Homework 3

Tuesday, October 30, 2018 11:23 PM

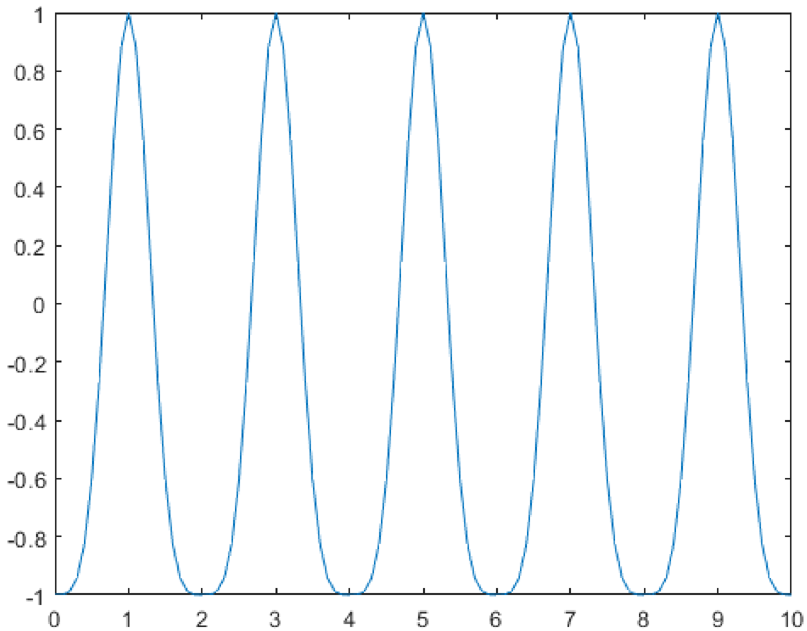
Problem 1 Textbook number 5-27

A sinusoidal signal m(t) = cos $2\pi f_m t$ is the input to an angle-modulated transmitter, A_c=1, and the carrier frequency is f_c = 1 Hz and $f_m = f_c/4$.

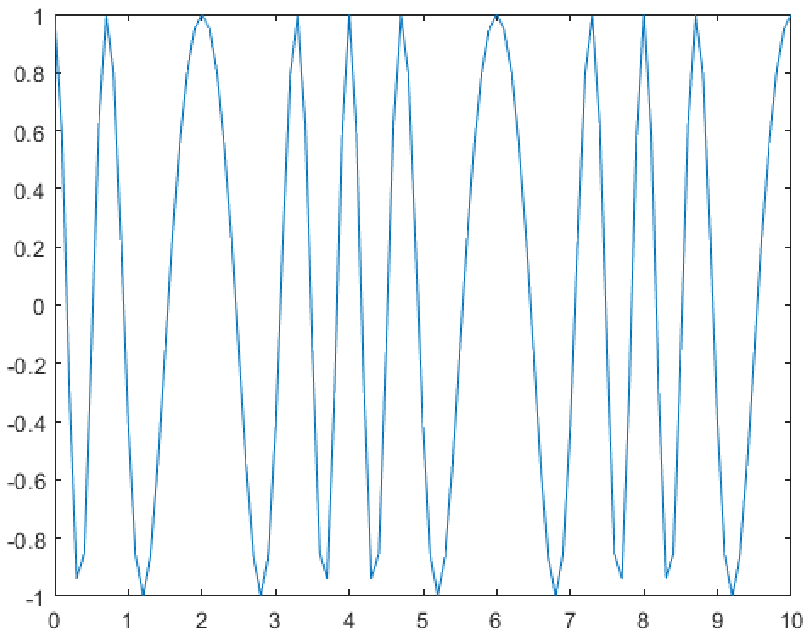
(a) Plot m(t) and the corresponding PM signal $S_p(t)$ using Matlab, where $D_p = \pi$.

(b) Plot m(t) and the corresponding FM signal $S_f(t)$ using Matlab, where $D_f = \pi$.

A)



B)



Problem 2 Textbook number 5-29

An FM signal has sinusoidal modulation with a frequency of f_m=15kHz and modulation index of β = 2.0.

(a) Find the transmission bandwidth by using Carson's rule.

(b) What percentage of the total FM signal power lies within the Carson rule bandwidth?

(a)

$f_m = 15\ kHz$

$\beta = 2$

$B = f_m$

$B_T = 2 * (\beta + 1) * B = 90\ kHz$

(b)

$J_n(\beta) = J_n(\beta)(-1)^n$

The signal power within the Carson's Rule band width is half the sum of the squares of the Bessel function values for $-3 \leq k \leq 3$ which is *0.4999* Ac^2 (**99.98% of** $\frac{Ac^2}{2}$).

Problem 3 Textbook number 5-32

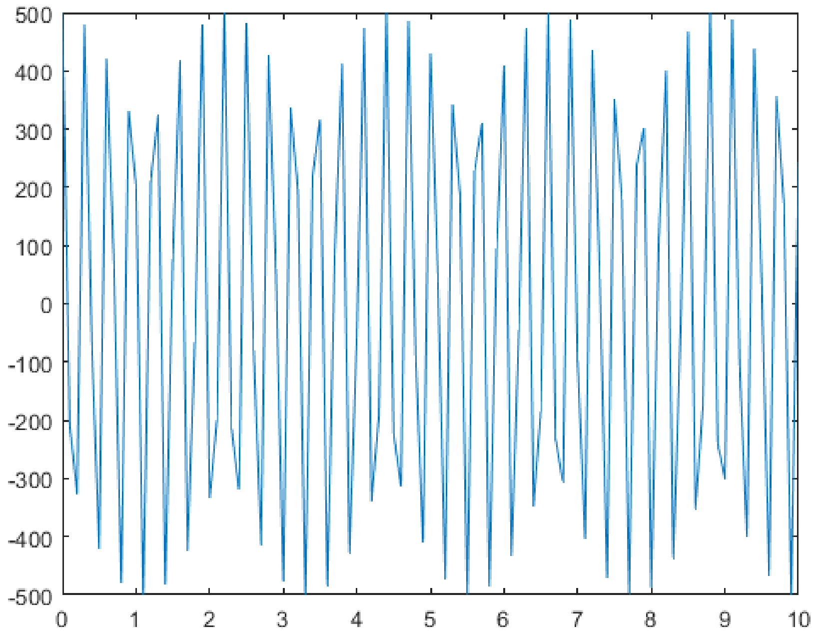
A modulated RF waveform is given by $500\cos[\omega_c t + 20\cos \omega_1 t]$, where $\omega_1 = 2\pi f_1$, $f_1 = 1\text{kHz}$, and $\omega_c = 2\pi f_c$, $f_c = 100\text{MHz}$.

(a) If the phase sensitivity D_p is 100 rad/V, find the mathematical expression for the corresponding phase modulation voltage m(t). What is its peak value and its frequency?

(b) If the frequency deviation constant D_f is 1×10^6 rad/V-s, find the mathematical expression for the corresponding FM voltage m(t). What is its peak value and its frequency?

(c) If the RF waveform appears across a 50-Ω load, determine the average power and the PEP.

RF Waveform



(a) $m_p(t) = \left(\frac{20}{D_p}\right)\cos(\omega_1 t)$

Peak value $= \frac{20}{D_p} = .02$

Freq ->

Peak V = $-7.85 * 10^{10}$ V

(b)

$D_f = 1 * 10^6 \frac{rad}{V-s}$

FM =

$\Theta(t) = Df\int_{-\infty}^{t} m_t(\lambda)d\lambda = 20\cos(\omega_1 t)$

$D_f M_f(t) = 20w_1 \sin(w_1 t)$

$m_f(t) = \frac{-20\omega_1 sin\omega_1 t}{1.6*10^6}$

(c)

Amplitude = 500

$R_{load} = 50\Omega$

$P_{avg} = \text{PEP}$

$\text{PEP} = \frac{V_p^2}{2R} = \frac{500^{\,2}}{100} = \mathbf{2,500\ W}$

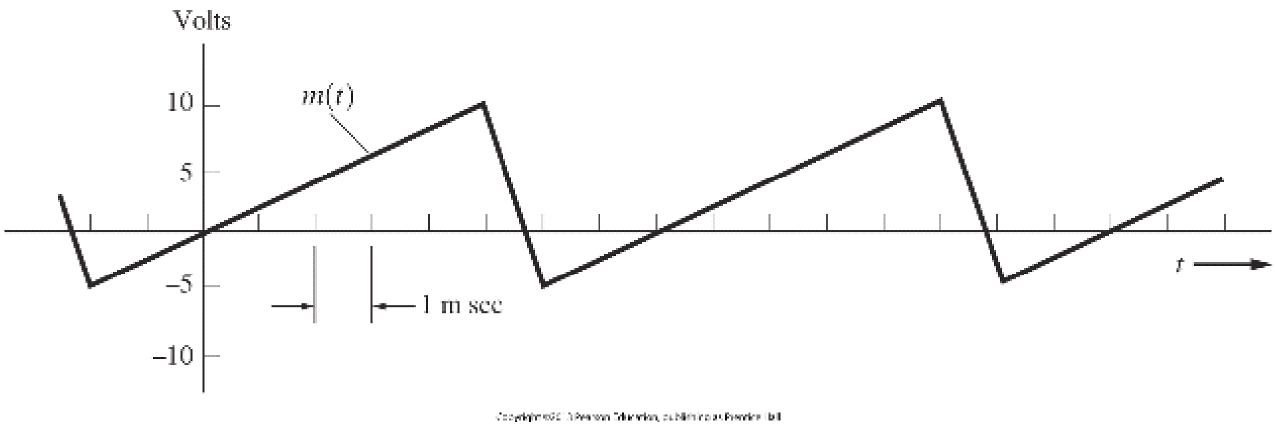
Problem 4 Textbook number 5-48

An FM signal, $s(t) = A_c \cos[\omega_c t + D_f \int_{-\infty}^{t} m(\sigma)d\sigma]$. Where A_c=100V, $\omega_c=2\pi f_c$, f_c=420MHz and the message signal m(t) is shown in the following figure.

(a) Determine the value of D_f so that the peak-to-peak frequency deviation is 25kHz.

(b) Evaluate and sketch the **approximate** PSD. (Please review the corresponding example in the lecture)

(c) Skip part (c) in the text book



(a)

$$s(t) = A_C \cos\left[\omega_c t + D_f \int m(\sigma)d\sigma\right]$$

$A_c = 100V, \omega_c = 2\pi f_c, f_c = 420MHz$

$\Delta F_{pp} = 25kHz = \max\left\{\frac{1}{2\pi}\left[\frac{d\Theta(t)}{dt}\right]\right\} - \min\left\{\frac{1}{2\pi}\left[\frac{d\Theta(t)}{dt}\right]\right\}$

$V_{pp} = (10 \rightarrow -5) = 15V$

25kHz = $\frac{D_f}{2\pi}(15) =$

D_f = **10472**

(b)

PDF $\rightarrow$ square

Amp = $\frac{1}{15}$

p(f) = $\frac{\pi A_C^2}{2D_f}\left\{f_m\left[\frac{2\pi}{D_f}(f-f_c) + f_m\left(\frac{2\pi}{D_f}(-f-f_c)\right)\right]\right\}$