

Homework assignment 4Due date: May 4, 2016

1. Consider the following angle-modulated signal

$$x(t) = \cos(50\pi t + 2 \sin(10\pi t)) .$$

- Determine the instantaneous frequency.
- Find the maximum phase deviation and maximum frequency deviation.
- What is the bandwidth of the signal that contains 99% of the power (use Carson's rule)?

2. An angle-modulated signal is given by

$$u(t) = 5 \cos(200\pi t + 2 \sin(16\pi t)) .$$

- If it is known that signal is a PM signal with $k_p = 4$, find the message signal $m(t)$.
 - If it is known that signal is an FM signal with $k_f = 4\pi$, find the message signal $m(t)$.
3. Let $m_1(t)$ and $m_2(t)$ be two message signals, and let $u_1(t)$ and $u_2(t)$ be two modulated signals corresponding to $m_1(t)$ and $m_2(t)$, respectively (using the same modulation and the same carrier).
- Show that if DSB-SC modulation is used, then the message signal $m_1(t) + m_2(t)$ will result in a modulated signal $u_1(t) + u_2(t)$.
 - Show that if PM modulation is used, then generally the message signal $m_1(t) + m_2(t)$ will **not** result in a modulated signal $u_1(t) + u_2(t)$.

4. Consider an angle-modulated signal given by

$$u(t) = A_c \cos(2\pi f_c t + \beta_1 \sin(2\pi f_1 t) + \beta_2 \sin(2\pi f_2 t)) .$$

Find the spectrum of $u(t)$ in the frequency domain.

Hint: follow the derivations we did in the class. You need to substitute expression for the Bessel function. It is okay, if you obtain an expression that contains double summation.