HELICAL ANTENNA

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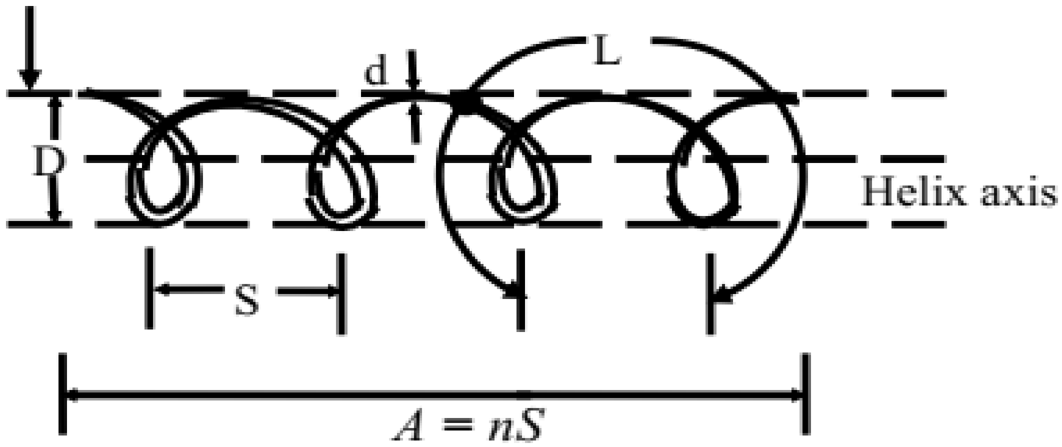
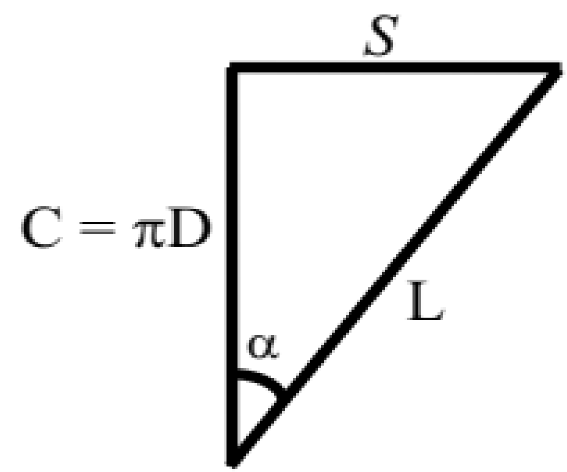




Total Length of wire = nL

Total axial length (A) = nS

$$L = \sqrt{S^2 + C^2}$$

$$\alpha = \tan^{-1}\left(\frac{S}{\pi D}\right) = \tan^{-1}\left(\frac{S}{C}\right)$$

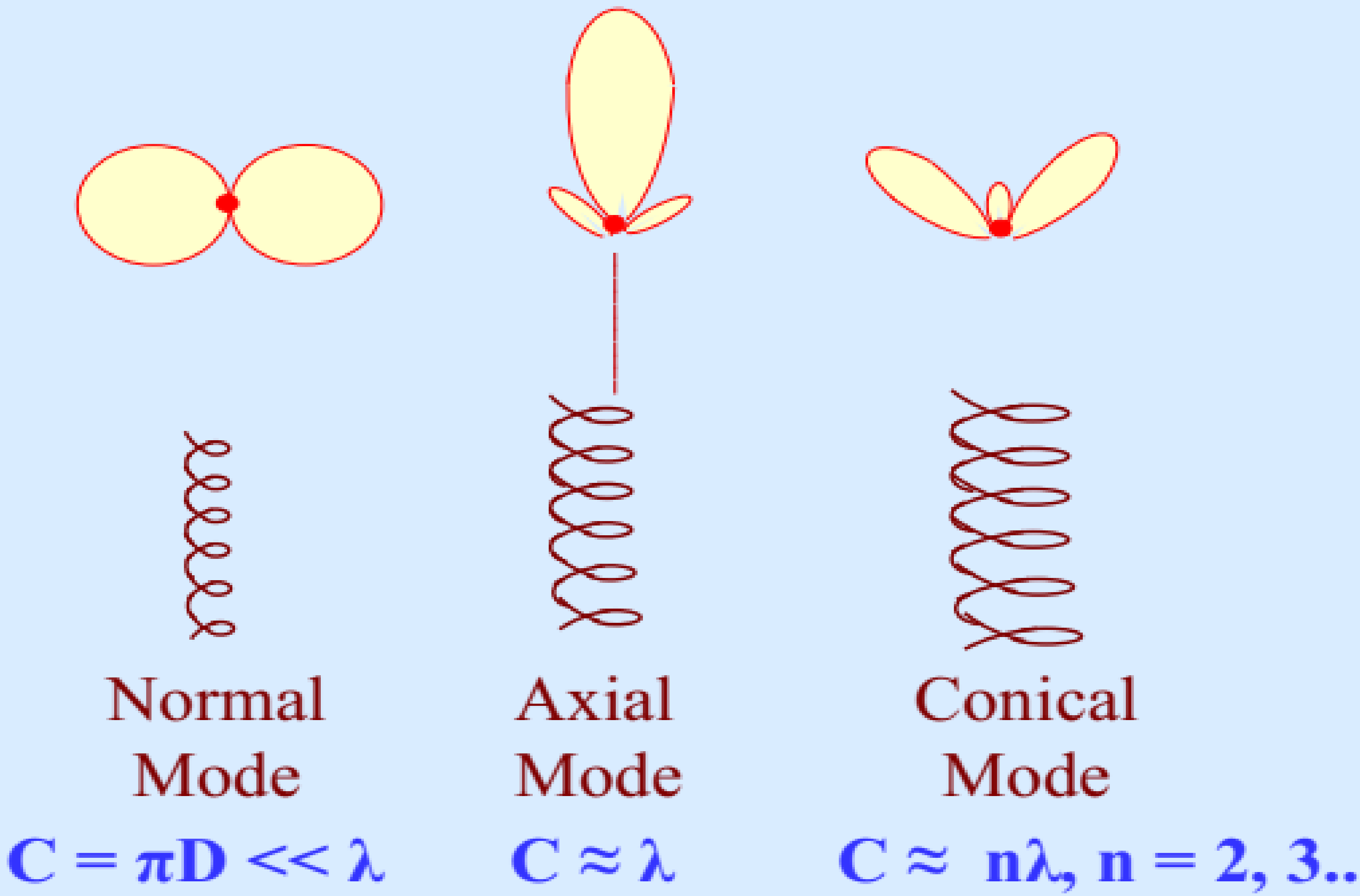
Special Cases of Helical Antenna:

Case 1: $\alpha = 0° \Rightarrow S = 0 \Rightarrow$ Loop Antenna

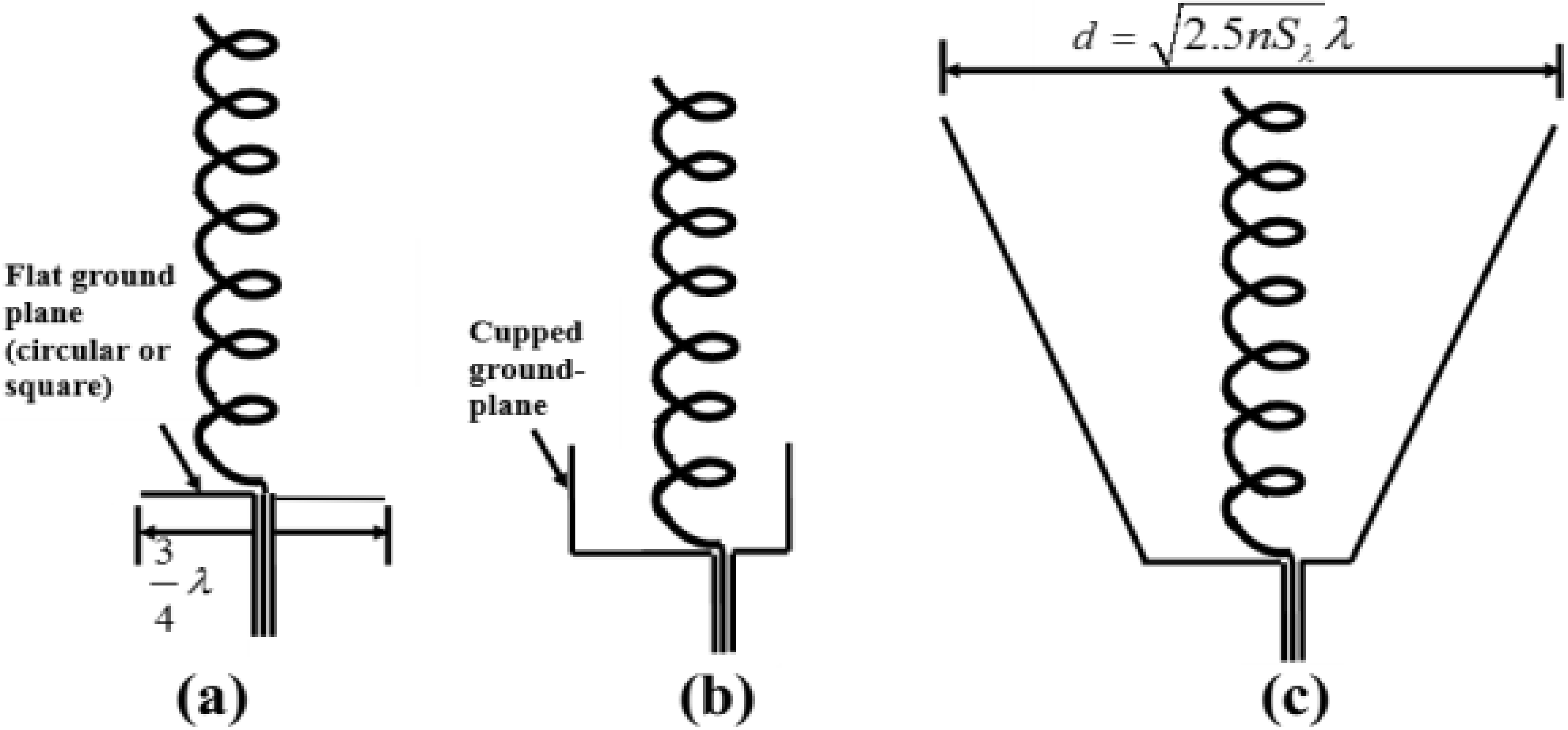
Case 2: $\alpha = 90° \Rightarrow D = 0 \Rightarrow$ Linear Antenna

(Reference: JD Kraus, Antennas, Tata-McGraw Hill, 1988)

Modes in Helical Antenna



Axial Mode Helical Antenna: Ground Plane



Monofilar Axial Mode Helical Antenna

a) Flat Ground Plane

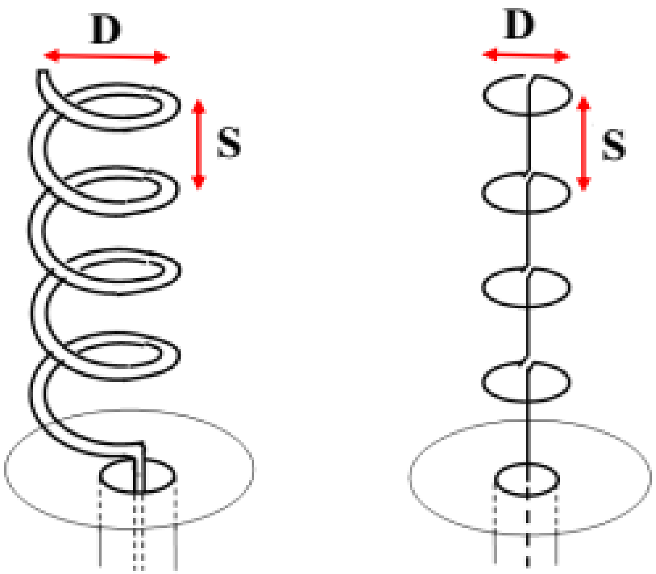
b) Shallow Cupped Ground Plane

c) Deep Conical Ground Plane Enclosure.

Normal Mode Helical Antenna

Small Dipole:

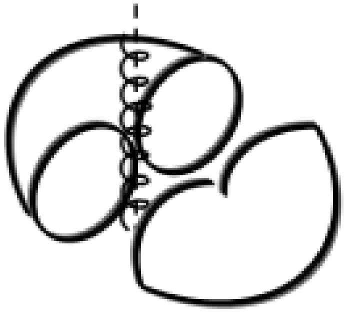
$$E_\theta = j\eta \frac{kI_o S e^{-jkr}}{4\pi r} \sin\theta$$



Small Loop:

$$E_\phi = \eta \frac{k^2 I_o \left(\frac{D}{2}\right)^2 e^{-jkr}}{4r} \sin\theta$$

Therefore, Axial Ratio is:



$$AR = \frac{|E_\theta|}{|E_\phi|} = \frac{2S\lambda}{C^2} = \frac{2S_\lambda}{C_\lambda^2}$$

For Circular Polarization, AR = 1 ⇒ $C_\lambda = \sqrt{2S_\lambda}$

Axial Mode Helical Antenna - Input Impedance

For Axial Feed: $R = 140 * C_\lambda \;\; \Omega$

For Peripheral or Circumferential Feed:

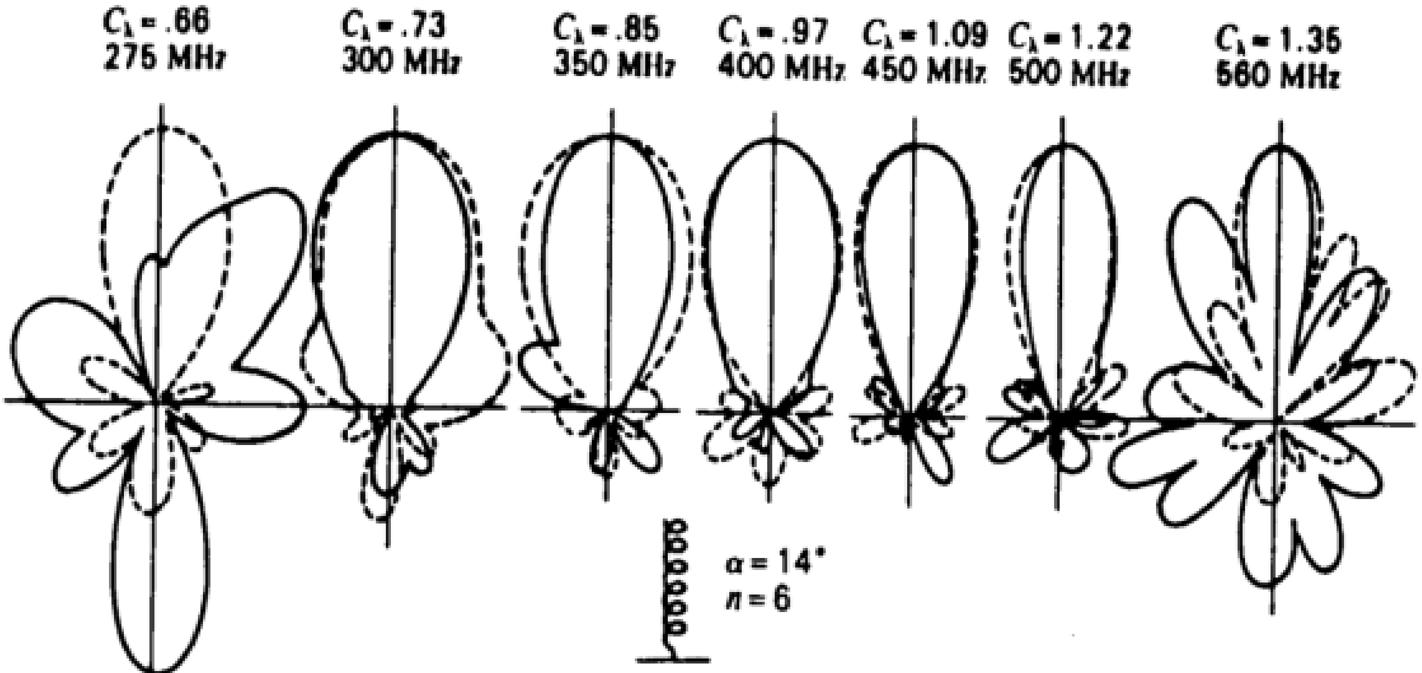
$$R \approx 150 / \sqrt{C_\lambda} \;\; \Omega$$

Restrictions: (a) $0.8 \leq C_\lambda \leq 1.2$

(b) $12° \leq \alpha \leq 14°$

(c) $n \geq 4$

Radiation Pattern of Axial Mode Helical Antenna



- ❑Measured Field Patterns of Axial Mode Helical Antenna of 6 turns and pitch angle $\alpha = 14°$.
- ❑**CP Radiation Pattern for C/λ from 0.73 to 1.22.**
- ❑ (—) Horizontally polarized field component and (- - ·) Vertically polarized.

Gain of Axial Mode Helical Antenna

$$\text{HPBW (Half-Power Beamwidth)} \cong \frac{52}{C_\lambda \sqrt{n\, S_\lambda}} \text{(deg)}$$

$$\text{BWFN (Beamwidth Between First Nulls)} \cong \frac{115}{C_\lambda \sqrt{n S_\lambda}} \text{(deg)}$$

$$\text{Directivity} = 32{,}400 \,/\, \text{HPBW}^2$$

$$Directivity = 12\, C_\lambda^2\, n S_\lambda$$

Gain = η x Directivity, $\eta \approx 60\%$

Design of Axial Mode Helical Antenna

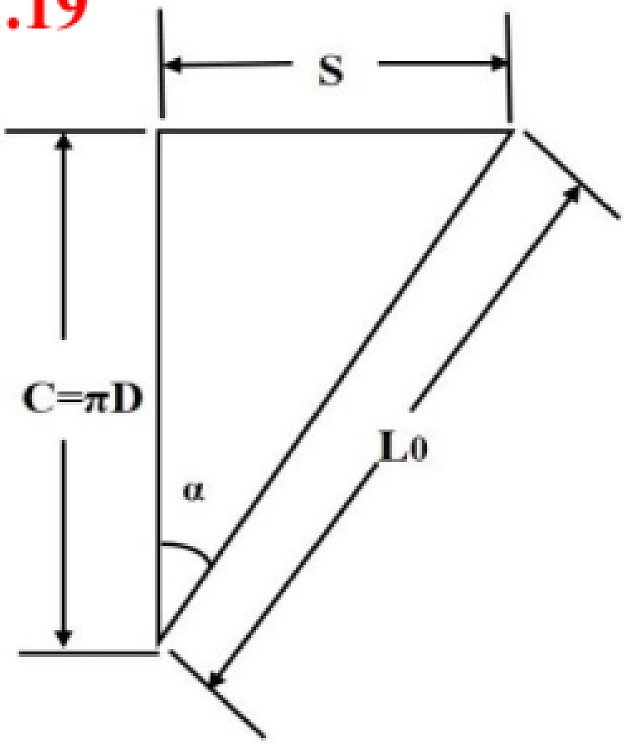
Desired: Directivity = 24 dB = 251.19

For Axial Mode Helical Antenna:

Assume: $C_\lambda = 1.05$ (0.8 to 1.2)

$\alpha = 12.7°$ (12° to 14°)

Calculate: $S_\lambda = C_\lambda \tan\alpha = 0.2366$



$$Directivity = 12\, C_\lambda^2\, n S_\lambda$$

$$n = \frac{251.19}{12(0.2366)(1.05)^2} = 80$$

The helical antenna is used for following applications.

• It is used for transmission and reception of VHF signals through ionosphere.

• It is used for satellite and radiometry applications.

• It is possible to establish communication between moon and earth using it.

Benefits or advantages of Helical Antenna

Following are the benefits or advantages of Helical Antenna:

➨It is simple in design.

➨As it uses circular polarised pattern, it is acceptable by both horizontal and vertical polarised antenna types.

➨It can be used for broadband applications due to wider bandwidth.

➨It can be used at HF/VHF frequencies for transmission and reception.

➨It offers higher directivity.

➨It is very robust in construction.

Drawbacks or disadvantages of Helical Antenna

Following are the disadvantages of Helical Antenna:

➨It is large in size. This requires more space for installation.

➨For higher number of turns its efficiency decreases. The maximum efficiency of about 80% can be achieved with the use of 3 to 4 turns.

➨It is higher in cost.

Thank You…