17. REVIEW QUESTIONS

1. Describe the general concept of a waveguide. Why is it important?

2. Define what a waveguide is in the most general sense. When you do, make sure that your definition includes, for example, acoustic and optical waveguides.

3. What is a TEM wave?

4. What is a TM wave and how does it differ from TEM waves?

5. What is a TE wave and how does it differ from TEM and TM waves?

6. Convince yourself that the sum of two identical TEM waves with components in opposite directions can produce a TE wave. What are the additional conditions necessary for this to happen?

7. Convince yourself that the sum of two TEM waves which have components in opposite directions can produce a TM wave. What are the additional conditions necessary for this to happen?

8. Phase velocity of a TEM wave is the same as phase velocity of a plane wave in unbounded domain *T/F*.

9. A TEM wave can exist (mark all that apply):

(a) In a parallel plate waveguide.

(a) In a rectangular waveguide.

(b) In free space.

(c) In a transmission line.

(d) In a lossy dielectric.

10. Wave impedance of TEM waves in waveguides is the same as the intrinsic impedance for plane waves in unbounded domain *T/F*.

11. Wave impedance of TE waves is lower or higher than for TEM waves *T/F*. Can they be equal? Under what condition?

12. Wave impedance for TE waves can be zero *T/F*. If so, what is the condition for this to happen?

13. Wave impedance for TM waves is lower or equal to that for TEM waves *T/F*. When are the two impedances equal?

14. Explain the meaning of cutoff frequency.

15. Parallel plate waveguides can support TE, TM, and TEM waves *T/F*.

16. The guide phase velocity is always larger than the phase velocity of the same wave in unbounded space *T/F*. Explain.

17. What is a mode of propagation?

18. Power propagated in a waveguide for any given frequency is mode independent *T/F*.

19. The dimensions of the waveguide are only important for mechanical reasons *T/F*. Explain.

20. Guide wavelength is always lower than free space wavelength *T/F*.

21. Suppose that propagation at a given frequency can be done in TE or TM modes. Which of the two propagates more power, assuming both can be propagated?

22. Give a simple physical description of the rectangular waveguide.

23. Rectangular waveguides can propagate (mark correct answer):

(a) Only TE modes.

(b) Only TM modes.

(c) TM and TEM modes.

(d) TE and TM modes.

24. For rectangular waveguides, the higher the frequency, the higher the phase velocity *T/F*.

25. The phase velocity in a waveguide is largest in the direction of propagation. If true, why? If not, which velocity is largest?

26. The phase velocity in a waveguide can be infinite. When does this occur and what does it mean?

27. At cutoff the phase velocity is zero, regardless of the mode *T/F*.

28. A TEM wave cannot propagate in a single conductor waveguide *T/F*. Explain.

29. Power propagated in a waveguide increases with the mode index *T/F*.

30. Why is it important to have large mode separation?

31. Why is the lowest propagating mode the most often used mode?

32. A waveguide can propagate an infinite number of modes *T/F*.

33. A waveguide cannot propagate more than one mode at the same time *T/F*. Explain.

34. If a waveguide were made of a perfect conductor and filled with a perfect dielectric, there would be no attenuation in the waveguide *T/F*.

35. An obstruction in a rectangular waveguide causes a reduction in one dimension of the waveguide. Those modes which depend on this dimension will experience one of the following:

(a) An increase in the cutoff frequency.

(b) A decrease in the cutoff frequency.

(c) There will be no change in the cutoff frequencies of any of the modes in the waveguide.

36. Because of cutoff, the waveguide can be viewed as a filter. What kind of filter is it?

37. Does guiding of waves require a closed, conducting surface?

38. An optical waveguide has no conducting media. What are the conditions that dispense with the conductor?

39. If you wanted to build a dielectric waveguide (no conductor), what is the absolute necessary condition to do so?

40. A stripline is a parallel plate waveguide. Discuss the reasons a stripline may be less desirable than an enclosed waveguide in many applications.

41. Striplines are often used in microwave integrated circuits (MICs) or monolithic microwave integrated circuits (MMICs). Give reasons for this choice.

42. What is a cavity resonator?

43. Why does a cavity resonate?

44. The mode designation in a cavity is ambiguous. What we call a TE mode may be a TM mode and vice versa, depending on the way we look at the cavity *T/F*.

45. What kind of energy can exist in a cavity resonator?

46. What is quality factor of a cavity resonator?

47. Coupling to a cavity can be done in any way that will excite a valid mode of the cavity. Explain how this might be done in practice.