King Fahd University of Petroleum & Minerals
Electrical Engineering Department
EE370: Communications Engineering I (101)

Major Exam I

November 4, 2010
10:00-11:30 AM
Building 59-2002

Serial #

Name: ______________________

ID#______________________________

Question	Mark
1	/10
2	/10
3	/10
Total	/30

Instructions:
1. This is a closed-books/notes exam.
2. The duration of this exam is one and half hours.
3. Read the questions carefully. Plan which question to start with.
4. <u>CLEARLY LABEL ALL SIGNIFICANT VALUES ON BOTH AXIES OF ANY SKETCH</u>
5. Work in your own.
6. Strictly no mobile phones are allowed.

<u>Good luck</u>

Dr. Ali H. Muqaibel

Problem 1: **(10 points)**

Choose the **best** answer. Do not circle. Write the answer clearly in the table below

1) The most suitable method for detecting a DSB-SC modulated signal is using:
   a) Envelope detector
   b) Synchronous detector
   c) Non-coherent detector
   d) Costas loop
   e) Both **a** and **c**

2) The following is **not** an objective of modulation
   a) Frequency division multiplexing
   b) Effective radiation
   c) Control the antenna size
   d) Increase the signal power
   e) Change the frequency band of the signal

3) The following is/are **not** usually found in a phased locked loop (PLL).
   a) Voltage controlled oscillator
   b) Low pass filter
   c) Multiplier
   d) Full wave rectifier
   e) Both **b** & **d**

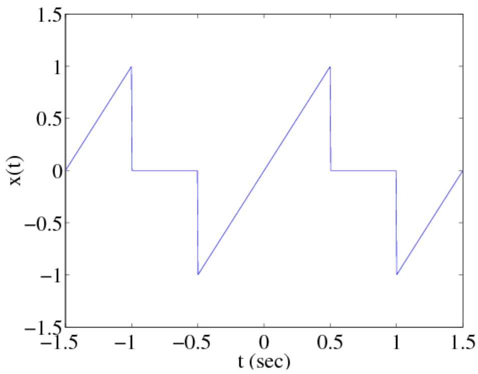
4) The following is **true** about VSB modulation
   a) requires less bandwidth than SSB.
   b) requires double the bandwidth of QAM
   c) more bandwidth efficient than DSB-SC
   d) more bandwidth efficient than AM (DSB+C)
   e) both **c** & **d** are correct

5) For a distortion less transmission, A system must have a frequency response with
   a) Constant amplitude and linear phase
   b) Constant amplitude and constant phase
   c) Linear amplitude and linear phase
   d) Liner amplitude and constant phase
   e) Liner delay and constant phase

Question	1	2	3	4	5
Answer					

6) An AM *superheterodyne* receiver is tuned to a carrier frequency of 800 *k*Hz. If the the tuning frequency of the Intermediate Frequency (IF) stage is 455 *k*Hz, what is **the local oscillator frequency at the mixer** (frequency converter)? and what is **the image station** **(2 points)**

7) Find the **power** , **rms** value, and **energy** of the shown **periodic** signal (show steps) **(3 points)**



<u>Problem 2:</u> (10 points)

A SSB signal is generated from a massage $m(t) = 2\cos(100t) + 4\cos(200t)$ using a carrier frequency ω_c=1000 rad/sec

a) Write down $M(\omega)$ and plot the spectrum of $m(t)$, i.e., $M(\omega)$. **(2 points)**

b) Find the Hilbert Transform of $m(t)$. **(1 point)**

c) Write down the LSB signal in time domain, i.e., $\phi_{LSB}(t)$. Plot the spectrum of $\phi_{LSB}(t)$. **(3 points)**

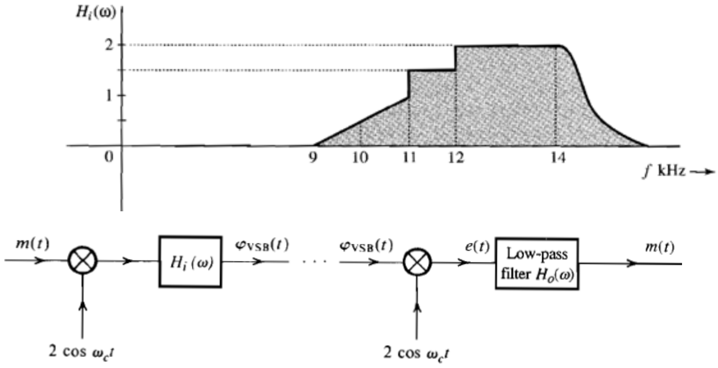
d) A SSB+C (SSB signal plus carrier) is generated by adding a carrier of amplitude A. Such a signal can be expressed as $\emptyset_{LSB+C}(t) = A\, cos\omega_c t + m(t)cos\omega_c t + m_h(t)sin\omega_c t$
For the given $m(t)$, find the power efficiency η of the resultant SSB+C signal as function of A. What is the efficiency when A=10. **(3 points)**

e) In SSB+C, what is the condition on A relative to $m(t)$ that allows for envelope detection **and** what is the impact on the efficiency **(1 points)**

Problem 3: **(10 points)**

1. Sketch the block diagram for a QAM modulator. Show all important details. **(2 points)**

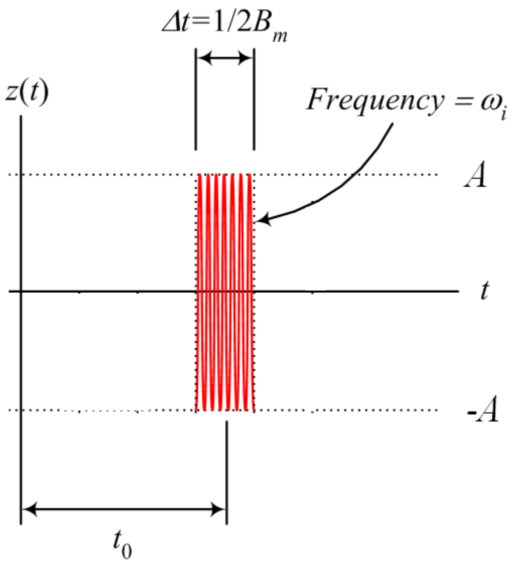
2. A vestigial filter $H_i(\omega)$ at the transmitter has a transfer function as shown in the Figure below. The carrier frequency is f_c=10 kHz and the baseband signal bandwidth is 4 kHz. Find the corresponding transfer function of the equalizer filer $H_o(\omega)$ at the receiver. ***Show your steps*** **(3 points)**



3. For the signal shown below

 a) Write an expression for $z(t)$ **(2 points)**

 b) Use Fourier Transform Tables to find $Z(\omega)$ **(3 poitns)**



Short Table of Fourier Transforms

	$g(t)$	$G(\omega)$	
1	$e^{-at}u(t)$	$\frac{1}{a+j\omega}$	$a>0$
2	$e^{at}u(-t)$	$\frac{1}{a-j\omega}$	$a>0$
3	$e^{-a\|t\|}$	$\frac{2a}{a^2+\omega^2}$	$a>0$
4	$te^{-at}u(t)$	$\frac{1}{(a+j\omega)^2}$	$a>0$
5	$t^n e^{-at}u(t)$	$\frac{n!}{(a+j\omega)^{n+1}}$	$a>0$
6	$\delta(t)$	1	
7	1	$2\pi\delta(\omega)$	
8	$e^{j\omega_0 t}$	$2\pi\delta(\omega-\omega_0)$	
9	$\cos\omega_0 t$	$\pi[\delta(\omega-\omega_0)+\delta(\omega+\omega_0)]$	
10	$\sin\omega_0 t$	$j\pi[\delta(\omega+\omega_0)-\delta(\omega-\omega_0)]$	
11	$u(t)$	$\pi\delta(\omega)+\frac{1}{j\omega}$	
12	$\operatorname{sgn} t$	$\frac{2}{j\omega}$	
13	$\cos\omega_0 t\, u(t)$	$\frac{\pi}{2}[\delta(\omega-\omega_0)+\delta(\omega+\omega_0)]+\frac{j\omega}{\omega_0^2-\omega^2}$	
14	$\sin\omega_0 t\, u(t)$	$\frac{\pi}{2j}[\delta(\omega-\omega_0)-\delta(\omega+\omega_0)]+\frac{\omega_0}{\omega_0^2-\omega^2}$	
15	$e^{-at}\sin\omega_0 t\, u(t)$	$\frac{\omega_0}{(a+j\omega)^2+\omega_0^2}$	$a>0$
16	$e^{-at}\cos\omega_0 t\, u(t)$	$\frac{a+j\omega}{(a+j\omega)^2+\omega_0^2}$	$a>0$
17	$\operatorname{rect}\left(\frac{t}{\tau}\right)$	$\tau\operatorname{sinc}\left(\frac{\omega\tau}{2}\right)$	
18	$\frac{W}{\pi}\operatorname{sinc}(Wt)$	$\operatorname{rect}\left(\frac{\omega}{2W}\right)$	
19	$\Delta\left(\frac{t}{\tau}\right)$	$\frac{\tau}{2}\operatorname{sinc}^2\left(\frac{\omega\tau}{4}\right)$	
20	$\frac{W}{2\pi}\operatorname{sinc}^2\left(\frac{Wt}{2}\right)$	$\Delta\left(\frac{\omega}{2W}\right)$	

<u>**Trigonometric Identities**</u>

cos A cos B = ½[cos (A+B) + cos (A-B)]

sin A sin B = ½[cos (A-B) – cos (A+B)]

sin A cos B = ½[sin (A+ B) + sin (A- B)]

Fourier Transform Operations

Operation	$g(t)$	$G(\omega)$
Addition	$g_1(t)+g_2(t)$	$G_1(\omega)+G_2(\omega)$
Scalar multiplication	$kg(t)$	$kG(\omega)$
Symmetry	$G(t)$	$2\pi g(-\omega)$
Scaling	$g(at)$	$\frac{1}{\|a\|}G\left(\frac{\omega}{a}\right)$
Time shift	$g(t-t_0)$	$G(\omega)e^{-j\omega t_0}$
Frequency shift	$g(t)e^{j\omega_0 t}$	$G(\omega-\omega_0)$
Time convolution	$g_1(t)*g_2(t)$	$G_1(\omega)G_2(\omega)$
Frequency convolution	$g_1(t)g_2(t)$	$\frac{1}{2\pi}G_1(\omega)*G_2(\omega)$
Time differentiation	$\frac{d^n g}{dt^n}$	$(j\omega)^n G(\omega)$
Time integration	$\int_{-\infty}^{t} g(x)\,dx$	$\frac{G(\omega)}{j\omega}+\pi G(0)\delta(\omega)$

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