15.7 Find the Laplace transforms of the following functions:

(a) $2\delta(3t) + 6u(2t) + 4e^{-2t} - 10e^{-3t}$

(b) $te^{-t}u(t-1)$

(c) $\cos 2(t-1)u(t-1)$

(d) $\sin 4t[u(t) - u(t-\pi)]$

15.8 Determine the Laplace transforms of these functions:

(a) $f(t) = (t-4)u(t-2)$

(b) $g(t) = 2e^{-4t}u(t-1)$

(c) $h(t) = 5\cos(2t-1)u(t)$

(d) $p(t) = 6[u(t-2) - u(t-4)]$

15.9 In two different ways, find the Laplace transform of

$$g(t) = \frac{d}{dt}(te^{-t}\cos t)$$

15.10 Find $F(s)$ if:

(a) $f(t) = 6e^{-t}\cosh 2t$ (b) $f(t) = 3te^{-2t}\sinh 4t$

(c) $f(t) = 8e^{-3t}\cosh tu(t-2)$

15.11 Calculate the Laplace transform of the function in Fig. 15.49.

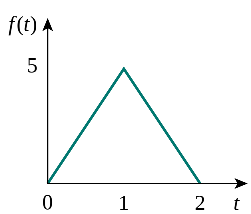


Figure 15.49 For Prob. 15.11.

15.12 Find the Laplace transform of the function in Fig. 15.50.

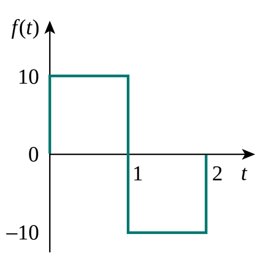


Figure 15.50 For Prob. 15.12.

15.13 Obtain the Laplace transform of $f(t)$ in Fig. 15.51.

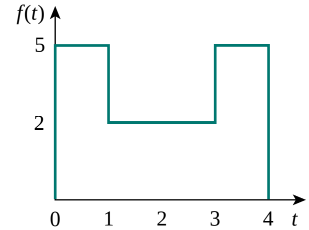


Figure 15.51 For Prob. 15.13.

15.14 Determine the Laplace transforms of the function in Fig. 15.52.

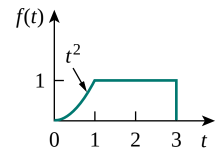


Figure 15.52 For Prob. 15.14.

15.15 Obtain the Laplace transforms of the functions in Fig. 15.53.

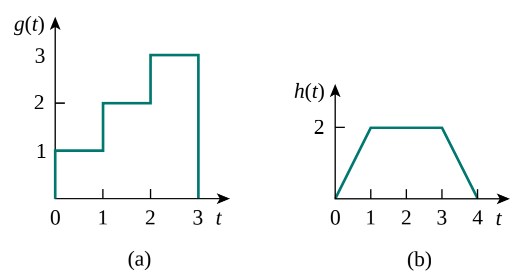


Figure 15.53 For Prob. 15.15.

15.16 Calculate the Laplace transform of the train of unit impulses in Fig. 15.54.

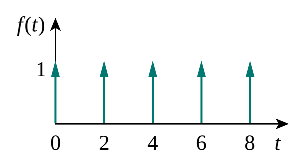


Figure 15.54 For Prob. 15.16.

15.27 Calculate the inverse Laplace transform of:

(a) $\dfrac{6(s-1)}{s^4-1}$ (b) $\dfrac{se^{-\pi s}}{s^2+1}$ (c) $\dfrac{8}{s(s+1)^3}$

15.28 Find the time functions that have the following Laplace transforms:

(a) $F(s) = 10 + \dfrac{s^2+1}{s^2+4}$

(b) $G(s) = \dfrac{e^{-s}+4e^{-2s}}{s^2+6s+8}$

(c) $H(s) = \dfrac{(s+1)e^{-2s}}{s(s+3)(s+4)}$

15.29 Obtain $f(t)$ for the following transforms:

(a) $F(s) = \dfrac{(s+3)e^{-6s}}{(s+1)(s+2)}$

(b) $F(s) = \dfrac{4-e^{-2s}}{s^2+5s+4}$

(c) $F(s) = \dfrac{se^{-s}}{(s+3)(s^2+4)}$

15.30 Obtain the inverse Laplace transforms of the following functions:

(a) $X(s) = \dfrac{1}{s^2(s+2)(s+3)}$

(b) $Y(s) = \dfrac{1}{s(s+1)^2}$

(c) $Z(s) = \dfrac{1}{s(s+1)(s^2+6s+10)}$

15.31 Obtain the inverse Laplace transforms of these functions:

(a) $\dfrac{12e^{-2s}}{s(s^2+4)}$ (b) $\dfrac{2s+1}{(s^2+1)(s^2+9)}$

(c) $\dfrac{9s^2}{(s^2+4s+13)}$

15.32 Find $f(t)$ given that:

(a) $F(s) = \dfrac{s^2+4s}{s^2+10s+26}$

(b) $F(s) = \dfrac{5s^2+7s+29}{s(s^2+4s+29)}$

*__15.33__ Determine $f(t)$ if:

(a) $F(s) = \dfrac{2s^3+4s^2+1}{(s^2+2s+17)(s^2+4s+20)}$

(b) $F(s) = \dfrac{s^2+4}{(s^2+9)(s^2+6s+3)}$

Section 15.5 Application to Circuits

15.34 Determine $i(t)$ in the circuit of Fig. 15.59 by means of the Laplace transform.

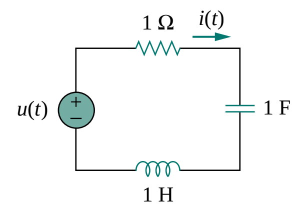


Figure 15.59 For Prob. 15.34.

15.35 Find $v_o(t)$ in the circuit in Fig. 15.60.

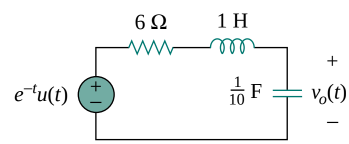


Figure 15.60 For Prob. 15.35.

15.36 Find the input impedance $Z_{in}(s)$ of each of the circuits in Fig. 15.61.

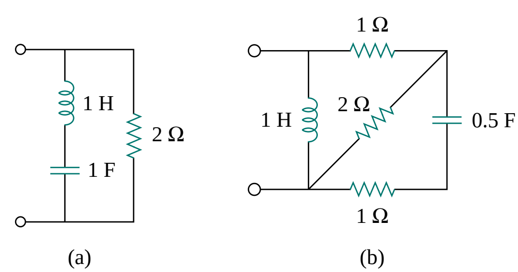


Figure 15.61 For Prob. 15.36.

15.37 Obtain the mesh currents in the circuit of Fig. 15.62.

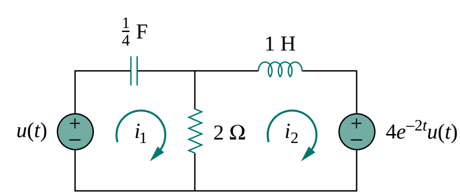


Figure 15.62 For Prob. 15.37.

15.38 Find $v_o(t)$ in the circuit in Fig. 15.63.

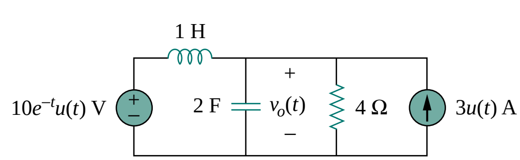


Figure 15.63 For Prob. 15.38.

16.2 Determine the period of these periodic functions:

(a) $f_1(t) = 4\sin 5t + 3\sin 6t$

(b) $f_2(t) = 12 + 5\cos 2t + 2\cos(4t + 45^\circ)$

(c) $f_3(t) = 4\sin^2 600\pi t$

(d) $f_4(t) = e^{j10t}$

16.3 Give the Fourier coefficients a_0, a_n, and b_n of the waveform in Fig. 16.47. Plot the amplitude and phase spectra.

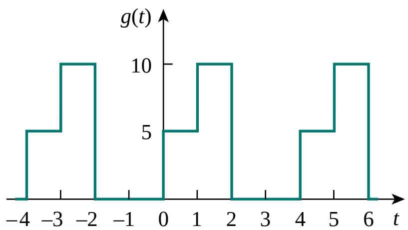


Figure 16.47 For Prob. 16.3.

16.4 Find the Fourier series expansion of the backward sawtooth waveform of Fig. 16.48. Obtain the amplitude and phase spectra.

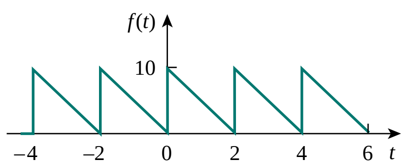


Figure 16.48 For Probs. 16.4 and 16.50.

***16.5** A voltage source has a periodic waveform defined over its period as

$$v(t) = t(2\pi - t)\ \text{V}, \qquad 0 < t < 2\pi$$

Find the Fourier series for this voltage.

16.6 A periodic function is defined over its period as

$$h(t) = \begin{cases} 10\sin t, & 0 < t < \pi \\ 20\sin(t - \pi), & \pi < t < 2\pi \end{cases}$$

Find the Fourier series of $h(t)$.

16.7 Find the quadrature (cosine and sine) form of the Fourier series

$$f(t) = 2 + \sum_{n=1}^{\infty} \frac{10}{n^3 + 1} \cos\left(2nt + \frac{n\pi}{4}\right)$$

16.8 Express the Fourier series

$$f(t) = 10 + \sum_{n=1}^{\infty} \frac{4}{n^2 + 1} \cos 10nt + \frac{1}{n^3} \sin 10nt$$

(a) in a cosine and angle form,

(b) in a sine and angle form.

*An asterisk indicates a challenging problem.

16.9 The waveform in Fig. 16.49(a) has the following Fourier series:

$$v_1(t) = \frac{1}{2} - \frac{4}{\pi^2}\left(\cos \pi t + \frac{1}{9}\cos 3\pi t + \frac{1}{25}\cos 5\pi t + \cdots\right)\ \text{V}$$

Obtain the Fourier series of $v_2(t)$ in Fig. 16.49(b).

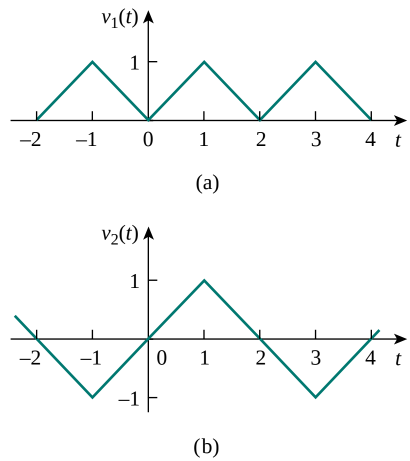


Figure 16.49 For Probs. 16.9 and 16.52.

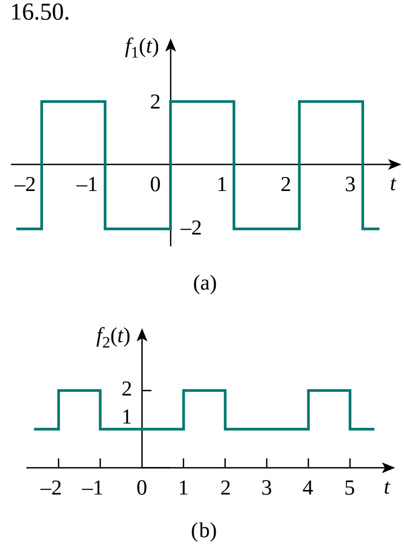
Section 16.3 Symmetry Considerations

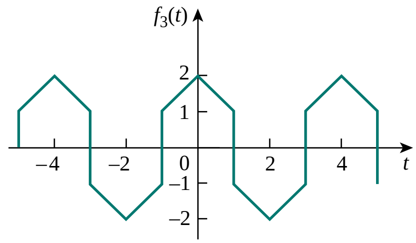
16.10 Determine if these functions are even, odd, or neither.

(a) $1 + t$ (b) $t^2 - 1$ (c) $\cos n\pi t \sin n\pi t$

(d) $\sin^2 \pi t$ (e) e^{-t}

16.11 Determine the fundamental frequency and specify the type of symmetry present in the functions in Fig. 16.50.





(c)

Figure 16.50 For Probs. 16.11 and 16.48.

16.12 Obtain the Fourier series expansion of the function in Fig. 16.51.

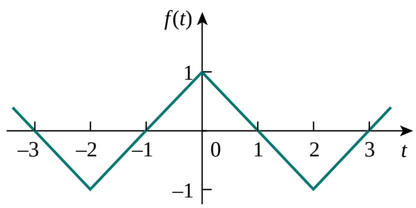


Figure 16.51 For Prob. 16.12.

16.13 Find the Fourier series for the signal in Fig. 16.52. Evaluate $f(t)$ at $t = 2$ using the first three nonzero harmonics.

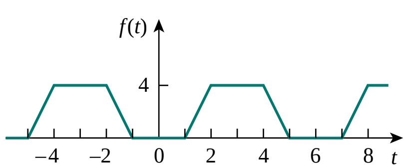


Figure 16.52 For Probs. 16.13 and 16.51.

16.14 Determine the trigonometric Fourier series of the signal in Fig. 16.53.

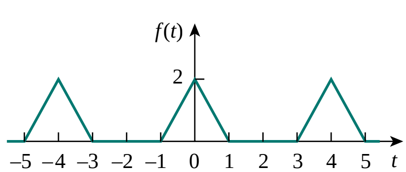


Figure 16.53 For Prob. 16.14.

16.15 Calculate the Fourier coefficients for the function in Fig. 16.54.

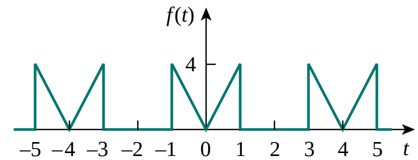


Figure 16.54 For Prob. 16.15.

16.16 Find the Fourier series of the function shown in Fig. 16.55.

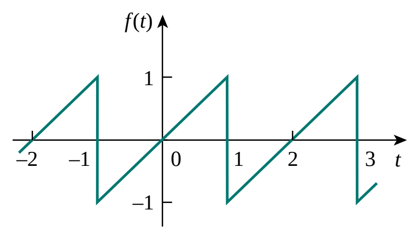


Figure 16.55 For Prob. 16.16.

16.17 In the periodic function of Fig. 16.56,

(a) find the trigonometric Fourier series coefficients a_2 and b_2,

(b) calculate the magnitude and phase of the component of $f(t)$ that has $\omega_n = 10$ rad/s,

(c) use the first four nonzero terms to estimate $f(\pi/2)$,

(d) show that

$$\frac{\pi}{4} = \frac{1}{1} - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \frac{1}{9} - \frac{1}{11} + \cdots$$

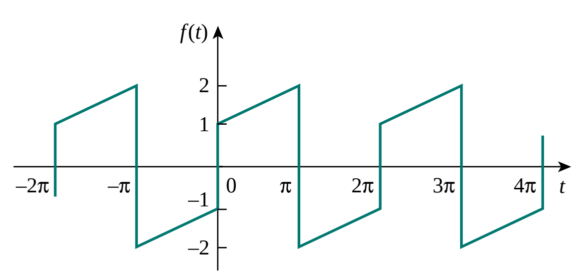


Figure 16.56 For Prob. 16.17.

16.18 Determine the Fourier series representation of the function in Fig. 16.57.

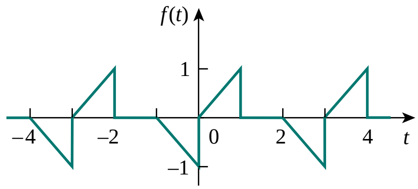


Figure 16.57 For Prob. 16.18.

16.19 Find the Fourier series representation of the signal shown in Fig. 16.58.

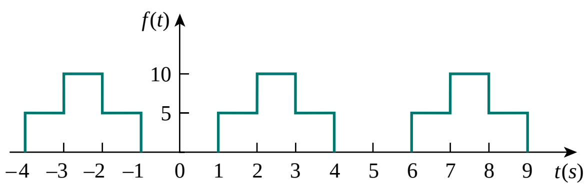


Figure 16.58 For Prob. 16.19.

16.20 For the waveform shown in Fig. 16.59 below,

(a) specify the type of symmetry it has,

(b) calculate a_3 and b_3,

(c) find the rms value using the first five nonzero harmonics.

16.21 Obtain the trigonometric Fourier series for the voltage waveform shown in Fig. 16.60.

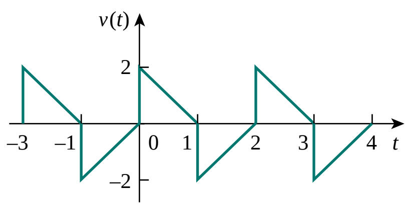


Figure 16.60 For Prob. 16.21.

16.22 Determine the Fourier series expansion of the sawtooth function in Fig. 16.61.

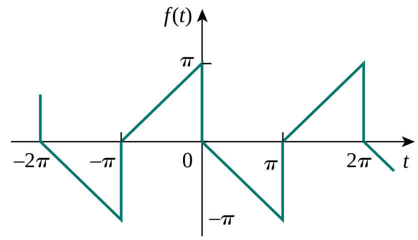


Figure 16.61 For Prob. 16.22.

Section 16.4 Circuit Applications

16.23 Find $i(t)$ in the circuit of Fig. 16.62 given that

$$i_s(t) = 1 + \sum_{n=1}^{\infty} \frac{1}{n^2} \cos 3nt \text{ A}$$

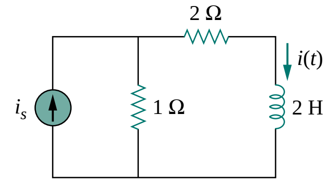


Figure 16.62 For Prob. 16.23.

16.24 Obtain $v_o(t)$ in the network of Fig. 16.63 if

$$v(t) = \sum_{n=1}^{\infty} \frac{10}{n^2} \cos\left(nt + \frac{n\pi}{4}\right) \text{ V}$$

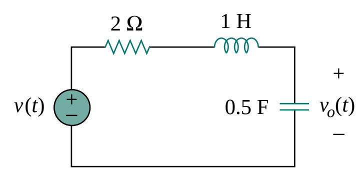


Figure 16.63 For Prob. 16.24.

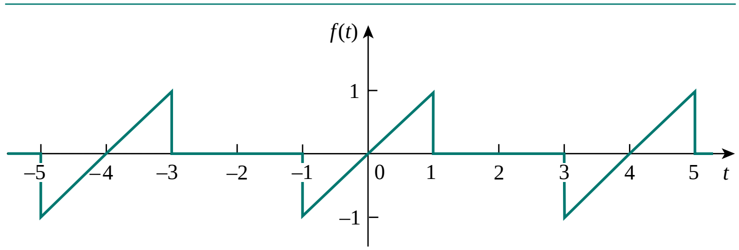


Figure 16.59 For Prob. 16.20.