BITS, Pilani-Dubai
Dubai International Academic City

Fourth Year EEE, II Semester, 2007-2008
Comprehensive Examination
Course No. and Title: EEE UC416 Digital Communication.

22 May 2008 Duration: 3 hours Max Marks: 80 Weightage: 40%

Answer all questions

1. Explain clearly the idea behind predictive coding. How is it an improvement over PCM? Explain the working of DPCM with the help of neat block diagrams.
   What are the best choice values of a_1 and a_2 in a 2-tap predictor when the input has a correlation function given by
   $R_x(0)=1, R_x(1)=R_x(-1)=0.5, R_x(2)=0.25$? (3+5+4)

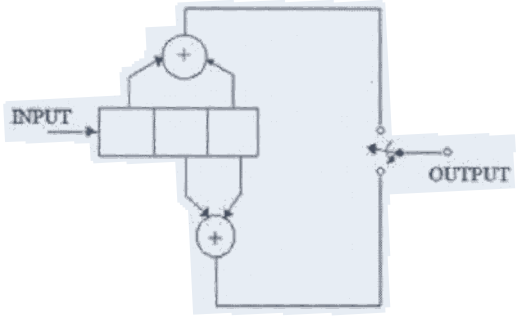
2. Distinguish clearly between random processes and random variables with the help of examples.
   Determine the mean and the autocovariance of a random process described by $p(x(t_1,A))=p(x_1)=\frac{1}{\sqrt{2\pi}}e^{-\left(\frac{x_1^2}{2}\right)}$ for all times t_1, and
   $p(x(t_1,A),x(t_2,A))=p(x_1,x_2)=p(x_1).p(x_2)=\frac{1}{2\pi}e^{\left(\frac{-x_1^2-x_2^2}{2}\right)}$ (5+5)

3. Obtain the relationship between the Q-function and the error-complementary function. (4)

4. The term *matched filter* is often used synonymously with the term *correlator*. Explain clearly how this is possible in spite of their mathematical operations being different.
   Show that the impulse response of a matched filter $h(t)$ matched to a signal $s(t)$ is $h(t)=k.s(T-t)$, where T is the duration of the signal and k is a constant of proportionality. (6+6)

5. Explain how inter-symbol interference can be minimized by appropriate pulse shaping. (8)

6. Draw the state diagram and trellis diagram for the (2, 1, 3) convolutional encoder shown in figure below: (6+6)



7. Derive an expression for the probability of bit error for a coherently detected BPSK signal in AWGN channel with noise power spectral density $N_o/2$ watts/Hz. (8)

8. Explain briefly the principle of a Rake modulator/demodulator. (6)

9. What are the requirements to be satisfied for a system to be described as a *spread spectrum* system?
   A spread spectrum communication system has the following parameters: Information bit duration $T_b = 4.095ms$, PN chip duration $T_c = 1\mu s$, energy-to-noise ratio $E_b/N_o = 10$. Find the processing gain and jamming margin. (3+5)

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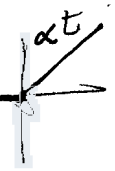
Test II (Open Book)
Course No.: EEE UC 416 Course Title: Digital Communication
Date: Apr 10th, 2008 Duration: 50 min Max. Marks: 40 Weightage : 20%

Note:- Answer all questions

1. A matched filter has the frequency response $H(f)=\frac{1-e^{-j2\pi fT}}{j2\pi f}$. Determine the impulse response $h(t)$ corresponding to $H(f)$. Also, determine the signal waveform to which the filter characteristic is matched. 8
2. A given delta modulation system operates with a sampling frequency f_s and fixed size Δ. If the input to the system is $m(t)=\alpha t u(t)$, determine the value of α for which slope overload occurs. 8
3. The noise voltage in an electric circuit can be modeled as a Gaussian random variable with mean equal to zero and variance equal to 10^{-8}. What is the probability that the value of the noise exceeds 4×10^{-4}? Express the answer in terms of the Q-function. 8
4. A 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, and 0.5. Construct a Huffman code and calculate the code efficiency. 8
5. A bipolar binary signal $s_i(t)$ ia a $+A$ or $-A$-volt pulse during the interval $(0, T)$. Assuming that $P(s_1)=P(s_2)=0.5, \eta/2=10^{-9}W/Hz, A=10mV$ and the transmission rate of data is 10^4 bits/sec, find the probability of error P_e. 8



$$\frac{2A^2T}{\eta} = \frac{A^2T}{\eta/2} = \frac{(0.01)^2(10^{-4})}{10^{-9}} = 10$$

$\alpha < f_s \cdot \Delta$

$$P_e = Q(\sqrt{10})$$

(1)

$$H(f) = \frac{1}{j2\pi f} + \frac{e^{-j2\pi fT}}{j2\pi f}$$

$$h(t) = sgn(t) - sgn(t-T)$$
$$= 2\,rect\left(\frac{t-T/2}{T}\right)$$

$s(t) = h(T-t) = h(t)$

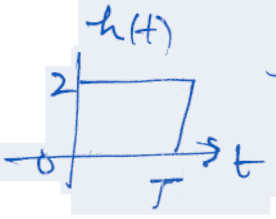
$\sigma^2 = 10^{-8}$

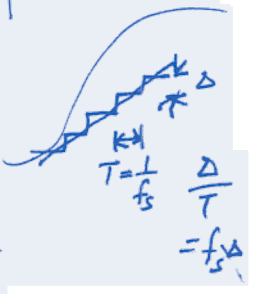
$P(X>x) = Q\left(\frac{x}{\sigma}\right)$

$$P(X>4\times10^{-4}) = Q\left(\frac{4\times10^{-4}}{10^{-4}}\right) = Q(4)$$

SOD

$\left|\frac{dm(t)}{dt}\right| < \left|\frac{d\tilde{m}(t)}{dt}\right|$





$\Delta \cdot f_s \geq \alpha$

$\alpha \leq \Delta \cdot f_s$

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Fourth-Year EEE, II Semester, 2007-2008
Test – 1 (Closed Book)
Course No. / Course Name: EEE UC416 / Digital Communication
Date: 24 Feb 2008 Duration: 50 min Marks: 50 Weightage: 25%

Note:- *Answer all questions*

1. Discuss the various channel models used in digital communication. (10 marks)

2. A signal $m(t) = \cos 200\pi t + 2\cos 320\pi t$ is ideally sampled at $f_s = 300$ Hz. 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? Illustrate your answer with the spectra for the original modulating signal as well as that of the sampled signal. (10 marks)

3. The bandwidth of a signal is 5 MHz. It is converted to PCM with 1024 quantizing levels. Determine the bit rate of the PCM signal. Assume that the signal is sampled at a rate 20% above the Nyquist rate. Also draw a block diagram showing the components of the PCM system.(10 marks)

4. A signal $m_1(t)$ is bandlimited to 3.6 kHz. Three other signals $m_2(t), m_3(t)$ and $m_4(t)$ are bandlimited to 1.2 kHz each. The signals are to be transmitted using time-division multiplexing. Show a scheme for achieving this with each signal sampled at *its* Nyquist rate. (10 marks)

5. The joint pdf of random variables X and Y is given by $f_{XY}(x, y) = ke^{-(ax+by)}u(x)u(y)$, where a and b are positive constants. Determine the value of constant k. (10 marks)