Antenna Theory and Design

Homework 16

7-3-1) Compare the radiation resistances of the resonant stub helix to a short monopole for the height values of 0.01, 0.05, 0.08 and 0.1λ

Sol

$\frac{h}{\lambda} = 0.01$

$\frac{h}{\lambda} = 0.05$

$\frac{h}{\lambda} = 0.08$

$\frac{h}{\lambda} = 0.1$

For Normal Mode Helical Antenna the radiation resistance $R_r = 640\left(\frac{h}{\lambda}\right)^2$

If $\frac{h}{\lambda} = 0.01$, then $R_r = 0.06\,\Omega$

If $\frac{h}{\lambda} = 0.05$, then $R_r = 1.6\,\Omega$

If $\frac{h}{\lambda} = 0.08$, then $R_r = 4.096\,\Omega$

If $\frac{h}{\lambda} = 0.1$, then $R_r = 6.4\,\Omega$

For Short monopole the radiation resistance

$R_r = 40\pi^2\left(\frac{h}{\lambda}\right)^2$

If $\frac{h}{\lambda} = 0.01$ then $R_r = 0.039\,\Omega$

If $\frac{h}{\lambda} = 0.05$ then $R_r = 0.986\,\Omega$

If $\frac{h}{\lambda} = 0.08$ then $R_r = 2.526\,\Omega$

If $\frac{h}{\lambda} = 0.1$, then $R_r = 3.95\,\Omega$

7.3.4)

a) given pitch angle $\alpha = 12.5°$

Half power beam width $= 39°$

frequency $= 475 MHz$

So $\lambda = \frac{c}{f}$

$= 0.6$ mt

$\frac{h}{\lambda} = \left(\frac{65°}{39°}\right)^2$

$= 2.77$

$\frac{s}{\lambda} = \tan(12.5°)$

$= 0.22$

$\rightarrow \frac{h}{\lambda} = N\left(\frac{s}{\lambda}\right)$

So $N = \frac{\left(\frac{h}{\lambda}\right)}{\left(\frac{s}{\lambda}\right)}$

$= \frac{2.77}{0.22} = 12.5$

b) Directivity in decibels:

$$D = \frac{26000}{(\text{Half Power Beam Width})^2}$$

$$= \frac{26000}{39^2}$$

$$= 17.09$$

$$= 12.4\ dB$$

c) Axial Ratio is given by

$$|AR| = \frac{2N+1}{2N}$$

$$= \frac{2(12.5)+1}{2(12.5)}$$

$$= 1.04$$

d) Range of frequencies

$$C = \frac{3}{4}\lambda_L$$

$$\Rightarrow f_L = \frac{c}{\lambda_L} = 356\ MHz$$

$C = \frac{4}{3} \lambda_h$

$\Rightarrow f_h = \frac{c}{\lambda_h}$

$= 633 MHz$

e) Input impedance at design frequency and at ends of band

$R_A = 140 \frac{C}{\lambda}$

$C = \lambda$

then $R_A = 140\Omega$

Input impedance at ends is given by

$R_{AL} = 140 \left(\frac{3}{4}\right)$

$= 105\Omega$

$R_{AH} = 140 \left(\frac{4}{3}\right)$

$= 186.72\Omega$

f) H.P at band ends is given by

$\frac{S}{\lambda} = 0.166$

$HP_L = \frac{65^\circ}{\frac{C}{\lambda}\sqrt{N\frac{S}{\lambda}}} = 60.52^\circ$

$\frac{S}{\lambda_h} = 0.29 \Rightarrow HP_H = \frac{65^\circ}{\frac{C}{\lambda}\sqrt{N\frac{S}{\lambda}}} = 25.4^\circ$