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

Note:- *Answer all questions*

1. A single-tone modulated conventional AM signal $s(t) = A(1 + \mu \cos \omega_m t) \cos \omega_c t$ is applied to a square-law device, such that the output is given by $v_o(t) = [s(t)]^2$. This output is passed through an ideal lowpass filter whose cutoff frequency is $3\omega_m$. Find the ratio between the second harmonic to the fundamental frequency component at the output of the filter. (3 marks)

2. Consider an FM signal $s_{FM}(t) = 10\cos(\omega_c t + 5\cos \omega_m t)$. Derive the sinusoidal expansion of $s_{FM}(t)$ in terms of Bessel functions and sketch its magnitude spectrum, clearly indicating the frequency components and corresponding amplitudes. (5 marks)

3. Prove quantitatively that narrowband FM offers no improvement in SNR over AM. Assume single-tone modulation in each case. (3 marks)

4. State and prove the sampling theorem for lowpass signals. (5 marks)

5. Consider five messages with the following probabilities of occurrence, respectively: 0.4, 0.2, 0.2, 0.1, and 0.1. Find the Huffman code and the Shannon-Fano code for the messages and compare the resulting average code word lengths. (3 marks)

6. A delta modulator is designed to operate on a lowpass message signal of bandwidth 3.4 kHz. The sampling rate is 10 times of the Nyquist rate of the signal, and the step size is 100 mV. The modulator is tested with a signal $m(t) = A\sin(2000\pi t)$. Determine the maximum permissible amplitude A of this test signal to avoid slope overload. (3 marks)

7. Describe a practical method for studying the effects of inter-symbol interference and other degradation in baseband data transmission. (4 marks)

8. Sketch the state diagram, the tree diagram, and the trellis diagram for the convolutional encoder shown below. Find the free distance of this convolutional code. (4 marks)

BITS PILANI, DUBAI CAMPUS
Dubai International Academic City, Dubai, UAE
BE (Hons.) EEE Third Year, II Semester, 2011-2012
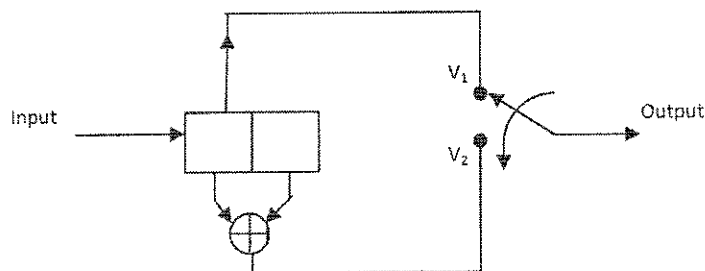**Course No. / Course Title: EEE C383 COMMUNICATION SYSTEMS**
Test 2 (Open Book)
Duration: 50 min   Max. Marks: 15   Weightage: 15%

1. A DSB-SC and a SSB-SC transmission are each sent at 1 MHz in the presence of additive white noise. The modulating signal in each case is bandlimited to 3 kHz. The received signal power in each case is 0.2 mW. The received noise is assumed to be white with a two-sided power spectral density of 10^{-3} μW/Hz. The receiver consists of a bandpass filter whose bandwidth matches the bandwidth of each transmission, followed by a synchronous detector.

     a) Compare the signal-to-noise ratios at the detector inputs. (2 marks)
     b) Compare the signal-to-noise ratios at the detector outputs. (2 marks)
     c) Repeat part (a) if the (two-sided) power spectral density were $10^3/|f|$ μW/Hz. Would a "white noise" assumption be valid here? (3 marks)

2. A 10 kHz sinusoidal signal is to be transmitted using FM in the presence of additive white Gaussian noise. If the S/N improvement at the demodulator output is required to be 20 dB, determine the required peak frequency deviation if no pre-emphasis / de-emphasis is used. (4 marks)

3. A Gaussian channel has a two-sided noise power spectral density of 10^{-14} W/Hz and bandwidth of 4 kHz. The signal power at the receiver 0.1 mW. Calculate the channel capacity. (4 marks)

BITS Pilani, Dubai Campus
B.E. (Hons.) EEE, Third Year, Second Semester, 2011-2012
Test 1 (Closed Book)
EEE C383 COMMUNICATION SYSTEMS

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

Answer all questions. Appropriate assumptions may be made, where necessary.

1. Obtain the Fourier transform of $x(t) = e^{j\omega_0 t}$ and plot its spectrum. (1.5 marks)

2. A cosine wave of frequency 2 kHz modulates a carrier using conventional AM. If the bandwidth of the modulated signal has to be less than 2% of the carrier frequency, what should the carrier frequency be? (1.5 marks)

3. An USB-SSB signal is obtained by modulating a 1 MHz carrier with the modulating signal $m(t) = \cos(10000\pi t) + 2\sin(10000\pi t)$. The carrier amplitude is 20 volts. (a) Obtain the time domain expression for the modulated signal. (b) Plot the magnitude spectrum of $s(t)$. (5 marks)

4. A sinusoidal carrier of frequency 100 kHz is SSB-SC modulated by a 1 KHZ sine wave. Sketch the corresponding USB-SSB signal? If this USB-SSB signal is passed through an ideal envelope detector, sketch the detector output? (3 marks)

5. From first principles, obtain the expression for a single-tone phase-modulated signal. Also obtain the modulation index for the PM signal. How does it contrast with the modulation index for single-tone FM? (4 marks)

--- Paper ends ---

Answer all questions. Perform rough work in the space provided after the questions. Indicate the answers in the blanks provided in each question.

1. A PCM system operating at 50 Mb/s uses a uniform quantizer followed by a 8-bit binary encoder. What is the maximum message bandwidth for which system operation is satisfactory? Ans. _____ (1.5 marks)

2. The minimum sampling rate necessary to sample and perfectly reconstruct the signal $m(t) = \sin(6280t)/(6280t)$ is: Ans. _____ (1.5 marks)

3. A waveform $m(t) = 10\cos(1000t + \pi/3) + 20\cos(2000t + \pi/6)$ is uniformly sampled at the Nyquist rate for digital transmission. If we want to reproduce one hour of this waveform, how many sample values need to be stored? Ans. _____ (1 mark)

4. (a) To improve the linear region of the frequency characteristic of a slope detector, we use a _____. (0.25 mark)

   (b) The indirect method of FM generation is also known as _____ method. (0.25 mark)

   (c) An FM demodulator can be implemented using a differentiator followed by an _____. (0.25 mark)

   (d) The present day AM/FM receivers almost invariably use the _____ for detection. (0.25 mark)

(Space for rough work. You may use the backside too.)