7.28 Design a 3 dB Lange coupler for operation at 5 GHz. If the coupler is to be fabricated in microstrip on an alumina substrate with $\epsilon_r = 10$ and $d = 1.0$ mm, compute Z_{0e} and Z_{0o} for the two adjacent lines, and find the necessary spacing and widths of the lines.

- Assume $Z_0 = 50\ \Omega$ and unfolded Lange coupler.

Per (7.20a), $C = 10^{-\text{CdB}/20} = 10^{-3/20}$ $\Rightarrow$ **$C = 0.707945784$.**

Use (7.100a) to get

$$Z_{0e} = \frac{4C - 3 + \sqrt{9 - 8C^2}}{2C\sqrt{(1-C)/(1+C)}} Z_0 = \frac{4(0.707946) - 3 + \sqrt{9 - 8(0.707946^2)}}{2(0.707946)\sqrt{(1-0.707946)/(1+0.707946)}} 50$$

$\Rightarrow$ **$Z_{0e} = 176.408\ \Omega$.**

Use (7.100b) to get

$$Z_{0o} = \frac{4C + 3 - \sqrt{9 - 8C^2}}{2C\sqrt{(1+C)/(1-C)}} Z_0 = \frac{4(0.707946) + 3 - \sqrt{9 - 8(0.707946^2)}}{2(0.707946)\sqrt{(1+0.707946)/(1-0.707946)}} 50$$

$\Rightarrow$ **$Z_{0o} = 52.538\ \Omega$.**

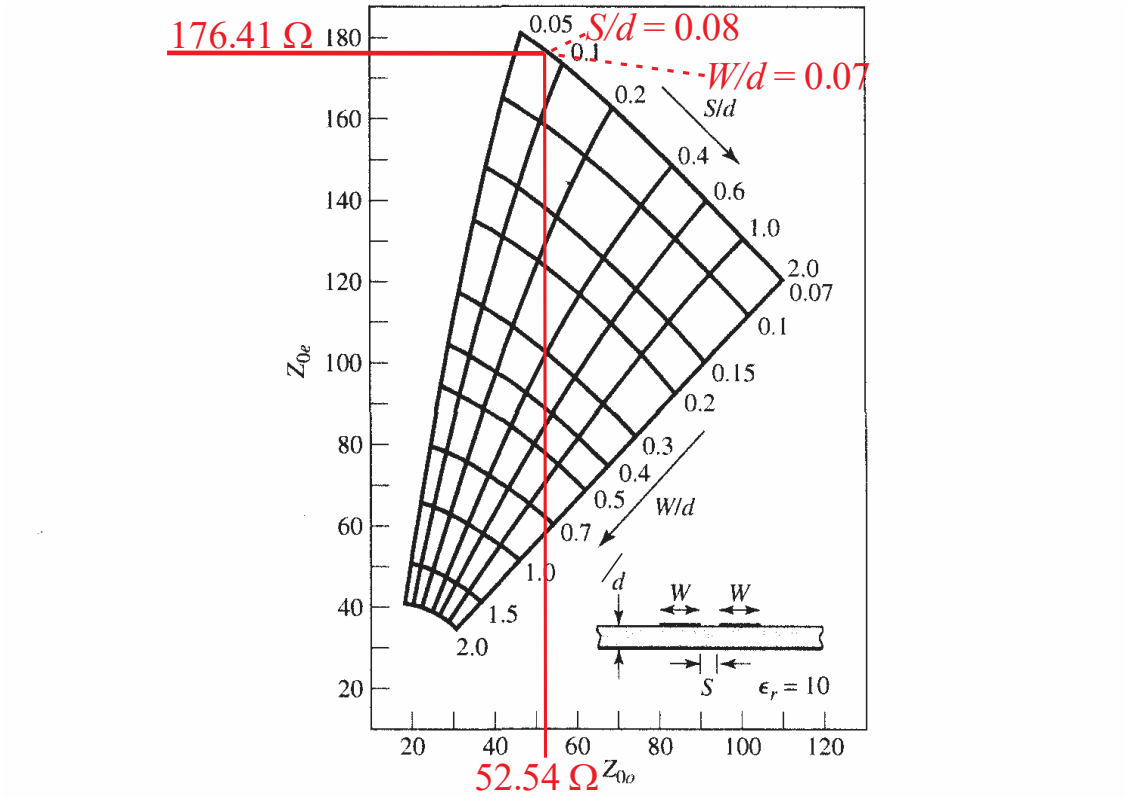

FIGURE 7.30 Even- and odd-mode characteristic impedance design data for symmetric coupled microstrip lines on a substrate with $\epsilon_r = 10$.

$S = S/d\ (d) = 0.08\ (1\text{ mm})$ $\Rightarrow$ **$S = 0.08$ mm**

$W = W/d\ (d) = 0.07\ (1\text{ mm})$ $\Rightarrow$ **$W = 0.07$ mm**