


## GUIDED TOUR

The main objective of this book is to present electromagnetics in a manner that is clearer, more interesting, and easier to understand. For you, the student, here are some features to help you study and be successful in the course.

**Examples:** Numerous easy-to-spot examples, which help to reinforce the concepts presented, are integrated throughout each chapter.



where  $V_{RMS} = |V_p|/\sqrt{2}$ .

**EXAMPLE 11.4**

A 20-m length of transmission line is known to produce a 2.0-dB drop in power from end to end. (a) What fraction of the input power reaches the output? (b) What fraction of the input power reaches the midpoint of the line? (c) What exponential attenuation coefficient,  $\alpha$ , does this represent?

**Solution.** (a) The power fraction will be

$$\frac{P(20)}{P(0)} = 10^{-0.2} = 0.63$$


(b) 2.0 dB in 20 m implies a loss rating of 0.2 dB/m. So, over a 10-meter span, the loss is 1.0 dB. This represents the power fraction,  $10^{-0.1} = 0.79$ .

(c) The exponential attenuation coefficient is found through

$$\alpha = \frac{2.0 \text{ dB}}{(0.69 \text{ dB})/\text{m}(20 \text{ m})} = 0.012 \text{ Np/m}$$

A final point addresses the question: Why are decibels? The most compelling reason is this: when evaluating the accelerated loss for several lines and devices that are all end-to-end connected, the net loss in dB for the entire span is just the sum of the dB losses of the individual elements.

**Drill Problems:** Many drill problems are also integrated throughout each chapter. These problems, which include answers, serve as a quick way for you to check your understanding of the material.



**D14.3.** The conductors of a two-wire transmission line each have a radius of 0.8 mm and a conductivity of  $3 \times 10^7 \text{ S/m}$ . They are separated by a center-to-center distance of 0.8 cm in a medium for which  $\epsilon_r = 2.5$ ,  $\mu_r = 1$ , and  $\sigma = 4 \times 10^{-9} \text{ S/m}$ . If the line operates at 60 Hz, find: (a)  $\delta$ ; (b)  $C$ ; (c)  $G$ ; (d)  $L$ ; (e)  $R$ .

**Ans.** 1.2 cm; 30 pF/m; 5.5 nS/m; 1.02  $\mu\text{H/m}$ ; 0.033  $\Omega/\text{m}$ .

**End-of-Chapter Problems:** Each chapter features a wide selection of problems, with answers to selected problems in Appendix E, to give you a chance to practice what you are learning.

- 14.17 A rectangular waveguide has dimensions  $a = 6$  cm and  $b = 4$  cm. (a) Over what range of frequencies will the guide operate single mode? (b) Over what frequency range will the guide support both  $TE_{10}$  and  $TE_{01}$  modes and no others?
- 14.18 Two rectangular waveguides are joined end-to-end. The guides have identical dimensions, where  $a = 2b$ . One guide is air-filled; the other is filled with a lossless dielectric characterized by  $\epsilon_r'$ . (a) Determine the maximum allowable value of  $\epsilon_r'$  such that single-mode operation can be simultaneously assured in both guides at some frequency. (b) Write an expression for the frequency range over which single-mode operation will occur in both guides; your answer should be in terms of  $\epsilon_r'$ , guide dimensions as needed, and other known constants.

**Student Media Suite:** Your book comes with a CD-ROM intended to further enhance your understanding of electromagnetics. (Details of the CD-ROM contents appear on the next two pages.) CD icons appear in the text margin throughout the book to indicate when you might use the CD for additional help with that material.

#### 2.4 FIELD OF A LINE CHARGE

Up to this point we have considered two types of charge distribution, the point charge and charge distributed throughout a volume with a density  $\rho$ , C/m<sup>3</sup>. If we now consider a filamentlike distribution of volume charge density, such as a very fine, sharp beam in a cathode-ray tube or a charged conductor of very small radius, we find it convenient to treat the charge as a line charge of density  $\rho_L$ , C/m. In the case of the electron beam the charges are in motion and it is true that we do not have an electrostatic problem. However, if the electron motion is steady and uniform (a dc beam)

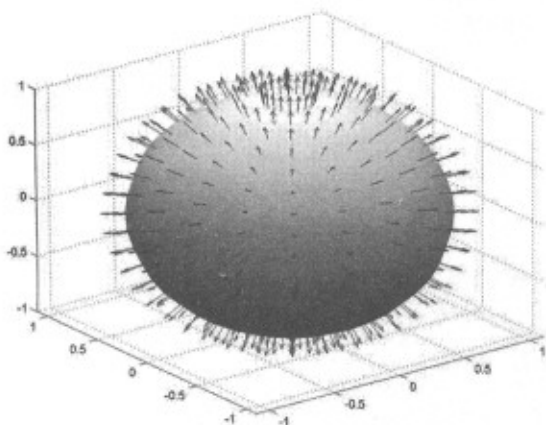


## Student Media Suite



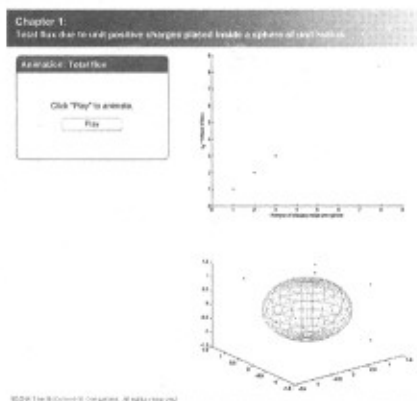
The CD-ROM material was created to provide you additional learning resources for the more difficult electromagnetics concepts. This self-study tool has an easy-to-navigate interface that allows you to look up material by chapter.

## Sphere

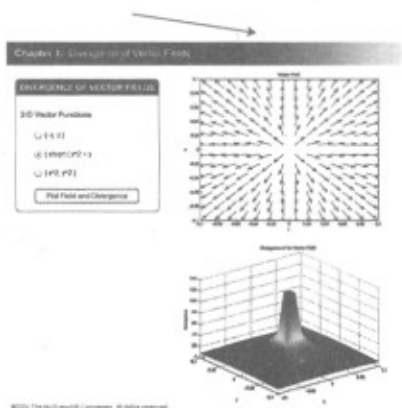


← **Learning Resource #1—Illustrations:** In order to help you to better visualize the concepts, additional illustrations in four colors have been included.

**Learning Resource #2—Animations:** Numerous animations go one step further by showing you a demonstration of electromagnetic phenomena with Flash animation.



**Learning Resource #3—Interactives:** The interactives not only allow you to see the concepts, but they also let you physically adjust the variables or the figure itself to see the concepts in action.



**Learning Resource #4—Quizzes:** To help you further test your understanding, a quick quiz is provided for each chapter. Immediate feedback is given to let you know if you have answered the questions correctly.

### QUIZ – CHAPTER 1 (Vector Analysis)

1. The cross product of  $8a_x + 6a_y$  (first vector) and  $9a_x - 4a_y$  (second vector) is

- $72a_x - 24a_y$
- $-24a_x + 32a_y - 54a_z$
- $72a_x + 24a_y + 16a_z$
- $24a_x - 32a_y + 54a_z$

2. A vector function whose divergence is  $4x$  could be

- $4xa_x$
- $(4x^2 + y)a_x$
- $4x^2a_x$
- $(2x^2 - y)a_x$

3. The gradient of the scalar function  $xyz$  is

- $xa_x + ya_y + za_z$
- 0
- $yz a_x + xy a_y + xz a_z$
- $xyz a_x + xyz a_y + xyz a_z$