EE 483/583 Antennas for Wireless Communications Quiz #6 (Spring 2025)

Name Key

Instructions: Open notes. Place answers in indicated spaces and **show/indicate all work** for credit.

A Yagi-Uda antenna, operating at λ_c = 50 cm, is to be driven using a T-match. The driven element has a diameter of 0.8 cm and length of 23 cm. The T-match has a diameter of 0.4 cm, length of 10 cm, and spacing of 2.6 cm. Calculate the characteristic impedance of transmission line mode of the T-match as well as the input impedance of transmission line mode. Next, calculate the current divisor factor and equivalent radius (cm) of the T-match section for the antenna mode. Then, find the overall input impedance (rectangular format) if the impedance of the antenna mode was found to be $13.6 + j3.1\ \Omega$.

$s = 2.6\text{cm}$ $\ell' = 10\text{cm}$
$a = 0.4\text{cm}$
$a' = 0.2\text{cm}$

$$Z_0 = \frac{\eta}{2\pi}\cosh^{-1}\left[\frac{s^2 - a^2 - a'^2}{2aa'}\right]$$

$$= \frac{376.7303}{2\pi}\cosh^{-1}\left[\frac{2.6^2 - 0.4^2 - 0.2^2}{2(0.4)(0.2)}\right]$$

$$Z_0 = 264.2111\ \Omega$$

$$Z_t = jZ_0\tan\left(\frac{k\ell'}{2}\right) = j264.2111\tan\left(\frac{\frac{2\pi}{0.5}0.1}{2}\right)$$

$$Z_t = j191.9606\ \Omega$$

$$u = s/a' = \frac{0.4}{0.2} = 2 \qquad v = \frac{s}{a'} = \frac{2.6}{0.2} = 13$$

$$\alpha = \frac{\cosh^{-1}\left(\frac{v^2 - u^2 + 1}{2v}\right)}{\cosh^{-1}\left(\frac{v^2 + u^2 - 1}{2vu}\right)} = \frac{\cosh^{-1}\left(\frac{13^2 - 2^2 + 1}{2(13)}\right)}{\cosh^{-1}\left(\frac{13^2 + 2^2 - 1}{2(13)2}\right)}$$

$$= \frac{\cosh^{-1}(6.38461)}{\cosh^{-1}(3.30769)} = 1.36186$$

$$a_e = a' e^{\frac{1}{(1+u)^2}(u^2 \ln u + 2u \ln v)}$$

$$= 0.2\, e^{\frac{1}{(1+2)^2}(2^2 \ln 2 + 2(2)\ln 13)}$$

$$= 0.2\, e^{1.44B} = \underline{0.85096\,cm}$$

$$Y_{in} = \frac{Y_t}{2} + \frac{Y_a}{(1+\alpha)^2} = \frac{\frac{1}{j191.96}}{2} + \frac{\frac{1}{13.6+j3.1}}{(1+1.36186)^2}$$

$$= 0.0125301 - j\,0.0054608\,S$$

$$Z_{in} = \frac{1}{0.01253 - j\,0.00546}$$

$$= \underline{67.0689 + j\,29.2297\,\Omega}$$

char. imp. of TL mode = 264.21Ω

input imp. of TL mode = j191.96Ω

current divisor factor = 1.362

equiv. radius of ant. mode = 0.851 cm

Z_{in} = 67.07 + j29.23Ω