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Subject :- Antenna and wave propagation.

Semester : 8th

Q No 1. (a) The directivity of an antenna array can be increased by adding more antenna element, as larger number of element.

(A) improves The radiation efficency

(B) increases The effective area of The antenna.

(c) results in a better impedance matching

(d) allows more power to be transmitted by The antenna

Ans:

(B) increase The effective area of The antenna

Q1(b)

Radiation resistance of an antenna is 90 ohm & loss resistance is 30 ohm calculate antenna radiation efficiency.

Sol:

$R_{rad} = 90\,\Omega$

$R_{loss} = 30\,\Omega$

$$\eta = \frac{R_{rad}}{R_{rad} + R_{loss}}$$

$$= \frac{90}{90+30}$$

$$= \frac{90^{3}}{120_{4}}$$

$= 3/4$ Ans

Q No 2: (a)

An antenna has a loss resistance of 40 ohms, power gain of 60, and directivity 13. Calculate the radiation resistance.

Sol; Give Data

$R_L = 40\Omega$

Power gain = 60

$D = 13$

Power gain = KD

$\Rightarrow K = K/D$

$= \frac{60}{13}$

$\boxed{= 4.61}$

$R_L = 40\Omega$

Power gain = 60

$D = 13$

Power gain KD

$\Rightarrow K = KD$

$\frac{60}{13} \Rightarrow 4.61$

$$K = \frac{R_x}{R_x + R_L}$$

$$\frac{60}{13} = \frac{R_x}{R_x + 40}$$

$$60(R_x + 40) = 13R_x$$

$$60R_x + 2400 = 13R_x$$

$$2400 = 13R_x - 60R_x$$

$$2400 = -47R_x$$

÷ing both side -47

$$\frac{2400}{-47} = \frac{-47R_x}{-47}$$

$$R_x = \frac{2400}{-47}$$

$$\boxed{R_x = -51.06}$$

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Q2 (b)

Explain Scattering parameter and VSWR?

Ans.

Scattering parameter:

Scattering parameters decribes the input-output relationship between port in an electrical system.

Specifically at high frequency it becomes essential to describe a given network in terms of waves rather than voltage or current. Thees in S-Parameter we use power waves.

In RF design, we cant use other parameter for analysis such as Z, Y, H parameters as we can't do short circuit and open circuit analysis as it is not feasible.

VSWR:

VSWR stands for voltage standing wave Ratio, and also referred to the standing wave Ratio (SWR). VSWR is a function of the reflection coefficient, which describes the power reflected from The antenna. if The reflection coefficent, ~~which~~ is given by Γ, Then The VSWR is defined by The following formula.

$$VSWR = \frac{1+|\Gamma|}{1-|\Gamma|}$$

The VSWR is always a real and positive number of antennas. The smaller The VSWR is The better The antenna is matched to The transmission line and The more power is delivered to The antenna. The minimum VSWR is 1.0. in This case, no power is reflected from The antenna.

QNo3 (a)

Briefly Explain Ground wave Propagation, sky wave propagation and Space wave propagation:

Ans. Ground wave propagation:

Ground wave propagation is a method of radio wave propagation That uses The area between The surface of The earth and The ionosphere for transmittion.

The ground wave can propagate a considerable distance over the earth's surface particularly in the low frequency and medium frequency portion of the radio spectrum.

Sky wave propagation:

The sky wave propagation are the radiowave of frequency between 2MHz to 30MHz These radio waves can propagate through atmosphere and are reflected back by the ionosphere of earth's atmosphere.

Since these waves go from transmitter antenna to reciver antenna while travelling through sky, hence their propagation is known is sky wave propagation.

Space wave propagation:

The space waves are the radio waves of very high frequency (i.e 30 MHz to 300 MHz or more). The space waves can travel

Through atmosphere from transmitter antenna to reciver antenna eith directly or after reflection from ground in the earth's troposphere region. That is why the space wave propagation is also called as troposphere propagation.

Q3 (b)

What is Effective aperture, Reciprocity and FNBW?

Effective aperture:-

A useful parameter calculating the reciver power of an antenna is the effective area or effective aperture. Then the effective aperature paramater describe how much power is captured from a given plane wave. let 'P' be the power density of the plane wave (in W/m^2). if P_t represent the power (in watt) at the antennas terminals available to the antenna reciver.

$$P_t = PA_e$$

Reciprocity

Reciprocity states that the reciver and antenna can bes used as both transmitting antenna and reciving antenna while using so, may come across a Qustion wheather of the antenna might changed. ~~as its mode~~

FNBW:

According to the standard definiteon the angular span b/w the first pattern nulls adjacent to the main lobe, is called as the first Null Beam width.

FNBW is the angular seperation, Quoted away from the main beam, which is drawn b/w the null points of the radeation pattern, on its major lobe

FNBW = 2 HPBW

FNBW 2(70λ/D) = 140λ/D

Q No 4: Explain The design and working principle of MPA (Micro strip patch Antenna) and discuss four feeding Method. of MPA.

Ans:

Basic of microstrip patch antenna.

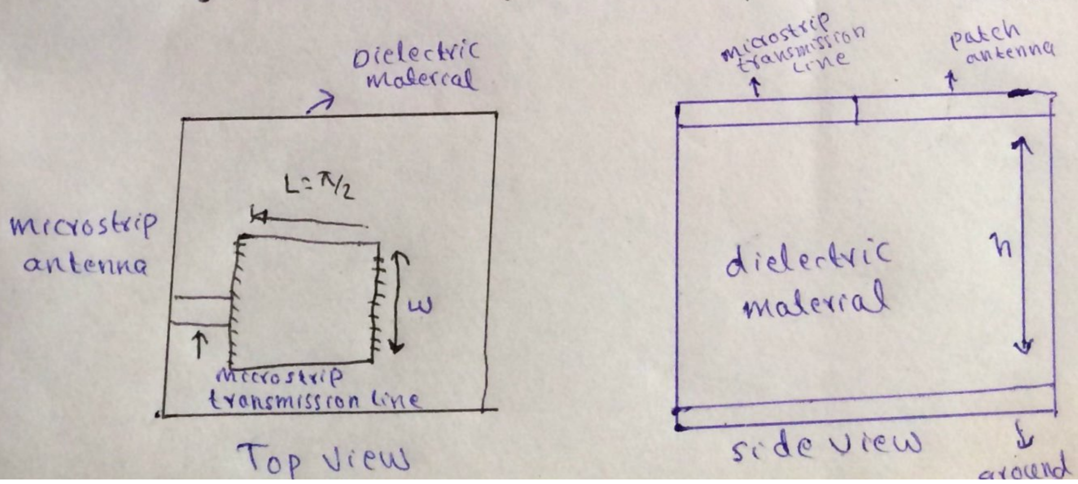
i) It is metallic patch placed on directric material and supported by ground plane.

2) it could by easily fubri coded on printed circuit board.

3) It is most widely used antenna.

4) Installion is very easy due too size weight and cost.

Structure of microstrip patch antenna:-



Operating frequency:-

$$f_o = \frac{c}{2w\sqrt{\varepsilon_r}}$$

Electric field of microstrip:-

$$E_{\theta} = \frac{\sin\left[\frac{kw\sin\theta\sin\phi}{2}\right]}{\frac{kw\sin\theta\sin\phi}{2}} \cos\left(\frac{kL}{2}\sin\theta\cos\phi\right)\cos\phi$$

$$E_{\phi} = \frac{\sin\left[\frac{kw\sin\theta\cos\phi}{2}\right]}{\frac{kw\sin\theta\sin\phi}{2}} \cos\left(\frac{kL}{2}\sin\theta\cos\phi\right)\cos\theta\cos\phi$$

Working principle:-

microstrip antenna radiate primarily because of The fringing fields because between The patch edge and The ground plane for good antenna performance a Thick dielectric substrate having a low dielectric constant (<6) is desirable since it provides higher efficiency, larger bandwidth and better rediant.

Design Equation for microstrip pitch antenna:-

for the ε_r

$$\lambda = c/f$$

$$w = \frac{c}{2f} = \sqrt{\frac{2}{\varepsilon_r + 1}}$$

$$L = L_{eff} - 2\Delta L$$

L_{eff} is effective length and it is given

$$L_{eff} = \frac{c}{2f\sqrt{\varepsilon_{reff}}}$$

Feeding Method:

A feeding is used to excite to radiate by direct or indirect contact There are many different method of feeding and four most popular method are microstrip. line feed, caxial probe, aperture, coupling and promitty coupling.

1) microstrip line feeding:

Microstrip line feeding is one of the easier method to fabricate as it is a just conducting strip connecting to the patch and therefore can be consider a extension of patch. It is a simple to model and easy to match by controlling th inset position.

However the disadvantage of this method is that as substrate a thickness increases surface wave and superious feed radiation.

2) Coaxial feeding:

Coaxial feeding method in which that the inner conductor of the coaxial is attached to the radiation patch of the antenna while the outer conductor is connected to the ground plane.

3) Aperture coupling:

Aperture coupling consists of two different substrate separated by a ground plane. on the bottom side of lower substrate There is a microstrip feed line.

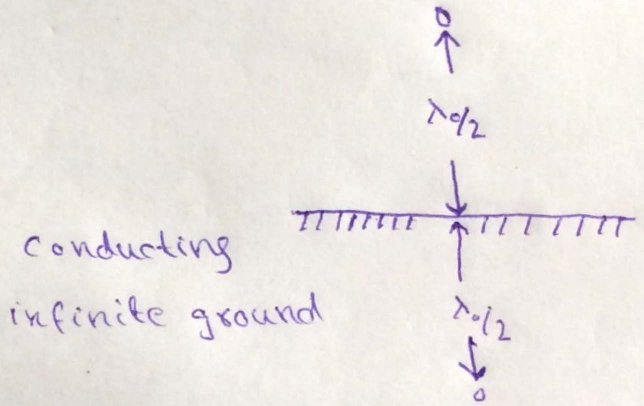
4) Proximity Coupling:

proximity coupling has the largest bandwidth, has low spurrous radiatcon. However fabrication is difficult. length of feeding stub and width-to-length ratio of patch is used to control the match.

Q NO 5

Sol:

A $\lambda/2$ dipole is kept horizontally at a height of $\lambda_0/2$ above conducting ground plane



Here $d = \lambda$ $\alpha = \pi$ Thus $\beta d = \frac{2\pi}{\lambda} \cdot \lambda = 2\pi$

Array Factor is $= \cos\left[\frac{\beta d \cos\phi + \alpha}{2}\right]$

$$= \cos\left[\frac{2\pi \cos\phi + \pi}{2}\right]$$

$$= \sin(\pi \cos\phi)$$

correct option (B)

—— x —— x. —— x —— x.