BITS PILANI DUBAI

DUBAI INTERNATIONAL ACADEMIC CITY DUBAI

EEE C383 / ECE C383 COMMUNICATION SYSTEMS

III yr BE(Hons) EEE & ECE — DATE: 30-12-2010

TIME: 3 Hours — Comprehensive Examination — MAX MARKS: 60 (30%)

*Note : Answer **ALL** questions . Any missing data can be suitably assumed .*

PART – A

1.Two signals $m_1(t)$ & $m_2(t)$, both bandlimited to 5000 rad/sec are being transmitted simultaneously over a channel by the multiplexing scheme as shown in **Fig 1.** The signal at point 'b' is the multiplexed signal which modulates a carrier of frequency 20000 rad/sec. The modulated signal is at point 'c' is transmitted over the channel.

(i) Sketch the spectra at points 'a', 'b' and 'c'.

(ii) What must be the channel Bandwidth?

iii) Design a receiver to recover signals $m_1(t)$ & $m_2(t)$ from the modulated signal at point 'c'.

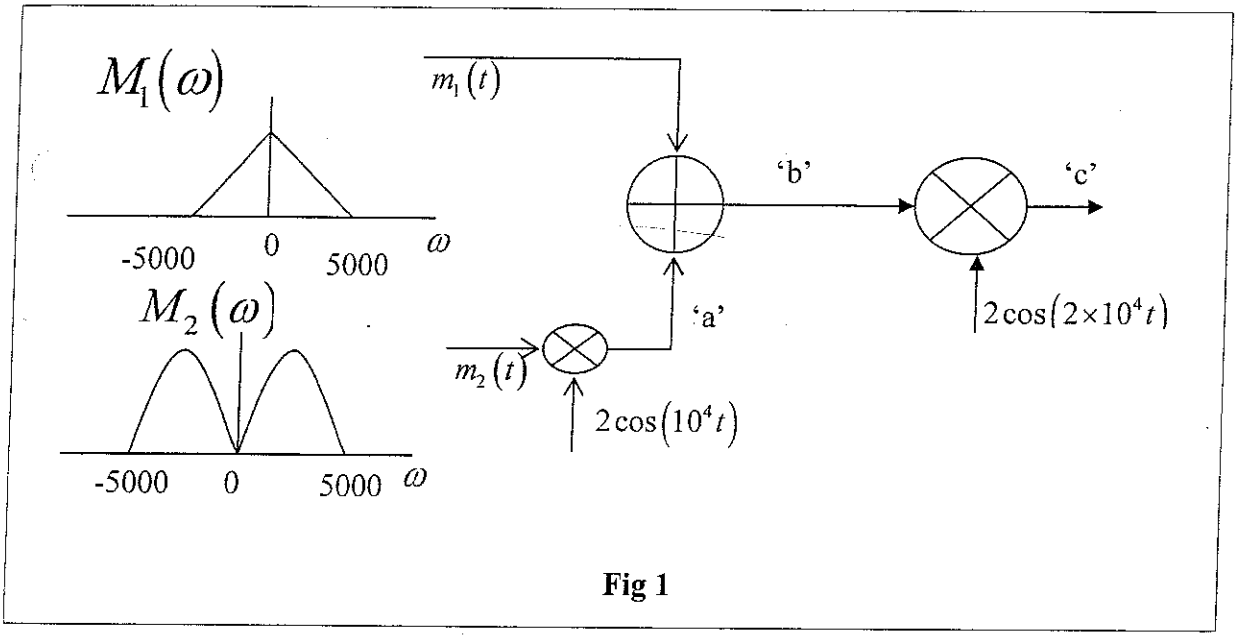

Fig 1

(4 marks)

2Consider a coherent demodulator being used for demodulating the DSB-SC signal. Draw the coherent demodulator block diagram and in such a process , if the carrier reinserted is given to be $Cos((\omega_c + \Delta\omega)t + \Delta\theta)$, discuss the effects of $\Delta\omega$ & $\Delta\theta$ separately , upon the demodulated output **(4 marks)**

3 An angle modulated signal has the form $e(t) = 100\cos\left(2\pi\times10^6 t + 4\sin\left(2\pi\times10^3 t\right)\right)$

(i) Assuming that this is a Frequency Modulated signal , determine the modulation index and the transmission bandwidth using Carson's rule . What would be the new result if the frequency of the modulating signal is doubled?

(ii) Repeat the above part assuming the signal $e(t)$ to be a Phase Modulated signal **(4 marks)**

4 Design (only the block diagram) an Armstrong Frequency Modulator to generate an FM output with a carrier frequency 98.1 MHz and $\Delta f = 75KHz$. A narrowband FM generator with a carrier frequency $f_c = 100KHZ$ and a frequency deviation $\Delta f = 10Hz$ is available.A variable frequency oscillator with an adjustable frequency in the range 10 to 11 MHz , along with doublers , triplers and quintuplers (multiplication by five) are available. **(4 marks)**

5 Consider a Random variable 'X' specified by its pdf $f_X(x)$ as shown in **Fig 5**. Find the value of 'K' , mean $\overline{X}$, the variance σ_{x^2} for the random variable **(4 marks)**

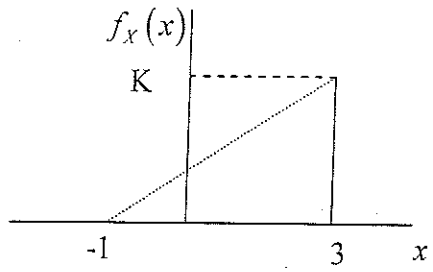

Fig 5

6 A random process $Z(t) = X\cos(\omega_0 t) + Y\sin(\omega_0 t)$ where X & Y are two zero- mean random variables each having a variance $\sigma^2 = 1$.Determine (i) $\mu_Z(t)$ (ii) $R_{ZZ}(t+\tau, t)$ and hence show that the random process Z(t) is a wide sense stationary. **(3 marks)**

7 Refer to **Fig 7**. Consider the signal at point 'A' as $p(t)$ and its sampled version at point 'B' as $p(t - nT_s)$ and sketch the spectra related to these two signals at points A & B respectively. Assume impulse sampling at a sampling rate of 36 KHz.

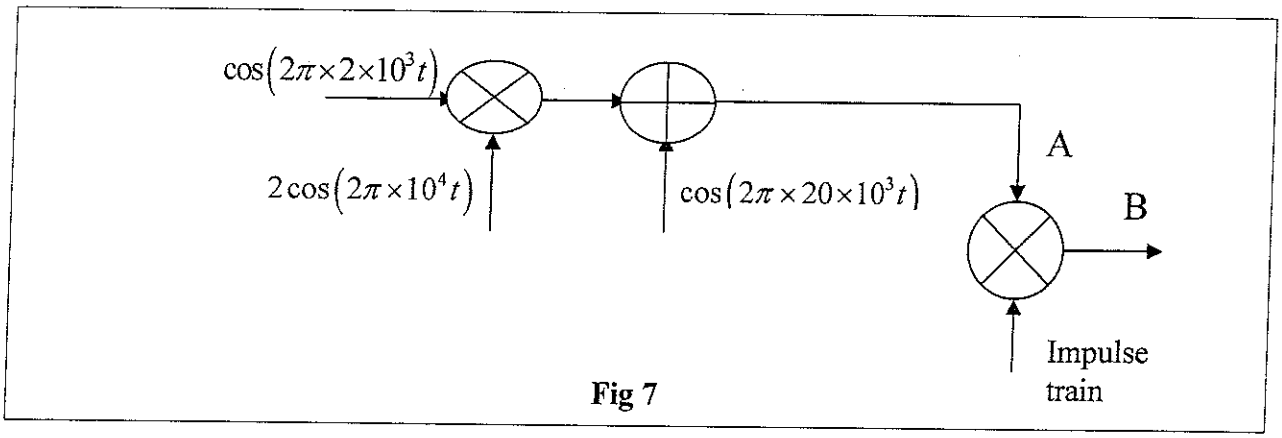

Fig 7

(4marks)

8 A Compact Disc (CD) records audio signals digitally by using PCM. Assume the audio signal to be bandlimited to 15 Khz.

a) calculate its Nyquitz Rate.

b) If the samples are quantized into L = 65,536 levels , determine the number of binary pulses required to encode each sample

c) Calculate the bit rate required to encode the audio signal (considering the Nyquist rate)

d) For implementation , it has been decided to sample the audio signal well above the Nyquist rate , say 44,100 samples/sec . and hence determine the required bit rate to encode the audio signal.

(3 marks)

PART – B

9 For the same demodulator input signal power , establish that the noise performance of SSB – SC system is equal to that of the reference baseband system **(4 marks)**

10 Consider a DSB-SC signal corrupted by additive white noise and demodulated by the synchronous detector having a phase error . Find the output SNR **(4 marks)**

11 Show that in the Power Spectral Density of the additive noise exhibits a parabolic variation with frequency in FM system and discuss the consequence of the same by considering the speech signal to be the modulating signal. **(4 marks)**

12 Considering single tone modulation , compare the noise performance of FM and PM and show that PM is superior to FM . **(3 marks)**

13 The input to a Delta Modulator is an alternating waveform as shown in the fig 13. Determine the minimum clock- rate necessary to avoid slope overload , if a step size of 1 mV is associated with it.

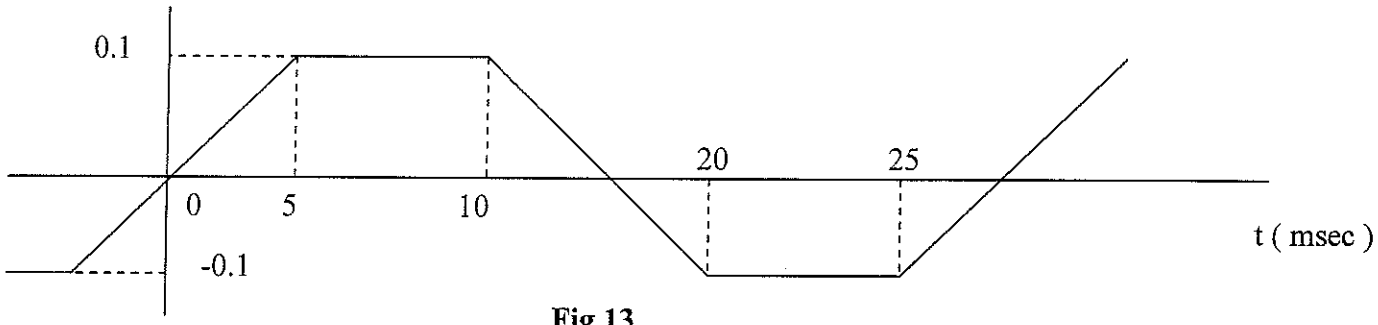

Fig 13

(4 marks)

14 The data input to a BPSK modulator is given to be d_k = 01011...appearing at the rate of 1000 symbols /sec.If the carrier signal is $e(t)=\cos\left(2\pi\times3\times10^3 t\right)$., Draw the modulated waveform

(3 marks)

15 A source emits three symbols X,Y & Z with $P(X)=P(Y)=\alpha$ Determine its entropy and show that it attains a maximum value for $\alpha=\frac{1}{3}$ **(3 marks)**

16 A binary source emits 5 messages $\{m_1,m_2,m_3,m_4,m_5\}$ with corresponding probabilities $(0.5,0.25,0.1,0.1,0.05)$. Obtain a binary Huffman Code and calculate the coding efficiency.

(5 marks)

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BITS PILANI DUBAI

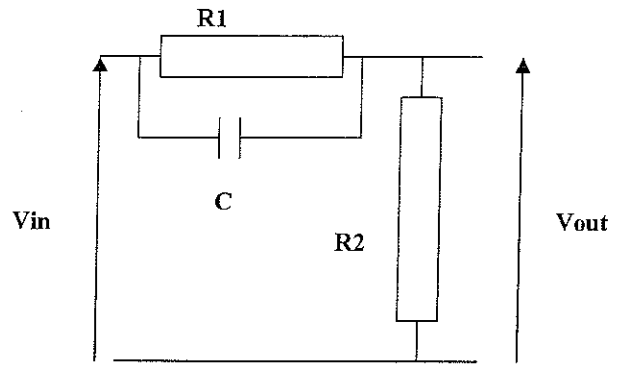
DUBAI INTERNATIONAL ACADEMIC CITY DUBAI

EEE C 383 / ECE C 383 COMMUNICATION SYSTEMS

III yr BE(Hons) EEE & ECE — DATE: 12-12-2010

TIME: 50 MINS — TEST II(Open Book) — MAX MARKS: 30 (15%)

*Note : Answer **ALL** questions . Any missing data can be suitably assumed .*

1	Consider an AM system which uses an envelope detector for demodulation. Determine the output SNR , given that the average noise power per unit bandwidth measured at the receiver input to be 2×10^{-3} Watts/Hz , the carrier power 60 kW and the two sidebands having 10 kW each. How does the same result compare to that of a DSB-SC system ? Assume the modulating signal frequency of 4 kHz.. Hint :Consider the envelope detection operation under low noise condition.	6
2	Consider the circuit (refer fig 1). Obtain the transfer function $\frac{V_{out}(\omega)}{V_{in}(\omega)}$.  **Fig 1** Explain the effect of this circuit on the noise performance a) Considering FM and b) considering PM	6
3	Consider a message $m(t)=\sin^2(2\pi\times10^3 t)+\cos(2\pi\times10^4\times t)\cos(2\pi\times9500\times t)$ being sampled using an ideal impulse train with impulses separated by an interval of 50 μsec Sketch the spectrum of the sampled signal	6
4	Consider a message signal which exhibits an uniform pdf over the range $\left(-\frac{x_{max}}{2},\frac{x_{max}}{2}\right)$. Design an uniform quantizer having L levels and calculate the Signal to Quantization Noise ratio interms of the number of bits. Note : $L=2^R$: R = number of bits/sample	6
5	A signal $m(t)=6\sin(2\pi\times10^3)t+4\sin(4\pi\times10^3)t$ is quantized using delta modulation. Assuming that the sampling frequency is five times the Nyquist rate, find the minimum required step size in order that slope overload distortion is avoided.	6

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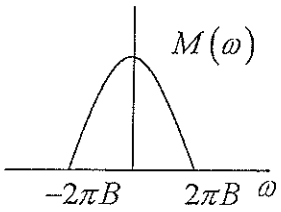
EEE C383 / ECE C383 COMMUNICATION SYSTEMS

III yr BE(Hons) EEE & ECE — DATE: 31-10-2010

TIME: 50 MINS — TEST I — MAX MARKS: 30 (15%)

*Note : Answer **ALL** questions . Any missing data can be suitably assumed .*

1A	Describe any one method of generating the SSB signal and discuss the implementation challenges associated with	**5**
1B	Consider a coherent demodulator being used for demodulating the Single Sideband Suppressed carrier signals. Draw the coherent demodulator block diagram and in such a process , if the carrier reinserted is given to be $Cos(\omega_c t + \Delta\theta)$, discuss the effect of $\Delta\theta$ (lack of synchrony in phase) upon the demodulated output	**5**
2A	Consider the modulating signal m (t) to be a sinusoidal signal varying between -1 V and + 1 V, having a period of 1 msec. If this signal is used to frequency modulate a carrier of $\omega_c = 2\ \pi$ x 10^8 rad/sec , Obtain the peak frequency deviation $\Delta\omega$ and the instantaneous frequency $\omega_i(t)$,assuming $K_f = 2\pi \times 10^5 \ \frac{rad}{\sec - volt}$	**4**
2B	A carrier signal $S(t) = 10\cos\left(2\pi \times 10^6 t\right)$ is frequency modulated by the single tone signal $m(t) = 3\cos\left(2\pi \times 10^3 t\right)$. Let the deviation constant be $K_f = 4000\pi \ \frac{rad}{\sec - volt}$ .Using Carson's formula , estimate the bandwidth of the FM signal and If now the frequency of the modulating signal is increasded by a factor of three , what is its effect on the FM signal bandwidth ?	**4**
3A	With a suitable diagram , analytically establish that a PLL is capable of demodulating an FM signal	**6**
3B	In the lab , using a product modulator , it is desired to generate a DSB-SC signal of the form $s(t) = A_c\ m(t)\ \cos(\omega_c t)$ where A_c: Carrier amplitude , ω_c: Carrier frequency & m(t): modulating signal , However , the available Carrier is of the form $\cos^3 \omega_c t$ only . Hence, to build the above modulator with this carrier, a multiplier and a suitable filter are used. a) Explain whether it would be possible to generate the DSB – SC signal. b) If so, What kind of filter is required? (mention the type along with the cut-off frequency) c) Sketch the signal spectra at the outputs of the Multiplier and Filter d) If the Carrier available is $\cos^2(\omega_c t)$, is it possible to get the DSB SC output? Explain. Hint : $4\cos^3(x) = 3\cos(x) + \cos(3x)$ With a suitable diagram , analytically establish that a PLL is capable of demodulating an FM signal	**6**



BITS, Pilani-Dubai
Dubai International Academic City, Dubai

B.E. (Hons.) Third Year, First Semester, 2010-2011
Quiz #2
EEE C383 / ECE C383: Communication Systems

Duration: 20 minutes Marks: 10 Weightage 10%

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1. A random variable X takes the values 0 and 1 with probabilities α and $\beta = 1 - \alpha$, respectively. Find the variance of X. (2 marks)

2. State the assumptions made with regard to the channel model and receiver model in the noise analysis of analog communication systems. (1 mark)

3. What is the effect of the quadrature component of bandpass noise at the output of a DSB-SC receiver? (1 mark)

4. A signal is given by $r(t) = s(t) + n(t)$ where $s(t) = 5\cos(2\pi \times 1{,}000t) + 10\cos(2\pi \times 1{,}100t)$. The noise $n(t)$ is white with two-sided power spectral density of 0.05 watt/Hz. The total received signal is put through a bandpass filter with passband between 990 and 1,100 Hz. Find the SNR at the filter output. (2 marks)

5. Calculate the required transmitter power of an SSB-SC system for transmitting an audio signal which has a bandwidth of 10 kHz with a receiver output SNR of 40 dB. Assume that the channel introduces a 40-dB power loss and channel noise is AWGN with two-sided power spectral density $\eta/2 = 10^{-9}$ watt/Hz. (4 marks)

BITS, PILANI-DUBAI
Dubai International Academic City, Dubai
BE (Hons.) ECE III Year, I Semester, 2010-2011
Quiz I (Closed Book)
Course No.: **ECE C383** Course Title: **Communication Systems**
Date: Oct 06 , 2010 Time: 20 min Max. Marks: 10 Weightage: 5%

Name :	**Student Id :**	**Section :**

Note: Answer all questions. Appropriate assumptions may be made wherever necessary

1. Mention two of the most important reasons for modulating a base band signal . (1 Marks)

Answer

a)

b)

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2. Consider a DSB-SC signal given by $S_{DSB\text{-}SC}(t)=5(\cos(2000\pi t)+\cos(4000\pi t))\cos(20000\pi t)$. Sketch the two sided spectrum of the modulated signal (2 Marks)

Answer

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3. Consider an amplitude modulated signal given by $S_{AM}(t)=5(2+1.6\cos(2000\pi t))\cos(20000\pi t)$. Plot the AM waveform (as function of time) indicating the following: a) the Minimum and the Maximum values of the amplitude of the carrier b) The envelope c) Also determine the modulation index μ (2 Marks)

Answer

4. In the previous problem , on an one ohm basis , calculate the following : a) the unmodulated carrier power P_C b) the modulated Carrier Power P_{Total} c) the sideband Power P_{SB} and d) the transmission efficiency η. Considering envelope detector to be used for demodulation ,Select the appropriate time constant value (RC) for proper demodulation , among the choices provided
1) RC = 50 μsec 2) RC = 500 μsec 3) RC = 10 $m$sec (4 marks)
Answer :

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5) Find the Hilbert Transform of $-\sin \omega t + j \cos \omega t$ (1 marks)