BITS PILANI, DUBAI CAMPUS

Dubai International Academic City, Dubai, UAE

BE (Hons.) ECE Third Year, I Semester, 2011-2012

Course No. / Course Title: ECE C383 COMMUNICATION SYSTEMS

Comprehensive Examination

Duration: 3 hours Max. Marks: 60 Weightage: 30 %

Note:- Answer all questions

1. An USB SSB-SC signal is given by the expression $s_{SSB}(t) = m(t)\cos\omega_c t + \tilde{m}(t)\sin\omega_c t$. In order to enable envelope detection at the receiver, a pilot carrier $A_c \cos\omega_c t$ is added to this SSB signal at the transmitter. For this approach to work, i.e., yield $m(t)$ at the envelope detector output in the receiver, what should be the relationship between A_c and $|m(t)|$? Hence, explain why this method has not been adopted for commercial radio broadcasting instead of conventional AM in spite of saving in bandwidth. (8 marks)

2. Consider a PM signal $s_{PM}(t) = 10\cos(\omega_c t + 5m(t))$ where $m(t) = \cos\omega_m t$. Obtain the sinusoidal expansion of $s_{PM}(t)$ in terms of Bessel functions. (6 marks)

3. A noise process has a power spectral density given by $S_n(f) = \begin{cases} 10^{-8}\left(1 - \dfrac{|f|}{10^8}\right), & |f| < 10^8 \\ 0, & |f| > 10^8 \end{cases}$

   This noise is passed through an ideal bandpass filter with a bandwidth of 2 MHz, centred at 50 MHz. (a) Find the power of the output process $n(t)$. (b) Write the output process in terms of the in-phase and quadrature components, $n_c(t)$ and $n_s(t)$, and find the power in each component. (c) Find the power spectral densities of $n_c(t)$ and $n_s(t)$. (8 marks)

4. Explain, with the help of neat figures, the terms *aliasing* and *aperture effect* in connection with practical sampling of signals. How are these effects overcome? (6 marks)

5. With the help of a neat sketch illustrate the phenomenon of slope overloading in delta modulation. Discuss some practical approaches for avoiding slope overload. (6 marks)

6. With the help of a circuit diagram, explain how the four possible phases of the carrier are generated in a QPSK modulator. (The entire QPSK modulator circuit is not necessary; just show the phase generation part.) (6 marks)

7. Describe, with the help of a block diagram, a practical method for studying the effects of inter-symbol interference and other degradation in baseband data transmission. (8 marks)

8. Consider a DMS X with two symbols x_1 and x_2 having probabilities of occurrence $P(x_1) = 0.9$, $P(x_2) = 0.1$. If the two symbols are encoded as 0 and 1 respectively, find the efficiency and redundancy of the code. (6 marks)

9. Define spread spectrum modulation. What is a PN sequence and how is it usually generated? When is a PN sequence called a maximal length sequence? (6 marks)

*** Paper ends ***

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Test 2 (Open Book)

Duration: 50 min | Max. Marks: 30 | Weightage: 15%

Note:- Answer all questions

1. A low-pass signal $m_1(t)$ is bandlimited to 3.6 kHz. Three other low-pass signals $m_2(t), m_3(t),$ and $m_4(t)$ are bandlimited to 1.2 kHz each. These signals are to be transmitted by means of time-division multiplexing. Draw a scheme for accomplishing this, with each signal being sampled at its Nyquist rate. What must be the sampling rate? (8 marks)

2. A signal $s(t) = \cos 2\pi t$ is uniformly quantized into 16 levels. (a) Obtain its mean-square quantization noise power. (b) What is the signal-to-quantization noise power ratio in dB? (6 marks)

3. A delta modulator is fed by the message signal $m(t) = 4\sin 2\pi(10)t + 4\sin 2\pi(20)t$. Determine the minimum sampling frequency required to prevent slope overload, assuming that the step size of the modulator is 0.1π. (8 marks)

4. A communication system consists of three possible messages *A*, *B*, and *C*. The probability of message *A* is *p*, and the probability of message *B* is also *p*. Plot the entropy as a function of *p*. (8 marks)

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Course No. / Course Title: ECE C383 COMMUNICATION SYSTEMS

Test 1

Duration: 50 min Max. Marks: 30 Weightage: 15%

Note:- Answer all questions

1. A power signal $x(t)$ has a normalized two-sided power spectral density given by: $S_x(f) = 3\delta(f-2) + 3\delta(f+2)$. Sketch $S_x(f)$ and compute the average power in $x(t)$. What can you say about the time-domain behavior of $x(t)$? (3 marks)
2. The output of a full AM transmitter modulated by a sinusoid is given by: $s(t) = 40\cos 500\pi t + 10\cos 450\pi t + 10\cos 550\pi t$. Find (a) the peak envelope amplitude; (b) modulating signal frequency; (c) modulation index and (d) modulation efficiency. (6 marks)
3. Devise a way to use an envelope detector to demodulate a DSB-SC signal. A simple block diagram is sufficient. (3 marks)
4. The input to a 100 MHz, 50 watt FM transmitter with frequency deviation constant $k_f = 30\pi$ rad/sec/volt is $10\cos(5000\pi t)$. Obtain the expression for the output of the transmitter $s(t)$. (5 marks)
5. Write briefly on the following:
    a. What does a Hilbert transform network do? (2 marks)
    b. Why is the filter method of SSB-SC generation suitable only for message signals with very little spectrum component in and around DC? (3 marks)
    c. Why is the problem of phase distortion worse in DSB-SC than in SSB-SC demodulation? (3 marks)
    d. List three properties of the Bessel function. (3 marks)
    e. What is a frequency discriminator? (2 marks)

BITS PILANI, DUBAI CAMPUS
B.E. (Hons.) ECE, Third Year, First Semester, 2011-2012
QUIZ #2
ECE C383 / Communication Systems
Duration: 20 min Max. Marks: 10 Weightage: 5%

Set - A

Name: _____

ID No.: _____

1. A zero-mean white Gaussian noise $n_w(t)$ with two-sided power spectral density $\eta/2$ is passed through an ideal filter whose passband is from 3 to 11 kHz. The output process is denoted by $n(t)$. Find and sketch $S_{n_c}(f)$ and $S_{n_s}(f)$, where $n_c(t)$ and $n_s(t)$ are the in-phase and quadrature components of $n(t)$. (4 marks)

2. The receiver output SNR of an FM system (without pre-emphasis/de-emphasis) is 50 dB. The message signal has the following characteristics: $|m(t)|_{\max} = 1, \overline{m^2(t)} = 0.5$, and bandwidth 5 MHz. The channel noise has a two-sided PSD of 0.5×10^{-14} W/Hz and the channel attenuation is 60 dB. The deviation ratio is 5. Find the transmitter power. (6 marks)

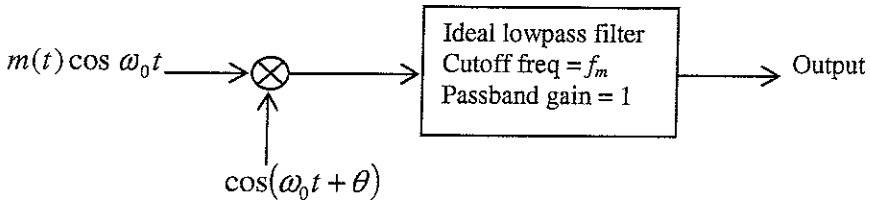
BITS Pilani, Dubai Campus
BE (Hons.) ECE, III Year, First Semester, 2011-12
Quiz # 1
Course Title: Communication Systems Course No.: ECE C383
Marks: 10 Weightage: 5% Duration: 20 minutes
SET - A

Name: _____

ID No.: _____

Answer all questions:

1. A low pass message signal $m(t)$ bandlimited to f_m Hz has a power P_m. For the set up shown below, (i) obtain the expression for the output signal; and (ii) find the power of the output signal in terms of P_m. Assume $\omega_0 >> 2\pi f_m$. (1.5 + 1.5 = 3 marks)



2. List the advantages and disadvantages of modulating a signal. (2 marks)

3. Consider the square-law modulator for conventional AM discussed in the class. Recall the spectrum at the output of the non-linear (square-law) device. For a baseband message signal of bandwidth 15 kHz, what is the minimum required value of carrier frequency for satisfactory operation of the modulator? *Note:- There is only one specific numerical answer. No derivation necessary.* (2 marks)

4. For a single tone modulating signal of frequency 1 kHz and a carrier signal of 10 kHz, **sketch** the following:
   (a) The corresponding SSB-USB signal as a function of time;
   (b) The spectrum of the above SSB-USB signal; and
   (c) The output of an ideal envelope detector used to detect the above SSB-USB signal. (1 + 1 + 1 = 3 marks)