Department of Electrical Engineering

Final-Assignment

Date: 23/06/2020

Course Details

Course Title: Antennas & Wave Propagation **Module:** ____________

Instructor: ____________ **Total Marks:** 50

Student Details

Name: ____________ **Student ID:** ____________

Q1. (a) The directivity of an antenna array can be increased by adding more antenna elements, as a larger number of elements

(A) improves the radiation efficiency
(B) increases the effective area of the antenna
(C) results in a better impendance matching
(D) allows more power to be transmitted by the antenna

Marks 5
CLO 2

(b) Radiation resistance of an antenna is 90 ohms & loss resistance is 30 ohms. calculate antenna radiation efficiency?

Marks 5
CLO 1

Q2. (a) An antenna has a loss resistance of 40 ohms, power gain of 60, and directivity 13. Calculate the radiation resistance

Marks 4
CLO 3

(b) Explain Scattering Parameter and VSWR?

Marks 6
CLO 2

Q3. (a) Briefly explain Ground wave propagation, sky wave propagation & space wave propagation?

Marks 4
CLO 1

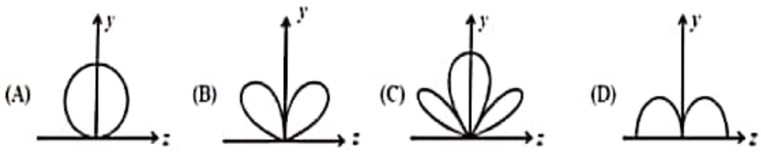
(b) What is Effective aperture, Reciprocity and FNBW?

Marks 6
CLO 2

Q4. Explain the design and working principle of MPA (Micro strip patch Antenna) and discuss four feeding methods of MPA

Marks 15
CLO 3

Q5. A $\frac{\lambda}{2}$ dipole is kept horizontally at a height of $\frac{\lambda_0}{2}$ above a perfectly conducting infinite ground plane. The radiation pattern in the plane of dipole ($\bar{E}$ plane) looks approximately as



Marks 05
CLO 2

Name Saqib Ali

ID 13041

Subject Antennas & wave propagation.

Date 23/1/2020

IQRA NATIONAL UNIVERSITY HAYATABAD

PESHAWAR.

Question No 1 :-

(a) The directivity of an antenna array can be increased by adding more antenna elements as a larger number of elements.

(A) Improves the radiation efficiency.

(B) Increases the effective area of the antenna.

(C) Results in a better impendence matching.

(D) allows more power to be transmitted by the antenna.

Ans :-

Option B :- Increases the effective area of the antenna.

Question No 2 :-

(b) Radiation resistance of an antenna is 90 Ω & loss resistance is 30 Ω. Calculate antenna radiation efficiency.?

Solution :-

Given Data.

$R_{rad} = 90\Omega$

$R_{loss} = 30\Omega$

Required :-

Antenna radiation efficiency $= \eta = ?$

Formula

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

$$= \frac{90}{90 + 30} \Rightarrow \frac{90}{120}$$

$$\eta = 3/4 \text{ —— Ans}$$

Question No 2

(a) An antenna has a loss resistance 40 Ω power gain of 60 and directivity 13. Calculate the radiation resistance?

Solution:-

Given Data.

Loss Resistance = $R_L = 40\,\Omega$

Power gain = $G = 60\,\Omega$

Directivity = $D = 13$

Requried :-

Radiation resistance = $R_r = ?$

$$G = KD$$

$$K = G/D$$

$$K = 60/13$$

$$\boxed{K = 4.62}$$

We know that

$$K = \frac{R_r}{R_r + R_e}$$

$$60/13 = \frac{R_r}{R_r + 40}$$

~~60 R_r +~~

$$60 R_r + 2400 = 13 R_r$$

$$60 R_r - 13 R_r = -2400$$

$$47 R_r = -2400$$

$$R_r = -2400/47$$

$$\boxed{R_r = -51.06\,\Omega}$$

or

$$\boxed{R_r = 51.06\,\Omega}$$

Question No 2

(b) Explain scattering Parameter and VSWR?

(*) Scattering Parameters :- Scattering parameter is also called S-Parameter. The S-Parameter is also used to discribe the relationship between different ports. When it is becomes ~~impor~~ especially important to discribe a network in terms of amplitude and phase versus frequencies., rather than voltages and currents. S-Parameter are used to show a complicated network as a simple block box and to ~~easy~~ easily present what happens to the signal in that network.

(*) VSWR :-

VSWR stands for Voltage Standing Wave Ratio and is also ~~reff~~ referred to as standing wave ratio (SWR). VSWR is a function of the reflection coefficient, which describes the power reflection from the antenna. If the reflection co-efficient ~~by~~

is given by Γ than the VSWR is defined by the following formula.

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

The VSWR is always a real and positive numbers of antenna. The smaller the VSWR is the better the antenna is matched to the transmission line and more power is delivered to the anetenna. The minimum VSWR is 1.0. In this case the no power is reflected from the antenna. Which is ideal. and the reflection coefficient is less than 0.5 over the quoted frequency range.

Question No 3

(a) Briefly explain Ground wave propagation sky propagation and Space propagation?

(*) Ground wave Propagation :- When the electromegetic wave emitted from transmitting antenna and propagate along the surface of the earth is called Ground wave.

(i) There wave are close to the earth

(ii) There ~~are~~ is attenuation when the wave close to the surface.

(iii) Energy loss by Carvature.

(iv) Used in amplitude modulation AM

(v) Can't Used high frequency and frequency modulation FM.

(*) Sky wave Propagation :-

When the electromegatic wave emitted by transmitting antenna and receivied after being reflected from ionsphere are called sky wave Propagation.

(i) Using the low of totall intenal reflection.
(ii) ionization occour due to positive and negative ions.
(iii) Frequency Range 2MHz to 30 MHz.
(iv) Medium requried as gases state
(v) $f_e = 9\sqrt{N_{max}}$.

(*) Space wave Propagation :- When the electromegatic wave transmitted by transmitter antenna travel directly from the transmitting antenna to the reciving antenna. are called space wave propagation.
(i) It used line of sight (los) and Satellite communication
(ii) Using high frequency
(iii) High losses of energy.
(iv) Very High frequency (VHF) band and altro high frequency (VHF) band
(v) Frequency Range 54 MHz - to 80.6 MHz.

Question No 3

(b) What is effective aperture, Reciprocity and FNBW?.

Ans :- Effective aperture :-

Effective area is the area of the receiving antenna which absorb most of the power from the incoming wave front to the total area of the antenna which is exposed to the wave front.

Effective area is represented by A_{eff} or gain.

The ratio of recived power at the terminal of an antenna to the power per Unit :

$$\frac{A}{G} = \frac{\lambda^2}{4\pi}$$

(*) Reciporocity :-

An antenna can be used both transmitting antenna and receiving anetenna while so may come area's a question whether the properties of the antenna might changes as its operation made is changed. when the properties of antenna being unchangeable is called as a properties reciposcity.

(i) Equality of directional pattern.
(ii) Equality of Directives.
(iii) Equality of effective length.
(iv) Equality of antenna impedence.

(*) First Null Beam width (FNBW) :-

The angular spain between the first pattern nulls adjacnt to the main labe is called as the first Null Beam width.

(i) Angular separation from the main Beam.

(iii) i.e. an null point of radiation pattern on its major lobe equation

$$FNBW = 2 HPBW$$

$$FNBW \; 2(70\lambda/D) = 140\lambda/D$$

where as

λ is wave length $= 0.3/Freq$

D is distance.

Question No 4:- Explain the design and working principle of MPA (micro strip patch antenna) and discuss four feeding method of MPA:?

Answer:- Micro Strip patch antenna:- The idea of micro strip patch antenna are arise from ~~utiliza~~ utralizing printed circuit Technology not only for the circuit components and transmission lines but also for the radiation elements of an electronic system. It was first proposed by Deschamps However little attention was paid to his idea until the 1970's. The basic structure of the micro strip patch anetenna is show in the figure ①.

It consist of area of metalization supported above the ground plane by thin dielectric substrate and fied against the ground at an appropriate location. This patch shape can be principle be arbitrary:

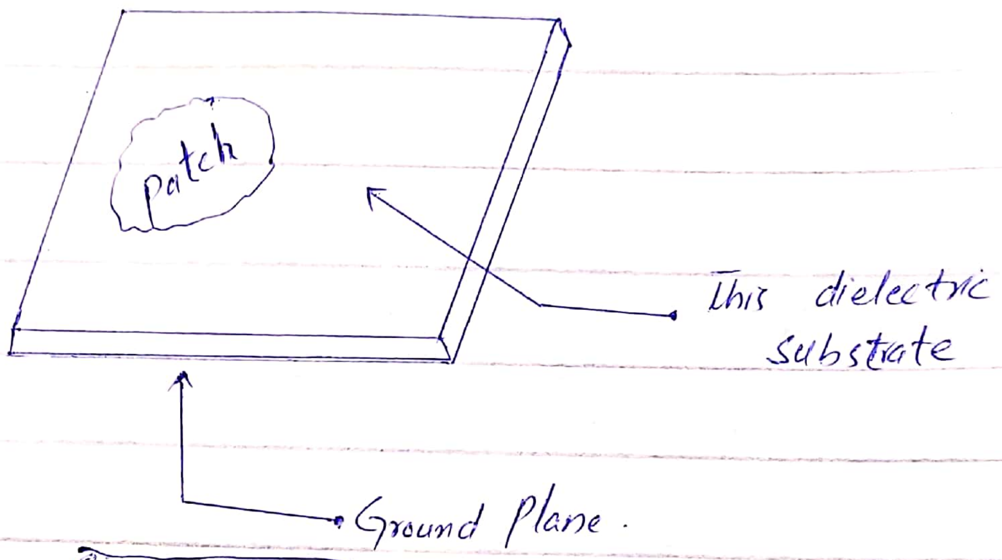


Figure 1

The rectangle the circile the equitrangle and the annular ring are common shapes. There are four feeding Method which are coaxial probe feed, microstrip line feed, operture - coupled feed and proximity feed. Electromegnatic energy is first guided or coupled to the region under this patch which acts like a resonant cavity with open circuits on ~~the~~ the side space, Resulting in an antenna.

(*) Material Consideration :- The metalic patch are normally made of thin copper foil. The The substrate meterials provide the mechnical support for the radiating patch. It also maintaine ~~the~~ the required spacing between the patch and its ground plane the substrate thickness for the basic geometry is in the range of 0.01 to 0.05 free space wave length.
The dieleetric constants ranges from 1 to 10 and can be seperated into three categories.

(i) Those having a relative dielectric constant ~~Reetive~~ (Reclative permitivity) in the range of 1.0 to 2.0. This type of material can be air, polystyrene foam, or dielectric honey comb.

(iii) Those with a relative dielectric constants between 4.0 to 10.0 this type of material can be ceramic, quartz or alumina. The most common using meterial is Teflon-based with a relative permitivity between 2 to 3. This material is also called PTEE (Polytetra Fluoro Ethylene). It has a structure very similar to fiber glass meterial used for digital circuit boards but has a much lower loss longest.

(*) Four Feeding Methods :-

→ Coaxial probe feed :- The coaxial probs usually has a characteristic impedence of 50 Ω. The input impedence of the patch antenna varies with the feed location. This the location of the probs should be at 50 Ω point of the patch to achive impedence matching.

→ Microstrip Line Feed :-

A microstrip patch can be connected directly to the microstrip transmission line. At the edge of patch The impedence is gernally much heigher than 50 Ω to aviod impedence. When the microtrip line feed approach an array of patch elements and their microstrip power devision line can be designed and chemicaly etched on the same substrate with relativity low fabrication cost per element.

→ Proximity - Coupled Microstrip Line Feed :- An open ended microstrip line can also be used to feed a patch antenna through proximity coupling. An open ended microstrip line can be also be placed in parallel and very close to the edge of the patch to achive excitation through fringe field coupling.

→ Aperture - Coupled Feed :-

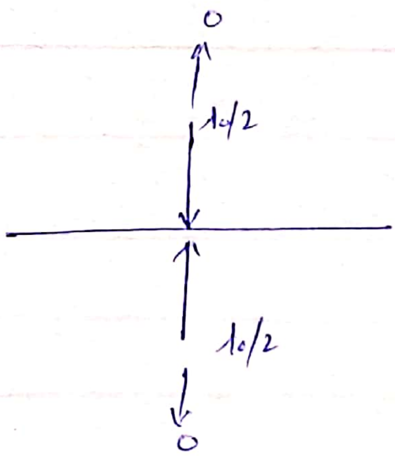
An open - ended microstrip line can be placed on one side of the ground plane. to excite the patch antenna situated on the other side through in opening slot in the ground plane. This slot coupling or aperture coupling technique can be used to aviod soldering connection as well as aviod leakage. radiation of the line. to ~~int~~ interfere with the patch radiation.

Question No 5 :- A $\lambda/2$ dipole is kept horizontally at a height of $\lambda_0/2$ above a perfectly conducting infinite ground plane. The radiation pattern at the ~~point~~ plane of dipole ($\vec{E}$ plane) looks approximately as.

Ans :- The Answer is Option B

Solution :-

A $\lambda/2$ dipole is kept horizontal at 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 $= \cos\left[\frac{\beta d \cos\psi + \alpha}{2}\right]$

$= \cos\left[\frac{2\pi \cos\psi + \pi}{2}\right] \Rightarrow \sin(\pi \cos\psi)$

The Answer is Option B