12. REVIEW QUESTIONS

1. Throughout this chapter we assume media to be linear homogeneous and isotropic (simple media).

(a) Explain what is meant by a linear medium. Can you name a common nonlinear, magnetic material?

(b) Explain what is meant by a homogeneous medium.

(c) Explain what is meant by an isotropic medium.

(d) Suppose a vapor cloud of varying density occupies a section of spaceso that the permittivity of the material varies according to density. How would you characterize this material.

2. What is a wave? What distinguishes a wave from a field?

3. Is it possible to have "electric waves" or "magnetic waves" alone or must we have only electromagnetic waves? Explain.

4. What do you consider the most fundamental difference between electromagnetic waves and sound waves? Explain.

5. Is the velocity of propagation of the wave a property of the wave itself or that of the medium in which the wave propagates? Explain.

6. What kind of applications are governed by the source-free wave equation?

7. Define uniform plane waves in your own words. How can these waves be generated?

8. If you could produce a true uniform plane wave, how much energy would you require? Explain.

9. A true plane wave can be generated in practice *T*/*F*.

10. The phase and amplitude of a uniform plane wave are constant on any plane perpendicular to the direction of propagation of the wave *T*/*F*.

11. Describe the difference between phase velocity and speed of propagation. Can the two be the same?

12. Define wavelength. Can the definition of wavelength be used with nonsinusoidal sources? Explain.

13. Define wave number. Can the definition of wave number be used with nonsinusoidal sources?

14. What is the relation between the electric and magnetic field intensities of a plane wave? Discuss both spatial and numerical relations.

15. The intrinsic impedance of free space is 120π. This has units of Ω. Does this mean that free space has "impedance"? Explain.

16. Discuss the relationship between phase velocity and intrinsic impedance. Does phase velocity increase or decrease with a decrease in intrinsic (wave) impedance?

17. Discuss the relationship between wave impedance and wave number.

18. Do you think the electromagnetic spectrum is finite or, perhaps, there are phenomena that occur in an infinite spectrum? Speculate on this possibility.

19. State the Poynting theorem.

20. What is a Poynting vector and what is its physical interpretation?

21. Is the Poynting vector a real quantity or can it be complex? If so, what are the meanings of the real and imaginary parts?

22. A negative Poynting vector means flow of energy out of a volume *T*/*F*.

23. A transmitter (generator, transmitting antenna, etc.) has a positive Poynting vector *T*/*F*.

24. If a generator also has an internal resistance that dissipates power, how would you take this into account in the expression of Poynting's theorem? Write the required expression explicitly.

25. Describe instantaneous, time-averaged, and reactive power.

26. Does the Poynting theorem apply to static fields? Explain.

27. In a system with sinusoidal sources, can there be storage of real energy? Discuss the implications of this result.

28. In a system with sinusoidal sources, can there be storage of reactive energy? Discuss the implications of this result.

29. Is it safe to say that the propagation of power in all materials is at speeds lower than that in free space?

30. Define complex permittivity. Is this quantity only a convenient notation or is it a physically measurable quantity? If so, what are the meanings of its real and imaginary parts?

31. Define attenuation, phase, and propagation constants and the relations between them.

32. What is the relation between phase constant and wave number in:

(a) free space,

(b) lossless dielectrics,

(c) lossy dielectrics.

33. Define and discuss the intrinsic impedance of a general material.

34. Discuss the intrinsic impedance, propagation constant, phase constant, and attenuation constant of a low-loss material.

35. Discuss the intrinsic impedance, propagation constant, phase constant and attenuation constant of a high-loss material.

36. Consider the definition of plane waves. Can they exist in a very high-loss material? If so, what are the differences between plane waves in low- and high-loss materials?

37. Define dispersive propagation. Is it related to the wave or to the material in which the wave propagates?

38. Discuss the differences between group and phase velocities.

39. What do you understand by polarization of plane waves?

40. Elliptical polarization can always be viewed as the superposition of two linearly polarized waves *T*/*F*.

41. A circularly polarized wave can be viewed as the superposition of two linearly polarized waves. What are the necessary conditions on the linearly polarized waves for this to be true?

42. Polarization refers to the direction in space but not to the sense of rotation of the wave *T*/*F*.

43. What is a right circularly polarized wave? Describe and sketch.