Study Material

Text Book

Elements of Electromagnetics, 6th Ed.
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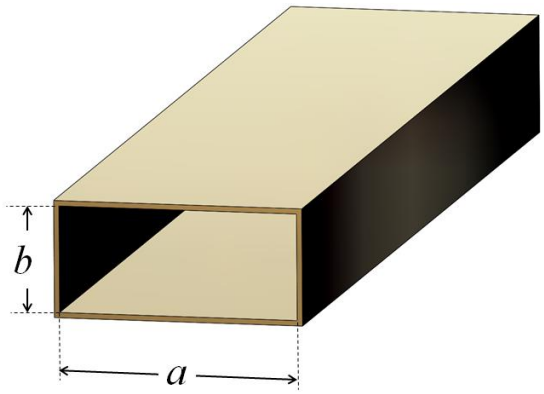
Oxford University Press

Study Waveguides

Read Chapter 12, pp. 612–646.



Problems

Problem #1

Write a MATLAB program that determines the first 20 modes supported by an air-filled rectangular waveguide and sorts them to be in ascending order, starting with the fundamental mode. The program should output a formatted table that labels each mode as either TE_{mn} or TM_{mn} along with its cutoff frequency. Please write your own code. Do not copy another student's work. Be sure to use the correct integers in place of *m* and *n* in the labels. Create five difference tables, one for each of the following five cases:

Table 1:	a = 0.5 cm and b = 1.0 cm
Table 2:	a = 1.0 cm and b = 1.0 cm
Table 3:	a = 1.5 cm and b = 1.0 cm
Table 4:	a = 2.0 cm and b = 1.0 cm
Table 5:	a = 2.5 cm and b = 1.0 cm

Problem #2

Use MATLAB to plot the fractional bandwidth (FBW) for single mode operation as a function of a/b over the range $0.2 \le a/b \le 2.5$. Remember the order of the modes changes with dimension of the waveguide and your calculation of FBW must take this into account in order to be correct.

Problem #3

Assuming $a > b$, what is the ideal choice for the size of a in order to maximize the FBW? Derive this analytically from the cutoff conditions and compare this to the data in Problem #2.

Problem #4

Use MATLAB to visualize the first four electromagnetic modes in a rectangular waveguide with a/b = 2.25.

Problem #5

Design a single mode rectangular waveguide (i.e. choose a and b) filled with air to operate at 1.5 GHz. Justify your design and specify the range of frequencies over which the waveguide is single mode.

Problem #6

Use MATLAB to plot the phase constant β of the fundamental mode in Problem #5 from 0.5 GHz up to 3.0 GHz.