EEEN 322 Communication Engineering
Homework 2

Due: 20.05.2019

Problem 1 (30 points)

Suppose that $m(t) = 5\cos 3000\pi t$ is the message signal to be frequency-modulated.

a) Calculate the bandwidth of the modulated signal, if the modulation is NBFM.
b) For WBFM with bandwidth $B_{FM} \approx 2\Delta f$, find the smallest value of k_f. (Let << and >> mean "at least ten times" smaller and greater, respectively).
c) For the value of k_f found in (b), what is the bandwidth of the modulated signal?

Problem 2 (30 points)

Suppose that the message signal is $m(t) = 6\cos 2000\pi t - 2\sin 4000\pi t$, $\omega_c = 10^6$ rad/s, $A = 5$, and $k_f = 10^5\pi$.

a) Write the expression of $\varphi_{FM}(t)$ (use the indefinite integral of $m(t)$).
b) Calculate the bandwidth of $\varphi_{FM}(t)$.
c) What should be the value of k_p for $\varphi_{PM}(t)$ to have the same bandwidth as that of $\varphi_{FM}(t)$?
d) Write the expression of $\varphi_{PM}(t)$ by using the k_p value you have found in (c).

Problem 3 (40 points)

Suppose that we perform FM and PM modulations with $k_f = 20000\pi$ and $k_p = 10\pi$. The following information are given for $m(t)$:

(i) $m_p = 2$
(ii) $m_p' = 4000$
(iii) Bandwidth is 2500 Hz.

a) Calculate the bandwidths of FM and PM modulated signals obtained using $m(t)$ as the message signal.
b) Calculate the bandwidths of FM and PM modulated signals obtained using $m^2(t)$ as the message signal.
c) Comment on the differences of the bandwidths you have calculated in (a) and (b) referring to the differences in FM and PM modulations.