BITS, PILANI-DUBAI
Dubai International Academic City, Dubai

BE(Hons.) EEE THIRD YEAR, I SEMESTER, 2009-2010
COMPREHENSIVE EXAMINATION

Course No. / Course Title: EEE C383 / COMMUNICATION SYSTEMS
Duration: 3 hrs Max. Marks: 60 Weightage: 30%

Note:-

- *This question paper consists of two pages. There are two parts: Part A and Part B. These are to be answered on separate answer booklets.*
- *Answer all questions. Appropriate assumptions may be made, wherever necessary.*

PART – A (25 marks)

1. A single-tone AM signal is detected using an envelope detector. The carrier frequency and modulating signal frequency are 2 MHz and 1 kHz respectively. Give the circuit diagram and show how the values of *R* and *C* are arrived at. (4 marks)
2. (a) Distinguish between narrowband FM and AM for a single-tone modulated signal. (2 marks)
   (b) Explain, with the help of a block diagram, the PLL method of demodulating an FM signal. (4 marks)
3. Consider a single-tone AM signal with modulation index of 0.5 and having an unmodulated carrier power of 1.5 kW. Find the amplitude of the carrier in the case of an FM transmitter employing the same transmitted (modulated) power as in the case of AM above. Assume a 1-Ohm basis for power calculations. (4 marks)
4. Give the expression for the pdf of a Gaussian random variable X having μ and standard deviation σ. Why is this distribution so important in communication theory? (3 marks)
5. (a) Consider a DSB-SC signal corrupted by additive white noise, and demodulated by a synchronous detector. Find the output SNR at the receiver and compare its performance with that of an ideal baseband system. If now, the detector has a phase error ϕ, how is the noise performance in DSB-SC affected? Discuss. (6 marks)
   (b) Write a brief note on threshold effect in FM. (2 marks)

PART – B (35 marks)

1. (a) A message signal has a spectrum limited to the frequency band from dc to f_m Hz. It is converted to a pulse-amplitude modulated signal by sampling it with a periodic pulse train of amplitude A, width d and period T_s. Derive and plot the spectrum of the modulated signal. (5 marks)
   (b) Distinguish between the terms *aliasing* and *aperture effect* as applied to a sampled signal. How are these effects minimized / overcome? (2 marks)
2. (a) Discuss the coherent method of frequency shift keyed signal detection with the help of a block diagram. (3 marks)

(b) Draw the NRZ and Manchester encoding waveforms for the data sequence: 10010101. Identify and discuss how the drawbacks in NRZ format are removed by Manchester encoding. (4 marks)

3. (a) Give a mathematical representation of QPSK and explain its principle of operation with a block diagram. What is the advantage of QPSK over binary PSK? (4 marks)

   (b) A discrete memoryless source X has five symbols $\{x_1, x_2, x_3, x_4, x_5\}$ with respective probabilities $\{0.2, 0.15, 0.05, 0.1, 0.5\}$. Construct a Huffman code for X and calculate the code efficiency. (4 marks)

4. The specification for a Class 1 telephone link is a guaranteed flat bandwidth of 300 Hz to 3400 Hz with a minimum SNR of 40 dB. The specification for a Class 2 telephone link is a guaranteed flat bandwidth from 600 Hz to 2800 Hz with a minimum SNR of 30 dB. A company has a requirement to send data at a bit rate of 20 kbps without error. Would you advise the company to use the more expensive Class 1 service or the cheaper Class 2 service? Justify your decision. (4 marks)

5. (a) Explain how degradation of digital signals due to inter symbol interference (ISI) can be studied on the oscilloscope. (3 marks)

   (b) What are the upper and lower limits on the entropy of a source comprised of 32 messages? Under what conditions are these limits attained? (2 marks)

   (c) What is a matched filter and why is it so named? (Derivation not necessary) (2 marks)

   (d) Name the two main types of spread-spectrum systems and the type of modulation they employ. (2 marks)

*** *Good Luck!* ***

BITS, Pilani-Dubai
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BE (Hons) EEE Third Year, I Semester, 2009-2010
Test 2 (Open Book)

Course No. / Course Name: **EEE C383 / Communication Systems**
Duration: 50 minutes Max. Marks: 30 Weightage: 15%

Note: ***Answer all questions. Make suitable approximations, wherever necessary***

1. A signal $m(t)$ is uniformly distributed in the range $\pm V_m$. It is quantized using a uniform quantizer. Find the peak SNR and the average SNR for the quantized signal. How do they compare with each other? Assume that the step size (level separation) is Δ and the number of quantization levels is L. (3 + 2 + 1 = 6 marks)
2. Consider a modulating signal $m(t) = \cos 200\pi t + 4\cos 320\pi t$. It is ideally sampled at a sampling frequency f_s = 300 Hz.
   (a) Plot the spectra of $m(t)$ as well as that of the sampled signal. Indicate the frequencies and magnitudes of the spectral components clearly. (4 marks)
   (b) If the sampled signal is passed through an ideal low-pass filter with a cutoff frequency of 250 Hz, what frequency components will appear in the output of the filter? What do you infer from this? (2 + 1 = 3 marks)
3. Consider an AM receiver where the incoming signal is a tone modulated signal with modulation index $\mu = 0.3$. The message signal is $m(t) = 10\cos 1000\pi t$.
   (a) Compute the output SNR and indicate the improvement or otherwise (in dB) over the ideal baseband system. (4 marks)
   (b) Find the improvement (in dB) in the output SNR that results if μ is increased from 0.3 to 0.6. (3 marks)
4. Why is pre-emphasis/de-emphasis not employed for conventional AM broadcasting? Give two main reasons. (1.5 + 1.5 = 3 marks)
5. Compare the noise power spectral density (PSD) in PM and FM (without pre-emphasis) receivers at the input of the low-pass filter. Based on this comparison, explain which angle modulation scheme is more suitable for SSB frequency-division multiplexing. (4 + 3 = 7 marks)

BITS, PILANI-DUBAI
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BE (Hons.) EEE III Year, I Semester, 2009-2010
Test I (Closed Book)

Course No.: **EEE C383** Course Title: **Communication Systems**
Date: Oct 25, 2009 Time: 50 min Max. Marks: 30 Weightage: 15%

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

1. List two advantages of an SSB-SC signal over a conventional AM signal. (1 mark)

   Given a sinusoidal message signal of frequency 1 kHz and a sinusoidal carrier signal of frequency 10 KHz, plot the corresponding upper-sideband SSB-SC waveform obtained. (3 marks)

2. Consider two transmitters: one for sending an AM signal and the other for sending an FM signal. The maximum frequency deviation of the FM transmitter is found to be five times the AM bandwidth. The powers in the spectral components at $f_c \pm f_m$ are identical for both the systems. Obtain the percentage modulation index for the AM system, assuming single-tone modulation for both the systems. Your answer should be supported by the spectra for both the transmitted signals. (6 marks)

   Some Bessel function values (you may not need all of them!):
   $J_0(5) = -0.178,\ J_5(5) = 0.261,\ J_1(10) = 0.043,\ J_{10}(10) = 0.207,\ J_5(2) = 0.007.$

3. How will the average power output of an FM signal be affected when the modulating signal voltage is doubled? Similarly, when the modulating signal voltage is doubled, how will the practical FM bandwidth be affected assuming wideband FM? Justify your answers with appropriate mathematical expressions. (2 + 2 = 4 marks)

4. Let $m(t) = \cos(2000\pi t)\cos(3000\pi t)$ modulate a 1-volt, 10 kHz sinusoidal carrier to produce an AM DSB-SC signal. Obtain the resulting AM DSB-SC signal spectrum. (3 marks)

5. The output signal from an AM generator is $s_{AM}(t) = 5\cos(1800\pi t) + 20\cos(2000\pi t) + 5\cos(2200\pi t)$. Determine (a) the modulating signal $m(t)$ and the carrier $c(t)$, (b) modulation index, and (c) the ratio of the power in the sidebands to the power in the carrier. (3 + 2 + 2 = 7 marks)

6. An angle modulated signal has the form $s(t) = 100\cos(2\pi f_c t + 4\sin 2000\pi t)$ where f_c = 10 MHz. Determine (a) the average transmitted power, and (b) the peak frequency deviation. (c) If this is an FM signal, determine the modulating signal $m(t)$. Assume that the FM sensitivity constant $k_f = 2$ rad/sec-volt. (2 + 2 + 2 = 6 marks)

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BE (Hons.) EEE III Year, I Semester, 2009-2010
Quiz II (Closed Book) – Set A
Course No.: **EEE C383** Course Title: **Communication Systems**
Date: Nov 25, 2009 Time: 20 min Max. Marks: 10 Weightage: 5%

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

1. A box contains the following components : Two diodes marked D1 & D2 and two transistors marked T1 & T2. Two components are drawn from the box in succession without replacement.

a) Determine the probability that both of them are transistors

b) Determine the probability that the second component drawn is a transistor given that the one picked first was a diode. (2 Marks)

2. For a continuous random variable X having the probability density function $f_X(x)$ as given in the figure below, determine the mean value of the random variable. (2 marks)

3. Consider the random process $X(t) = ACos(2\pi ft)$, where 'f ' is a constant and 'A' is a random variable uniformly distributed over (0 ,1) . Evaluate the mean and the autocorrelation for the process and show that the process is wide sense stationary. (3 Marks)

4. A zero mean white Gaussian noise with power spectral density $\frac{\eta}{2}$ watts / Hz is applied as input to an ideal Low Pass Filter with bandwith 'B' Hz. Calculate the autocorrelation function of the output random process. State the relations used. (3 marks)

BITS, PILANI-DUBAI, DUBAI INTERNATIONAL ACADEMIC CITY
THIRD YEAR, EEE (Sections 1 & 2), I SEMESTER, 2009-2010

QUIZ 1 (Set B)
Course Title / Course No.: COMMUNICATION SYSTEMS / EEE C383
Duration: 20 minutes Max. Marks: 10 Weightage: 5% Date: 07 Oct 2009

Name: ______________________________ **ID:** _______________

1. Sketch, with appropriate labeling, the AM wave $s_{AM}(t) = 5[1 + 2\cos(2\pi \times 10^3 t)]\cos(2\pi \times 10^4 t)$. Also, indicate clearly on this plot the output when this signal is passed through an ideal envelope detector. (2 + 1 = 3 marks)

2. Why would it not be possible to broadcast a lowpass modulating signal by simply adding it to a high frequency cosine wave carrier? (1 mark)

3. List the advantages of modulation. (1 mark)

4. A signal $m(t) = 10\cos(2\pi \times 10^3 t)$ is used to amplitude modulate a carrier. Find the carrier frequency, f_c, if the bandwidth of the transmitted signal is 2% of the carrier frequency. (2 marks)

5. Show that a conventional AM signal $s_{AM}(t) = A_c[1 + k_a m(t)]\cos(\omega_c t)$ can be demodulated using coherent (synchronous) detection? Include the block diagram of the detector and give appropriate mathematical analysis. (3)