Problems

Problem 3.1 A carrier wave of frequency 1 MHz is modulated 50 percent by a sine-wave of frequency 5 kHz. The resulting AM wave is transmitted through the resonant circuit of Fig. P3.1 which is tuned to the carrier frequency, and has a Q factor of 175. Determine the modulated wave after transmission through this circuit. What is the percentage modulation of this modulated wave?

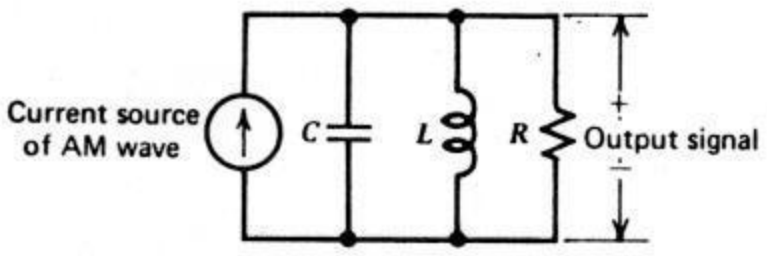

Figure P3.1

Problem 3.3 Suppose nonlinear devices are available for which the output current i_o and input voltage v_i are related by

$$i_o = a_1 v_i + a_3 v_i^3$$

where a_1 and a_3 are constants. Explain how these devices may be used to provide: (1) a product modulator and (2) an amplitude modulator.

Problem 3.6 Consider a modulating wave $m(t)$ with $|m(t)| \leq 1/k_a$ so that $1 + k_a m(t) \geq 0$ for all t. Assume that the spectrum of $m(t)$ is zero for $|f| \geq W$. Let

$$s(t) = A_c[1 + k_a m(t)]\cos(2\pi f_c t),$$

where the carrier frequency $f_c > W$.

(a) The modulated wave $s(t)$ is applied to a full-wave rectifier, producing the output $v_1(t)$. Determine the spectrum of $v_1(t)$.

Problem 3.28

(a) Consider a baseband signal $m(t)$ containing frequency components at 100, 200, and 400 Hz. This signal is applied to an SSB modulator together with a carrier at 100 kHz, with only the upper sideband retained. In the coherent detector used to recover $m(t)$, the local oscillator supplies a sine-wave of frequency 100.02 kHz. Determine the frequency components of the detector output.
(b) Repeat your analysis, assuming that only the lower sideband is transmitted.

Problem 7.1 The signal

$$g(t) = 10\cos(20\pi t)\cos(200\pi t)$$

is sampled at the rate of 250 samples per second.

(a) Determine the spectrum of the resulting sampled signal.
(b) Specify the cutoff frequency of the ideal reconstruction filter so as to recover $g(t)$ from its sampled version.
(c) What is the Nyquist rate for $g(t)$?
(d) By treating $g(t)$ as a band-pass signal, determine the lowest permissible sampling rate for this signal.

Problem 7.3 The signal

$$g(t) = 10\cos(60\pi t)\cos^2(160\pi t)$$

is sampled at the rate of 400 samples per second. Determine the range of permissible cutoff frequencies for the ideal reconstruction filter that may be used to recover $g(t)$ from its sampled version.

Problem 7.6 The spectrum of a signal $g(t)$ is shown in Fig. P7.1. This signal is sampled at the Nyquist rate with a periodic train of rectangular pulses of duration 50/3 milliseconds. Plot the spectrum of the sampled signal for frequencies up to 50 hertz.

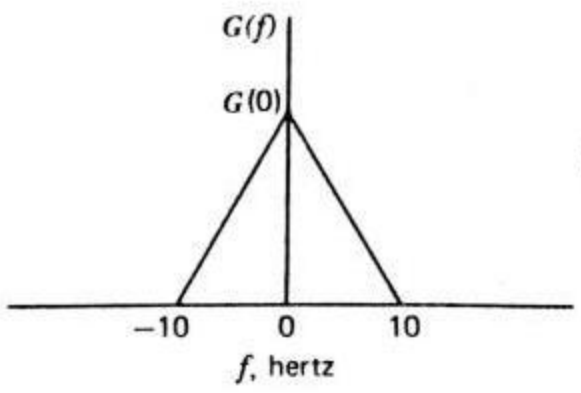

Figure P7.1