BENGAL ENGINEERING AND SCIENCE UNIVERSITY, SHIBPUR
ME, 1ST SEMESTER (ICE) FINAL EXAMINATION, 2012
Sub: Advanced Communication Systems (ICE-901)

F.M = 70

Time = 3 Hrs.

Answer any FIVE questions. The questions are of equal value.

1.a) Develop the discrete time equations for the encoding and decoding operations of differential pulse code modulation (DPCM). Draw the block diagram showing the elements constituting such a system.

b) A PCM system uses a uniform quantizer followed by a 7-bit binary encoder. The bit rate of the system is equal to 50×10^6 b/s.

i) What is the maximum message bandwidth for which the system operates satisfactorily?

ii) Determine the output signal-to-quantization noise ratio when a full-load sinusoidal modulating wave of frequency 1 MHz is applied to the input.

c) A certain PCM channel consists of 'n' identical links in tandem. The pulses are detected at the end of each link and clean new pulses are transmitted over the next link. If p_e is the probability of error in detecting a pulse over any one link, show that P_E, the probability of error in detecting a pulse over the entire channel (over the n links in tandem), is

$$P_E \approx n p_e$$

(4+3)+(2+2)+3

2.

(a) Show that Manchester coding satisfies the condition of null at dc i.e. P(w)=0 at w=0 but bandwidth requirement for transmission rate R_b using half width rectangular pulse is $2R_b$.

What are the merits and demerits of using controlled ISI over zero ISI ? Explain the benefit of using the duobinary pulse with differential coding.

(b) In a certain telemetry system, there are eight analog measurements, each of bandwidth 2 kHz. Samples of these signals are time-division multiplexed, quantized, and binary coded. The error in sample amplitudes cannot be greater than 1% of the peak amplitude.

i) Determine L, the number of quantization levels.

ii)Find the transmission bandwidth B_T if Nyquist criterion pulses with roll-off factor r=0.2 are used. The sampling rate must be at least 25% above the Nyquist rate.

(4+3+2) + (2+3)

3.(a) A binary encoded PCM baseband data with polar signaling is transmitted through an additive white Gaussian channel with PSD $\eta/2$. Show that an integrate and dump receiver cannot be wrong more than half the time on the average.

(b) If the integrate and dump receiver in (a) is designed as optimum filter that

minimizes probability of error, derive the expression of transfer function H(f) and the corresponding minimum probability of error (P_e)min.

(c) Find the signal shape at output of the matched filter for an input

$S(t) = A \quad 0 \leq t \leq T$

$= 0$ otherwise

Label all the important points and axes

(3 + 7 + 4)

4. a) Draw the block diagram of offset QPSK transmitter and very briefly explain the operation. How do you modify it to design non-offset QPSK? Highlight the critical differences between these two types of QPSK and also mention the associated difficulty in QPSK communication systems that employ repeaters.
   b) "In M-ary PSK receiver with synchronous detection, carrier recovery is accomplished by raising the received signal to M^{th} power, tuned at Mf_o (f_o is the carrier frequency used at the transmitter) using bandpass filter and finally frequency division by factor M"---Show mathematically what would happen if the steps used in synchronous BPSK demodulation are sequentially applied for the same purpose (carrier recovery) in M-PSK system.
   c) If digital message input data rate is 8 kbps and average energy per bit is 0.01 unit, find (i) bandwidth required for transmission of the message through BPSK, QPSK, 16 MPSK. (ii) put these schemes in order of their susceptibility to noise after calculating the minimum separation in signal space.

(4+2+1)+3+(2+2)

5) a) Develop BFSK technique with block diagram representation using two balanced modulators. From this block diagram representation, develop mathematical expression of BFSK signal, show the spectrum and geometrical representation of orthogonal BSK.
   "When compared BPSK and BFSK for transmission bandwidth and noise immunity (P_e value), the latter shows inferior performance and seems to be useless "--- Counter argue this statement to show its use with other modulation in hostile environment.

b) Write down the properties of the code pattern to be used for spread spectrum modulation.

A frequency-hopping spread spectrum system utilizes a fast-hop system with
k=10 hops per message bit
m=1024 frequencies
message bit rate=2500 b/ps
Final RF multiplication of K=10
Find:

i) The RF signal bandwidth
ii) Processing gains in decibels

(2+3+2)+3+4

6 a) Derive the expression of probability of bit error (P_e) in a K-user communication system (transmitting in same radio frequency f_0) with equal power P_s using code division multiple access (CDMA) with uncorrelated and distinct spreading codes. If the value of $P_e=10^{-3}$, determine the processing gain required for a CDMA system to have 20 simultaneous users.

b) What is partial cross-correlation between two arbitrary users in CDMA system? Mention few nonlinear suboptimum detectors used in CDMA along with their relative merits and demerits. Draw the generation of gold sequences and write the cross-correlation values. Comment on users' capacity about the Walsh codes.

(3+2)+(2+3+3+1)

7. Write short notes on any **two**

a) DS-SS system
b) Correlation detection
c) OFDM system

7x2=14