# 3614: Introduction to Communication Systems

## Midterm Exam II

November 2, 2006

I pledge that I have neither given nor received any assistance on this exam.

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(signed)

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Name (print) Student Number

ECE 3614 Midterm II – Test A

1. (20 points) Short answer and multiple choice

1.1 [5 points] Rank the following modulation schemes in terms of required bandwidth (least bandwidth = 1, most bandwidth = 4)

___ Large Carrier AM with $k_a = 0.5$
___ Single Sideband AM
___ FM with $k_f = 5000$
___ FM with $k_f = 5000$

1.2 [5 points] What is the Fourier Transform of the time domain signal $x(t) = \sum_{n=-\infty}^{\infty} p(t - nT)$ given that $p(t) \rightleftharpoons P(f)$

(a) $X(f) = \sum_{n=-\infty}^{\infty} P(f - nT)$

(b) $X(f) = \sum_{n=-\infty}^{\infty} P(nf)\delta\left(f - \frac{n}{T}\right)$

(c) $X(f) = \frac{1}{T} P(f) \sum_{n=-\infty}^{\infty} \delta\left(f - \frac{n}{T}\right)$

(d) None of the above

1.3 [5 points] The basic trade-off involved in Vestigial Sideband modulation is

(a) bandwidth vs. implementation complexity
(b) bandwidth vs. power efficiency
(c) power efficiency vs. implementation complexity
(d) transmit bandwidth vs. message bandwidth
(e) None of the above

1.4 [5 points] Which of the following is an example of an AM receiver?

(a) Envelope detector
(b) Product detector
(c) Both of the above
(d) None of the above

2. (40 points) Amplitude Modulation

Consider a message signal with the following spectrum

$$M(f) = \frac{1}{1 + j2\pi f}$$

(a) [10 points] Sketch the time domain signal of a large carrier AM modulated signal if $k_a$ = 0.5 and $f_c$ = 50Hz. Clearly label all axes.

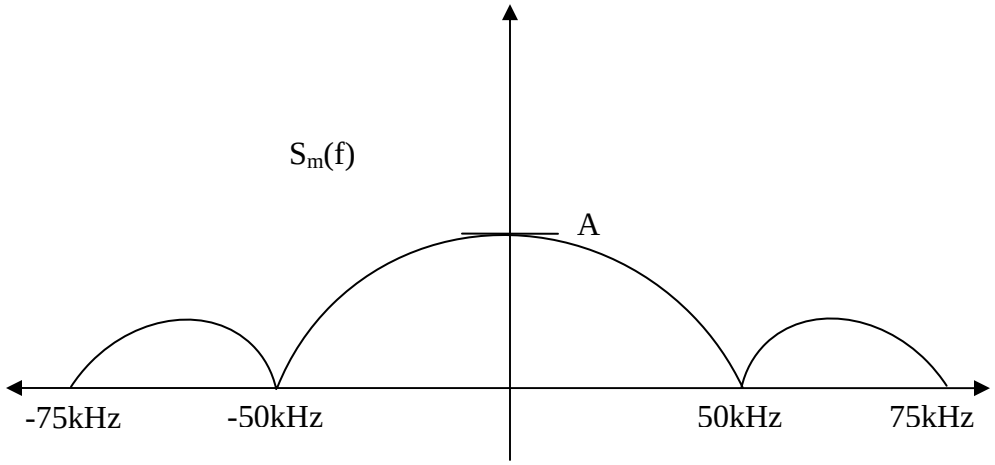
(b) [10 points] Sketch the frequency domain of the transmit signal described in part (a).

(c) [10 points] Sketch the time domain of a DSB-SC signal when $f_c$ = 50Hz. Clearly label all axes and points.

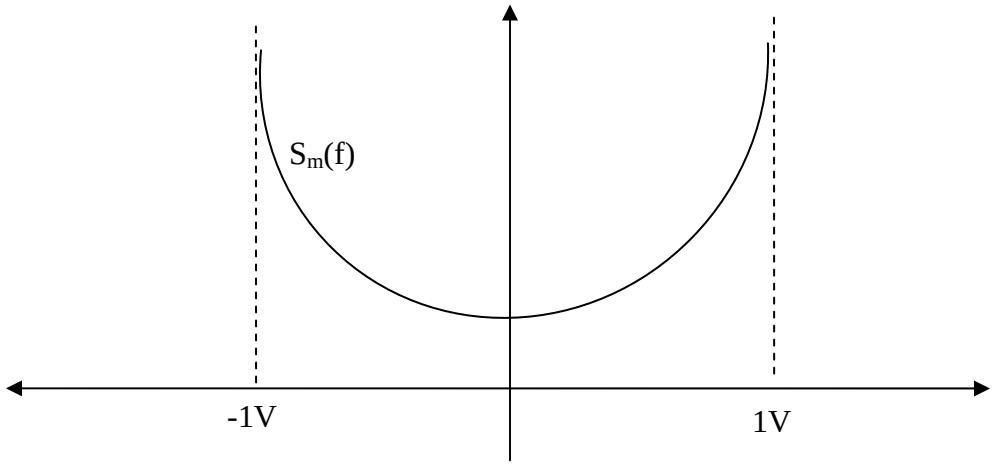
(d) [10 points] Sketch the frequency domain of a SSB signal when $f_c$ = 50Hz.

3. (30 points) Frequency Modulation

Consider a message signal with power spectral density




and probability density function



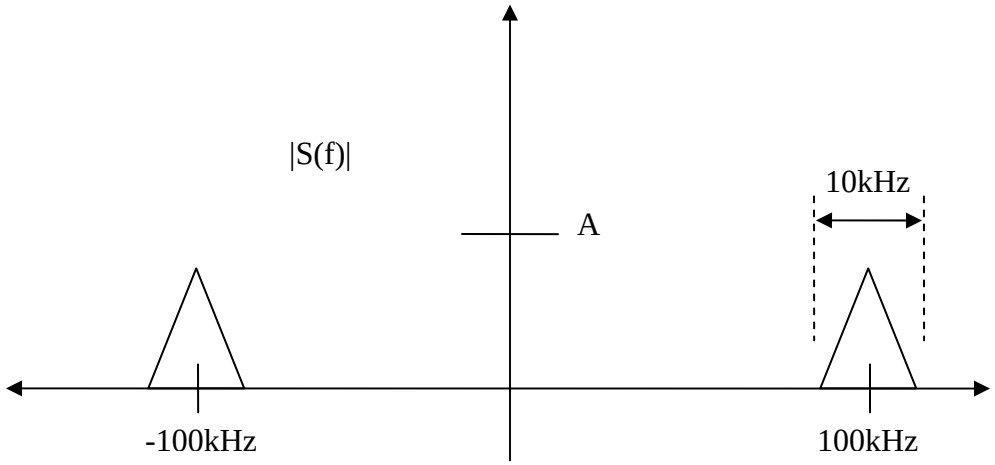

(a) [10 points] Plot the Power spectral density of an FM signal if $f_c$ = 1MHz and $k_f$ = 200.

(b) [10 points] Plot the Power spectral density of an FM signal if $f_c$ = 1MHz and $k_f$ = 200000.

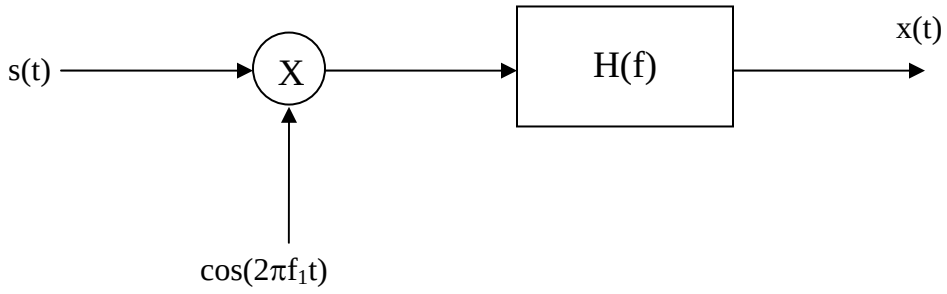
(c) [5 points] How does the bandwidth of the signal plotted in part (a) compare to Carson's Rule?

(d) [5 points] How does the bandwidth of the signal plotted in part (b) compare to Carson's Rule?

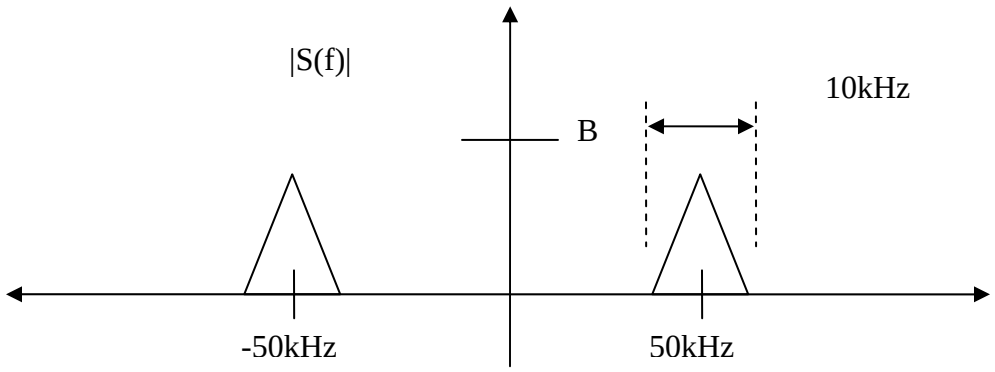
4. (10 points) Consider the following received signal.




This received signal is passed through the following down-conversion system:




where $H(f) = rect\left(\frac{f - f_o}{10000}\right)$. If the output signal is



Determine proper values of $f_1$ *and* $f_o$.