

8.46 A hollow cavity made of aluminum has dimensions $a = 4$ cm and $d = 3$ cm. Calculate Q of the TE_{101} mode for

(a) $b = 2$ cm, and

(b) $b = 3$ cm.

Solution:

For the 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,

$$Q = 9850.$$
