

**Problem 8.47** A hollow cavity made of aluminum has dimensions  $a = 4$  cm and  $d = 3$  cm. Calculate  $Q$  of the  $\text{TE}_{101}$  mode for

(a)  $b = 2$  cm, and

(b)  $b = 3$  cm.

**Solution:**

For the  $\text{TE}_{101}$  mode,  $f_{101}$  is independent of  $b$ ,

$$\begin{aligned} f_{101} &= \frac{c}{2} \sqrt{\left(\frac{1}{a}\right)^2 + \left(\frac{1}{d}\right)^2} \\ &= \frac{3 \times 10^8}{2} \sqrt{\left(\frac{1}{4 \times 10^{-2}}\right)^2 + \left(\frac{1}{3 \times 10^{-2}}\right)^2} \\ &= 6.25 \text{ GHz.} \end{aligned}$$

For aluminum with  $\sigma_c = 3.5 \times 10^7$  S/m (Appendix B),

$$\delta_s = \frac{1}{\sqrt{\pi f_{101} \mu_0 \sigma_c}} = 1.08 \times 10^{-6} \text{ m.}$$

(a) For  $a = 4$  cm,  $b = 2$  cm and  $d = 3$  cm,

$$\begin{aligned} Q &= \frac{1}{\delta_s} \frac{abd(a^2 + d^2)}{[a^3(d + 2b) + d^3(a + 2b)]} \\ &= 8367. \end{aligned}$$

(b) For  $a = 4$  cm,  $b = 3$  cm, and  $d = 3$  cm,

$$Q = 9850.$$