Ques-4 An Electric field str of 10mV/m is to be measured at an elevation point $\theta = \pi/2$, 500 Km from a half wave (resonant) dipole antenna operating in air at 50MHz.

(a) What is the length of the dipole?
(b) Calculate the current that must be fed to the antenna.
(c) Find the av. power radiated by the antenna.
(d) If a transmission line of $Z_0 = 75\Omega$ is connected the antenna determine the standing wave ratio.

Soln (a) $d = \lambda/2$

$\{\lambda = c/f\} \Rightarrow \frac{3\times10^8}{50\times10^6} \Rightarrow \frac{3\times10^2}{50}$

$\Rightarrow 6m$

$\{d = 6/2 \Rightarrow 3m\}$ length of dipole.

*** half length dipole

(b) $d = \frac{2D^2}{\lambda} = \frac{2}{\lambda}(\lambda/2)^2$.

$|E_\theta| = \frac{\eta_0 I_0 \cos(\frac{\pi}{2}\cos\theta)}{2\pi r \sin\theta}$

$I_0 \Rightarrow \frac{|E_\theta| 2\pi r \sin\theta}{\eta_0 \cos(\frac{\pi}{2}\cos\theta)} \Rightarrow \frac{10\times10^{-6}\times 2\times\pi\times(500\times10^3)}{}$

constant.

(c) $R_{rad} \approx 73\Omega$ ↗ $P_{rad} = \frac{1}{2}|I_0|^2 R_{rad}$

$\Rightarrow 253.5\,mW$

$\Gamma = \frac{Z_L - Z_0}{Z_L + Z_0}$ $\Rightarrow \frac{73 + j42.5 - 75}{73 + j42.5 + 75}$

$73 + j42.5 = Z_L$ $\Rightarrow \frac{-2 + j42.5}{148 + j42.5}$

$\Rightarrow \frac{42.55 \angle 92.69°}{153.98 \angle 16.02}$ $\Rightarrow 0.2763 \angle 76.67°$

$S = \frac{1 + |\Gamma|}{1 - |\Gamma|} = \frac{1 + 0.2763}{1 - 0.2763} \Rightarrow 1.763$

In the far field $W_{rad} = \bar{W}_{avg} \approx \hat{a}_r U_0 \frac{\cos\theta}{r^2}$

The radiated power density is symmetric wrt ϕ & exist only in the upper hemis $0 \leq \theta \leq \pi/2$;

$0 \leq \phi \leq 2\pi$; U_0 is a constant. The power radiated by antenna (in watt) & maximum directivity of antenna (10 dB)

Ans Power rad = Maximum dire =

$P_{rad} = \oint W_{rad} \, ds$

Ex 12.1
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Ques A magnetic filed $|H_\phi| = 5\ \mu A/m^2$ is required at a point at $\theta = \pi/2$, which is 2 Km. from an antenna in air, Neglecting ohmic loss. how much power the is to must the antenna to be emitted. if

(a) A Hertzian dipole of length $\lambda/25$?

(b) a half wave dipole?

(c) a quarter wave monopole.

(d) a 10 turn loop antenna of radius $\rho_0 = \lambda/20$

Soln

(a) For Hertzian dipole.

$$|H_\phi| = \frac{I_0 \beta dl \sin\theta}{4\pi r_0}$$

where $\{dl = \lambda/25$ (given)

or

$$\beta dl = \frac{2\pi}{\lambda} \cdot \frac{\lambda}{25} = \frac{2\pi}{25}$$

↳ phase constant $= \beta$

$$5\times10^{-6} = I_0 \times \frac{2\pi}{25} \quad (1)$$

$$4\times\pi\ (2\times10^3)$$

$$\Rightarrow \frac{I_0}{10^5}$$ (leave it)

$I_0 = 0.5A \Longrightarrow$ $\boxed{P_{rad} = 40\pi^2 \left(\frac{dl}{\lambda}\right)^2 I_0^2}$

$$\Rightarrow \frac{40\pi^2 (1/2)^2}{(25)^2} \Rightarrow 158\ mA$$

① for half wave dipole

$$|H_\phi| = \frac{I_0 \cos\left(\frac{\pi}{2}\cos\theta\right)}{2\pi r \sin\theta}$$ learn this

$$\Rightarrow 5\times10^{-6} = \frac{I_0}{2\times\pi\times(2\times10^3)}$$

$$\Rightarrow I_0 = 5\times10^{-6}\times2\times\pi\times2\times10^3$$

$$\Rightarrow 5\times4\times\pi\times10^{-3}$$

$$\Rightarrow 20\pi mA.$$

$$P_{rad} = \frac{1}{2} I_0^2 R_{rad}$$

$\downarrow$

73Ω.

$$\Rightarrow \frac{1}{2}\times(20\times\pi\times10^{-3})^2\times73$$

$$\Rightarrow \frac{400\times\pi^2\times10^{-6}\times73}{2}$$

$$\Rightarrow 20\times\pi^2\times10^{-3}\times73$$

$$\Rightarrow 194\,mA.$$

② for a quarter wave monopole

$\frac{\lambda}{4}$.

$I_0 = 20\pi\,mA.$

$P_{rad} = \frac{1}{2} I_0^2 R_{rad}$

END SEM.

diagrams

(1) wave propagation
(2) field components
(3) Incident & transmitted components.

③]

book

Tut-08/11 (Antenna)

Ques The total radiated power.

$$P_{rad} = \oint u(\theta,\phi)\, d\Omega, W.$$

$$\Rightarrow \int_{\theta=0}^{\pi}\int_{\phi=0}^{\pi} \sin\theta \sin\phi \,(\sin\theta\, d\theta\, d\phi).$$

$$+ \int_{\theta=0}^{\pi}\int_{\phi=\pi}^{2\pi} 0 \cdot d\Omega.$$

$$\Rightarrow \int_{\theta=0}^{\pi}\int_{\phi=0}^{\pi} \sin^2\theta \sin\phi \, d\theta\, d\phi.$$

$$\Rightarrow \int_{\theta=0}^{\pi}\int_{\phi=0}^{\pi} \frac{1}{2}(1+\cos 2\theta)\sin\phi \, d\theta\, d\phi. \Rightarrow \pi W.$$

Ans The directivity $D(\theta,\phi) = \dfrac{4\pi u(\theta,\phi)}{P_{rad}}$.

$$\Rightarrow \frac{4\pi \sin\theta \sin\phi}{\pi}$$

$$\Rightarrow 4\sin\theta\sin\phi$$

The maximum value of directivity is 4.

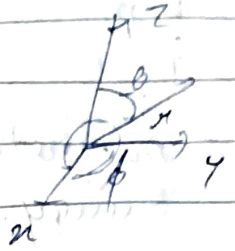
$\therefore D_{dB} = 10\log_{10} 4 = 6.02$ dB.

Ques 2 Calculate the beamwidth in xy and yz plane of an antenna. The power pattern of which is given by.

$$U(\theta,\phi) = \begin{cases} \sin^2\theta \sin\phi ; & 0 \le \theta \le \pi ; \quad 0 \le \phi \le \pi \\ 0 ; & 0 \le \theta \le \pi , \quad \pi \le \phi \le 2\pi \end{cases}$$

Sol:- In x-y plane

$(\theta = \pi/2)$



& power pattern.

$$U(\frac{\pi}{2}, \phi) = \sin\phi$$

The angles along which the power is half the maximum value is given by the solution of

$(\sin\phi = 0.5)$

which is satisfied for

$\phi = 30°$ & $\phi = 150°$

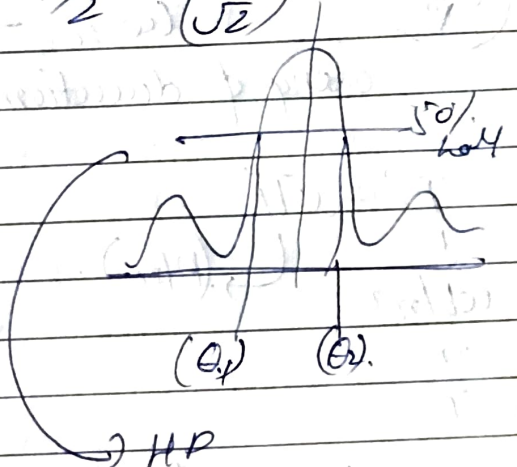
3dB beam width.

in xy plane is

$150 - 30° = 120°$

$P \propto V^2$

$P/2 \propto \left(\frac{V}{\sqrt{2}}\right)^2$



HP half Power $= \theta_1 - \theta_2$ beamwidth

In y-z plane the $\phi = \pi/2$ the power pattern is given by

$$U(\theta, \pi/2) = \sin^2\theta$$

{ filled min 70% power pattern min 50% }

3dB point occur along θ satisfying the condition $\sin^2\theta = 0.5$

$\theta = 45°$ & $135°$

Beamwidth in y-z plane is $135 - 45° = 90°$