2.1-1 Both \( \varphi(t) \) and \( w_0(t) \) are periodic.

The average power of \( \varphi(t) \) is \( P_\varphi = \frac{1}{T} \int_0^T \varphi^2(t) \, dt = \frac{1}{\pi} \int_0^\pi (e^{-t/2})^2 \, dt = \frac{1-e^{-\pi}}{\pi} \).

The average power of \( w_0(t) \) is \( P_{w_0} = \frac{1}{T_0} \int_0^{T_0} w_0^2(t) \, dt = \frac{1}{T_0} \int_0^{T_0} 1 \cdot dt = 1 \).

2.1-8

(a) From Eq. (2.5a), the power of a signal of amplitude \( C \) is \( P_g = \frac{C^2}{2} \), regardless of phase and frequency; therefore, \( P_g = 100/2 = 50 \); the rms value is \( \sqrt{P_g} = 5\sqrt{2} \).

(b) From Eq. (2.5b), the power of the sum of two sinusoids of different frequencies is the sum of the power of individual sinusoids, regardless of the phase, \( \frac{C_1^2}{2} + \frac{C_2^2}{2} \); therefore, \( P_g = 100/2 + 256/2 = 50 + 128 = 178 \); the rms value is \( \sqrt{P_g} = \sqrt{178} \).

(c) \( g(t) = (10 + 2 \sin (3t)) \cos (10t) = 10 \cos (10t) + 2 \sin (3t) \cos (10t) = 10 \cos (10t) + \sin (13t) - \cos (7t) \)

Therefore, \( P_g = 100/2 + 1/2 + 1/2 = 50 + 0.5 + 0.5 = 51 \); the rms value is \( \sqrt{P_g} = \sqrt{51} \).

(d) \( g(t) = 10 \cos (5t) \cos (10t) = \frac{10(\cos (15t) + \cos (5t))}{2} = 5 \cos (15t) + 5 \cos (5t) \)

Therefore, \( P_g = 25/2 + 25/2 = 25 \); the rms value is \( \sqrt{P_g} = 5 \).

(e) \( g(t) = 10 \sin (5t) \cos (10t) = 5 (\cos (15t) - \cos (5t)) = 5 \cos (15t) - 5 \cos (5t) \)

Therefore, \( P_g = 25/2 + 25/2 = 25 \); the rms value is \( \sqrt{P_g} = 5 \).

(f) \( |g(t)|^2 = \cos^2(\omega_0 t) \)

Therefore, \( P_g = 1/2 = 0.5 \); the rms value is \( \sqrt{P_g} = \sqrt{0.5} \).

2.3-1

\[ g_2(t) = g(t-1) + g_1(t-1), \quad g_3(t) = g(t-1) + g_1(t+1), \quad g_4(t) = g(t-0.5) + g_1(t+0.5) \]

The signal \( g_5(t) \) can be obtained by (i) delaying \( g(t) \) by 1 second (replace \( t \) with \( t-1 \)), (ii) then time-expanding by a factor 2 (replace \( t \) with \( t/2 \)), (iii) then multiplying by 1.5. Thus \( g_5(t) = 1.5g(\frac{t}{2}-1) \).
(b) Energy of $g(t)$,

$$
E_g = \int_{-\infty}^{\infty} g^2(t) \, dt = \int_{6}^{15} \left[ \frac{1}{6} (t - 12)^2 \right] \, dt + \int_{15}^{24} \left[ -\frac{1}{18} (t - 24)^2 \right] \, dt = \frac{9}{4} + \frac{3}{4} = 3
$$

Since [see Problem 2.3-5], time shifting or time inversion does not change the signal energy,

$$
E_{g(-t)} = E_{g(t+12)} = E_{g(t)} = 3
$$

On the other hand, a scaling of $g(at)$ will change the signal energy to $E_g/a$ [Problem 2.3-5], the energy of $g(3t)$ is 1 and energy of $g(6-2t)$ is $\frac{3}{2}$.