

14-1. By using (14-1), the effective dielectric constant is equal to

$$\epsilon_{\text{eff}} = \frac{10.2-1}{2} + \frac{10.2-1}{2} \left[1 + 12 \left(\frac{1}{1.2} \right) \right]^{-1/2} = 6.8568$$

Using (14-19), $\frac{W}{h} = 1.2$

$$Z_c = \frac{\sqrt{\epsilon_{\text{eff}}}}{120 \cdot \pi} \left[1.2 + 1.373 + 0.667 \cdot \ln(1.2 + 1.444) \right]$$

$$= \frac{2.6185 (3.24152)}{120 \cdot \pi} = 44.415 \text{ ohms}$$

14-2. $\epsilon_{\text{eff}} = \frac{6.8+1}{2} + \frac{6.8-1}{2} \left[1 + 12 \left(\frac{1}{1.5} \right) \right]^{-1/2} = 4.8667$

At low frequencies, the characteristic impedance can be found by

using eq. (4-19), if $\frac{W}{h} > 1$.

$$Z_c (f=0) = \frac{\sqrt{4.8667}}{120 \cdot \pi} \left[1.5 + 1.373 + 0.667 \ln(1.5 + 1.444) \right]$$

$$= 170.889 / (3.6132) = 47.296 \text{ ohms}$$

14-3 a. Using (14-6), the width of the patch is

$$W = \frac{30}{2(1.6)} \sqrt{\frac{2}{10.2-1}} = 3.962 \text{ cm}$$

$$\epsilon_{\text{eff}} = \frac{10.2+1}{2} + \frac{10.2-1}{2} \left[1 + 12 \left(\frac{0.127}{3.962} \right) \right]^{-1/2} = 9.51$$

$$\Delta L = (0.127)(0.412) \frac{(9.51+0.3) \left(\frac{3.962}{0.127} + 0.264 \right)}{(9.51-0.3) \left(\frac{3.962}{0.127} + 0.8 \right)} = 0.05455 \text{ cm}$$

$$L = \frac{\lambda}{2} - 2\Delta L = \frac{30}{2(1.6) \sqrt{9.51}} - 2(0.05455) = 2.931 \text{ cm}$$

b. Using (14-12) and (14-12a)

$$G_1 = \frac{I_1}{120 \pi^2}, \quad I_1 = -2 + \cos(X) + X \sin(X) + \frac{\sin(X)}{X}, \quad X = k_0 W$$

$$X = \frac{2\pi}{\lambda_0} W = \frac{2\pi}{18.75} (3.962) = (0.4226) \pi = 1.3277$$

$$I_1 = -2 + \cos(1.3277) + (1.3277)(1.204348) + \frac{\sin(1.3277)}{1.3277}$$

$$= 0.57075$$

$$G_1 = 0.57075 / (120 \cdot \pi^2) = 4.81916 \times 10^{-4} \text{ Siemens}$$

$$\text{Resonant input impedance, } R_{in} = Z_{in} = \frac{1}{2G_1} = 1.0375 \times 10^3 = 1037.5 \text{ ohms}$$

(Continued)

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