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SUBJECT NAME: Antenna wave propagation

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NOORUL ISLAM COLLEGE OF ENGINEERING,KUMARACOIL

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SUBJECT: ANTENNAS AND WAVE PROPAGATION

SEMESTER:VI

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 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 (Ω_A) consists of the main beam area (Ω_M) plus the minor lobe area (Ω_m) . Thus $\Omega_A = \Omega_M + \Omega_m$.

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

Beam efficiency = $\Sigma_M = \Omega_M / \Omega_A$.

5.**Define Directivity?**

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

$D = P(\theta,\phi)_{max} / P(\theta,\phi)_{av.}$ Directivity from Pattern.

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

6.**What are the different types of aperture.?**

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 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).

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.

8. **Define Aperture efficiency?**

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

Aperture efficiency = η_{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 ay be divided into two principal regions.

i. Near field zone (Fresnel zone)

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

FBR = Power radiated in desired direction / 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.

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 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 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) = ---

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).

23. What is meant by Beam Area.?

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

$$\Omega_A = \int \int_{4\pi} P_n(\theta,\phi)\, d\Omega$$

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 filed 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 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 between adjacent element is $\delta=0$.

31.Define End fire array.?

End fire array is defined as an arrangement in which the principal direction of radiation is coincides with the array axis.

For end Fire array $\delta= -\beta d$

Where $\beta = 2\pi / \lambda$. And d = distance between the elements.

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.?

When $\delta= -\beta d$, produces maximum field in the direction $\phi = 0$ 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 between the sources so that ,$\delta= - (\beta d+ \pi / n)$.

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,

$$E= (1/ n) (\sin (n \psi / 2) /.\sin (\psi / 2)).$$

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 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,

$$BWFN = ((+/ -)2\ \lambda / n\ d)$$

For End fire array the expression for beam width between the first nulls is given by,

$$BWFN = ((+/ -)\ 2(2\ \lambda / n\ d))^{1/2}.$$

38. Differentiate broad side and End fire array.?

Broad side array	End fire array
1. Antennas fed in Phase $\delta=0$.	Antenna elements are fed of out of Phase $\delta= -\beta\ d$
2. Maximum Radiation is perpendicular to the direction of array axis.	Maximum Radiation is directed along the array axis.
3. Beam width of major lobe is twice the	Beam width is greater than that for a broad side array of same length. $BW = ((+/ -)\ 2(2\ \lambda / n\ d))^{1/}$

reciprocal of the array length. BW = ((+/ -)2 λ / n d)	[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 Sr at a constant radius as a function of angle is called power density pattern or 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

44.What is the advantage of pattern multiplication?

- Useful tool in designing antenna
- 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:

- ❖ No minor lobes

Disadvantages:

- ❖ Increased beam width
- ❖ Maintaining the large ratio of current amplitude in large arrays is difficult

48.What is the difference between isotropic and non-isotropic source

- ❖ Isotropic source radiates energy in all directions but non-isotropic source radiates energy only in some desired directions.
- ❖ 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

- ❖ Binomial Array:Tapering follows the coefficient of binomial series

- 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 throughtout the entire length 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 filed 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.

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 Idl 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 Oscilllating 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 throughtout its length.The effect of 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]=Io exp(jẁ(t-r/c))

Where ẁr/c is the phase retardation

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 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?

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

$$r=0.159\lambda$$

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

$$Ae=0.119\lambda^2$$

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

$$Ae=0.13\lambda^2$$

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

The radiation resistance of a half wave dipole is given by

Rr=73 ohm

66.What is a loop antenna?

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

$Rr=31,200 (A/ \lambda^2)2$

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. Electrically Small(Circumference <λ/10)
2. Electrically Large(Dimension comparable to λ)

70.What are Electrically Small loop antennas?

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

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:

- It became thw workhouse of space communications for telephone,television and data,being employed both on satellites and at ground stations
- Many satellites including weather satellites,data relay satellites all have helical antennas
- It is on many othe 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.

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.

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

86.What is meant by 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.

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 requires antennas spaced at least 100λ apart are preferred and the antenna which high 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 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 ionosheric 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.

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

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 earths magnetic flux density B.

93. Define critical frequency.

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

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

94. Define Magneto-Ions Splitting.

The phenomenon of splitting the wave into two different components (ordinary and extra-ordinary) by the earths 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 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 $n = c / v_p$

$$n = \frac{\text{Velocity of light in vacua}}{\text{Phase velocity in the medium}}$$

$$n = \sqrt{\epsilon_r}$$

97Define maximum Usable Frequency.

The maximum Frequency that can be reflected back for a given distance of transmission is called the maximum usable frequency (MUF) for that distance.

$$MUF = f_{cr} \sec \Phi_i$$

98. Define skip distance.

The distance with in 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.?

Otimum 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.?

$$\eta = \eta_0 / \sqrt{1 - (f_c / f)}$$

ie $$\eta = 377 / \sqrt{1 - (f_c / f)}$$

101. Define wave velocity and Group velocity.?

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

Group velocity, $v_p v_g = c^2$

$$v_g = c^2 / v_p$$

16 MARK QUESTIONS

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).

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

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

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 is called so, because the length of the dipole is short and the current is almost constant throughtout 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 filed 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 filed 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 ay 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 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 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

$$Ae=0.119\lambda$$

The directivity is found to be

$$D= 4\Pi Ae/ sq(\lambda)$$

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 atleast 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.

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 form a ellipse called 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 filed vector rotates and form 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

- **Case 1**: Arrays of two isotropic sources fed with currents of equal amplitude and in phase
- **Case 2**: Arrays of two isotropic sources fed with currents of equal amplitude and opposite phase
- **Case 3**: Arrays of two isotropic sources fed with currents of unequal amplitude and any phase
- **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 between adjacent element is $\delta=0$.

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

For end Fire array $\delta= -\beta d$

Where $\beta = 2\pi / \lambda$. And d = distance between the elements.

- 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 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

- **Situation 1:** Array of two point sources fed in phase with the amplitude of the individual source to be $Eo=Eo^1$ Sin (theta)
- **Situation 2:** Array of two point sources fed in phase with the amplitude of the individual source to be $Eo=Eo^1$ Cos (theta)
- **Situation 3:** Array of four point sources fed in phase with the amplitude of the individual source to be $Eo=Eo^1$ 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.

Techniques used for array tapering:

- ❖ Binomial Array:Tapering follows the coefficient of binomial series
- ❖ 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:

- ❖ No minor lobes

Disadvantages:

- ❖ Increased beam width
- ❖ Maintaining the large ratio of current amplitude in large arrays is difficult

2. Dolph Tchebycheff Array:

- ❖ 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.

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

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

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

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 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
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 requires antennas spaced at least 100λ apart are preferred 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.

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 earths 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 elecro magnetic wave but also by the earth magnetic field, which causes the charged 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 ionosheric 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 Permitivity and conductivity of ionized gas.?

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

Plasma is formed Whenver the atoms ina gas are ionized to produce equal number of ions and electrons. Eg earth ionosphere.

$$\epsilon_r' = 1 - Ne^2 \quad / (m\epsilon_v \ (\omega^2 + \gamma^2)$$

$$\sigma = [Ne^2 \quad / m \ (\omega^2 + \gamma^2)]$$

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

Conductivity is small, waves gets 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.
v. Skip distance.

Important formula for problems:

i Critical frequency,

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

ii. Relative Dielectric constant

$\epsilon_r = 1- Ne^2 / (m (\omega^2 + v^2)$

iii. Phase constant,

$\beta = (2\pi/\lambda) \sqrt{}\ 1- (f_c / f)$

iv. Wave impedance.

$\eta = \eta_0 /\sqrt{}\ 1- (f_c / f)$

v. Wave velocity.

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

vi Group velocity,

$v_p\ v_g = c^2$

$v_g = c^2 / v_p$

vii. Incident angle .

$\sin i = \sqrt{}\ 1- (f_c / f)$