8.55 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,

$$f_{101} = \frac{c}{2}\sqrt{\left(\frac{1}{a}\right)^2 + \left(\frac{1}{d}\right)^2}$$

$$= \frac{3\times 10^8}{2}\sqrt{\left(\frac{1}{4\times 10^{-2}}\right)^2 + \left(\frac{1}{3\times 10^{-2}}\right)^2}$$

$$= 6.25 \text{ GHz}.$$

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,

$$Q = \frac{1}{\delta_s}\frac{abd(a^2+d^2)}{[a^3(d+2b)+d^3(a+2b)]}$$

$$= 8367.$$

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

$$Q = 9850.$$