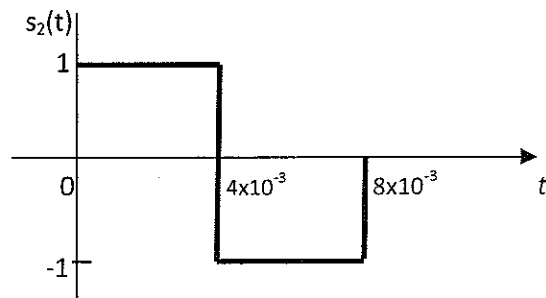
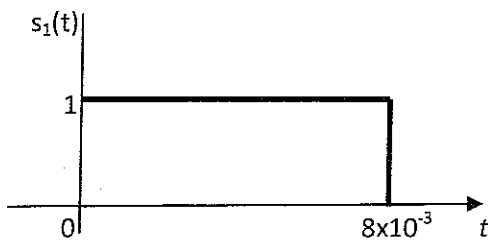


BITS Pilani, Dubai Campus
Dubai International Academic City
B.E. (ECE), Third Year – Second Semester, 2010-2011
Comprehensive Examination
Course No. / Course Title: ECE C392 / Modern Communication Technologies
Duration: 3 hours Max. Marks: 80 Weightage: 40%

Note: This question paper has two pages.

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

1. Consider a resistor $R = 100 \text{ k}\Omega$ at "room" temperature $T = 290 \text{ K}$. What is the open-circuit voltage across the resistor when measured using a true-RMS voltmeter with a bandwidth of 1 MHz ? Boltzmann's constant $= 1.38 \times 10^{-23} \text{ J/K}$. (4 marks)
2. Suppose binary information is transmitted using the two baseband signals of the form shown below. Design a matched filter detector, and find the probability of bit error, assuming that the additive noise in the channel has a two-sided power spectral density of $0.5 \times 10^{-3} \text{ watt/Hz}$. (For full credit, provide optimum design.) (8 marks)



3. A (4,3) linear code is generated by the matrix $[G] = \begin{bmatrix} 1 & 1 & 0 & 0 \\ 1 & 0 & 1 & 0 \\ 1 & 0 & 0 & 1 \end{bmatrix}$.

Find the code words associated with each possible information word. What is the nature of the resulting code? What is the role of the redundant bit in each code word? (6 marks)

4. Calculate the capacity of an AWGN channel with a bandwidth of 1 MHz and an S/N ratio of 40 dB ? (5 marks)
5. Explain briefly how the use of a channel equalizer in the receiver decreases the effects of intersymbol interference. (5 marks)
6. (i) How are multiple access radio protocols classified? Indicate the sub-classifications too. (3 marks)
(ii) In a ALOHA network, how does a terminal learn that its packet has collided? (2 marks)

- (iii) The ALOHA protocol is used to share a 56 kbps satellite channel. Let each frame be 1000 bits long. What is the maximum throughput of the system in frames/sec? (4 marks)
- (iv) What is meant by the term *vulnerable time*? By means of appropriate sketches, show that the vulnerable time for slotted ALOHA is one-half that of pure ALOHA. (4 marks)
7. (i) Expand the acronym CSMA/CD. Why is it difficult to implement CSMA/CD in a wireless environment? (2 marks)
- (ii) Explain the following types of CSMA protocols: (a) 1-persistent CSMA; (b) p-persistent CSMA. (4 marks)
8. Consider a multipath scenario where a receiver is moving at 70 mph and the two received signal components arrive from 10° and 150° with respect to the receiver's direction of motion. Let the received signal components differ in amplitude by 2 dB and have a phase difference of $\pi/6$. Find the Doppler spread. (5 marks) $f_c = 850 \text{ MHz}$.
9. In the reception of multipath signals, the normalized delay spread, D , is indicative of the nature of the channel. What is the nature of a channel for which (a) $D \ll 1$; (b) D approaches or exceeds unity? (4 marks)
10. Slow fading can generally be caused by events such as *shadowing*. What is shadowing and how is it modeled mathematically? (4 marks)
11. Sketch, in a single plot, the typical BER vs. S/N curves for (a) Gaussian channel (no fading); (b) Flat fading channel; (c) Frequency-selective channel (with equalization); and (d) Frequency-selective channel (no equalization). (4 marks)
12. (i) What is meant by the term *cluster* as applied to cellular communication? (2 marks)
- (ii) Expand the acronym MSC as applied to a cellular network. List the functions of an MSC. (3 marks)
13. If the refractive index of the core of an optic fiber is 1.47 and that of the cladding is 1.44, what is the angle of the cone of acceptance? (5 marks)
14. Name and compare the two common types of light emitters used in fiber optics. (3 marks)
15. What is a graded index waveguide and what are its advantages over the lens waveguide? (3 marks)

*** Paper ends ***

BITS Pilani, Dubai Campus
BE (Hons.) ECE Third Year, Second Semester, 2010-2011
Test 2 (Open Book)

ECE C392 Modern Communication Technologies

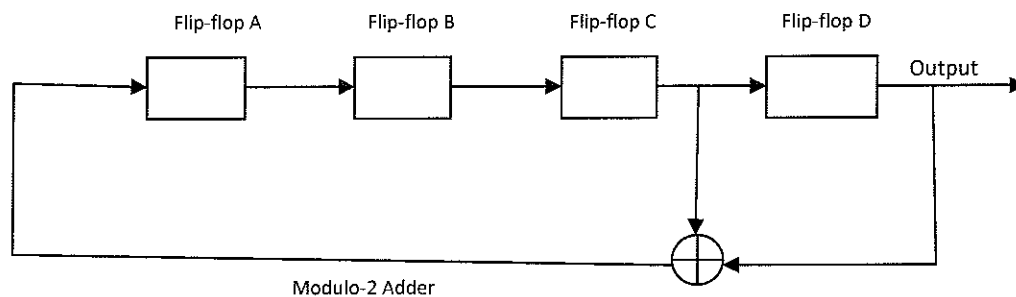
Duration: 50 min

Max. Marks: 40

Weightage: 20%

Answer all questions. All questions carry equal marks.

1. A satellite at a distance of 40,000 kilometres transmits a signal at 12 GHz with an EIRP of 10 watts towards an antenna having a diameter of 4.6 metres. The antenna has an aperture efficiency of 60 percent. What is the received signal level (in dBW) at the antenna output?
2. A binary signal $s_i(t)$ is transmitted as either a +1 -volt or -1-volt pulse during the interval $(0, T)$. The signal gets corrupted by additive white noise with power spectral density $\eta/2 = 10^{-5}$ W/Hz. Find the maximum bit rate that can be sent with a bit error probability of $P_e \leq 5 \times 10^{-4}$. It is given that $Q(3.35) = 5 \times 10^{-4}$.
3. Consider the four-stage shift register shown below. The initial state of the shift register is 1000. Obtain the output sequence and demonstrate the balance and run properties as applied to a PN sequence. Also, plot the autocorrelation function of the PN sequence produced by this shift register.



4. An FSK signal consists of bursts of frequency of 800 kHz and 900 kHz, with the higher frequency used to transmit a binary 1. The bit rate is 2 kbps. Sketch the power spectral density (PSD) of the signal. Find the bandwidth of the FSK signal. Assume that we define the bandwidth out to the first zero of each lobe of the PSD.
5. Consider the two signals $s_1(t) = \sqrt{2P_s} \cos \omega_c t$ and $s_2(t) = \sqrt{2P_s} \cos(\omega_c t + \pi)$, where $0 \leq t \leq T$ and P_s is the signal power. Find the orthonormal coordinates and draw the signal-space diagram.

*** Paper ends ***

GOOD LUCK!

BITS Pilani, Dubai Campus
BE (Hons.) ECE Third Year, Second Semester, 2010-2011

Test 1 (Closed Book)

EEE C392 Modern Communication Technologies

Duration: 50 min

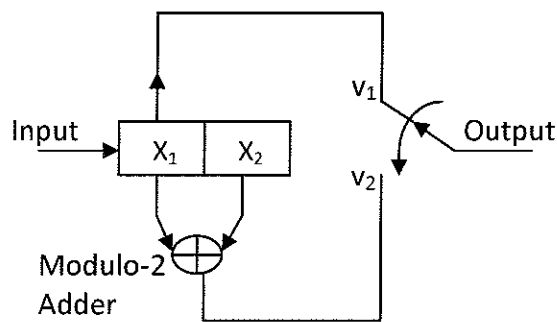
Max. Marks: 50

Weightage: 25%

Answer all questions. Appropriate assumptions can be made, wherever necessary.

1. A square wave of frequency 1 MHz is mixed in a receiver with a local oscillator sinusoid at 7.5 MHz and the resulting signal is passed through an ideal low pass filter with a cut-off at 700 Hz. (a) What will appear at the output of the receiver?; (b) The output of the receiver is found to be too small for practical use. How can this output level be increased simply by altering the shape of the 1 MHz modulating component? [Hint:-Recall that a square wave satisfies rotation (or half-wave) symmetry. What is its Fourier series?] (6 marks)
2. A four-level baseband data stream has a symbol period of 100 μ s. (a) What is the time taken to transmit one million bits?; (b) If it is required to transmit the information in half the time, how many symbol states (levels) would be required using the same transmission bandwidth? (6 marks)
3. An audio source signal contains frequencies in the range from 50 Hz to 18 kHz. (a) What is the minimum sampling rate required for an A/D converter in order to ensure that there will be no aliasing?; (b) What is the practical sampling rate used in the hifi industry for this signal? (Hint:-Read this question paper carefully!); (c) If, by accident, a high-frequency tone at 30 kHz is added to the audio source, at what frequency will this signal appear in the sampled waveform if the sampling rate is set at 40,000 samples/sec? (7 marks)
4. The specification for a Class 1 telephone link is a guaranteed flat bandwidth of 300 Hz to 3400 Hz and a minimum signal to noise ratio of 40 dB. The specification for a Class 2 telephone link is a guaranteed flat bandwidth from 600 Hz to 2800 Hz and a minimum signal to noise ratio of 30 dB. A company has a requirement to send data over a telephone link at a bit rate of 20 kbps without error. Would you advise the company to rent the more expensive Class 1 service or the cheaper Class 2 service? Justify your decision using appropriate calculations. (8 marks)
5. In a CD player, the sampling rate is 44.1 kHz and the samples are quantized using a 16-bit/sample quantizer. Determine the resultant number of bits for a piece of music with a duration of 50 minutes. (6 marks)
6. Discuss the various sources of quantization error. (5 marks)
7. List the various criteria for comparing and selecting PCM waveforms. (4 marks)
8. Based on the model for speech generation mechanism, explain briefly how speech can be compressed to low bit rates using LPC parameters. (8 marks)

3. A linear code of minimum distance d_{min} can correct up to t errors if and only if $d_{min} \geq \underline{\hspace{2cm}}$. (1 mark)
4. When is a code C called linear? Show that $C = \{000, 001, 101\}$ is not a linear code. (2 marks)
5. Consider the convolutional encoder shown below. (a) Find the “impulse” response of the encoder; (b) Using the impulse response, determine the output code word for the input data $\mathbf{d} = [1\ 0\ 1]$. (4 marks)



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BE (Hons) ECE, Third Year, Second Semester, 2010-2011

Quiz 1 (Closed Book)

ECE C392 Modern Communication Technologies

Duration: 20 min Max. Marks: 16 Weightage: 8%

1. The noise voltage in an electric circuit is modeled as a Gaussian random variable with zero mean and variance equal to 10^{-8} . What is the probability that the value of the noise exceeds 4×10^{-4} ? Express your answer in terms of the Q-function as well as the error complementary function. (6 marks)

2. A matched filter has the frequency response $H(f) = \frac{1 - e^{-j2\pi fT}}{j2\pi f}$. Determine its unit-impulse response $h(t)$. Also, determine the signal waveform to which the filter characteristic is matched. (10 marks)