Problem 2.38

(a) We are given the power signal

$$g(t) = A_0 + A_1 \cos(2\pi f_1 t + \theta_1) + A_2 \cos(2\pi f_2 t)$$

The three components of $g(t)$ are uncorrelated with each other. Therefore, the power spectral density of $g(t)$ is the sum of the power spectral densities of the three constituent components, as shown by

$$S_g(f) = \frac{A^2}{2}\delta(f) + \frac{A_1^2}{4}[\delta(f - f_1) + \delta(f + f_1)] + \frac{A_2^2}{4}[\delta(f - f_2) + \delta(f + f_2)]$$

Correspondingly, the autocorrelation function $R_g(\tau)$ is given by

$$R_g(\tau) = \frac{A^2}{2} + \frac{A_1^2}{2}\cos(2\pi f_1 \tau) + \frac{A_2^2}{2}\cos(2\pi f_2 \tau)$$

(Here we are postulating a fundamental result that, as with energy signals, the autocorrelation function and power spectral density of a power signal constitute a Fourier-transform pair).

(b) $R_g(0) = \frac{A^2}{2}$.

(c) In calculating the autocorrelation function, information about the phase shifts θ_1 and θ_2 is completely lost.