

EE881 – PRINCÍPIOS DE COMUNICAÇÕES - 2ª LISTA - 1º Sem 2012 - Prof. Luís Meloni

Exercícios selecionados do livro do Lathi, *Modern Digital and Analog Communication Systems*, 3rd Ed.

1º)

4.2-4 You are asked to design a DSB-SC modulator to generate a modulated signal $km(t) \cos \omega_c t$, where $m(t)$ is a signal band-limited to B Hz. Figure P4.2-4 shows a DSB-SC modulator available in the stock room. The carrier generator available generates not $\cos \omega_c t$, but $\cos^3 \omega_c t$. Explain whether you would be able to generate the desired signal using only this equipment. You may use any kind of filter you like.

- What kind of filter is required in Fig. P4.2-4?
- Determine the signal spectra at points b and c , and indicate the frequency bands occupied by these spectra.
- What is the minimum usable value of ω_c ?
- Would this scheme work if the carrier generator output were $\cos^2 \omega_c t$? Explain.
- Would this scheme work if the carrier generator output were $\cos^n \omega_c t$ for any integer $n \geq 2$?

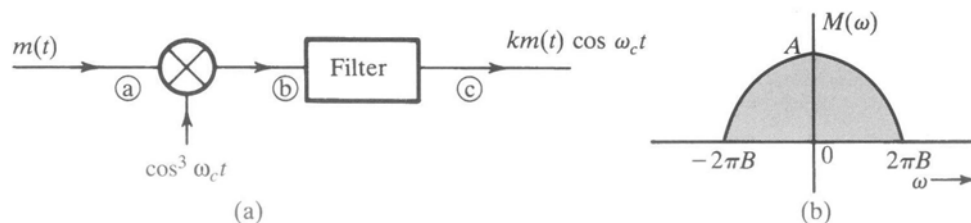


Figure P4.2-4

2º)

4.2-8 Two signals $m_1(t)$ and $m_2(t)$, both band-limited to 5000 rad/s, are to be transmitted simultaneously over a channel by the multiplexing scheme shown in Fig. P4.2-8. The signal at point b is the multiplexed signal, which now modulates a carrier of frequency 20,000 rad/s. The modulated signal at point c is transmitted over a channel.

- Sketch signal spectra at points a , b , and c .
- What must be the bandwidth of the channel?
- Design a receiver to recover signals $m_1(t)$ and $m_2(t)$ from the modulated signal at point c .

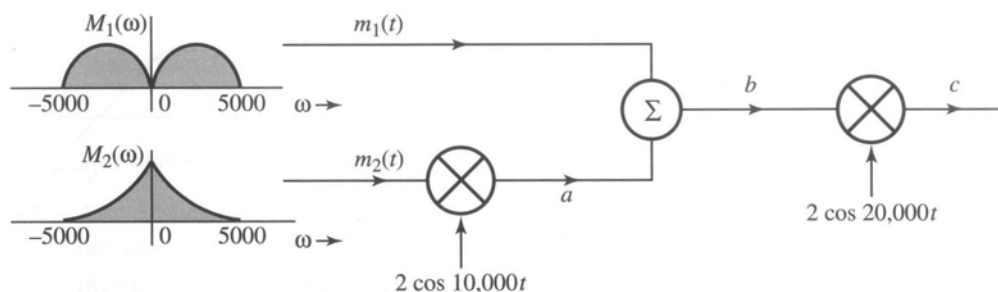


Figure P4.2-8

3°) e 4°)

- 4.3-1** Figure P4.3-1 shows a scheme for coherent (synchronous) demodulation. Show that this scheme can demodulate the AM signal $[A + m(t)] \cos \omega_c t$ regardless of the value of A .

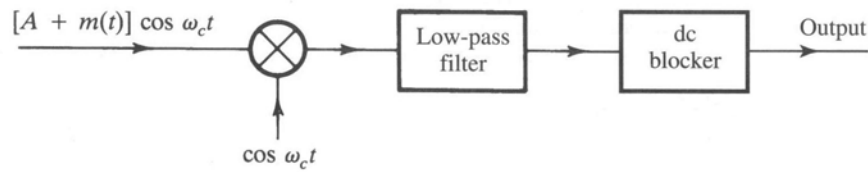


Figure P4.3-1

- 4.3-2** Sketch the AM signal $[A + m(t)] \cos \omega_c t$ for the periodic triangle signal $m(t)$ shown in Fig. P4.3-2 corresponding to the modulation index: (a) $\mu = 0.5$; (b) $\mu = 1$; (c) $\mu = 2$; (d) $\mu = \infty$. How do you interpret the case $\mu = \infty$?

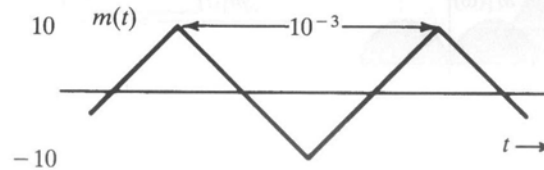


Figure P4.3-2

5°)

- 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 $k_p = \pi/2$. Explain why it is necessary to use $k_p < \pi$ in this case.

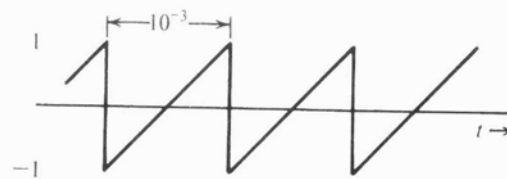


Figure P5.1-2

6°)

- 5.2-6** 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 $m(t)$.

7°)

- 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. 5.11). Sketch the waveforms at points b , c , d , and e .

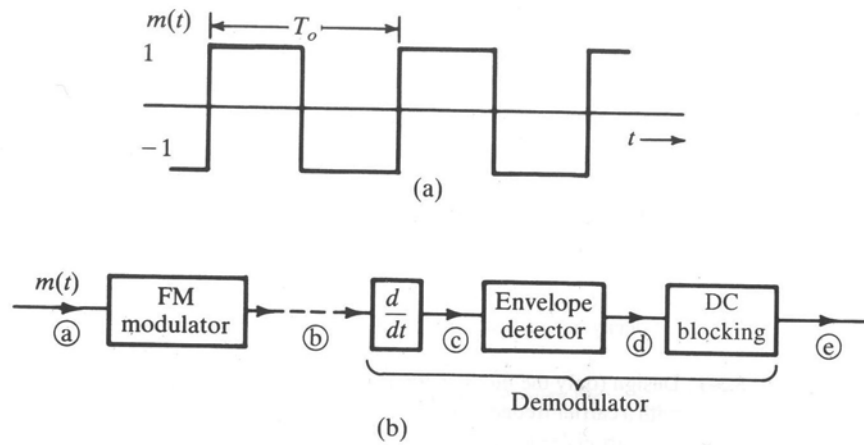


Figure P5.4-2

8°)

- 6.1-6** A zero-order hold circuit (Fig. P6.1-6) is often used to reconstruct a signal $g(t)$ from its samples.

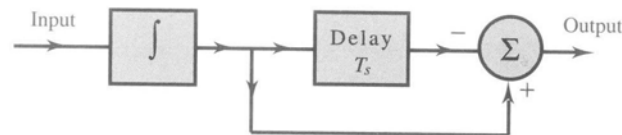


Figure P6.1-6

- Find the unit impulse response of this circuit.
- Find the transfer function $H(\omega)$ and sketch $|H(\omega)|$.
- Show that when a sampled signal $\bar{g}(t)$ is applied at the input of this circuit, the output is a staircase approximation of $g(t)$. The sampling interval is T_s .

9°) e 10°)

- 6.2-2** A compact disc (CD) records audio signals digitally by using PCM. Assume the audio signal bandwidth to be 15 kHz.

- What is the Nyquist rate?
- If the Nyquist samples are quantized into $L = 65,536$ levels and then binary coded, determine the number of binary digits required to encode a sample.
- Determine the number of binary digits per second (bit/s) required to encode the audio signal.
- For practical reasons discussed in the text, signals are sampled at a rate well above the Nyquist rate. Practical CDs use 44,100 samples per second. If $L = 65,536$, determine the number of bits per second required to encode the signal, and the minimum bandwidth required to transmit the encoded signal.

- 6.2-3** A television signal (video and audio) has a bandwidth of 4.5 MHz. This signal is sampled, quantized, and binary coded to obtain a PCM signal.

- Determine the sampling rate if the signal is to be sampled at a rate 20% above the Nyquist rate.
- If the samples are quantized into 1024 levels, determine the number of binary pulses required to encode each sample.
- Determine the binary pulse rate (bits per second) of the binary-coded signal, and the minimum bandwidth required to transmit this signal.

11°)

7.3-4 The Fourier transform $P(\omega)$ of the basic pulse $p(t)$ used in a certain binary communication system is shown in Fig. P7.3-4.

- From the shape of $P(\omega)$, explain if this pulse satisfies the Nyquist criterion.
- Find $p(t)$ and verify that this pulse does (or does not) satisfy the Nyquist criterion.
- If the pulse does satisfy the Nyquist criterion, what is the transmission rate (in bits per second) and what is the roll-off factor?

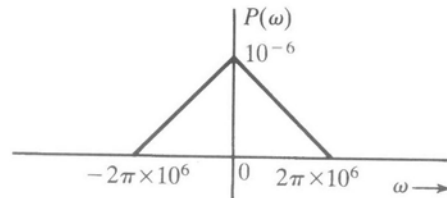


Figure P7.3-4

12°)

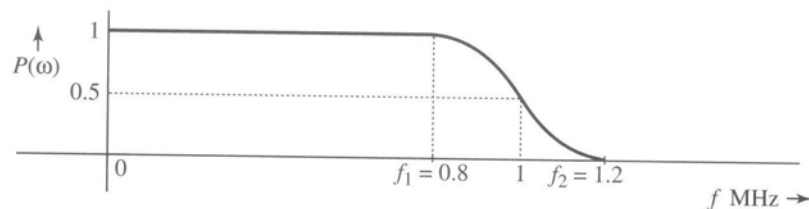


Figure P7.3-5

7.3-6 Binary data at a rate of 1 Mbit/s is to be transmitted using Nyquist criterion pulses with $P(\omega)$ shown in Fig. P7.3-5. The frequencies f_1 and f_2 (in hertz) of this spectrum are adjustable. The channel available for the transmission of this data has a bandwidth of 700 kHz. Determine f_1 and f_2 and the roll-off factor.

13°)

7.7-1 In multiamplitude scheme with $M = 16$,

- Determine the minimum transmission bandwidth required to transmit data at a rate of 12,000 bit/s with zero ISI.
- Determine the transmission bandwidth if Nyquist criterion pulses with a roll-off factor $r = 0.2$ are used to transmit data.

14°)

7.7-3 Binary data is transmitted over a certain channel at a rate of R_b bit/s. To reduce the transmission bandwidth, it is decided to transmit this data using 8-ary multiamplitude signaling.

- By what factor is the bandwidth reduced?
- By what factor is the transmitted power increased, assuming the minimum separation between pulse amplitudes to be the same in both cases? *Hint:* Take the pulse amplitudes to be $\pm A/2$, $\pm 3A/2$, $\pm 5A/2$, and $\pm 7A/2$ so that the minimum separation between various amplitude levels is A (the same as in the binary case pulses $\pm A/2$). Assume all the eight levels equally likely.