

ELECTRONICS AND COMMUNICATION ENGINEERING

ANTENNAS AND WAVE PROPAGATION

TWO MARK QUESTIONS

1. Define an antenna.

Antenna is a transition device or a transducer between a guided wave and a free space wave or vice versa. Antenna is also said to be an impedance transforming device.

2. What is meant by radiation pattern?

Radiation pattern is the relative distribution of radiated power as a function of distance in space. It is a graph which shows the variation in actual field strength of the EM wave at all points which are at equal distance from the antenna. The energy radiated in a particular direction by an antenna is measured in terms of FIELD STRENGTH. (E Volts/m)

3. Define Radiation intensity?

The power radiated from an antenna per unit

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solid angle is called the radiation intensity U (watts per steradian or per square degree). The radiation intensity is independent of distance.

4. Define Beam efficiency?

The total beam area (WA) consists of the main beam area (WM) plus the minor lobe area (Wm) .

Thus $WA = WM + Wm$.

The ratio of the main beam area to the total beam area is called beam efficiency.

Beam efficiency = $SM = WM / WA$.

5. Define Directivity?

The directivity of an antenna is equal to the ratio of the maximum power density $P(q,f)_{max}$ to its average value over a sphere as observed in the far field of an antenna.

$D = P(q,f)_{max} / P(q,f)_{av}$. Directivity from Pattern.

$D = 4\pi / WA$. . Directivity from beam area(WA).

6. What are the different types of aperture.?

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- i) Effective aperture.
- ii). Scattering aperture.
- iii) Loss aperture.
- iv) collecting aperture.
- v). Physical aperture.

7. Define different types of aperture.?

Effective aperture(A_e).

It is the area over which the power is extracted from the incident wave and delivered to the load is called effective aperture.

Scattering aperture(A_s .)

It is the ratio of the reradiated power to the power density of the incident wave.

Loss aperture. (A_e).

It is the area of the antenna which dissipates power as heat.

Collecting aperture. (A_e).

It is the addition of above three

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apertures.

Physical aperture. (A_p).

This aperture is a measure of the physical size of the antenna.

8. Define Aperture efficiency?

The ratio of the effective aperture to the physical aperture is the aperture efficiency. i.e

$$\text{Aperture efficiency} = \eta_{ap} = A_e / A_p$$

(dimensionless).

9. What is meant by effective height?

The effective height h of an antenna is the parameter related to the aperture. It may be defined as the ratio of the induced voltage to the incident field. i.e

$$H = V / E.$$

10. What are the field zone?

The fields around an antenna may be divided into two principal regions.

i. Near field zone (Fresnel zone)

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ii. Far field zone (Fraunhofer zone)

11. What is meant by Polarization.?

The polarization of the radio wave can be defined by direction in which the electric vector E is aligned during the passage of atleast one full cycle. Also polarization can also be defined the physical orientation of the radiated electromagnetic waves in space.

The polarization are three types. They are Elliptical polarization, circular polarization and linear polarization.

12. What is meant by front to back ratio.?

It is defined as the ratio of the power radiated in desired direction to the power radiated in the opposite direction. i.e

$$\text{FBR} = \frac{\text{Power radiated in desired direction}}{\text{power radiated in the opposite direction.}}$$

13. Define antenna efficiency.?

The efficiency of an antenna is defined as the ratio of power radiated to the total input power supplied to the antenna.

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Antenna efficiency = Power radiated / Total input power

14. What is radiation resistance ?

The antenna is a radiating device in which power is radiated into space in the form of electromagnetic wave.

$$W' = I^2 R$$

$$R_r = W' / I^2$$

Where R_r is a fictitious resistance called as radiation resistance.

15 What is meant by antenna beam width?

Antenna beamwidth is a measure of directivity of an antenna. Antenna beam width is an angular width in degrees, measured on the radiation pattern (major lobe) between points where the radiated power has fallen to half its maximum value. This is called as "beam width" between half power points or half power beam width.(HPBW).

16. What is meant by reciprocity Theorem.?

If an e.m.f is applied to the terminals of an antenna

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no.1 and the current measured at the terminals of the another antenna no.2, then an equal current both in amplitude and phase will be obtained at the terminal of the antenna no.1 if the same emf is applied to the terminals of antenna no.2.

17.What is meant by isotropic radiator?

A isotropic radiator is a fictitious radiator and is defined as a radiator which radiates fields uniformly in all directions. It is also called as isotropic source or omni directional radiator or simply unipole.

18. Define gain

The ratio of maximum radiation intensity in given direction to the maximum radiation intensity from a reference antenna produced in the same direction with same input power. i.e

Maximum radiation intensity
from test antenna

Gain (G) = $\frac{\text{Maximum radiation intensity from test antenna}}{\text{Maximum radiation intensity from reference antenna}}$

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Maximum radiation intensity from the reference antenna with same input power

19. Define self impedance

Self impedance of an antenna is defined as its input impedance with all other antennas are completely removed i.e away from it.

20 . Define mutual impedance

The presence of near by antenna no.2 induces a current in the antenna no.1 indicates that presence of antenna no.2 changes the impedance of the antenna no.1.This effect is called mutual coupling and results in mutual impedance.

21. What is meant by cross field.?

Normally the electric field E is perpendicular to the direction of wave propagation. In some situation the electric field E is parallel to the wave propagation that condition is called Cross field.

22.Define axial ratio

The ratio of the major to the minor axes of the polarization ellipse is called the Axial Ratio. (AR).

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23. What is meant by Beam Area.?

The beam area or beam solid angle or WA of an antenna is given by the normalized power pattern over a sphere.

$$WA = \int_0^{\pi} \int_0^{2\pi} P_n(\theta, \phi) d\Omega$$

Where $d\Omega = \sin \theta d\theta d\phi$

24. What is duality of antenna.?

It is defined as an antenna is a circuit device with a resistance and temperature on the one hand and the space device on the other with radiation patterns, beam angle, directivity gain and aperture.

25. State Poynting theorem.

It states that the vector product of electric field intensity vector E and the magnetic field intensity vector H at any point is a measure of the rate of energy flow per unit area at that point. The direction of power flow is perpendicular to both the electric field and magnetic field components.

26. What is point source?

It is the waves originate at a fictitious volumeless

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emitter source at the center 'O' of the observation circle.

27. What is meant by array.?

An antenna is a system of similar antennas oriented similarly to get greater directivity in a desired direction.

28. What is meant by uniform linear array.?

An array is linear when the elements of the array are spaced equally along the straight line. If the elements are fed with currents of equal magnitude and having a uniform progressive phase shift along the line, then it is called uniform linear array .

29. What are the types of array.?

- a. Broad side array.
- b. End fire array
- c. Collinear array.
- d. Parasitic array.

30. What is Broad side array.?

Broad side array is defined as an arrangement in which the principal direction of radiation is perpendicular to the array axis and also the plane containing the array element. For Broad side array the phase difference EHWZHHQ

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DGMDFHQW HOHPHQW LV

31. Define End fire array.?

End fire array is defined as an arrangement in which the principal direction of radiation coincides with the array axis.)RU HQG)LUH DUUD\ - G :KHUH \$QG G GLVWDQFH EHWZHHQ WKH HOHPHQWV

32. What is collinear array.?

In this array the antenna elements are arranged coaxially by mounting the elements end to end in straight line or stacking them one over the other with radiation pattern circular symmetry. Eg. Omnidirectional antenna.

33. What is Parasitic array.?

In this array the elements are fed parasitically to reduce the problem of feed line. The power is given to one element from that other elements get by electro magnetic coupling.

Eg. Yagi uda antenna.

34. What is the condition on phase for the end fire array with increased directivity.?

:KHQ - G SURGXFHV PD[LXP ILHOG LQ WKH GLUHFWRU

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= 0 but does not give the maximum directivity. It has been shown by Hansen and Woodyard that a large directivity is obtained by increasing the phase change β between adjacent elements. The condition for maximum directivity is given by

This condition will be referred to as the condition for increased directivity.

35. Define array factor.

The normalized value of the total field is given by, $F(\theta) = \frac{E(\theta)}{E_m}$

The field is given by the expression E will be referred to as array factor.

36. Define beam width of major lobe?

It is defined as the angle between the first nulls (or) it is defined as twice the angle between the first null and the major lobe maximum direction.

37. List out the expression of beam width for broad side array and end fire array.

For broad side array the expression for beam width between the first nulls is given by,

$$BW_{BS} = \frac{2\lambda}{N} \sin \left(\frac{\pi}{2} \right)$$

For End fire array the expression for beam width

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between the first nulls is given by,

$$BWFN = \left(\frac{1}{2} \right) \left(\frac{1}{\sin \theta} \right)$$

38. Differentiate broad side and End fire array.?

Broad side

array

End fire

array

1. Antennas fed in Phase

2. Maximum Radiation is
perpendicular

to the direction of array

axis.

3. Beam width of major

lobe is twice the

Antenna elements are fed of
out of Phase – G

Maximum Radiation is
directed along the array axis.

Beam width is greater than
that for a broad side array of

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same length.

$$BW = \left(\frac{1}{2} - \frac{Q}{G} \right)^2$$

2

reciprocal of the array

length.

$$BW = \left(\frac{1}{2} - \frac{Q}{G} \right)^2$$

2.

39. What is the need for the Binomial array.?

The need for a binomial array is

i). In uniform linear array as the array length is increased to increase the directivity, the secondary lobes also occurs.

ii) For certain applications, it is highly desirable that secondary lobes should be eliminated completely or reduced to minimum desirable level compared to main lobes.

40. Define power pattern.?

Graphical representation of the radial component of the pointing vector S_r at a constant radius as a function of angle is called power density pattern or

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power pattern.

41. What is meant by similar Point sources.?

Whenever the variation of the amplitude and the phase of the field with respect to the absolute angle for any two sources are same then they are called similar point sources.

The maximum amplitudes of the individual sources may be unequal.

42. What is meant by identical Point sources.?

Similar point sources with equal maximum amplitudes are called identical point sources.

43. What is the principle of the pattern multiplication?

The total field pattern of an array of non isotropic but similar sources is the product of the

i) individual source pattern and

ii) The array pattern of isotropic point sources each located at the phase center of the individual source having the same amplitude and phase.

While the total phase pattern is the sum of the phase patterns of the individual source pattern and array pattern.0

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44. What is the advantage of pattern multiplication? TM Useful tool in designing antenna TM It approximates the pattern of a complicated array

without making lengthy computations

45. What is tapering of arrays?

Tapering of array is a technique used for reduction of unwanted side lobes. The amplitude of currents in the linear array source is non-uniform; hence the central source radiates more energy than the ends. Tapering is done from center to end.

46. What is a binomial array?

It is an array in which the amplitudes of the antenna elements in the array are arranged according to the coefficients of the binomial series.

47. What are the advantages of binomial array?

Advantage: TM No minor lobes

Disadvantages: TM Increased beam width TM Maintaining the large ratio of current

amplitude in large arrays is difficult

48. What is the difference between isotropic and nonisotropic

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source TM Isotropic source radiates energy in all directions but non-isotropic source radiates energy only in some desired directions. TM Isotropic source is not physically realizable but non-isotropic source is physically realizable.

49. Define Side Lobe Ratio

Side Lobe Ratio is defined as the ratio of power density in the principal or main lobe to the power density of the longest minor lobe.

50. List the arrays used for array tapering TM Binomial Array: Tapering follows the

coefficient of binomial series

TM Dolph Tchebycheff Array: Tapering follows the coefficient of Tchebycheff polynomial

51. What is a Short Dipole?

Ans: A short dipole is one in which the field is oscillating because of the oscillating voltage and current. It is called so, because the length of the dipole is short and the current is almost constant throughout the entire length

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of the dipole. It is also called as Hertzian Dipole which is a hypothetical antenna and is defined as a short isolated conductor carrying uniform alternating current.

52. How radiations are created from a short Dipole?

Ans: The dipole has two equal charges of opposite sign oscillating up and down in a harmonic motion. The charges will move towards each other and electric field lines were created. When the charges meet at the midpoint, the field lines cut each other and new field are created. This process is spontaneous and so more fields are created around the antenna. This is how radiations are obtained from a short dipole. (See Figure from John. D .Kraus Book)

53. Why a short dipole is also called an elemental dipole?

A short dipole that does have a uniform current will be known as the elemental dipole. Such a dipole will generally be considerably shorter than the tenth wave length maximum specified for a short dipole. Elemental dipole is also called as elementary dipole, elementary doublet and hertzian dipole.

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54. What is a Infinitesimal Dipole?

When the length of the short dipole is vanishingly small, then such a dipole is called a infinitesimal dipole. If dl be the infinitesimally small length and I be the current, then $I dl$ is called as the current element.

55. Why a short dipole is called a oscillating dipole?

A short dipole is initially in neutral condition and the moment a current starts to flow in one direction, one half of the dipole require an excess of charge and the other a deficit because a current is a flow of electrical charge. Then, there will be a voltage between the two halves of the dipole. When the current changes its direction this charge unbalance will cause oscillations. Hence an oscillating current will result in an oscillating voltage. Since, in such dipole, electric charge oscillates, it may be called as Oscillating electric dipole.

56. What do you understand by retarded current?

Since, the short electric dipole is so short, the current which is flowing through the dipole is assumed to be constant throughout its length. The effect of

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this current is not felt instantaneous at a distance point only after an interval equal to the time required for the wave to propagate over the distance r is called the retardation time.

The retarded current $[I] = I_0 \exp(j \omega - r/c)$

Where U F LV WKH SKDVH UHWDUGDWLRQ

57. Define induction field

The induction field will predominate at points close to the current element, where the distance from the centre of the dipole to the particular point is less. This field is more effective in the vicinity of the current element only. It represents the energy stored in the magnetic field surrounding the current element or conductor. This field is also known as near field.

58. Define Radiation field

The radiation field will be produced at a larger distance from the current element, where the distance from the centre of the dipole to the particular point is very large. It is also called as distant field or far field.

59. At what distance from the dipole is the induction field equal to the radiation field?

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As the distance from the current element or the short dipole increases, both induction and radiation fields emerge and start decreasing. However, a distance reaches from the conductor at which both the induction and radiation field becomes equal and the particular distance depends upon the wavelength. The two fields will thus have equal amplitude at that particular distance. This distance is given by

U

60. Define Radiation Resistance

It is defined as the fictitious resistance which when inserted in series with the antenna will consume the same amount of power as it is actually radiated. The antenna appears to the transmission line as a resistive component and this is known as the radiation resistance.

61. Give the expression for the effective aperture of a short dipole

The effective aperture of a short dipole is given by

\$H 2

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62. What is a dipole antenna?

A dipole antenna may be defined as a symmetrical antenna in which the two ends are at equal potential relative to the midpoint.

63. What is a half wave dipole?

A half wave antenna is the fundamental radio antenna of metal rod or tubing or thin wire which has a physical length of half wavelength in free space at the frequency of operation

64. Give the expression for the effective aperture of a Half wave Dipole

The effective aperture of a half wave dipole is given by

$$A_e = 0.2$$

65. What is the radiation resistance of a half wave dipole

The radiation resistance of a half wave dipole is given by

$$R_r = 73 \text{ ohm}$$

66. What is a loop antenna?

A loop antenna is a radiating coil of any convenient cross-section of

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one or more

turns carrying radio frequency current. it may assume any shape (e.g. rectangular, square, triangular and hexagonal)

67. Give an expression of radiation resistance of a small loop

Radiation resistance of a small loop is given by

$$R_r = 31,200 \left(\frac{A}{\lambda^2} \right)^2$$

68. How to increase the radiation resistance of a loop antenna

The radiation resistance of a loop antenna can be increased by:

1. increasing the number of turns
2. inserting a ferrite core of very high permeability with loop antenna's

circumference which will rise the magnetic field intensity called ferrite loop.

69. What are the types of loop antennas?

Loop antennas are classified into:

1. (OHFWULFD00\ 6PDOO &LUFXPIHUHQFH
2. (OHFWULFD00\ /DUJH 'LPHQVLRQ FRPSDUDEOH WR

70. What are Electrically Small loop antennas?

Electrically Small loop antennas is one in which the overall length of the loop is less

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than one-tenth of the wavelength. Electrically Small loop antennas have small radiation resistances that are usually smaller than their loop resistances. They are very poor radiators and seldom employed for transmission in radio communication.

71. What are Electrically large loop antennas?

Electrically Large loop antennas is one in which the overall length of the loop approaches the wavelength.

72. List out the uses of loop antenna

Various uses of loop antenna are:

™ It is used as receiving antenna in portable radio and pagers

™ It is used as probes for field measurements and as directional antennas for radio wave navigation

™ It is used to estimate the direction of radio wave propagation

73. What are the parameters to be considered for the design of an helical antenna?

The parameters to be considered for the design of an helical antenna are:

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1. Bandwidth
2. Gain
3. Impedance
4. Axial Ratio

74. What are the types of radiation modes of operation for an helical antenna

The two types of radiation modes of operation possible for an helical antenna are:

1. Normal mode of operation
2. Axial mode of operation

75. Which antenna will produce circularly polarized waves

Helical antenna radiates circularly polarized wave.

76. List the applications of helical antenna

The applications of helical antenna are:

TM It became the workhouse of space communications for telephone, television and

data, being employed both on satellites and at ground stations

TM Many satellites including weather satellites, data relay satellites all have helical antennas

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™ It is on many other probes of planets and comets, including moon and mars, being used alone, in arrays or as feeds for parabolic reflectors, its circular polarization and high gain and simplicity making it effective for space application

77. Define Sky wave.

Waves that arrive at the receiver after reflection in the ionosphere is called sky wave.

78. Define Tropospheric wave.

Waves that arrive at the receiver after reflection from the troposphere region is called Tropospheric wave. (ie 10 Km from Earth surface).

79. Define Ground wave.

Waves propagated over other paths near the earth surface is called ground wave propagation.

80. What are the type of Ground wave.

Ground wave classified into two types.

i. Space wave

ii. Surface wave.

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81 What is meant by Space Wave.?

It is made up of direct wave and ground reflected wave. Also includes the portion of energy received as a result of diffraction around the earth surface and the reflection from the upper atmosphere.

82. What is meant by Surface Wave.?

Wave that is guided along the earth's surface like an EM wave is guided by a transmission is called surface wave. Attenuation of this wave is directly affected by the constant of earth along which it travels.

83. What is meant by fading.?

Variation of signal strength occur on line of sight paths as a result of the atmospheric conditions and it is called .It can not be predicted properly.

84. What are the type of fading.?

Two types. i. Inverse bending.

iii. Multi path fading.

85. What is inverse and multi path fading.?

Inverse bending may transform line of sight path into an obstructed one.

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Multi path fading is caused by interference between the direct and ground reflected waves as well as interference between two or more paths in the atmosphere.

86. What is meant by diversity reception.?

To minimize the fading and to avoid the multi path interference the techniques used are diversity reception. It is obtained by two ways.

- i. Space diversity reception.
- ii. Frequency diversity reception.
- iii. Polarization diversity.

87. Define Space diversity Reception.

This method exploits the fact that signals received at different locations do not fade together. It is the signal which has the highest signal strength at the moment dominates.

88. Define frequency diversity Reception.

This method takes advantage of the fact that signals of slightly different frequencies do not fade synchronously. This fact is utilized to minimize fading in

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radio telegraph circuits.

89. Define polarization diversity reception.

It is used in normally in microwave links, and it is found that signal transmitted over the same path in two polarizations have independent fading patterns. In broad band dish antenna system, Polarization diversity combined with frequency diversity reception achieve excellent results.

90. What is meant by Faraday's rotation?

Due to the earth's magnetic fields, the ionospheric medium becomes anisotropic and the incident plane wave entering the ionosphere will split into ordinary and extraordinary waves/modes.

When these modes re-emerge from the ionosphere they recombine into a single plane wave again. Finally the plane of polarization will usually have changed, this phenomenon is known as Faraday's rotation.

91. What are the factors that affect the propagation of radio waves?

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- i. Curvature of earth.
- ii. Earth's magnetic field.
- iii. Frequency of the signal.
- iv. Plane earth reflection.

92. Define gyro frequency.

Frequency whose period is equal to the period of an electron in its orbit under the influence of the earth's magnetic flux density B .

93. Define critical frequency.

For any layer, the highest frequency that will be reflected back for vertical incidence is

$$f_{cr} = 9\sqrt{1\max}$$

94. Define Magneto-Ions Splitting.

The phenomenon of splitting the wave into two different components (ordinary and extra-ordinary) by the earth's magnetic field is called Magneto-Ions Splitting.

95. Define LUHF.

The lowest useful HF for a given distance and transmitter power is defined as the lowest frequency that will give satisfactory reception for that distance and

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power.

It depends on

- i. The effective radiated power
- ii. Absorption character of ionosphere for the paths between transmitter and receiver.
- iii. The required field strength which in turn depends upon the radio noise at the receiving location and type of service involved .

96. Define Refractive index.

It is defined as $n = c / v_p$

Velocity of light

in vacua

$n =$

Phase velocity in

the medium

$n = \sqrt{\epsilon_r}$

97 Define maximum Usable Frequency.

The maximum Frequency that can be reflected back for a given distance of transmission is called

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the maximum usable frequency (MUF) for that distance.

$$MUF = f_{cr} VHF$$

98. Define skip distance.

The distance within which a signal of given frequency fails to be reflected back is the skip distance for that frequency. The higher the frequency the greater the skip distance.

99. Define Optimum frequency.?

Optimum frequency for transmitting between any two points is therefore selected as some frequency lying between about 50 and 85 percent of the predicted maximum usable frequency between those points.

100. What is wave impedance.?

$$Z_0 = \frac{c}{f} - (f_c / f)$$

$$Z_{LH} = \frac{c}{f} - (f_c / f)$$

101. Define wave velocity and Group velocity.?

$$\text{wave velocity } v_p = \frac{c}{\sqrt{1 - (f_c / f)^2}}$$

$$\text{Group velocity, } v_g = \frac{c^2}{v_p}$$

$$v_g = \frac{c^2}{v_p}$$

16 MARK QUESTIONS

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1. Write the potential function in different form.

2. Explain in detail about the aperture Concept

Aperture represents the area of the antenna
confining the effective radiations

The various types of antenna apertures are

i) Effective aperture.

ii). Scattering aperture.

iii) Loss aperture.

iv) collecting aperture.

v). Physical aperture.

Effective aperture(A_e).

It is the area over which the power
is extrated from the incident
wave and delivered to the load is called
effective aperture.

Scattering aperture(A_s .)

It is the ratio of the reradiated
power to the power density of the
incident wave.

Loss aperture. (A_e).

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It is the area of the antenna which dissipates power as heat.

Collecting aperture. (A_e).

It is the addition of above three apertures.

Physical aperture. (A_p).

This aperture is a measure of the physical size of the antenna.

The ratio of the effective aperture to the physical aperture is the aperture efficiency. i.e

Aperture efficiency = $\eta_{ap} = A_e / A_p$ (dimensionless).

Antenna matching:

When the antenna is receiving with a load resistance matched to the antenna radiation resistance , maximum power is transferred to the load and the power is also reradiated from the dipole. This is called antenna matching(Give detailed explanation)

3. Briefly explain the radiation from a short dipole

Defn: A short dipole is one in which the field is oscillating because of the oscillating voltage and current. It

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is called so, because the length of the dipole is short and the current is almost constant throughout the entire length of the dipole.

Fields from Oscillating Dipole: The dipole has two equal charges of opposite sign oscillating up and down in a harmonic motion. The charges will move towards each other and electric field lines were created. When the charges meet at the midpoint, the field lines cut each other and new field are created. This process is spontaneous and so more field are created around the antenna. This is how radiations are obtained from a short dipole. (See Figure from John. D. Kraus Book)

Antenna Field Zones: The regions containing the radiations that are present around the antenna are called Zones. The fields around an antenna may be divided into two principal regions.

a) Near field zone (Fresnel zone)

b) Far field zone (Fraunhofer zone)

Electric and Magnetic field components of short Dipole: Write the derivations by referring The

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Book,K.D.Prasad.

4.Gives notes on the antenna impedances. Find the effective aperture and Directivity of a short dipole antenna.

Self Impedance:

Defn:Self impedance of an antenna is defined as its input impedance with all other antennas are completely removed i.e away from it.

Write the formula required

Mutual Impedance:

Defn:The presence of near by antenna no.2 induces a current in the antenna no.1 indicates that presence of antenna no.2 changes the impedance of the antenna no.1.This effect is called mutual coupling and results in mutual impedance.

State Reciprocity theorem

Formula required

Effective aperture and Directivity of a short dipole antenna.

Consider a plane wave incident on a short

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dipole. The wave is assumed to be linearly polarized with electric field in the y direction. The current in the dipole is assumed constant and in the same phase over its entire length, and the terminating resistance is assumed equal to the dipole radiation resistance.

The effective aperture of this dipole is given by A_{eff}

The directivity is found to be

$D = \frac{4\pi A_{eff}}{\lambda^2}$

5. Define Polarization? Explain the different types of polarization in detail.

Polarization is defined as the orientation of electric field as a function of direction. The polarization of the radio wave can be defined by direction in which the electric vector E is aligned during the passage of at least one full cycle. Also polarization can also be defined the physical orientation of the radiated electromagnetic waves in space. The polarization are of three types. They are:

Elliptical polarization

Circular polarization

Linear polarization.

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Linear Polarisation:

A linearly polarized wave is one in which the electric field remains in only one direction. For a linearly polarized wave, the axial ratio is infinity.

Elliptical polarization

The electric field vector rotates and forms an ellipse called a polarization ellipse. The ratio of the major to the minor axes of the polarization ellipse is called the Axial Ratio. (AR). AR is greater than 1.

Circular polarization

The electric field vector rotates and forms a circle and this wave is called circularly polarized wave. AR is unity.

6. Explain in detail the different cases of the array containing two isotropic sources

TM Case 1: Arrays of two isotropic sources fed with currents of equal amplitude and in phase TM Case 2: Arrays of two isotropic sources fed with currents of equal amplitude and opposite phase TM Case 3: Arrays of two isotropic sources fed with

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currents of unequal amplitude and any phase TM Case 1: Arrays of two isotropic sources fed with currents of equal amplitude and in phase quadrature.

Write about the following:

- Field pattern of the individual cases
- Find the maxima ,minima direction and half power point direction
- Draw the radiation pattern.

7. What is broadside array? Derive the maxima ,null directions and also the beamwidth of a broadside array.

Broad side array is defined as an arrangement in which the principal direction of radiation is perpendicular to the array axis and also the plane containing the array element. For Broad side array the phase difference $\frac{2\pi}{\lambda} d \sin \theta$ is zero. For Broad end fire array the phase difference $\frac{2\pi}{\lambda} d \sin \theta$ is 2π or 4π or 6π or 8π or 10π or 12π or 14π or 16π or 18π or 20π or 22π or 24π or 26π or 28π or 30π or 32π or 34π or 36π or 38π or 40π or 42π or 44π or 46π or 48π or 50π or 52π or 54π or 56π or 58π or 60π or 62π or 64π or 66π or 68π or 70π or 72π or 74π or 76π or 78π or 80π or 82π or 84π or 86π or 88π or 90π or 92π or 94π or 96π or 98π or 100π or 102π or 104π or 106π or 108π or 110π or 112π or 114π or 116π or 118π or 120π or 122π or 124π or 126π or 128π or 130π or 132π or 134π or 136π or 138π or 140π or 142π or 144π or 146π or 148π or 150π or 152π or 154π or 156π or 158π or 160π or 162π or 164π or 166π or 168π or 170π or 172π or 174π or 176π or 178π or 180π or 182π or 184π or 186π or 188π or 190π or 192π or 194π or 196π or 198π or 200π or 202π or 204π or 206π or 208π or 210π or 212π or 214π or 216π or 218π or 220π or 222π or 224π or 226π or 228π or 230π or 232π or 234π or 236π or 238π or 240π or 242π or 244π or 246π or 248π or 250π or 252π or 254π or 256π or 258π or 260π or 262π or 264π or 266π or 268π or 270π or 272π or 274π or 276π or 278π or 280π or 282π or 284π or 286π or 288π or 290π or 292π or 294π or 296π or 298π or 300π or 302π or 304π or 306π or 308π or 310π or 312π or 314π or 316π or 318π or 320π or 322π or 324π or 326π or 328π or 330π or 332π or 334π or 336π or 338π or 340π or 342π or 344π or 346π or 348π or 350π or 352π or 354π or 356π or 358π or 360π or 362π or 364π or 366π or 368π or 370π or 372π or 374π or 376π or 378π or 380π or 382π or 384π or 386π or 388π or 390π or 392π or 394π or 396π or 398π or 400π or 402π or 404π or 406π or 408π or 410π or 412π or 414π or 416π or 418π or 420π or 422π or 424π or 426π or 428π or 430π or 432π or 434π or 436π or 438π or 440π or 442π or 444π or 446π or 448π or 450π or 452π or 454π or 456π or 458π or 460π or 462π or 464π or 466π or 468π or 470π or 472π or 474π or 476π or 478π or 480π or 482π or 484π or 486π or 488π or 490π or 492π or 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744π or 746π or 748π or 750π or 752π or 754π or 756π or 758π or 760π or 762π or 764π or 766π or 768π or 770π or 772π or 774π or 776π or 778π or 780π or 782π or 784π or 786π or 788π or 790π or 792π or 794π or 796π or 798π or 800π or 802π or 804π or 806π or 808π or 810π or 812π or 814π or 816π or 818π or 820π or 822π or 824π or 826π or 828π or 830π or 832π or 834π or 836π or 838π or 840π or 842π or 844π or 846π or 848π or 850π or 852π or 854π or 856π or 858π or 860π or 862π or 864π or 866π or 868π or 870π or 872π or 874π or 876π or 878π or 880π or 882π or 884π or 886π or 888π or 890π or 892π or 894π or 896π or 898π or 900π or 902π or 904π or 906π or 908π or 910π or 912π or 914π or 916π or 918π or 920π or 922π or 924π or 926π or 928π or 930π or 932π or 934π or 936π or 938π or 940π or 942π or 944π or 946π or 948π or 950π or 952π or 954π or 956π or 958π or 960π or 962π or 964π or 966π or 968π or 970π or 972π or 974π or 976π or 978π or 980π or 982π or 984π or 986π or 988π or 990π or 992π or 994π or 996π or 998π or 1000π or 1002π or 1004π or 1006π or 1008π or 1010π or 1012π or 1014π or 1016π or 1018π or 1020π or 1022π or 1024π or 1026π or 1028π or 1030π or 1032π or 1034π or 1036π or 1038π or 1040π or 1042π or 1044π or 1046π or 1048π or 1050π or 1052π or 1054π or 1056π or 1058π or 1060π or 1062π or 1064π or 1066π or 1068π or 1070π or 1072π or 1074π or 1076π or 1078π or 1080π or 1082π or 1084π or 1086π or 1088π or 1090π or 1092π or 1094π or 1096π or 1098π or 1100π or 1102π or 1104π or 1106π or 1108π or 1110π or 1112π or 1114π or 1116π or 1118π or 1120π or 1122π or 1124π or 1126π or 1128π or 1130π or 1132π or 1134π or 1136π or 1138π or 1140π or 1142π or 1144π or 1146π or 1148π or 1150π or 1152π or 1154π or 1156π or 1158π or 1160π or 1162π or 1164π or 1166π or 1168π or 1170π or 1172π or 1174π or 1176π or 1178π or 1180π or 1182π or 1184π or 1186π or 1188π or 1190π or 1192π or 1194π or 1196π or 1198π or 1200π or 1202π or 1204π or 1206π or 1208π or 1210π or 1212π or 1214π or 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1438π or 1440π or 1442π or 1444π or 1446π or 1448π or 1450π or 1452π or 1454π or 1456π or 1458π or 1460π or 1462π or 1464π or 1466π or 1468π or 1470π or 1472π or 1474π or 1476π or 1478π or 1480π or 1482π or 1484π or 1486π or 1488π or 1490π or 1492π or 1494π or 1496π or 1498π or 1500π or 1502π or 1504π or 1506π or 1508π or 1510π or 1512π or 1514π or 1516π or 1518π or 1520π or 1522π or 1524π or 1526π or 1528π or 1530π or 1532π or 1534π or 1536π or 1538π or 1540π or 1542π or 1544π or 1546π or 1548π or 1550π or 1552π or 1554π or 1556π or 1558π or 1560π or 1562π or 1564π or 1566π or 1568π or 1570π or 1572π or 1574π or 1576π or 1578π or 1580π or 1582π or 1584π or 1586π or 1588π or 1590π or 1592π or 1594π or 1596π or 1598π or 1600π or 1602π or 1604π or 1606π or 1608π or 1610π or 1612π or 1614π or 1616π or 1618π or 1620π or 1622π or 1624π or 1626π or 1628π or 1630π or 1632π or 1634π or 1636π or 1638π or 1640π or 1642π or 1644π or 1646π or 1648π or 1650π or 1652π or 1654π or 1656π or 1658π or 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1882π or 1884π or 1886π or 1888π or 1890π or 1892π or 1894π or 1896π or 1898π or 1900π or 1902π or 1904π or 1906π or 1908π or 1910π or 1912π or 1914π or 1916π or 1918π or 1920π or 1922π or 1924π or 1926π or 1928π or 1930π or 1932π or 1934π or 1936π

- Draw the radiation pattern.

8. What is End Fire array? Derive the maxima, null directions and also the beamwidth of a Endfire array.

End fire array is defined as an arrangement in which the principal direction of radiation coincides with the array axis.)RU HQG)LUH DUUD\ - G :KHUH \$QG G GLVWDQFH EHWZHHQ WKH HOHPHQWV

- Field pattern of a linear array with n isotropic sources
- Determine the maxima, minima direction and half power point direction
- Draw the radiation pattern.

9. Explain the principle of pattern multiplication with some examples.

Principle of pattern multiplication:

The total field pattern of an array of non isotropic but similar sources is the product of the
 iii) individual source pattern and
 iv) The array pattern of isotropic point sources each located at the phase center of the individual

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source having the same amplitude and phase.

While the total phase pattern is the sum of the phase patterns of the individual source pattern and array pattern.

TM Situation 1: Array of two point sources fed in

phase with the amplitude of the individual

source to be $E_0 = E_0 \sin(\theta)$ TM Situation 2: Array of two point sources fed in

phase with the amplitude of the individual

source to be $E_0 = E_0 \cos(\theta)$ TM Situation 3: Array of four point sources fed in

phase with the amplitude of the individual

source to be $E_0 = E_0 \sin(\theta)$

10. Explain the different techniques used for tapering of arrays

Array Tapering:

Tapering of array is a technique used for reduction of unwanted side lobes. The amplitude of currents in the linear array source is non-uniform; hence the central source radiates more energy than the ends. Tapering is done from center to end.

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Techniques used for array tapering: TM Binomial Array: Tapering follows the coefficient of binomial series TM Dolph Tchebycheff Array: Tapering follows the coefficient of Tchebycheff polynomial.

1. Binomial Array:

It is an array in which the amplitudes of the antenna elements in the array are arranged according to the coefficients of the binomial series.

The need for a binomial array is

- i). In uniform linear array as the array length is increased to increase the directivity, the secondary lobes also occurs.
- ii) For certain applications, it is highly desirable that secondary lobes should be eliminated completely or reduced to minimum desirable level compared to main lobes.

Advantage: TM No minor lobes

Disadvantages: TM Increased beam width TM Maintaining the large ratio of current

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amplitude in large arrays is difficult

2. Dolph Tchebycheff Array: TM Tapering follows the coefficient of Tchebycheff polynomial.

11. Derive the fields radiated from a short electric dipole. List the far field

components. Determine its radiation resistance and directivity.

TM Fields radiated from the short dipole and radiation resistance (Refer Antennas & propagation By K.D. Prasad, Page No. 210 to 227)

TM Directivity is 1.5 (Refer Antennas & propagation By K.D. Prasad, Page No. 251 to 252)

12. Derive the expressions for the fields and power radiated from a half wave dipole

antenna. Find its radiation resistance and directivity.

TM Fields radiated from the short dipole and radiation resistance (Refer Antennas & propagation By K.D. Prasad, Page No. 229 to 234)

TM Directivity is 1.5 (Refer Antennas & propagation By K.D. Prasad, Page No. 252 to 253)

13. Derive the field radiated from a small loop antenna

TM Small loop radiated fields (Refer "Antennas" By John D. Kraus, Page No. 200 to 208)

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14.Explain in detail about the helical antenna

™ Definition of helical antenna

™ Helical Geometry

™ Radiated fields of helical antenna

™ Types of helix

Refer “Antennas” By John.D.Kraus

15.Explain the different modes of operation of helical antenna

™ Normal mode of operation

™ Axial mode of operation.

16. Explain Ground wave Propagation.

Sky wave.

Waves that arrive at the receiver after reflection in the ionosphere is called sky wave.

Tropospheric wave.

Waves that arrive at the receiver after reflection from the troposphere

region is called Tropospheric wave.(ie 10 Km from Earth surface).

Ground wave.

Waves propagated over other paths near the earth

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surface is called ground wave propagation.

Type of Ground wave.

Ground wave classified into two types.

iv. Space wave

v. Surface wave.

Space Wave.

It is made up of direct wave and ground reflected wave. Also includes the portion of energy received as a result of diffraction around the earth surface and the reflection from the upper atmosphere.

Surface Wave.

Wave that is guided along the earth's surface like an EM wave is guided by a transmission is called surface wave. Attenuation of this wave is directly affected by the constant of earth along which it travels.

17.Explain diversity reception.?

To minimize the fading and to avoid the multi path interference the technique used are diversity reception. It is obtained by two ways.

1. Space diversity reception

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2. Frequency diversity reception.

3. Polarization diversity.

Space diversity Reception.

This method exploits the fact that signals received at different locations do not fade together. It UHTXLUHV DQWHQQDV VSDFHG DW OHDVW DSDUW DUH SUHIHUHG and the antenna which high signal strength at the moment dominates.

Frequency diversity Reception.

This method takes advantage of the fact that signals of slightly different frequencies do not fade synchronously. This fact is utilized to minimize fading in radio telegraph circuits.

Polarization diversity reception.

It is used in normally in microwave links, and it is found that signal transmitted over the same path in two polarizations have independent fading patterns.in broad band dish antenna system, Polarization diversity combined with frequency diversity reception achieve excellent results.

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18. Explain in detail ionospheric propagation.

Waves that arrive at the receiver after the propagation through ionosphere is ionospheric propagation..

The ionosphere is that region of the earth's atmosphere in which the constituent gases are ionized by radiation from the outer space.

The region is 50 Km to 400 Km.

- Effective Dielectric and conductivity of an ionized gas.

- Reflection and refraction waves by the ionosphere.

(Refer Page no 667 to 681. Electro magnetic waves and radiating Systems .By. C.JORDAN and G.BALMAIN)

19. Explain

a. Effect of the earth magnetic field.

b. Faraday rotation in Sky wave Propagation.

Effect of the earth magnetic field

Electrons and ions in the ionosphere are influenced not only by the fields of a passing electro magnetic wave but also by the earth magnetic field, which causes the charged

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particles to move in circular or spiral paths.

(Refer Page no 687. Electro magnetic waves and radiating Systems .By. C.JORDAN and G.BALMAIN)

Faraday rotation in Sky wave Propagation

Due to the earth's magnetic fields, the ionospheric medium becomes anisotropic and the incident plane wave entering the ionosphere will split into ordinary and extra ordinary waves/modes.

When these modes re-emerge from the ionosphere they recombine into a single plane wave again. Finally the plane of polarization will usually have changed, this phenomenon is known as Faraday's rotation.

(Refer Page no 693. Electro magnetic waves and radiating Systems .By. C.JORDAN and G.BALMAIN)

20. Derive the expression for Permittivity and conductivity of ionized gas.?

Plasma: .Assembly of charged particles in which the time average charge density is Zero.

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Plasma is formed Whenever the atoms in a gas are ionized to produce equal number of ions and electrons.

Eg earth ionosphere.

$$r = 1 - \frac{N_e^2}{(P^2 - 1)} > 1$$

Note: Conductivity is maximum means the wave will pass through that medium.

Conductivity is small, waves get reflected.

(Refer Page no 670

fn. Electro magnetic waves and radiating Systems .By.

C.JORDAN and G.BALMAIN)

21.Explain the concept of Reflection and refraction waves by the ionosphere.

The reflection and refraction of radio waves by the ionosphere is a function of frequency.

Briefly describe the following.

- i. Reflection at low frequency.
- ii. Reflection at high frequency.
- iii. Maximum usable frequency.
- iv. Optimum frequency.

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v. Skip distance.

Important formula for problems:

i Critical frequency,

$$f_{cr} = 9\sqrt{1\max}$$

ii. Relative Dielectric constant $\epsilon_r = 1 - \frac{N_e^2}{P^2 + v^2}$

iii. Phase constant,

$$\beta = \frac{2\pi}{\lambda} \sqrt{1 - \left(\frac{f_c}{f}\right)^2}$$

iv. Wave impedance. $Z_0 / \sqrt{1 - \left(\frac{f_c}{f}\right)^2}$

v. Wave velocity.

$$v_p = c / \sqrt{1 - \left(\frac{f_c}{f}\right)^2}$$

vi Group velocity,

$$v_p v_g = c^2$$

$$v_g = c^2 / v_p$$

vii. Incident angle .

$$\sin i = \sqrt{1 - \left(\frac{f_c}{f}\right)^2}$$

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