EECS 562
Homework #4

1. Drill Problem 4.1 (pp 156)
2. Let the RF signal

$$s(t) = A_c \cos(\theta_i(t))$$

where

$$\theta_i(t) = 2\pi f_c t + k_p m(t) \quad m(t) = A_m \cos(2\pi f_m t)$$

Here the phase sensitivity factor=k_p=0.1radians/V and A_m=2.0V and f_c=100MHz and f_m=1kHz and A_c=10V

a. Find the frequency deviation.
b. Plot the amplitude spectrum of *s(t).* State any approximations.
c. Is the phase or frequency modulation?

3. Let the RF signal

$$s(t) = A_c \cos(\theta_i(t))$$

where

$$\theta_i(t) = 2\pi f_c t + \beta \sin(2\pi f_m t) \quad m(t) = A_m \cos(2\pi f_m t)$$

Here β =0.2 and A_m=2.0V and f_c=100MHz and f_m=1kHz and A_c=10V
a. Is the phase or frequency modulation?
b. What is the modulation index?
c. Find the frequency deviation.
d. Find the frequency sensitivity factor in Hz/V.
e. Plot the amplitude spectrum of *s(t).* State any approximations.
f. What is the total power in s(t)?
g. How much power is at f_c=100MHz?
h. What is the RF bandwidth?

4. Let the RF signal

$$s(t) = A_c \cos(\theta_i(t))$$

where

$$\theta_i(t) = 2\pi f_c t + \beta \sin(2\pi f_m t) \quad m(t) = A_m \cos(2\pi f_m t)$$

Here β =2 and A_m=2.0V and f_c=100MHz and f_m=1kHz and A_c=10V
a. What is the modulation index?
b. Find the frequency deviation.
c. Find the frequency sensitivity factor in Hz/V.
d. Plot the power spectrum of *s(t).* State any approximations.
e. Is the phase or frequency modulation?
f. What is the RF bandwidth?
g. What is the total power in s(t)?
h. How much power is at 100.003MHz?

Hint: use
http://demonstrations.wolfram.com/PowerContentOfFrequencyModulationAndPhaseModulation/
To confirm some of the above answers.

5. 4.13

6. Comparison of Carson's rule to a bandwidth criteria based on 98% power within the bandwidth. Use http://demonstrations.wolfram.com/PowerContentOfFrequencyModulationAndPhaseModulation/ for this problem. For each case below compare the bandwidth calculated using Carson's to the 98% power within the bandwidth.

a. A_c=1, f_m=1 Hz, f_c=8 Hz, message amplitude =A_m=1.5, deviation constant = 2.
b. A_c=1, f_m=0.4 Hz, f_c=8 Hz, message amplitude =A_m=1.0, deviation constant = 2.
c. A_c=1, f_m=1 Hz, f_c=8 Hz, message amplitude =A_m=1.0, deviation constant = 2.
d. A_c=1, f_m=1 Hz, f_c=8 Hz, message amplitude =A_m=0.5, deviation constant = 2.

7. Given a perfect 3rd order nonlinearity $v_{out} = a_3 v_{in}^3$ with a tone-modulated FM signal as input. Show that with a proper BPF, you can get an FM signal with carrier frequency and modulation index 3 times as large as the corresponding input values. YOU MUST specify the center frequency and bandwidth of the BPF in terms of the original (input) carrier frequency (f_{c1}) and modulation index (β_1). You may assume the BPF is ideal.