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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

ANTENNAS AND WAVE PROPOGATION

2 MARKS QUESTIONS & ANSWERS

Unit.1

Antenna fundamentals

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 (W_A) consists of the main beam area (W_M) plus the minor lobe area (W_m) . Thus $W_A= W_M+W_m$.

The ratio of the main beam area to the total beam area is called beam efficiency. Beam efficiency = $S_M=W_M/ W_A$.

5.Define Directivity?

The directivity of an antenna is equal to the ratio of the maximum power density to its average value over a sphere as observed in the far field of an antenna.

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 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 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 = $\Omega_{ap} = A_e / A_p$ (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 at least 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.

$W' = I^2R$ $R_r = W'/I^2$ Where R_r is a fictitious resistance called as radiation resistance.

15. What is meant by antenna beam width?

Antenna beam width 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

$$\text{Gain (G)} = \frac{\text{Maximum radiation intensity from test antenna}}{\text{Maximum radiation intensity from the reference antenna with same input power}}$$

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.

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16 marks

1.State and prove reciprocity theorem

2.explain the following with respect to antenna

i. Radiation resistance.
ii. Beam area.
iii. Radiation intensity.
iv. Directivity.
v. Gain.
vi. Isotropic radiator

3. Explain the following

a) vector effective length

b) antenna temperature

4. Write short notes on

a)equivalence of radiation pattern

b) equivalence of impedances

5.Derive the relation between gain and directivity

UNIT.2

Wire Antennas and Antenna Arrays

1.What is a Short Dipole?

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 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.

2.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 wavelength maximum specified for a short dipole. Elemental dipole is also called as elementary dipole, elementary doublet and hertzian dipole.

3.What is a Infinitesimal Dipole?

When the length of the short dipole is vanishing 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.

4.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 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(j w(t-r/c)) Where wr/c is the phase retardation.

5.Define induction field

The induction field will predominate at points close to the current element ,where the distance from the center 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.

6.Define Radiation field

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

7.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.

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

The effective aperture of a short dipole is given by $A_e = 0.119l^2$

9.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

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

The effective aperture of a half wave dipole is given by $A_e = 0.13l^2$

11.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)

12.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.

13.What are the types of loop antennas?

Loop antennas are classified into:

A.Electrically small (circumference <l/10)

B. Electrically large (dimension comparable to l)

14.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.

15.What are Electrically large loop antennas?

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

16.List out the uses of loop antenna

1) It is used as receiving antenna in portable radio and pagers

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

3)It is used to estimate the direction of radio wave propagation

17.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 .

18.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 adjacent element is d = 0.

19.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

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

20.Define array factor.

The normalized value of the total field is given by,

$E = (1/n) (\sin (nY/2)/ \sin (Y/2))$

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

21. Differentiate broad side and End fire array.

S.No	Broad side array	End fire array
1.	Antenna is fed in phase d = 0	Antenna elements are fed out of phase d = -bd
2.	Maximum radiation is perpendicular along the direction of array axis	Maximum radiation is along the array axis

22.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.

23. 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.

24.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.

25.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.

16 marks

1. Derive the expression for the radiated field from a short dipole?

2. Starting from first principles obtain the expression for the power radiated by a half wave dipole?

3. Derive the fields radiated from the small loop antenna

4. Explain the two element array

5. Explain the principle of pattern multiplication

Unit.3

Aperture Antennas

2 marks

1. State Huygen's Principle?

Huygen's principle states that each point on a primary wave front can be considered to be a new source of a secondary spherical wave that a secondary wave front can be constructed as the envelope of these secondary waves.

2. What is Slot Antenna?

The slot antenna is an opening cut in a sheet of a conductor, which is energized through a coaxial cable or wave guide.

3. Which antenna is complementary to the slot dipole?

The dipole antenna is the complementary to the slot antenna. The metal and air regions of the slot are interchanged for the dipole.

4. How will you find the directivity of a large rectangular broadside array?

$$\text{Directivity , } D = \frac{12.56 \times \text{Area of the aperture}}{l^2}$$

5. What is the relationship between the terminal impedance of slot and dipole antenna?

$Z_s Z_d = h_o^2/4$

Where Z_s is the terminal impedance of the slot antenna

Z_d is the terminal impedance of the dipole antenna

h_o is the intrinsic impedance of the free space » 377W\\

6. Define lens antenna?

An antenna, which collimates the incident divergent energy to prevent it from spreading in undesired directions, is called as lens antenna.

7. What are the different types of lens antenna?

1.E plane metal plate lens

2.H plane metal plate lens

8. What is a dielectric lens antenna?

Dielectric lens antennas are the antennas in which the traveling wave fronts are delayed by lens media

9. What are the drawbacks of lens antenna?

- Lens antennas are used only at higher frequencies (above 3 GHz) because at lower frequencies they become bulky and heavy. Lens antennas have excessive thickness at low frequencies.

- Costlier for the same gain and beam width in comparison with reflectors

10.What are the advantages of stepped dielectric lens antenna?

- It is mechanically strong
- Reduces weight
- Less power dissipation

15.What are the advantages of lens antenna

- the lens antenna, feed and feed support do not block the aperture as the rays are transmitted away from the feed
- It has greater design tolerance
- It can be used to feed the optical axis and hence useful in applications where beam is required to be moved angularly with respect to the axis.

16.What do you meant by sect oral horn?

If flaring (opened out) is done only in one direction, then it is called as a sectoral horn.

18.What do you meant by pyramidal horn?

If flaring is done along both the walls(E & H), then it is called as a pyramidal horn.

19.What are the various feeds used in reflectors?

1. Dipole antenna
2. Horn feed
3. End fire feed
4. Cassegrain feed

20.State uniqueness theorem

For a given set of sources and boundary conditions in a lossy medium the solution to maxwells equation is unique

16 marks

1. Derive the magnetic fields of an aperture antennas

2. Explain the type of lens antenna

3. Write short notes on image theory and duality principle

4. Explain reflector antennas

5.Expalin the field equivalence principles

UNIT.4

Special Antennas and Antenna Measurements

2 marks

1What is yagi uda antenna?

It is an array of driven element,reflectors and one or more directors.

2.What are the different regions in log periodic antenna?

Inactive region,active region and inactive reflective region\

3. What are the applications of log periodic antenna?

- HF communication
- Television reception
- All round monitoring

4. Define rhombic antenna

An antenna which consists of four straight wires,arranged in the shape of a diamond,suspended horizontally above the surface of the ground is called rhombic antenna

5. What are the different types of design of rhombic antenna?

- Alignment design
- Maximum field intensity design

6. What are the limitations of rhombic antenna?

- It needs large space for installation
- Due to minor lobes transmission efficiency is low

7. What is a long wire antenna?

The antennas in which there is no reflected wave is called long wire antenna or travelling wave antenna

8. What are the various modes of operation of helical antenna

The two modes are

- Normal mode
- Axial mode

9. What is a monofilar helical antenna?

An antenna constructed by a single conductor is called monofilar helical antenna.

10.What is the advantages of helical antenna?

- Very simple
- Higher directivity
- Wideband operation is possible
- Circular polarization is obtained

11.what is multifilar helix?

An antenna constructed with more than one conductor is called multifilar helix

12. State the principle of operation of a turnstile antenna

Two half wave dipoles placed at right angles to each other in the same phase are excited 90 degree out of phase with each other and produces circular pattern in the plane of turnstile

13.What are the applications of turnstile antenna

- FM transmission
- Television broadcasting

14.What is biconical antenna?

The biconical antenna is a double cone antenna which is driven by potential , charge or an alternating magnetic field at the vertex. In this antenna both the cones face in the opposite direction.

15.what are the parameters in designing the helical antenna

- Beamwidth
- Gain
- Axial ratio
- Impedance

16. What are the two types of feed for turnstile antenna?

1. two dipoles are connected to separate non resonant lines of unequal length

2. by introducing reactance in series with one of the dipoles ,quadrature phase currents are produced.

17.What are the two methods for impedance measurements?

Bridge method for low frequencies

Slotted line or standing wave method for high frequencies

18.how are spherical waves obtained?

When a voltage V is applied at the input terminals of a biconical antenna,it will produce outgoing spherical waves.The biconical antennas act as guide for spherical waves

19.What are the applications of microstrip patch antenna

- Used in spacecraft and aircraft engines
- Used for beam steering and beam scanning

20.What are the various shapes of the patch?

The patch may be square,elliptical or rectangular.the patch is usually radiating

16 marks

1.Explain the radiation from a long wire antenna

2.Explain the construction ,operation and design of a rhombic antenna

3.expalin helical antenna and explain its working modes

4.write in detail about the gain measurements techniques

5.derive the fields radiated from the biconical antenna

Unit.5

Radio wave propogation

1.Define Sky wave.

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

2.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).

3. What are the type of Ground wave.

Ground wave classified into two types.

i. Space wave

ii. Surface wave.

4. 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.

5. 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.

6. 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.

Two types. i. Inverse bending.

ii. Multi path fading.

7.What is meant by Faraday' s rotation?

Due to the earth' s magnetic fields, the ionosphere 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.

8. 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.

7. 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.

8. Define critical frequency.

For any layer , the highest frequency that will be reflected back for vertical incidence is f_{cr} $^{=9Ö}$max

9. 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.

10. 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 .

11. Define 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.

$MUF = f_{cr}\_secF_i$

12. 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.

13.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.

14. Define Ground wave.

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

15. 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.

16. What is sporadic E LAYER in ionosphere?

The sporadic E layer is a anomalous ionization layer in the atmosphere.It usually occurs in the form of clouds.

17. Define whistlers

They are transient electromagnetic disturbance which occur naturally

18.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.

19. Define Space diversity Reception.

This method exploits the fact that signals received at different locations do not fade together.

20 .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.

16 MARKS

1. Explain in detail about ionosphere?

2. Explain space wave propagation and sky wave propagation?

3. Explain the ground wave propagation?

4. Discuss the effects of earth's magnetic field on ionosphere radio wave Propagation?

5. Describe the troposphere and explain how ducts can be used for Microwave propagation?