10.27 Design a five-turn helical antenna which at 300 MHz operates in the axial mode and possesses circular polarization in the major lobe. Determine the

(a) near optimum circumference (in λ_0 and in meters)

(b) spacing (in λ_0 and in meters) for near optimum pitch angle design

(c) input impedance

(d) half-power beamwidth (in degrees), first-null beamwidth (in degrees), directivity (dimensionless and in dB), and axial ratio

(e) VSWR when the antenna is connected to 50- and 75-ohm coaxial lines

- Assume $\alpha = 14°$. Notes: (d) Use both formulas from the notes for the directivity. (c) & (e) Do for **both** axial and peripheral feeding.

a) circumference

$$C \simeq \lambda = \frac{2.998 \times 10^8}{300 \times 10^6} = 0.999\overline{3}\ m \simeq 1\ m$$

b) spacing $\rightarrow \alpha = 14°$

(10-24) $\alpha = \tan^{-1}(S/C) \Rightarrow S = C \tan\alpha = \lambda \tan 14°$

$$S = 0.24933\lambda = 0.24916\ m$$

c) input impedance

axial feed $R_{in} \simeq 140(C/\lambda) = 140(1) = 140\ \Omega$

peripheral feed $R_{in} \simeq \frac{150}{\sqrt{C/\lambda}} = \frac{150}{\sqrt{1}} = 150\ \Omega$

d) HPBW, FNBW, directivity + axial ratio.

(10-31) $HPBW = \frac{52\lambda^{3/2}}{C\sqrt{NS}} = \frac{52\,(0.999\overline{3})^{3/2}}{(0.999\overline{3})\sqrt{5\,(0.24916)}}$

$$HPBW = 46.573°$$

(10-32) $FNBW = \frac{115\lambda^{3/2}}{C\sqrt{NS}} = HPBW\left(\frac{115}{52}\right) = 102.998°$

d) cont.

(10-33) $D_o \simeq 15N\frac{c^2 S}{\lambda^3} = 15(5)\frac{(0.999\overline{3})^2(0.24916)}{(0.999\overline{3})^3}$

$D_o = 18.7108 = 12.721\ dB_i$ (Balanis)

$D_o \simeq 12N\frac{c^2 S}{\lambda^3} = 14.969 = 11.752\ dB_i$ (Kraus)

(10-34) $AR = \frac{2N+1}{2N} = \frac{2(5)+1}{2(5)} = 1.1$

e) VSWR when connected to 50Ω + 75Ω coaxial lines.

Axial Feed ($Z_{ant} = 140\Omega$)

$|\Gamma_{50}| = \left|\frac{140-50}{140+50}\right| = 0.4737$ $\quad VSWR_{50} = \frac{1+|\Gamma|}{1-|\Gamma|} = 2.8$

$|\Gamma_{75}| = \left|\frac{140-75}{140+75}\right| = 0.3023$ $\quad VSWR_{75} = 1.867$

Peripheral Feed ($Z_{ant} = 150\Omega$)

$|\Gamma_{50}| = \left|\frac{150-50}{150+50}\right| = 0.5$ $\quad VSWR_{50} = \frac{1+|\Gamma|}{1-|\Gamma|} = 3$

$|\Gamma_{75}| = \left|\frac{150-75}{150+75}\right| = 0.\overline{33}$ $\quad VSWR_{75} = \frac{1+0.\overline{33}}{1-0.\overline{33}} = 2$