

5.1-2 A baseband signal $m(t)$ is the periodic sawtooth signal shown in Fig. P5.1-2.

- Sketch $\varphi_{FM}(t)$ and $\varphi_{PM}(t)$ for this signal $m(t)$ if $\omega_c = 2\pi \times 10^6$, $k_f = 2000\pi$, and $k_p = \pi/2$.
- Show that this PM signal is equivalent to another PM signal modulated by a periodic rectangular message signal. Explain why it is necessary to use $k_p < \pi$ in this case. [Note that the PM signal has a constant frequency but has phase discontinuities corresponding to the discontinuities of $m(t)$.]

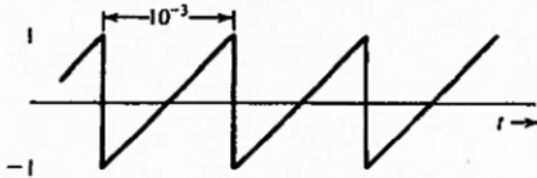


Figure P.5.1-2

5.2-7 Given $m(t) = \sin 2000\pi t$, $k_f = 200,000\pi$, and $k_p = 10$.

- Estimate the bandwidths of $\varphi_{FM}(t)$ and $\varphi_{PM}(t)$.
- Repeat part (a) if the message signal amplitude is doubled.
- Repeat part (a) if the message signal frequency is doubled.
- Comment on the sensitivity of FM and PM bandwidths to the spectrum of $m(t)$.

5.3-3 Design an Armstrong indirect FM modulator in block diagram to generate an FM signal with carrier 96.3 MHz and $\Delta f = 20.48$ kHz. A narrowband FM generator with $f_c = 150$ kHz and $\Delta f = 10$ Hz is available. Only a limited number of frequency doublers are available as frequency multipliers. In addition, an oscillator with adjustable frequency from 13 to 14 MHz is also available for mixing, along with bandpass filters of any specification.

5.4-2 A periodic square wave $m(t)$ (Fig. P5.4-2a) frequency-modulates a carrier of frequency $f_c = 10$ kHz with $\Delta f = 1$ kHz. The carrier amplitude is A . The resulting FM signal is demodulated, as shown in Fig. P5.4-2b by the method discussed in Sec. 5.4 (Fig. 5.12). Sketch the waveforms at points b , c , d , and e .

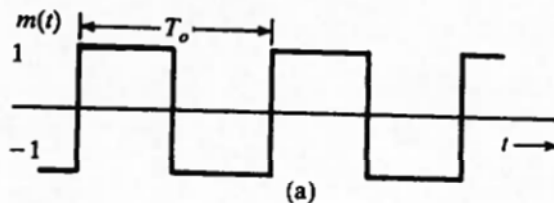
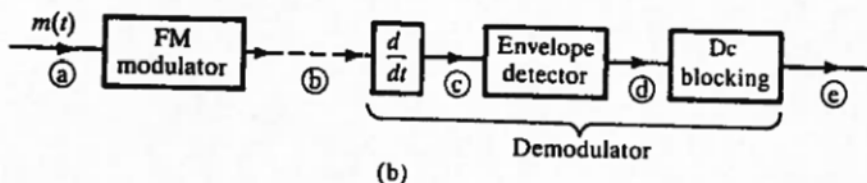


Figure P.5.4-2



5.6-2 Consider a superheterodyne FM receiver designed to receive the frequency band of 88 to 108 MHz with IF frequency 10.7 MHz. What is the range of frequencies generated by the local oscillator for this receiver? Analyze and explain whether it is possible for an FM receiver to receive both a desired FM station and an image FM station.