M.E. ICE 1st Semester Examination, 2011
Sub: Advanced Communication Systems
(ICE-901)

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

Full Marks: 70 Time- 3 hours

1. a) Develop the main equations for the operation of a delta modulator. Draw the block diagram showing the elements constituting such a system
   b) What are the different sources of error in Delta modulation (DM) and briefly explain how these are overcome in adaptive delta modulation (ADM)?
   c) The maximum frequency in an analog signal is f_m=2kHz. The information in the signal is to be conveyed over 8-level PCM system and the quantization noise is restricted to be <±0.781% of the peak-to-peak value of the analog signal, calculate the number of bits per symbols (bits per PCM word) to be used in this system. What is the bit transmission rate according to Nyquist criterion?

   5+ (3+2)+4

2. a) What is meant by duobinary pulse? Show that there exists one (and only one) pulse p(t) of bandwidth $R_b/2$ Hz that satisfies the criterion of duobinary pulse and this pulse is given by
   $p(t)=\{Sinc(\pi R_b t)+Sinc[\pi R_b (t-T)]\}=Sin(\pi R_b t)/\{\pi R_b t (1-R_b t)\}$

   b)Derive the expression of pulse shaping using Nyquist criterion for zero ISI? Calculate bandwidth of this pulse and also explain the term vestigial spectrum.

   c) A signal voltage in the frequency range 100 to 4000 Hz is limited to a peak to peak swing of 3V. It is sampled at a uniform rate of 8 KHz and the samples are quantized to 64 evenly spaced levels. Calculate and compare the bandwidth if the quantized samples are transmitted either as bits or four level pulses.

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

3. a) Derive a relation for signal- to- noise ratio at the output of a match filter in terms of energy of the input signal, transfer function of the filter and power spectrum of white Gaussian noise. Hence derive the condition when the filter will behave as a 'matched filter'.

   b) Briefly explain the operation of integrate-and-dump filter and show that signal-to-noise ratio gets maximum value at the end of the bit interval.

   c) Find the transform of the output of the matched filter for an input of
   S(t) =1 volt $0 \le t \le 1$ (t in second)
   =0 otherwise

If the input to the matched filter consists of the signal, S(t), plus additive white noise of two sided spectral density of 10^{-6} watts/Hz, find the maximum (S/N) output.

(3+2) +5+4

4. a) Derive the expression of PSD (power spectral density) for Polar signaling and highlight its merits and demerits. Mention the advantages and disadvantages of bipolar signaling.

b) A random binary data sequence 100 110... is transmitted using Manchester (Split-phase) line code with the pulse p (t) shown in Fig. 1 below

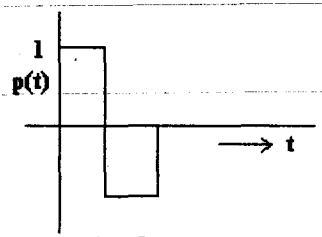

Fig. 1

Sketch the output waveform y(t) and derive S_y (w), the PSD of a Manchester signal assuming 1 and 0 equally likely. State disadvantages of this type of signaling technique.

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

5.a) Distinguish between QASK and QPSK signals. Describe a method for the generation and detection of QPSK signal. Show mathematically that bit error performance of 16-QASK is inferior to QPSK but superior to 16-PSK.

b) The output of a 2400 bits/s time division multiplexer is fed into a modem. Compare the transmission bandwidths required at the modem output for the following modulation scheme (raised cosine shapping is used).
i) FSK with frequency deviation of ± 2400 Hz about the carrier, ii) eight phase PSK.

(2+5+3)+4

6. a) Define spread spectrum (SS) modulation. Briefly explain operation principles of direct sequence spread spectrum (DS-SS) transmission and reception system with proper block diagram. Mention the relative merits and demerits of DS -SS and frequency hopping spread spectrum (FH-SS) system.

b) What is meant by "near far" problem in SS system? What type of SS will you prefer to solve near far problem? A direct-sequence system has a PN code rate of 192×10^6 chips per second and a binary message bit rate at 7500 b/s.

(i) If QPSK is used instead of biphase modulation, what is the process gain?

(ii) Assuming the received signal power is 4×10^{-14} watts and the one-sided noise spectral density level, N_0, is 1.6×10^{-20} W/Hz, find the signal-to-noise power ratio in the input bandwidth of the receiver.

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

7. a) Derive the expression of probability of bit error using spread spectrum (SS) modulation in hostile communication environment with single-tone interference and jamming. Extend this principle to derive the expression of probability of bit error 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

b) What is partial cross-correlation in connection with CDMA?- explain with block diagram. Draw the generation of gold sequences and write its cross-correlation properties.

c) A FH/PN hybrid SS system is specified by the following parameters:

B_s=1.92 GHz

M=512

PN code rate=3.75 Mb/s

15 chips per hop

2 hops per message bit

32-level quantizer

If error-correction coding is not used, what is the maximum frequency the message could have?

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

8) Write Short note on any two:

a) Delta-sigma modulation

b) Carrier Interferometry codes

c) 16-QASK

(7+7)