may be regarded as a flared out waveguide", Justify.	(8)	CO3	BTL 3	Applying
	What is reflector antenna? Explain with design procedure.	(8)	CO3		
12.	Summarize the different types of horn antenna used for radiation with suitable diagram.	(16)	CO3	BTL 3	Applying
13.	Explore the design and construction principles of a parabolic reflector antenna.	(16)	CO3	BTL 4	Analyzing
14.	Write short notes on field equivalence principle, uniform aperture distribution on slot antenna and aperture blockage.	(16)	CO3	BTL 4	Analyzing
15.	(i) Analyze the parabola geometry that makes it suitable for antenna reflectors.	(8)	CO3	BTL 4	Analyzing
	(ii) Design an antenna employing a parabolic reflector that is likely to be a highly directive receiving antenna.	(8)	CO3		
16.	Analyze the advantages and limitations of offset-fed reflector antennas with respect to blockage reduction, radiation pattern, and mechanical complexity.	(16)	CO3	BTL 4	Analyzing
17.	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.	(16)	CO3	BTL 3	Applying

UNIT IV - SPECIAL ANTENNAS AND ANTENNA MEASUREMENTS					
Yagi-Uda Antenna, Travelling Wave Antenna, Rhombic Antenna, Small Loop Antenna, Helical Antenna, Log-Periodic Antenna, Microstrip Patch Antenna. Antenna Measurements- VSWR, Impedance, Gain and Radiation pattern.					
PART – A					
Q.No	**Questions**			**BT Level**	**Competence**
1.	Define a Yagi–Uda antenna and name its three basic elements.		CO4	BTL 1	Remembering
2.	State the function of the reflector element in a Yagi–Uda antenna.		CO4	BTL 1	Remembering
3.	List any two examples of travelling wave antennas.		CO4	BTL 1	Remembering
4.	Why a helical antenna operating in axial mode produces circular polarization?		CO4	BTL 1	Remembering
5.	Write basic structural parameters of helical antenna.		CO4	BTL 1	Remembering
6.	What is the meaning of the scale factor (τ) used in log-periodic antenna design?		CO4	BTL 1	Remembering
7.	Write the expression for the radiation resistance of a small loop antenna.		CO4	BTL 1	Remembering
8.	Why a small loop antenna behaves as a magnetic dipole?		CO4	BTL 1	Remembering
9.	Mention the purpose of impedance matching in antenna systems.		CO4	BTL 1	Remembering
10.	Identify any two methods used for antenna impedance measurement.		CO4	BTL 1	Remembering
11.	List any two instruments used for measuring VSWR.		CO5	BTL 1	Remembering
12.	Define VSWR and state its importance in antenna measurements.		CO5	BTL 1	Remembering
13.	How the radiation pattern changes when the circumference of a helical antenna increase beyond one wavelength?		CO4	BTL 2	Understanding
14.	Summarize the advantages of microstrip antennas		CO4	BTL 2	Understanding
15.	Categorize the feeding methods of microstrip antenna.		CO4	BTL 2	Understanding
16.	Examine the applications of microstrip antenna.		CO4	BTL 2	Understanding
17.	Illustrate the expressions for design ratio, spacing factor of log periodic antenna.		CO4	BTL 2	Understanding
18.	Name the regions based on the length of dipole in LPDA.		CO4	BTL 2	Understanding
19.	Find the reason for the significance of pitch angle in determining the radiation characteristics of a helical antenna.		CO4	BTL 2	Understanding
20.	Why is the current distribution in a travelling wave antenna non-standing in nature?		CO4	BTL 2	Understanding
21.	How far-field conditions influence the accuracy of radiation pattern measurement?		CO5	BTL 2	Understanding
22.	Differentiate between 2D and 3D radiation pattern measurements.		CO5	BTL 2	Understanding
23.	Why is a reference antenna required in the gain comparison method?		CO5	BTL 2	Understanding
24.	How measurement distance affects the gain accuracy in far-field conditions?		CO5	BTL 2	Understanding
PART – B					
1.	(i) Explain the construction of a Yagi–Uda antenna with a neat diagram.	(8)	CO4	BTL 4	Analyzing
	(ii) List the advantages and limitations of Yagi–Uda antennas.	(8)	CO4	BTL 4	Analyzing
2.	(i) Explain the principle of operation of travelling wave antennas.	(8)	CO4	BTL 3	Applying

	(ii) Classify travelling wave antennas with suitable examples.	(8)	CO4	BTL 3	Applying
3.	(i) Describe the construction and operation of a rhombic antenna.	(8)	CO4	BTL 3	Applying
	(ii)List the advantages and limitations of rhombic antenna.	(8)	CO4	BTL 3	Applying
4.	Explain the principle of operation of a helical antenna in normal mode and axial mode, highlighting the differences in radiation characteristics.	(16)	CO4	BTL 4	Analyzing
5.	What is the importance of helical antenna? Explain the construction and operation of helical antenna with neat sketch. How does it differ from other antennas?	(16)	CO4	BTL 3	Applying
6.	Explain the radiation mechanism of a small loop antenna and compare it with that of a short dipole antenna.	(16)	CO4	BTL 4	Analyzing
7.	Explain radiation mechanism of a microstrip antenna considering square microstrip antenna. Also draw the normalized patterns for the same.	(16)	CO4	BTL 3	Applying
8.	(i) Compare a Yagi–Uda antenna with a log-periodic antenna with respect to bandwidth, gain, and applications.	(8)	CO4	BTL 4	Analyzing
	(ii) Compare travelling wave antennas with standing wave antennas.	(8)	CO4		
9.	Explain the radiation mechanism of a terminated travelling wave antenna, highlighting the role of phase progression of current.	(16)	CO4	BTL 3	Applying
10.	With neat schematic diagram, discuss the construction, principle and operation of a log periodic antenna.	(16)	CO4	BTL 3	Applying
11.	Illustrate a typical radiation-pattern measurement setup used in an anechoic chamber and explain the operation of its components with neat diagrams.	(16)	CO4	BTL 3	Applying
12.	Explain the commonly used antenna gain measurement techniques (comparison method, absolute gain method, and pattern integration) and explain their principles with neat diagrams.	(16)	CO5	BTL 3	Applying
13.	Explain the principle of operation of a Yagi–Uda antenna, highlighting the role of parasitic elements in achieving directivity.	(16)	CO4	BTL 4	Analyzing
14.	Describe the commonly used impedance measurement techniques (network analyzer method, slotted-line method, and bridge method) and explain their operating principles with neat diagrams.	(16)	CO5	BTL 4	Analyzing
15.	Illustrate the procedure for measuring VSWR using a slotted line and a network analyzer, and explain the underlying principles involved.	(16)	CO5	BTL 3	Applying
16.	(i) Obtain the radiation resistance and directivity of a small loop antenna.	(8)	CO4	BTL 4	Analyzing
	(ii) Compare the field quantities and the other relevant parameter of a small loop antenna with a short dipole antenna.	(8)	CO4		
17.	(i) With necessary sketches, explain in detail the radiation mechanism of a microstrip patch antenna.	(8)	CO4	BTL 4	Analyzing
	(ii)With suitable figures, explain the various feed techniques of a microstrip antenna.	(8)	CO4		

UNIT V - PROPAGATION OF RADIO WAVES

Modes of propagation, Structure of atmosphere, Ground wave propagation, Tropospheric propagation, Duct propagation, Troposcatter propagation, Flat earth and Curved earth concept, Sky wave propagation – Virtual height, critical frequency, Maximum usable frequency – Skip distance, Fading.

PART A

Q.No	Questions	CO	BT Level	Competence
1.	List the different modes of radio wave propagation.	CO6	BTL 1	Remembering
2.	Define ground wave propagation.	CO6	BTL 1	Remembering
3.	Outline the structure of atmosphere in terms of propagation layers.	CO6	BTL 2	Understanding
4.	Write two characteristics of tropospheric propagation.	CO6	BTL 1	Remembering
5.	Define duct propagation.	CO6	BTL 1	Remembering
6.	Summarize about troposcatter propagation.	CO6	BTL 2	Understanding
7.	Outline the concept of flat earth propagation model.	CO6	BTL 2	Understanding
8.	Distinguish between flat earth and curved earth propagation concepts.	CO6	BTL 2	Understanding
9.	Find the range of LOS system when receive and transmit antenna heights are 10 m and 100m respectively.	CO6	BTL 2	Understanding
10.	Define virtual height in sky wave propagation.	CO6	BTL 1	Remembering
11.	What is critical frequency?	CO6	BTL 1	Remembering
12.	Find the critical frequency of an ionosphere layer which has an electron density of $1.24x10^{6}cm^{-3}$	CO6	BTL 2	Understanding
13.	Define Maximum Usable Frequency (MUF).	CO6	BTL 1	Remembering
14.	Identify the relationship between MUF and critical frequency.	CO6	BTL 2	Understanding
15.	What is skip distance?	CO6	BTL 1	Remembering
16.	Define skip zone in radio wave propagation.	CO6	BTL 1	Remembering
17.	Name the types of fading in radio communication.	CO6	BTL 2	Understanding
18.	Summarize the causes of fading.	CO6	BTL 2	Understanding
19.	Write the two factors affecting ground wave propagation.	CO6	BTL 1	Remembering
20.	Point out the frequency range suitable for sky wave propagation.	CO6	BTL 2	Understanding
21.	Illustrate the characteristics of ionospheric layers.	CO6	BTL 2	Understanding
22.	Summarize the features of Magneto-Ions Splitting.	CO6	BTL 1	Remembering
23.	Write the formula for skip distance.	CO6	BTL 1	Remembering
24.	Mention the significance of gyro frequency in ionosphere propagation	CO6	BTL 2	Understanding

PART B

1.	Sketch the structure of atmosphere and elaborate on the various layers affecting radio wave propagation.	(16)	CO6	BTL 4	Analyzing
2.	(i) Summarize the structure of the atmosphere and explain each layer in detail. (ii) Determine the critical angle of propagation for D-Layer, if the transmitter and receiver are separated by 500km.	(8) (8)	CO6	BTL 3	Applying
3.	(i) Explain the modes of radio wave propagation in detail. (ii) Describe the concept of ground wave propagation and its limitations.	(8) (8)	CO6	BTL 3	Applying
4.	(i) Illustrate the mechanism of tropospheric propagation. (ii) Interpret the concept of duct propagation with suitable diagrams.	(8) (8)	CO6	BTL 4	Analyzing

5.	Discuss troposcatter propagation and evaluate its advantages and disadvantages for communication systems.	(16)	CO6	BTL 4	Analyzing
6.	Analyze the curved earth propagation model and compare it with flat earth model.	(16)	CO6	BTL 3	Applying
7.	Explain sky wave propagation in detail with the help of ionospheric layer structure.	(16)	CO6	BTL 4	Analyzing
8.	Analyze how different ionospheric layers affect sky wave propagation at different times of the day.	(16)	CO6	BTL 4	Analyzing
9.	(i) Construct a 2 ray model of sky wave propagation and explain in detail. (ii) When the maximum electron density of the ionospheric layer corresponds to refractive index of 0.92 at the frequency of 10 MHz, find the range if the frequency is MUF. The height of the ray reflection point on the ionospheric layer is 400km. Assume flat earth and negligible effect of earth's magnetic field.	(8) (8)	CO6	BTL 3	Applying
10.	(i) Elaborate the concept of virtual height and critical frequency. (ii) Determine the relationship between critical frequency and Maximum Usable Frequency with derivations	(8) (8)	CO6	BTL 3	Applying
11.	(i) Demonstrate the concept of skip distance with neat diagrams. (ii) Explain the factors affecting skip distance and skip zone.	(8) (8)	CO6	BTL 4	Analyzing
12.	A radio wave of frequency 2 MHz is incident on ionospheric layer at an angle of 60°. If the critical frequency is 1.5 MHz, calculate the maximum usable frequency and skip distance. Assume virtual height is 300 km.	(16)	CO6	BTL 3	Applying
13.	Derive the expression for Maximum Usable Frequency (MUF) and explain its significance in long distance communication.	(16)	CO6	BTL 4	Analyzing
14.	(i) Calculate the skip distance for a transmitter operating at 15 MHz when the critical frequency is 10 MHz and virtual height is 320 km. (ii) Identify the causes of multipath fading and its effects on communication.	(8) (8)	CO6	BTL 3	Applying
15.	Analyze the various types of fading in radio communication and analyze the techniques to minimize fading effects.	(16)	CO6	BTL 4	Analyzing
16.	Explain the causes and effects of fading in radio communication systems.	(16)	CO6	BTL 3	Applying
17.	A transmitter operating at 18 MHz needs to communicate with a receiver at 1800 km distance. If the critical frequency is 9 MHz and virtual height is 320 km, calculate: (i) MUF (ii) Skip distance (iii) Optimum working frequency	(16)	CO6	BTL 3	Applying