Last name: SOLUTIONS **First name:**

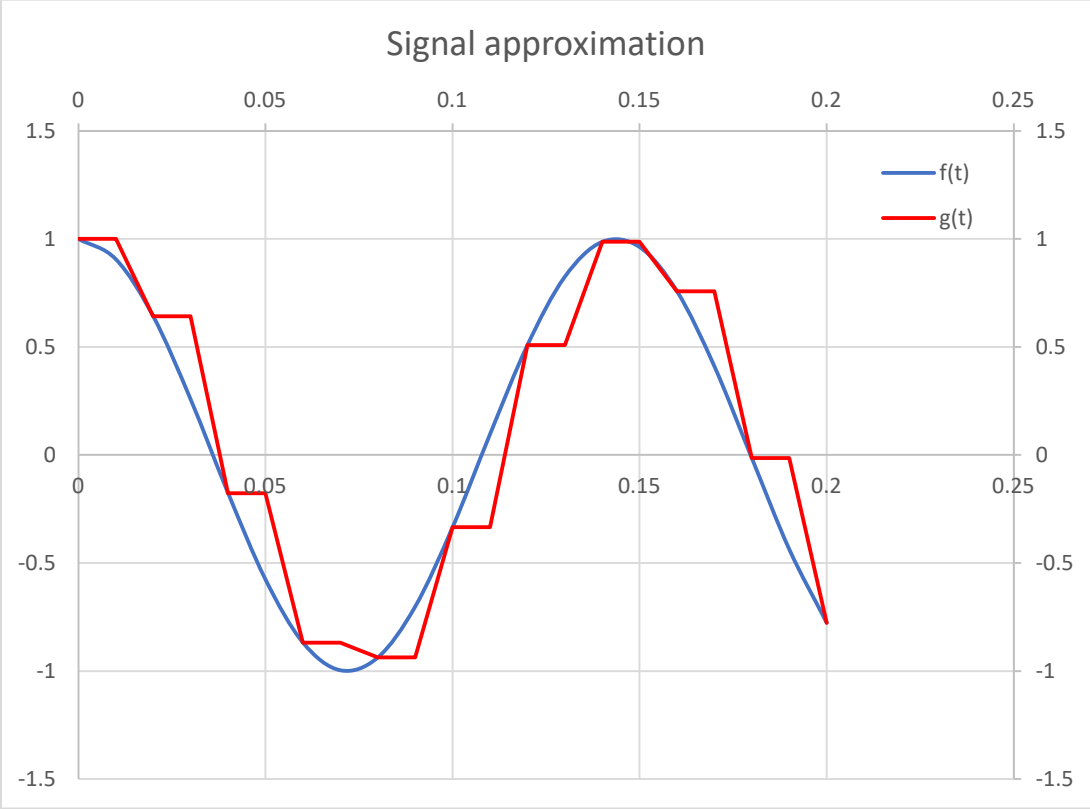
ECE 484: Communications Engineering

Midterm Examination – Spring 2018

Instructor: Dr. Ali Abedi, Professor of ECE

Important notes: Please write your name with pen on top of all pages. This exam is open book and notes and has 4 questions, one per page. Please only use the space provided for your answers, no additional pages are allowed. Phone or internet use is not allowed. Each student is expected to complete this test alone during the time allocated.

Question-1: Consider a periodic sinusoidal signal, f(t), and its approximated staircase signal, g(t) as illustrated in the figure below. **(a)** Write an equation representing f(t), determine its period, and carrier frequency. **(b)** Are these two signals, energy signal or power signal? **(c)** find the power or energy of both signals. **(d)** Determine percentage error in approximating f(t) using g(t). Enter all your final answers in the table below and show your work on the next page.



$f(t)=\cos(2\pi f_c t)$	$T=1/f_c$	$f_c=1$ MHz	
▪**Power** or ☐~~Energy~~	$P_f=0.558$	$P_g=0.562$	% error = 0.65

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Question-1 (cont.): Show your work on this page.

t	f(t)	g(t)	dx=0.01	$f_C = 10^6$	
0.00	1	1	1	1	
0.01	0.905964	1	0.820771	1	
0.02	0.641541	0.641541	0.411575	0.411575	
0.03	0.256463	0.641541	0.065773	0.411575	
0.04	-0.17685	-0.17685	0.031276	0.031276	
0.05	-0.5769	-0.17685	0.332815	0.031276	
0.06	-0.86845	-0.86845	0.754212	0.754212	
0.07	-0.99667	-0.86845	0.99336	0.754212	
0.08	-0.93745	-0.93745	0.87881	0.87881	
0.09	-0.70191	-0.93745	0.492684	0.87881	
0.10	-0.33437	-0.33437	0.111803	0.111803	
0.11	0.096061	-0.33437	0.009228	0.111803	
0.12	0.508424	0.508424	0.258495	0.258495	
0.13	0.825168	0.508424	0.680902	0.258495	
0.14	0.98672	0.98672	0.973617	0.973617	
0.15	0.962698	0.98672	0.926787	0.973617	
0.16	0.757619	0.757619	0.573987	0.573987	
0.17	0.410053	0.757619	0.168143	0.573987	
0.18	-0.01463	-0.01463	0.000214	0.000214	
0.19	-0.43657	-0.01463	0.19059	0.000214	
0.20	-0.77639	-0.77639	0.602787	0.602787	
			0.558237	**0.561854**	0.65%

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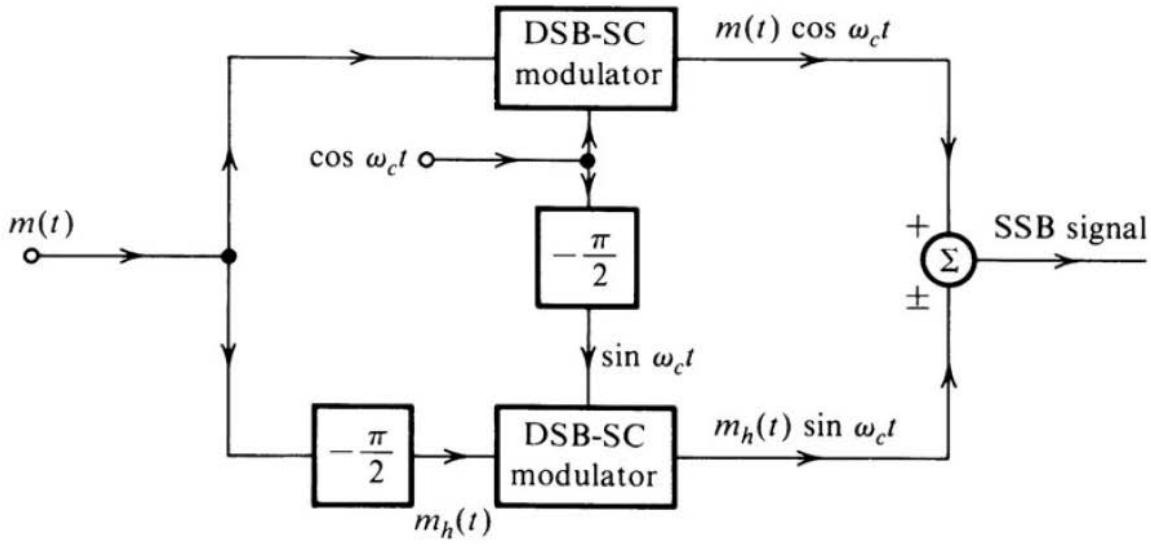
Question-2: Consider the following block diagram. **(a)** what is the function of this communication system? **(b)** If m(t) is a 1 KHz tone, determine the output of the system in time and frequency assuming that carrier frequency in the system below is 100 KHz. Write down both time and frequency equations and plot them on a labeled graph. Enter all your final answers in the table below and show your work and plot the output signal in time and frequency on the next page.



Function of this system is	SSB Modulator
Output in time domain is	$\cos(2\text{x}101\text{x}10^3\pi t)$
Output in frequency domain is	a delta function (tone) at 101 KHz assuming USB is used.

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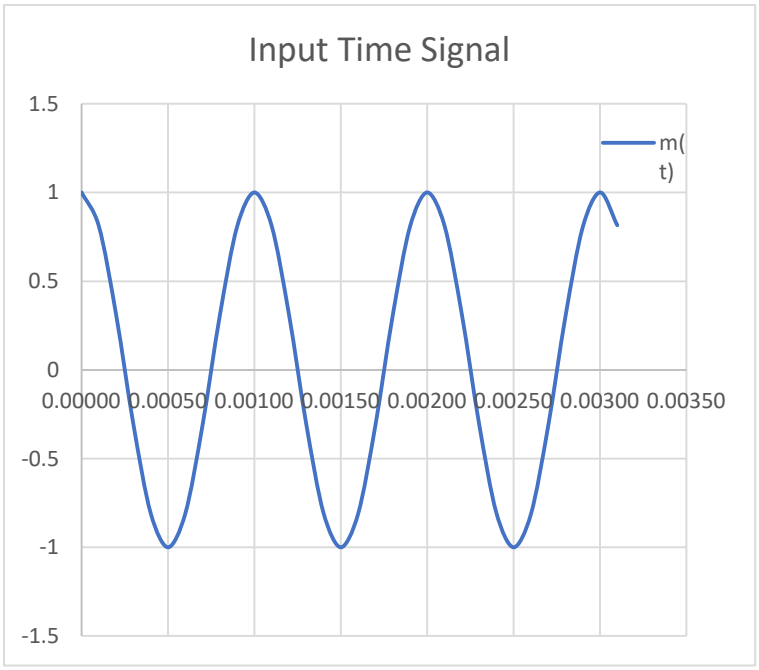
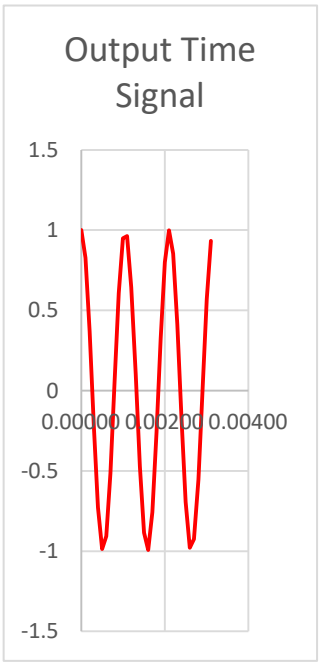
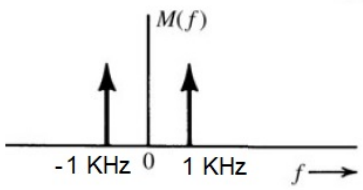
Question-2 (cont.): Show your work and out signal time and frequency plots on this page.

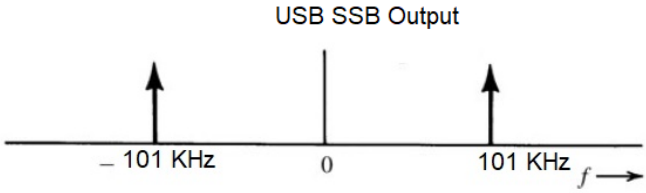
$m(t)\cos(w_c t) - m_h(t)\sin(w_c t) =$

$\cos(2\times10^3\pi t)\cos(2\times10^5\pi t) - \sin(2\times10^3\pi t)\sin(2\times10^5\pi t) = \cos(2\times101\times10^3\pi t)$









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Question-3: Draw block diagram of *Armstrong* indirect modulator and explain each block separately in 1-2 sentences. What is the advantage of using this system over direct FM modulator? Draw block diagram on the next page and enter explanations on the table below.

Block Name	Description
1. Integrator	Integrates the incoming message
2. DSB-SC	Modulates using AM double side band method.
3. phase shift	Phase shift of $-\pi/2$ changes the Cos to Sin function.
4. RF Osc.	200 KHz oscillator creates the Cos wave at RF freq.
5. Freq. Mult.	Multiplies the freq by 64 and 48 to increase freq. step by step
6. Freq. Conv.	Used IF osc. to change freq. from 12.8 MHz to 1.9 MHz
7. Adder	Adds two signals
8. Power amp	Increases the power of outgoing signal towards antenna
9. Antenna	Antenna radiates electromagnetic wave out of transmitter
10. IF Osc.	Intermediate or low freq. osci at 10.9 MHz.
11. N/A	
Advantages over direct modulation	Low cost high quality filters and amplifiers can be made using the step by step approach in this transmitter.

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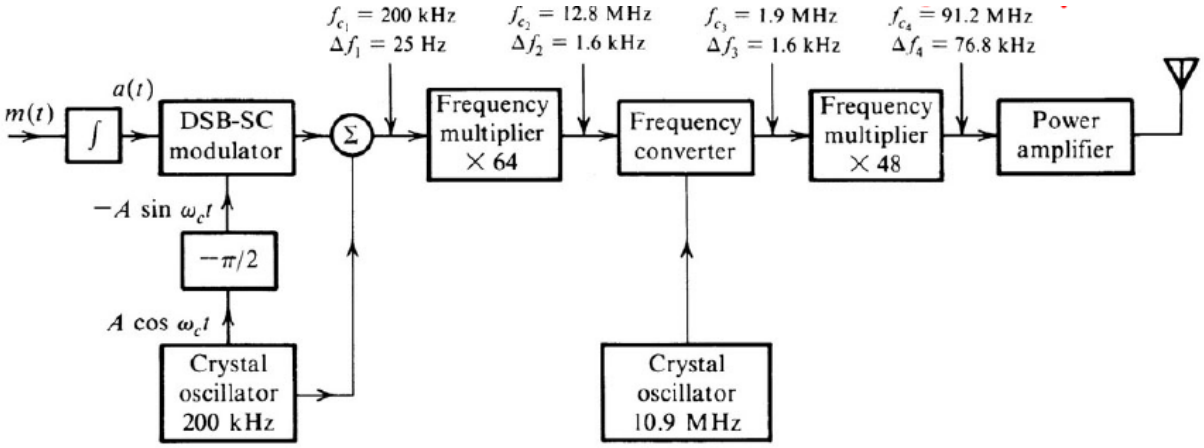
Question-3 (cont.): Draw block diagram on this page.



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Question-4: Draw block diagram of an FM stereo transmitter and an FM mono receiver. Explain how a mono receiver (single channel) can detect and demodulate a stereo signal (2 channel). Enter your explanations on this page and block diagram on the next page.

FM Stereo transmitter transmits both left plus right channels (L+R) and L-R which can be used by both mono and stereo receivers. The mono receiver only uses L+R.

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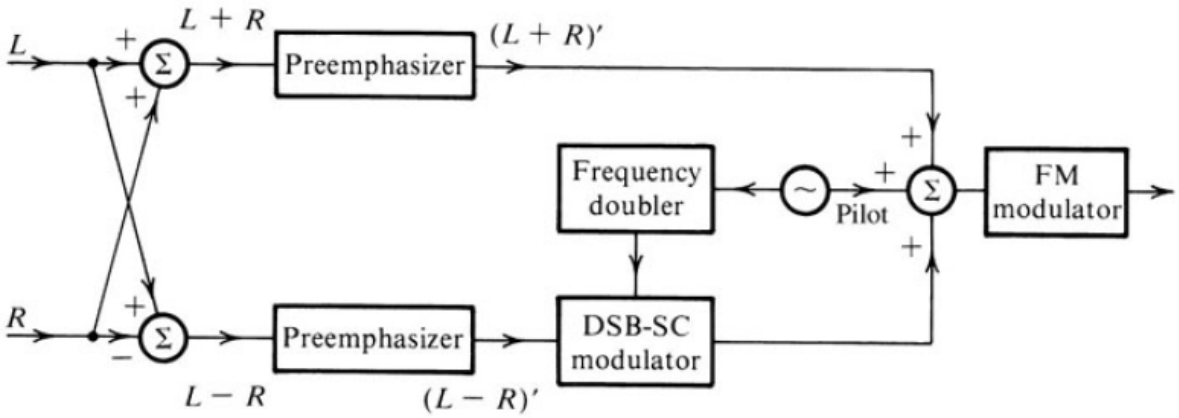
Question-4 (cont.): Draw the block diagrams on this page.



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