

## PROBLEM PF

LET'S CONSIDER A CIRCULAR LOOP ANTENNA MADE OF COPPER WIRE HAVING RADIUS  $a = 2 \text{ mm}$  (THE COPPER CONDUCTIVITY IS  $\sigma = 5,8 \cdot 10^7 \text{ } \Omega^{-1} \text{ m}^{-1}$ ). THE RADIUS OF THIS SINGLE TURN LOOP IS  $b = 12 \text{ cm}$  AND THE OPERATING FREQUENCY IS  $f = 30 \text{ MHz}$   
FIND THE INPUT IMPEDANCE

$$\lambda = \frac{c}{f} = \frac{3 \cdot 10^8}{30 \cdot 10^6} = 10 \text{ m} \quad \text{CIRCUMFERENCE } L_p = 2\pi b = 0,754 \text{ m} \quad L < \lambda$$

$$\text{RADIATION RESISTANCE } R_R = 31200 \left( \frac{N L}{\lambda^2} \right)^2 \quad N=1 \text{ SINGLE TURN}$$

$$\text{LOOP AREA } S = \pi b^2 = 0,0952 \text{ m}^2$$

$$R_R = 0,0065 \text{ } \Omega = 6,5 \text{ m}\Omega$$

$$\text{DISSIPATION RESISTANCE } R_d = \frac{L_p}{2\pi a \delta} \cdot \frac{1}{\sigma} = \frac{2\pi b}{2\pi a} \cdot \frac{1}{\delta \sigma} = \frac{b}{a} \cdot \frac{1}{\delta \sigma}$$

$$\text{SKIN DEPTH } \delta = \frac{1}{\sqrt{\pi \mu f \sigma}} = 13,07 \cdot 10^{-6} \text{ m} = 13,07 \text{ } \mu\text{m}$$

$$R_d = 0,0857 \text{ } \Omega = 85,7 \text{ m}\Omega$$

$$\text{THE INPUT INDUCTANCE IS } L_A = \mu b \left[ \ln \left( \frac{8b}{a} \right) - 2 \right] = 6,29 \cdot 10^{-7} \text{ H} \\ \downarrow \\ = 0,629 \text{ } \mu\text{H}$$

$$\text{THE REACTIVE PART OF THE INPUT IMPEDANCE IS } X_A = \omega L_A = 2\pi f L_A = 1186 \text{ } \Omega$$

$$\text{THE TOTAL INPUT IMPEDANCE IS } Z_A = R_R + R_d + jX_A = 0,0921 + j1186 \text{ } \Omega$$

$$\text{AND THE RADIATION EFFICIENCY IS } e_R = \frac{R_R}{R_R + R_d} = \frac{0,0065}{0,0065 + 0,0857} = 0,0695 \\ \downarrow \\ = 6,95 \%$$