Chapter 25: Test Chambers

25.1C Assuming that $d = 3$ m, $w = l_{th} = 6$ m, and $f = 1$ MHz, plot (on the same set of axes) versus position, the exact expression and the simplest approximate expression provided in this chapter for the magnitude of the electric field inside a cage antenna assuming an open-circuited load. Does the approximation improve as the frequency increases? Repeat the analysis for a short-circuited load.

25.2C Assuming that $d = 3$ m, $w = l_{th} = 6$ m, and $f = 1$ MHz, plot (on the same set of axes) versus position, the exact expression and the simplest approximate expression provided in this chapter for the magnitude of the magnetic field inside a cage antenna assuming an open-circuited load. Does the approximation improve as the frequency increases? Repeat the analysis for a short-circuited load.

25.3ES Why would the expression for the resonant frequencies for an isosceles cross-section cavity be equal to the expression for the resonant frequencies for a rectangular cross-section cavity (assuming they both have the same length and $a = a$ and $b = a$).

25.4 Determine the dominate TM and TE modes for an isosceles right-triangular cavity where $d > a$.

25.5 Determine an approximate expression for the total number of modes, $N(f)$, for an isosceles right-triangular cavity.

25.6 A reverberation chamber, designed to operate from 500 MHz to 1 GHz, has the dimensions 13' by 18' by 22'. Determine (approximately) the number of modes over this frequency range.

25.7 Sketch the magnitude of the electric field for the TE_{120} mode at $z = 0$.

25.8 Sketch the magnitude of the electric field for the TE_{221} mode at $y = b$.

25.9 Determine the lowest resonant frequency of a typical family van. Are there any common RF sources near this frequency?

25.10 Determine the lowest resonant frequency of a "typical" commercial-aircraft passenger cabin, assuming that the outer skin of the aircraft is aluminum. What affect does the fiberglass inner sheathing have on this frequency?

25.11 Show, by example, that the resonant frequencies of a cavity are not necessarily evenly spaced in the spectrum. Do not use the same numbers given in the example provided in this chapter.

25.12 Various parts of the body can also resonate! For example, the resonant frequency of an adult human head is around 400 MHz while for a baby head it is around 700 MHz. Modeling the head as a cube, estimate the size of the adult and baby head given these resonant frequencies.

25.13 By using the Q expressions given in this chapter for a rectangular resonant cavity, determine whether the Q increases with an increase in the mode number.

25.14 As the volume of a resonant cavity increases, its Q increases. However, larger cavities are more costly to build and more inconvenient to handle. Cylindrical cavities used for RF filtering are typically at least 1/4 of a wavelength long. Why? To increase a cylindrical cavity's volume, for a fixed length, its diameter must be increased. It is stated in a book, however, that most cavity diameters are only 1/4 to 1/3 their length since beyond this diameter very little additional performance is gained. Determine the validity of this statement.

25.15 For reverberation chambers, it is stated that "The multiblade fan is designed to reflect incident energy **(for lossy loads)** and to excite different modes **(for low-loss loads)**." Provide the rational for this statement.

25.16 Provide several advantages and disadvantages of a large reverb chamber over a small reverb chamber.

25.17 Provide several degenerative modes if $a = 3$ m, $b = 5$ m, and $c = 7$ m. Is possible to have degenerative modes if the dimensions are not integer multiples of each other?

25.18C Determine the reflectivity for a ferrite tile of thickness 4, 5, 6, 7, and 8 mm with a ½ inch plywood backing at 30, 60, 90, 200, 400, 600, 800, and 1,000 MHz. Use the complex permittivities and permeabilities provided in this chapter.

25.19C Using the data given in this chapter for urethane absorbing material, show that the magnitude of the intrinsic impedance generally decreases with increased carbon loading.

25.20C For a TEM cell of dimensions $w = 3$ m, $d = 3$ m, and $b = 2.48$ m, determine the cutoff frequency for the TE_{10} mode using

$$f_c = \frac{150\times 10^6}{w}\ \text{Hz}$$

and TE_{01} mode using the expressions

$$f_c = \frac{150\times 10^6}{\pi}\frac{2x}{d}\ \text{Hz}$$

and

$$x\tan x = \frac{\frac{\pi}{2}\frac{d}{w}}{\ln\left[\frac{2w}{\pi(w-b)}\right] + \sum_{p=1}^{\infty}\frac{1}{p}\left\{\left[\coth\left(\frac{p\pi d}{w}\right)-1\right]\cos^2\left[\frac{p\pi(w-b)}{w}\right]\right\}}$$

Which is the dominant mode? Then, determine the cutoff frequency for the TE_{01} mode using the following approximation expression:

$$f_c = \frac{150\times 10^6}{w}\sqrt{\frac{2w}{\pi d\ln\left[\frac{2w}{\pi(w-b)}\right]}}$$