4.2-7 Two signals $m_1(t)$ and $m_2(t)$, both band-limited to 5000 Hz, are to be transmitted simultaneously over a channel by the multiplexing scheme shown in Fig. P4.2-7. The signal at point b is the multiplexed signal, which now modulates a carrier of frequency 20,000 Hz. The modulated signal at point c is transmitted over a channel.

(a) Sketch signal spectra at points a, b, and c.

(b) What must be the bandwidth of the distortionless channel?

(c) Design a receiver to recover signals $m_1(t)$ and $m_2(t)$ from the modulated signal at point c.

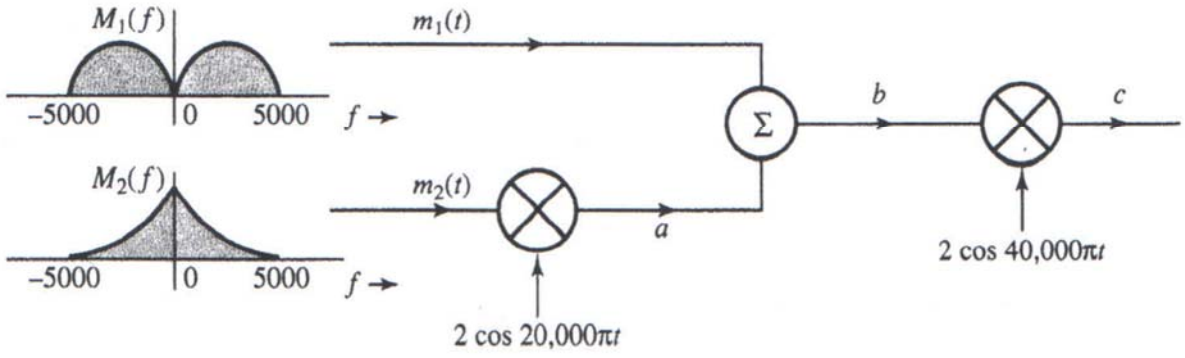


Figure P.4.2-7

4.3-1 In an amplitude modulation system, the message signal is given by Fig. P4.3-1 and the carrier frequency is 1 kHz. The modulator output is

$$s_{\mathrm{AM}}(t) = 2[b + 0.5m(t)] \cos \omega_c t$$

(a) Determine the average message power.

(b) If $b = 1$, determine the modulation index and the modulation power efficiency.

(c) Sketch the modulated signal of part **(a)** in the time domain.

(d) If $b = 0.5$, repeat parts **(a)** and **(b)**.

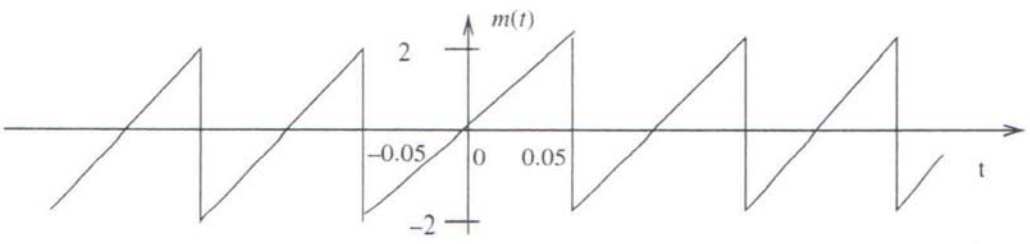


Figure P.4.3-1

4.4-2 A modulating signal $m(t)$ is given by:

(a) $m(t) = \cos\ 100\pi t + 2\cos\ 300\pi t$

(b) $m(t) = \sin\ 100\pi t \sin\ 500\pi t$

In each case:

(i) Sketch the spectrum of $m(t)$.

(ii) Find and sketch the spectrum of the DSB-SC signal $2m(t)\ \cos\ 1000\pi t$.

(iii) From the spectrum obtained in part **(ii)**, suppress the LSB spectrum to obtain the USB spectrum.

(iv) Knowing the USB spectrum in part **(ii)**, write the expression $\varphi_{\text{USB}}(t)$ for the USB signal.

(v) Repeat parts **(iii)** and **(iv)** to obtain the LSB signal $\varphi_{\text{LSB}}(t)$.

4.4-4 Find $\varphi_{\text{LSB}}(t)$ and $\varphi_{\text{USB}}(t)$ for the modulating signal $m(t) = \pi B\,\text{sinc}^2\,(2\pi Bt)$ with $B = 2000$ Hz and carrier frequency $f_c = 10,000$ Hz. Follow these steps:

(a) Sketch spectra of $m(t)$ and the corresponding DSB-SC signal $2m(t)\ \cos\ \omega_c t$.

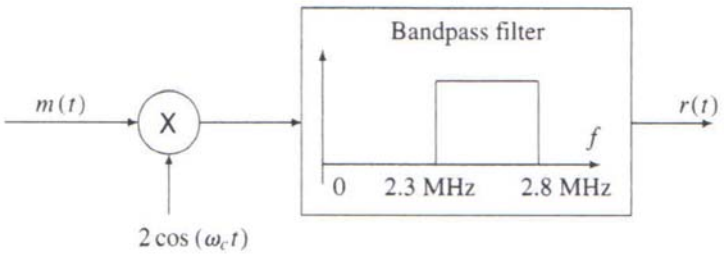
(b) To find the LSB spectrum, suppress the USB in the DSB-SC spectrum found in part **(a)**.

(c) Find the LSB signal $\varphi_{\text{LSB}}(t)$, which is the inverse Fourier transform of the LSB spectrum found in part **(b)**. Follow a similar procedure to find $\varphi_{\text{USB}}(t)$.

4.5-3 A transmitter must send a multimedia signal $m(t)$ with bandwidth of 400 kHz. Its assigned bandwidth is [2.3 MHz, 2.8 MHz]. As shown in the transmitter diagram of Figure P4.5-3, this is achieved by an ideal BPF bandpass filter $H_T(f)$ at the transmitter.

(a) Complete the design of the VSB system in Fig. P4.5-3 by specifying the carrier frequency and a detailed receiver system block diagram.

Figure P.4.5-3



(b) For distortionless detection, derive and plot the receiver filter frequency response needed at the front end of the demodulator.