14. In residential house wiring, the hot wire is usually color-coded
a. white.
b. green.
c. black or red.
d. as a bare copper wire.

15. A sine wave with a peak value of 20 V has an rms value of
a. 28.28 V.
b. 14.14 V.
c. 12.74 V.
d. 56.6 V.

16. A sine wave whose rms voltage is 25.2 V has a peak value of approximately
a. 17.8 V.
b. 16 V.
c. 50.4 V.
d. 35.6 V.

17. The unit of frequency is the
a. hertz.
b. maxwell.
c. radian.
d. second.

18. For an ac waveform, the period, *T*, refers to
a. the number of complete cycles per second.
b. the length of time required to complete one cycle.
c. the time it takes for the waveform to reach its peak value.
d. none of the above.

19. The wavelength of a radio wave is
a. inversely proportional to its frequency.
b. directly proportional to its frequency.
c. inversely proportional to its amplitude.
d. unrelated to its frequency.

20. Exact multiples of the fundamental frequency are called
a. ultrasonic frequencies.
b. harmonic frequencies.
c. treble frequencies.
d. resonant frequencies.

21. Raising the frequency of 500 Hz by two octaves corresponds to a frequency of
a. 2 kHz.
b. 1 kHz.
c. 4 kHz.
d. 250 Hz.

22. In residential house wiring, the neutral wire is always color-coded
a. black.
b. bare copper.
c. green.
d. white.

23. The second harmonic of 7 MHz is
a. 3.5 MHz.
b. 28 MHz.
c. 14 MHz.
d. 7 MHz.

24. A sine wave has a peak voltage of 170 V. What is the instantaneous voltage at an angle of 45°?
a. 240 V.
b. 85 V.
c. 0 V.
d. 120 V.

25. Unless indicated otherwise, all sine-wave ac measurements are in
a. peak-to-peak values.
b. peak values.
c. rms values.
d. average values.

Essay Questions

1. (a) Define *alternating voltage*. (b) Define *alternating current*. (c) Why does ac voltage applied across a load resistance produce alternating current in the circuit?
2. (a) State two characteristics of a sine wave of voltage. (b) Why does the rms value of 0.707 × peak value apply just to sine waves?
3. Draw two cycles of an ac sawtooth voltage waveform with a peak-to-peak amplitude of 40 V. Do the same for a square wave.
4. Give the angle in degrees and radians for each of the following: one cycle, one half-cycle, one quarter-cycle, three quarter-cycles.
5. The peak value of a sine wave is 1 V. How much is its average value? rms value? Effective value? Peak-to-peak value?
6. State the following ranges in hertz: (a) audio frequencies; (b) radio frequencies; (c) standard AM radio broadcast band; (d) FM broadcast band; (e) VHF band; (f) microwave band.
7. Make a graph with two waves, one with a frequency of 500 kHz and the other with 1000 kHz. Mark the horizontal axis in time, and label each wave.
8. Draw the sine waves and phasor diagrams to show (a) two waves 180° out of phase; (b) two waves 90° out of phase.
9. Give the voltage value for the 60-Hz ac line voltage with an rms value of 120 V at each of the following times in a cycle: 0°, 30°, 45°, 90°, 180°, 270°, 360°.
10. (a) The phase angle of 90° equals how many radians? (b) For two sine waves 90° out of phase with each other, compare their amplitudes at 0°, 90°, 180°, 270°, and 360°.
11. Tabulate the sine and cosine values every 30° from 0 to 360° and draw the corresponding sine wave and cosine wave.
12. Draw a graph of the values for $(\sin \theta)^2$ plotted against θ for every 30° from 0 to 360°.
13. Why is the wavelength of an ultrasonic wave at 34.44 kHz the same 1 cm as for the much higher frequency radio wave at 30 GHz?
14. Draw the sine waves and phasors to show wave V_1 leading wave V_2 by 45°.
15. Why are amplitudes for nonsinusoidal waveforms generally measured in peak-to-peak values, rather than rms or average value?
16. Define *harmonic frequencies*, giving numerical values.
17. Define *one octave*, with an example of numerical values.
18. Which do you consider more important for applications of alternating current—polarity reversals or variations in value?
19. Define the following parts in the assembly of motors: (a) armature rotor; (b) field stator; (c) collector rings; (d) commutator segments.
20. Show diagrams of Y and Δ connections for three-phase ac power.

Problems

SECTION 15–2 ALTERNATING-VOLTAGE GENERATOR

15–1 For a sine wave of alternating voltage, how many degrees are included in
a. ¼ cycle?
b. ½ cycle?
c. ¾ cycle?
d. 1 complete cycle?

15–2 For a sine wave of alternating voltage, how many radians are included in
a. ¼ cycle?
b. ½ cycle?
c. ¾ cycle?
d. 1 complete cycle?

15–3 At what angle does a sine wave of alternating voltage
a. reach its maximum positive value?
b. reach its maximum negative value?
c. cross the zero axis?

15–4 One radian corresponds to how many degrees?

SECTION 15–3 THE SINE WAVE

15–5 The peak value of a sine wave equals 20 V. Calculate the instantaneous voltage of the sine wave for the phase angles listed.
a. 30°.
b. 45°.
c. 60°.
d. 75°.
e. 120°.
f. 210°.
g. 300°.

15–6 The peak value of a sine wave equals 100 mV. Calculate the instantaneous voltage of the sine wave for the phase angles listed.
a. 15°.
b. 50°.
c. 90°.
d. 150°.
e. 180°.
f. 240°.
g. 330°.

15–7 A sine wave of alternating voltage has an instantaneous value of 45 V at an angle of 60°. Determine the peak value of the sine wave.

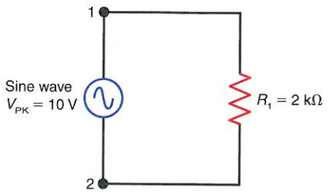
SECTION 15–4 ALTERNATING CURRENT

15–8 In Fig. 15–28, the sine wave of applied voltage has a peak or maximum value of 10 V, as shown. Calculate the instantaneous value of current for the phase angles listed.
a. 30°.
b. 60°.
c. 90°.
d. 120°.
e. 150°.
f. 180°.
g. 210°.
h. 240°.
i. 270°.
j. 300°.
k. 330°.

15–9 In Fig. 15–28, do electrons flow clockwise or counterclockwise in the circuit during
a. the positive alternation?
b. the negative alternation?

Note: During the positive alternation, terminal 1 is positive with respect to terminal 2.

Figure 15–28



SECTION 15–5 VOLTAGE AND CURRENT VALUES FOR A SINE WAVE

15–10 If the sine wave in Fig. 15–29 has a peak value of 15 V, then calculate
a. the peak-to-peak value.
b. the rms value.
c. the average value.