Antennas Exam - 15/07/2022

Ex. 1

a.) Define:

Beam solid angle - The solid angle through which all power if the intensity was constant across the angle and equal to the intensity at the maximum intensity (U_m)

Directivity - How much of the antenna energy focus in one direction as opposed to others.

Gain - Two definitions:

1. Based on ratio between the max. radiation intensity, U_m and the radiation intensity obtained if the power fed to the antenna was radiated isotropically.

2. Based on the ratio between the power density at distance "r" and the power density at the same distance if the antenna radiated isotropically.

Radiation Efficiency - The ratio between the power radiated by the antenna and the power inputted to the antenna.

b.) Define the E-field and the H-field of a radiation pattern:

E-field - 2D radiation pattern, in a given plane, for the electric field vector, $\vec{E}$

H-field - 2D radiation pattern, in a given plane, for the magnetic field vector, $\vec{H}$

c.) The field emitted by an antenna @ $r = 500m$ is: $E_\theta = 0.037\,|\sin\theta|\,|\cos\varphi|$

Plot the radiation pattern in the E-plane and calculate directivity:

Radiation pattern:

d.) Define effective area and effective area as a func. of gain:

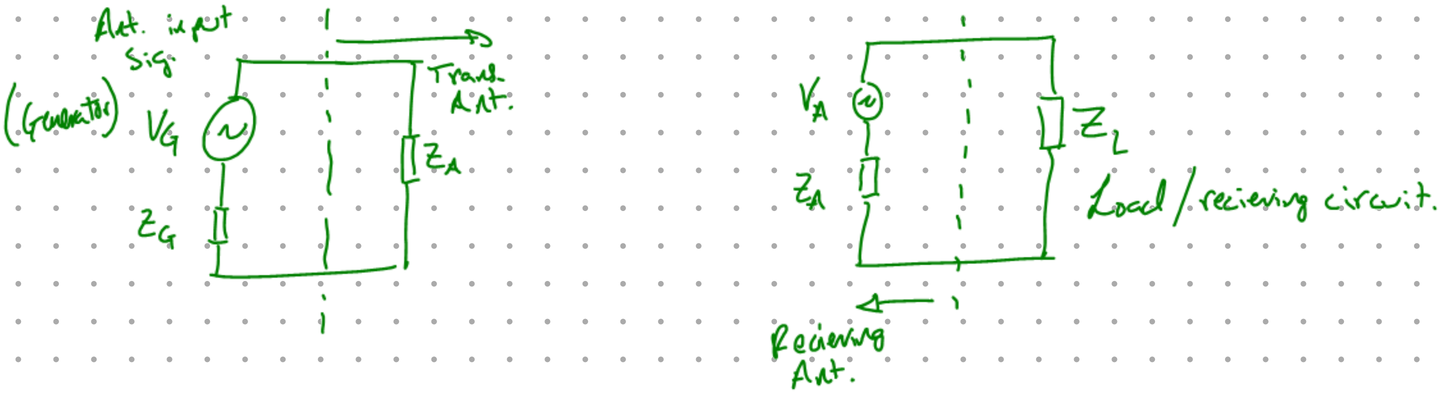
Effective area, $A_e = \dfrac{P_{rm}}{S} = \dfrac{\text{Max. recieved power}}{\text{Mag of poynting vector, } |\vec{S}|}$

As a function of gain : $A_e = \dfrac{G_T \cdot \lambda^2}{4\pi}$

e.) Define the input impedance of an antenna:

If we consider an antenna as a load of an electrical circuit, the input impedance is given by : $Z_A = R_A + jX_A$

with recieving/transmitting circuits that look like:



f.) Define the effective length (or height) and obtain an eq. to relate effective length as a $f(A_e)$

Effective length, $h = \dfrac{V_A}{E_i} = \dfrac{\text{Open circ. Voltage induced}}{\text{Incident electric field.}}$

$$h = f(A_e) = 2\sqrt{\frac{R_A A_e}{\eta}}$$

Ex. 2

Ideal Dipole EM field is given by....

a) Explain the meaning of the far-field of an antenna write the E- & H-field for the ideal dipole in the far-field, justifying your answer.

Ans.: The far-field is the radial distance at which the antenna's plane wave exhibit local plane wave behaviour.

For an ideal dipole $Z \ll \lambda$ and thus $r_{ff} \doteq 5\lambda$

So we could say $\beta r \gg 1$ i.e. $(\frac{2\pi}{\lambda} \cdot 5\lambda) \gg 1$ and so any term with $j\beta r$ in the denom. will be extremely small comp. to one giving:

$$\vec{E} = j\eta \frac{\beta}{4\pi} I \Delta Z \frac{e^{-j\beta r}}{r} \sin(\theta)\ \hat{\theta}$$

$$\vec{H} = j \frac{\beta}{4\pi} I \Delta Z \frac{e^{-j\beta r}}{r} \sin(\theta)\ \hat{\phi}$$

Phase Array Questions

Array Factor → Rad. pattern of a given antenna array if the placed antennas were isotropic.

Phase Factor → $\psi = \beta d \cos(\theta) + \alpha$ Does this give isotropic array shape??

$\beta \to \frac{2\pi}{\lambda}$ } use given freq. to get λ Careful that everything is in radians??

1. Phase factor
2. Array factor
3. Normalised radiation pattern → $|F(\theta,\psi)| = \left| \dfrac{\sin\left(N\frac{\psi}{2}\right)}{N\sin\left(\frac{\psi}{2}\right)} \right|$
4. if non-isotropic antennas are in use: multiply $|F|$ of above by that of the antenna in use?