1. [40 pts]

- (10 pts) Consider the modulation of a message $m(t)$ using a carrier with frequency f_c. For AM, DSB–SC, SSB, PM, and FM modulation give the expressions for the time domain modulated signal, $s(t)$.
- (6 pts) Suppose $m(t) = A_m \text{sinc}(f_m t)$. Give a rough plot of $s(t)$ for PM and FM.
- (6 pts) Determine and plot $S(f)$ for AM, DSB–SC, and SSB.
- (6 pts) What is the power of the modulated signal for AM, DSB–SC, and SSB case? What portion of this power is due to the modulated message?
- (6 pts) For the SSB and DSB–SC cases, determine expressions for the time domain modulated signal, $s(t)$, that allow for simple comparisons. How do these signals differ?
- (6 pts) Which is the more appropriate modulation scheme for this message, SSB or VSB? Why?

2. [30 pts]

- (15 pts) Consider the SSB modulation of a signal,

$$s(t) = m(t)\cos(2\pi f_c t) - \hat{m}(t)\sin(2\pi f_c t).$$

  Suppose the carrier, $A_c \cos(2\pi f_c t)$, is added to this signal, yielding what is referred to as a carrier plus SSB modulation scheme. Determine the output of an envelop detector operating on the received signal. Under what conditions does the output approximate the message?

- (15 pts) Suppose a FM signal is applied to a square law device, $v_2 = av_1^2$, where v_1 and v_2 are the input and output, respectively. Show that that by properly filtering v_2 we can obtain a FM signal with a frequency deviation double that of the input. What is the carrier frequency of the output?

3. [30 pts] Noise with a frequency dependent PSD, given by $S_N(f) = a|f|$, is added to a modulated signal $s(t)$. For the message given in problem #1, determine the SNR at the output of the demodulator for DSB–SC modulation. Assume that a proper BPF is applied prior to coherent demodulation and that the appropriate LPF is applied to the demodulator output.