Antennas &
Wave Propagation

Electronic Dep.

3rd Stage

Lecture Five

Power Radiation and radiation resistance of linear antennas

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Electrically Short Dipole Antennas

For Linear current distribution

$$P = 80\,\pi^2 \left(\frac{l}{2\lambda}\right)^2 \times I_{rms} \text{ Watts}$$

$$\boxed{P = 20\,\pi^2 \left(\frac{l}{\lambda}\right)^2 \cdot I_{rms} \text{ Watts}}$$

$$R_r = 20\,\pi^2 \left(\frac{l}{\lambda}\right)^2 \Omega$$

$$\boxed{R_r \cong 200 \left(\frac{l}{\lambda}\right)^2 \Omega}$$

Always Remember

- ✓ For linear distribution $l_{eff} = \frac{l}{2}$
- ✓ For Sinusoidal distribution $l_{eff} = \frac{2\,l}{\pi}$

Electrically Short Dipole Antennas

For sinusoidal current distribution

$$P = 80\,\pi^2 \cdot \left(\frac{l_e}{\lambda}\right)^2 \cdot I_{\text{rms}}^2$$

$$= 80\,\pi^2 \left(\frac{2l}{\pi\lambda}\right) \cdot I_{\text{rms}}^2$$

$$\boxed{P = 320 \left(\frac{l}{\lambda}\right)^2 I_{\text{rms}}^2 \quad \text{watts}}$$

$$\boxed{R_r = 320 \left(\frac{l}{\lambda}\right)^2 \ \Omega}$$

Always Remember

- ✓ For linear distribution $l_{eff} = \frac{l}{2}$
- ✓ For Sinusoidal distribution $l_{eff} = \frac{2\,l}{\pi}$

Monopole Antenna

For Linear current distribution

$$P = 10\,\pi^2 \left(\frac{l}{\lambda}\right)^2 \cdot I_{rms}^2 \text{ Watts}$$

$$R_r = 10\,\pi^2 \left(\frac{l}{\lambda}\right)^2 \,\Omega$$

$$R_r = 10\,\pi^2 \left(\frac{2h}{\lambda}\right)^2 \,\Omega$$

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

$$\boxed{R_r \cong 400 \left(\frac{h}{\lambda}\right)^2 \,\Omega}$$

Power radiated and radiation resistance will be half of corresponding dipoles

Monopole Antenna

For sinusoidal current distribution

$$P = 160 \left(\frac{l}{\lambda}\right)^2 I_{rms}^2 \text{ Watts}$$

$$R_r = 160 \left(\frac{l}{\lambda}\right)^2 \ \Omega$$

$$R_r = 160 \left(\frac{2h}{\lambda}\right)^2 \ W$$

$$R_r = 640 \left(\frac{h}{\lambda}\right)^2 \ \Omega$$

Power radiated and radiation resistance will be half of corresponding dipoles

Half – Wave Dipole Antenna

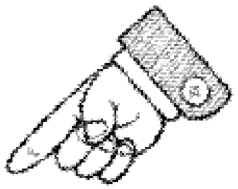
$$P = 80\,\pi^2 \left(\frac{l_e}{\lambda}\right)^2 \cdot I_{rms}^2$$

But $$l_{eff} = \frac{2l}{\pi} \text{ for sinusoidal}$$

$$P = 80\,\pi^2 \left(\frac{2l}{\pi\lambda}\right)^2 \cdot I_{rms}^2$$

for half wave dipole physical length $l = \lambda/2$ means

$$P = 80\,\pi^2 \cdot \left[\frac{2}{\pi} \cdot \frac{\lambda}{2\lambda}\right]^2 \cdot I_{rms}^2$$

and 

$$P = 80\, I_{rms}^2 \text{ Watts.}$$
$$R_r = 80\,\Omega$$

Actually the value of R_r for half wave dipole is 73 W.

$$l = \lambda/2$$

Vertically Earthed Antenna

In case of vertically grounded short antenna, antenna should be quite short and all rays will be parallel to ground (*i.e.*, $\sin\theta = \sin 90^\circ = 1$). If we take sinusoidal current distribution then power due to vertically short dipole is given by

$$P = 80\,\pi^2 \cdot \left(\frac{l_e}{\lambda}\right)^2 I_{rms}^2$$

But in case of grounded vertical antenna of effective length (l_e), due to image effect apparent height will be $2\,l_e$, so

$$P = 80\,\pi^2 \cdot \left(\frac{2l_e}{\lambda}\right)^2 I_{rms}^2$$

$$= 320\,\pi^2 \left(\frac{l_e}{\lambda}\right)^2 I_{rms}^2$$

$$R = 320\,\pi^2 \left(\frac{l_e}{\lambda}\right)^2 \Omega$$

Thanks for Listening

Any Question Please...