Name $\underline{\text{KEY}}$

ELC 4350 – Principles of Communication

Quiz 1 – January 20, 2014

Open Book/Open Notes/10 minutes

You must circle or box your answers for full credit.

PROBLEM 1 (10 points). The function

$$g(t) = \Delta\left(\frac{t}{2}\right)$$

is multiplied by $\cos(2\pi(1000)t)$ to give $h(t) = g(t)\cos(2\pi(1000)t)$.

~~(a) (6 points)~~ Write an expression for $H(f)$ using Table 3.1 on page 107 of your book and an appropriate property of the Fourier transform.

Pair 19: $\Delta\left(\frac{t}{\tau}\right) \Leftrightarrow \frac{\tau}{2}\,\mathrm{sinc}^2\left(\frac{\pi f \tau}{2}\right)$

$$\Delta\left(\frac{t}{2}\right) \Leftrightarrow \frac{2}{2}\,\mathrm{sinc}^2\left(\frac{\pi f 2}{2}\right)$$

$$= \mathrm{sinc}^2(\pi f) = G(f)$$

$$h(t) = g(t)\cos(2\pi f_0 t) \Leftrightarrow \frac{1}{2}\left[G(f-f_0) + G(f+f_0)\right] = H(\omega)$$

$$f_0 = 1000$$

$$H(\omega) = \frac{1}{2}\,\mathrm{sinc}^2[\pi(f-f_0)] + \frac{1}{2}\,\mathrm{sinc}^2[\pi(f+f_0)]$$

~~(b) (4 points) Plot $|H(f)|$ versus f.~~

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Quiz 2 – January 27, 2014

Open Book/Open Notes/10 minutes

You must circle or box your answers for full credit.

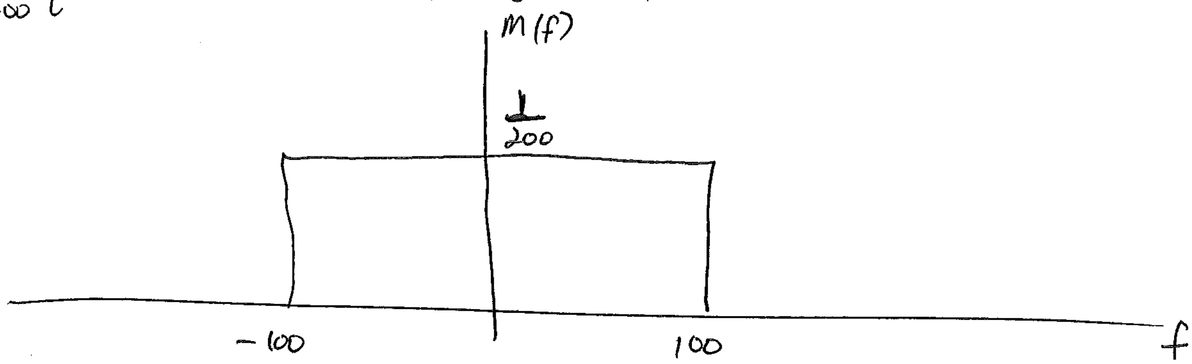
PROBLEM 1 (10 points). Consider the baseband signal $m(t) = \text{sinc}(200\pi t)$.

(a) (5 points) Sketch $M(f)$, the spectrum of $m(t)$.

Pair 18!

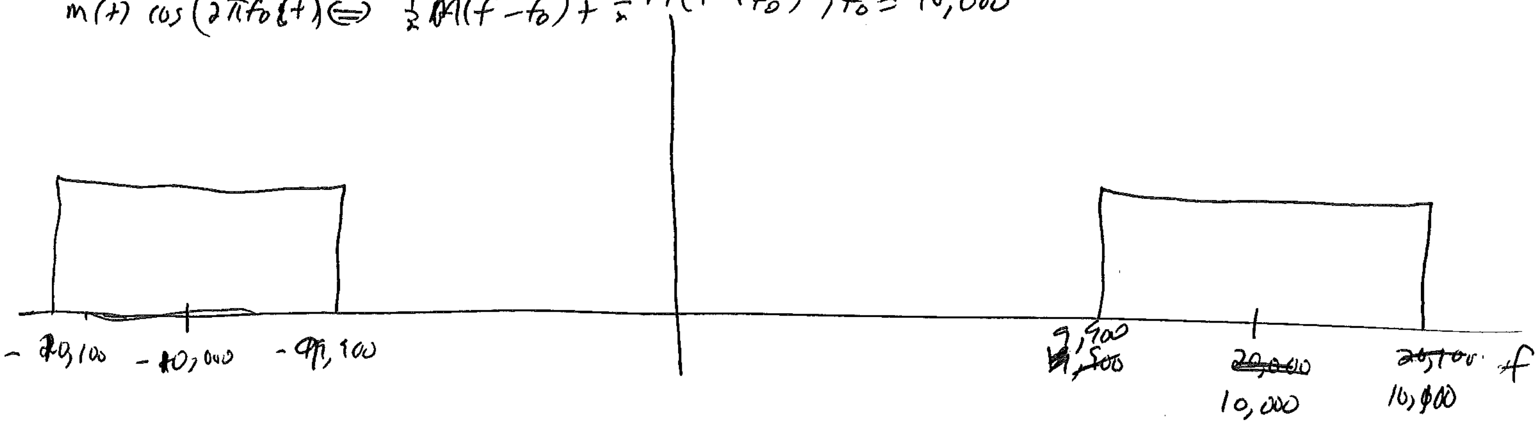
$2B \,\text{sinc}(2\pi B t) \Leftrightarrow \Pi\left(\frac{f}{2B}\right)$

$\frac{1}{200}\left[2(100)\,\text{sinc}[200\pi t]\right] \Leftrightarrow \frac{1}{200}\Pi\left(\frac{f}{200}\right)$



(b) (5 points) Sketch the spectrum of the double sideband, suppressed carrier (DSB-SC) signal $m(t)\cos(20{,}000\pi t)$.

$m(t)\cos(2\pi f_0 t) \Leftrightarrow \frac{1}{2}M(f-f_0) + \frac{1}{2}M(f+f_0), \; f_0 = 10{,}000$



Name____

ELC 4350 – Principles of Communication

Quiz 3 – February 3, 2015

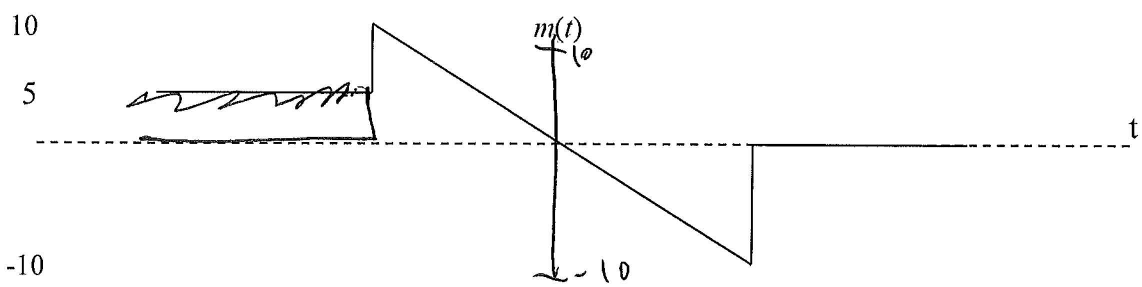
Open Book/Open Notes/10 minutes

You must circle or box your answers for full credit.

PROBLEM 1 (10 points). Sketch the AM signal

$$[A + m(t)]\cos\omega_c t$$

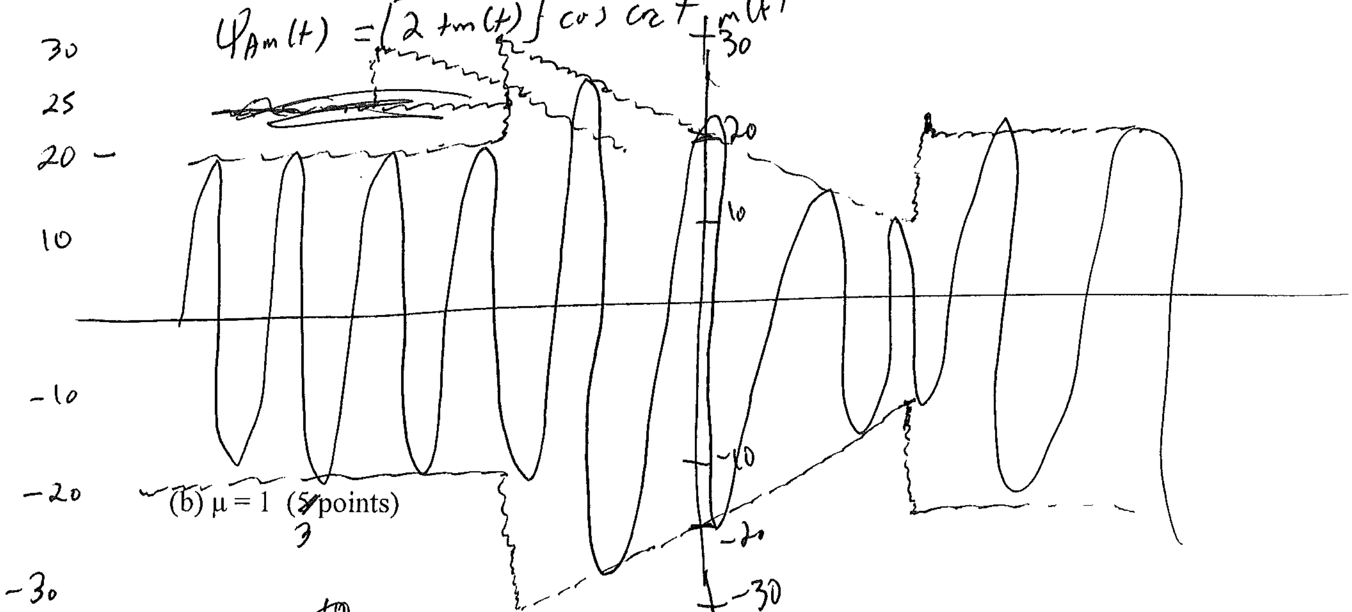
for the portion of the message signal $m(t)$ shown below for the listed values of the modulation index. <u>For each case</u>, state whether the message $m(t)$ will be able to be completely recovered from the envelope.



(a) $\mu = 0.5$ ($\cancel{5}$ 3 points)

$m_p = 10$ $\quad \mu = \frac{m_p}{A}$ $\quad A = \frac{m_p}{\mu} = \frac{10}{0.5} = 20$

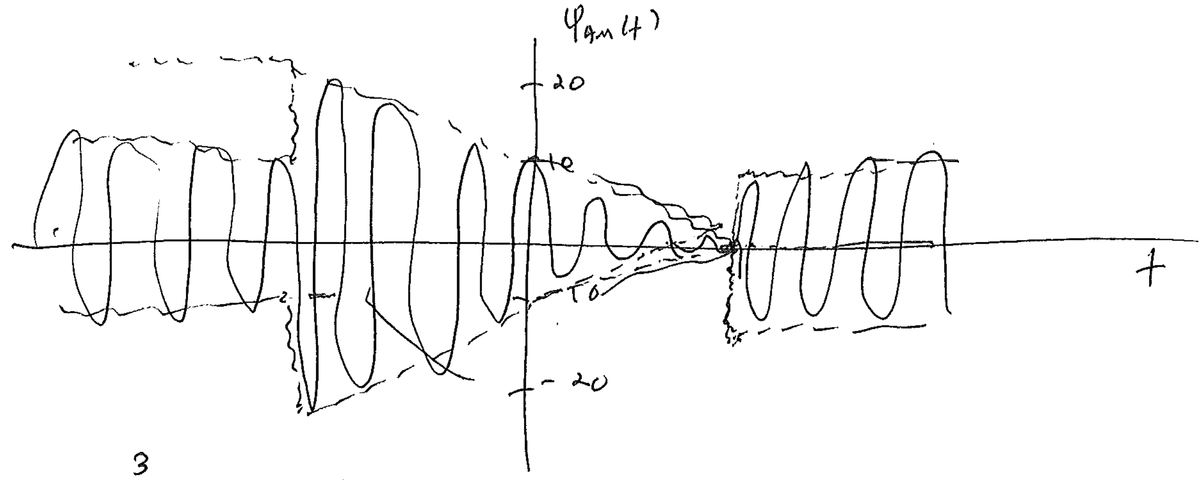
$\varphi_{Am}(t) = [2 + m(t)] \cos \omega_c t$



(b) μ = 1 ($\cancel{5}$ 3 points)

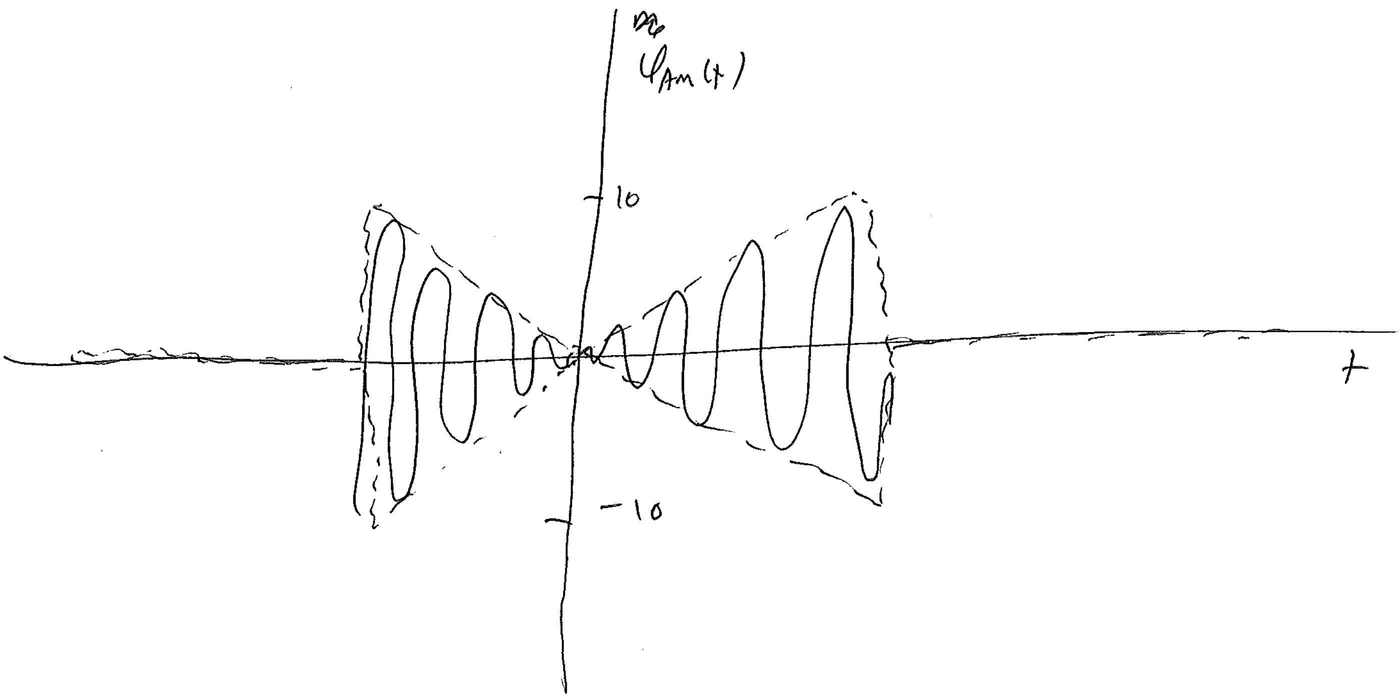
$\mu = \frac{m_p}{A}$

$A = \frac{m_p}{\mu} = \frac{10}{1} = 10$ $\qquad \varphi_{Am}(t) = [10 + m(t)] \cos \omega_c t$



(c) $\mu = \infty$ (~~8~~ 3 points)

$\mu = \infty$: $\quad A = \frac{m_p}{\mu} = \frac{10}{\infty} = 0 \quad \varphi_{AM}(t) = m(t)\cos\omega_c t$



(d) Which, if any, of the above modulation indices represents AM Double-Sideband-Suppressed-Carrier (AM-DSB-SC) modulation (~~5~~ 1 points)?

Case c: $\mu = \infty$

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Quiz 4 – February 10, 2015

Open Book/Open Notes/10 minutes

You must circle or box your answers for full credit.

PROBLEM 1 (10 points). A modulating signal $m(t)$ is given by

$$m(t) = \cos(200\pi t) + 8\cos(600\pi t).$$

This message is transmitted with AM single-sideband modulation using a carrier of frequency $f_c = 10{,}000$ Hz. Find a time-domain expression for the upper-sideband signal $\varphi_{USB}(t)$.

$m_h(t) = \cos(200\pi t - \frac{\pi}{2}) + 8\cos(600\pi t - \frac{\pi}{2})$

$m_h(t) = \sin(200\pi t) + 8\sin(600\pi t)$

$\varphi_{USB}(t) = m(t)\cos\omega_c t - m_h(t)\sin\omega_c t$

$\varphi_{USB}(t) = [\cos 200\pi t + 8\cos 600\pi t]\cos 20{,}000\pi t - [\sin 200\pi t + 8\sin 600\pi t]\sin 20{,}000\pi t$

$\boxed{\begin{array}{l} \cos A\cos B = \frac{1}{2}\cos(A+B) + \frac{1}{2}\cos(A-B) \\ \cancel{\sin A\sin B = \frac{1}{2}\sin(A+B) + \frac{1}{2}\sin(A-B)} \\ \sin A\sin B = \frac{1}{2}\cos(A-B) - \frac{1}{2}\cos(A+B) \end{array}}$ Identities

$\varphi_{USB}(t) = \frac{1}{2}\cos(20{,}200\pi t) + \cancel{\frac{1}{2}\cos(19{,}800\pi t)} + 4\cos(20{,}600\pi t) + \cancel{4\cos(19{,}400\pi t)}$

$\cancel{-\frac{1}{2}\cos(19{,}800\pi t)} + \frac{1}{2}\cos(20{,}200\pi t) - \cancel{4\cos(19{,}400\pi t)} + 4\cos(20{,}600\pi t)$

$\varphi_{USB}(t) = \cos(20{,}200\pi t) + 8\cos(20{,}600\pi t)$

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Quiz 5 – February 17, 2015

Open Book/Open Notes/10 minutes

You must circle or box your answers for full credit.

PROBLEM 1 (10 points): Over an interval |t| ≤ 1, an angle modulated signal is given by

$$\varphi_{EM}(t) = 5\cos(90{,}000t)$$

It is known that the carrier frequency is $\omega_c = 80{,}000$ radians per second.

(a) If this is assumed to be a phase-modulated (PM) signal with $k_p = 5000$, find an expression for $m(t)$ over the interval $|t| \leq 1$ (5 points).

$\varphi_{PM} = A\cos[\omega_c t + k_p m(t)] = 5\cos 90{,}000t$

$80{,}000t + k_p m(t) = 90{,}000t$

$5000 m(t) = 10{,}000t$

$m(t) = 2t$

(b) If this is assumed to be a frequency-modulated (FM) signal with $k_f = 10{,}000$, find an expression for $m(t)$ over the interval $|t| \leq 1$ (5 points).

$\varphi_{FM}(t) = A\cos\left[\omega_c t + k_f \int_{-\infty}^{t} m(\alpha)\,d\alpha\right] = 5\cos(90{,}000t)$

$80{,}000t + 10{,}000 \int_{-\infty}^{t} m(\alpha)\,d\alpha = (90{,}000t)$

$10{,}000 \int_{-\infty}^{t} m(\alpha)\,d\alpha = 10{,}000t$

$\int_{-\infty}^{t} m(\alpha)\,d\alpha = t$

$m(t) = 1$

$\int_{-1}^{1} m(\alpha)\,d\alpha = t$

OR:

$\omega_i = \omega_c + k_f m(t)$

$90{,}000 = 80{,}000 + 10{,}000 m(t)$

$10{,}000 = 10{,}000 m(t)$

$m(t) = 1$

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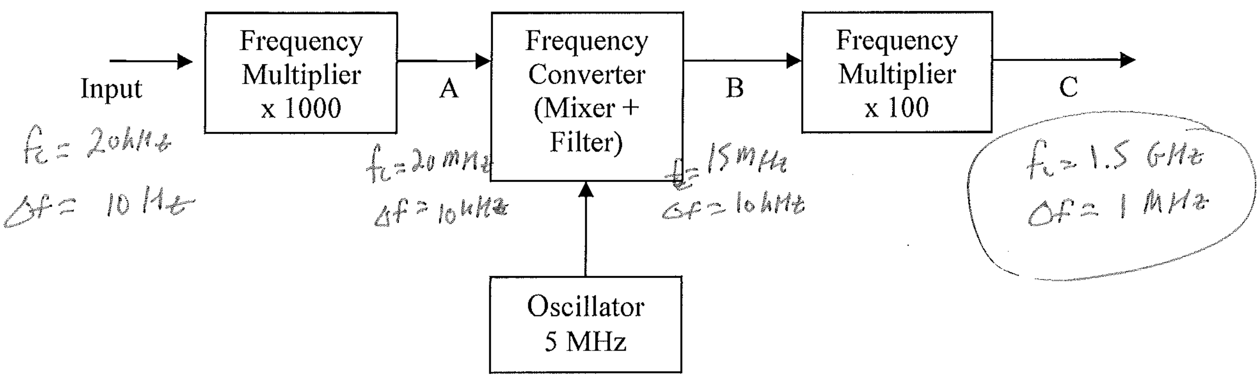
Quiz 6 – February 23, 2015

Open Book/Open Notes/10 minutes

You must circle or box your answers for full credit.

PROBLEM 1 (10 points): Consider the following indirect FM generator. The input to the generator is a narrowband FM signal with f_c = 20 kHz and Δf = 10 Hz.



Give both f_c and Δf at the following points in the circuit:

(a) Point A (3 points) ~~Both f_c and Δf~~ multiplied by 1000:

$f_c = 20$ MHz

$\Delta f = 10$ kHz

(b) Point B (assuming f_c is converted downward in frequency by the mixer and filter) (4 points)

f_c decreased by 5 MHz:

$f_c = 15$ MHz

$\Delta f = 10$ kHz

(c) Point C (3 points) Both f_c and Δf multiplied by 100:

$f_c = 1.5$ GHz

$\Delta f = 1$ MHz