Code No: RR310405 **Set No. 1**

III B.Tech I Semester Regular Examinations, November 2006
DIGITAL COMMUNICATIONS
(Common to Electronics & Communication Engineering and Electronics & Telematics)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) A signal m(t) = 2 Cos (100πt) Cos (500πt) is ideally sampled at 700 Hz, and is sent through an ideal LPF with cut off at 650 Hz. Determine the frequency components in the filter output. What changes will be there if the sampling is done at Nyquist rate? [10]
   (b) As applicable to pulse modulations systems, write short notes on Sampling theorem in frequency. [6]

2. (a) Sketch and explain the typical waveforms of PWM signals, for leading edge, trailing edge and symmetrical cases.
   (b) Compare the analog pulse modulation schemes with CW modulation systems.
   (c) Show that a PAM signal can be expressed as the convolution of an instantaneously sampled signal, and a rectangular pulse p(t) of the form
   $p(t) = \begin{cases} 1, & |t| \leq \tau/2 \\ 0 & elsewhere \end{cases}$ [5+5+6]

3. (a) Explain how the residual effect of the channel is responsible for Inter Symbol Interference (ISI). [8]
   (b) Explain about three tap preset equalizer. [8]

4. (a) Explain the working of scrambler and unscrambler with the aid of diagrams.
   (b) Explain about optimum equalizer that minimizes the peak Inter Symbol Interference. [8+8]

5. (a) Explain μ-law and A-law for compression.
   (b) In what way is PCM different from other analog pulse modulations? What makes it a digital system? [8+8]

6. In a single-integration DM system, the voice signal is sampled at a rate of 64kHz.The maximum signal amplitude is Amax=1.
   (a) Determine the minimum value of the step size σ to avoid slope over load error.
   (b) Determine the granular noise power if the voice signals bandwidth is 3.5 kHz.
   (c) Assuming that the voice signal is sinusoidal, determine output signal power and SNR
   (d) Determine the minimum transmission bandwidth. [4+4+4+4]

7. (a) In the on-off keying version of an ASK system, symbol 1 is represented by Tramsmitting a sinusoidal carier of amplitude $\sqrt{2}E_b$ / T_b, where Eb is the signal energy per bit and T_b is the bit duration. Symbol '0' is represented by switching off the carrier. Assume that 1 and 0 occur with equal probability. For an AWGN channel determine the average probability of error for this ASK system, assuming

   i. Coherent reception

   ii. Noncoherent reception, operating with a large value of a bit energy-to-noise density ratio.

   Note: For large value of x

   $$I_0(x) \approx \exp(x) / (\sqrt{2}\,\Pi x)$$

   (b) A high frequency transmitter used in a binary communication system is peak Power limited to 1 kw. The power loss in the channel is 60 dB and the noise power at the receiver input (ηr_b) is 10^{-4} Watts. Assuming maximum signaling rate and equiprobable message bits, find Pe for non coherent ASK and coherent PSK signaling schemes. [8+8]

8. (a) A (7,4) block code is generated by using a generator matrix

$$G = \begin{vmatrix} 1 & 0 & 0 & 0 & 1 & 1 & 1 \\ 0 & 1 & 0 & 0 & 1 & 1 & 0 \\ 0 & 0 & 1 & 0 & 1 & 0 & 1 \\ 0 & 0 & 0 & 1 & 0 & 1 & 1 \end{vmatrix}$$

   Find the following:

   i. Parity check matrix

   ii. Code vectors for a message block (1001) and (1110)

   iii. Show how a single error can be corrected.

   [12]

   (b) Define minimum distance of a code word and weight of the code words. [4]

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Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
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1. (a) With neat diagrams, explain the principle of working a sample and hold circuit. List out its applications. [8]

   (b) Show that $\sum_{R=-\infty}^{\infty} x(RT_s) = f_s \sum_{n=-\infty}^{\infty} X(nf_s)$, where x(t) is a signal band limited to f_1 , X(f) is the spectrum of x(t), and $f_s = \frac{1}{T_s} = 2f_1$ is the Nyquist sampling rate. [8]

2. (a) Explain the principles of TDM. List out their merits, demerits and applications. [8]

   (b) Explain the method of generation and detection of PAM signals with neat schematics. [8]

3. (a) Derive the transfer functions of transmitting and receiving filters to minimize the effect of noise. [8]

   (b) Find the duo-binary encoded sequence for the data sequence 101011. How it is detected? [8]

4. (a) Why equalization is necessary is Base band transmission? Give the block diagram of adaptive filter and explain about each element. [8]

   (b) The unequalized pulse in a PAM system has the following values at sampling times:

$$p_r(kT_b) = p_r(k) = \begin{cases} 0.2 & k = 1 \\ 0.8 & k = 0 \\ 0.2 & k = -1 \end{cases}$$

$$p_{r(k)} = 0 \, for \; |k| > 1$$

   i. Design a three-tap zero forcing equalizer so that the equalizer output is 1 at k = 0 and 0 at k = ±1

   ii. Calculate P_{eq} (k) for k = ±2, ±3. [8]

5. A signal band limited to 1MHz is sampled at a rate of 50% higher than Nyquist rate and quantized into 256 levels using a μ-law quantizer with μ=255.

   (a) Determine the signal to quantization noise ratio.

   (b) The SNR found in

      i. was unsatisfactory.

It must be increased at least by 10dB.Would you be able to obtain the desired SNR without increasing the transmission bandwidth, if it was found that a sampling rate 20% above the Nquist rate is adequate. If so, explain how. What is the maximum SNR that can be realized in this way. [16]

6. (a) The ramp signal m(t) = at is applied to a DM which operates with a sampling period Ts and step size δ.
   i. Show that the slope over load distortion occurs in δ <a T_s.
   ii. Sketch the modulator output for the following three values of step size:
   A. δ=0.75a T_s
   B. δ=a T_s
   C. δ=1.25a T_s [8]

   (b) Consider a speech signal with maximum frequency of 3.4 kHz and maximum amplitude of 1v. This speech signal is applied to a DM whose bit rate is set at 20kbps. Discuss the choice of appropriate step size for the modulator. [8]

7. (a) Write down the modulation waveforms for transmitting binary information over baseband channels, for the following modulation schemes.
   i. ASK
   ii. FSK
   iii. PSK and
   iv. Baseband pulse shaping followed by DSB modulation.

   what are the advantages and disadvantages of digital modulation schemes?

   (b) Discuss base band transmission of M-ary data. [6+10]

8. (a) What is meant by forward error correcting codes? State its advantages.

   (b) Find all code vectors for a (6,3) block code whose generator matrix is

$$G = \begin{vmatrix} 1 & 0 & 0 & 0 & 1 & 1 \\ 0 & 1 & 0 & 1 & 0 & 1 \\ 0 & 0 & 1 & 1 & 1 & 0 \end{vmatrix}$$

   and also find Parity check matrix and show how an error can be detected and corrected. [4+12]

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Code No: RR310405 **Set No. 3**

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Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
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1. (a) Explain the different types of Sampling. [10]
   (b) Obtain the Nyquist rate and Nyquist interval for the signal 10 Cos (2000πt) Cos (4000πt) based on ?
      i. low pass sampling theory, and
      ii. band pass sampling theory. [6]

2. Four signals Cos ω_0t, 0.2 Cos ω_0t, 2 Cos 2 ω_0t and Cos 4 ω_0t are to be multiplexed in a TDM system. Find the minimum sampling rate f_s , minimum interval and the associated commutator speed. If the commutator rotates at $f_s/4$, and $f_s/8$ revolutions per sec., determine the number of o/p samples of each signal per rotation. Illustrate and explain this process with neat schematics for a commutator switch rotating at a speed of $f_s/4$ revolutions per sec., showing the transmitting and receiving sides. Discuss the necessity of synchronization for this case. [16]

3. (a) What is the main draw back in Duo-binary signaling and how can you overcome the above? [8]
   (b) Duo-binary signaling utilizes controlled amounts of ISI. Justify the statement. [8]

4. (a) What is meant by Synchronization in the base band PAM. What are the different methods to obtain Synchronization? [8]
   (b) The T1 carrier system used in digital telephony multiplexes 24 voice channels based on 8-bit PCM. Each voice signal is usually put through a lowpass filter with cutoff frequency of about 3.4 KHz. The filtered voice signal is sampled at 8KHz. In addition, a single bit is added at the end of the frame for the purpose of synchronization. Calculate
      i. the duration of each bit
      ii. the resultant transmission rate and
      iii. the minimum required transmission bandwidth. [8]

5. A signal band limited to 1MHz is sampled at a rate of 50% higher than Nyquist rate and quantized into 256 levels using a μ-law quantizer with μ=255.
   (a) Determine the signal to quantization noise ratio.
   (b) The SNR found in

i. was unsatisfactory.

It must be increased at least by 10dB.Would you be able to obtain the desired SNR without increasing the transmission bandwidth, if it was found that a sampling rate 20% above the Nquist rate is adequate. If so, explain how. What is the maximum SNR that can be realized in this way. [16]

6. In a single-integration DM system, the voice signal is sampled at a rate of 64kHz.The maximum signal amplitude is Amax=1.
   (a) Determine the minimum value of the step size σ to avoid slope over load error.
   (b) Determine the granular noise power if the voice signals bandwidth is 3.5 kHz.
   (c) Assuming that the voice signal is sinusoidal, determine output signal power and SNR
   (d) Determine the minimum transmission bandwidth. [4+4+4+4]

7. (a) Explain DPSK modulator and DPSK demodulator with block diagram and differential encoding and decoding table.
   (b) In a binary PSK scheme using correlation receiver, the local carrier waveform is A cos ($W_c t + \varphi$) instead of A cos $W_c t$ due to poor carrier synchronization. Derive an expression for the probability of error and compute the increase in error probability when φ=$15^0$and A^2T_b /η =10. [8+8]

8. Consider a (7,4) linear code whose generator matrix is

$$G = \begin{bmatrix} 1 & 0 & 0 & 0 & 1 & 0 & 1 \\ 0 & 1 & 0 & 0 & 1 & 1 & 1 \\ 0 & 0 & 1 & 0 & 1 & 1 & 1 \\ 0 & 0 & 0 & 1 & 0 & 1 & 1 \end{bmatrix}$$

   (a) Find all the code vectors of this code.
   (b) Find the parity check matrix for this code.
   (c) Find the minimum weight of this code
   (d) Show the error correction capability of this code. [16]

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Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
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1. (a) With neat diagrams, explain the principle of working a sample and hold circuit. List out its applications. [8]
   (b) Show that $\sum_{R=-\infty}^{\infty} x(RT_s) = f_s \sum_{n=-\infty}^{\infty} X(nf_s)$, where x(t) is a signal band limited to f_1 , X(f) is the spectrum of x(t), and $f_s = \frac{1}{T_s} = 2f_1$ is the Nyquist sampling rate. [8]
2. (a) What are the different types of pulse modulation? [4]
   (b) Prove that PWM requires a greater average power a PAM system? [12]
3. (a) Derive the transfer functions of transmitting and receiving filters to minimize the effect of noise. [8]
   (b) Find the duo-binary encoded sequence for the data sequence 101011. How it is detected? [8]
4. (a) Why equalization is necessary is Base band transmission? Give the block diagram of adaptive filter and explain about each element. [8]
   (b) The unequalized pulse in a PAM system has the following values at sampling times:

$$p_r(kT_b) = p_r(k) = \begin{cases} 0.2 & k = 1 \\ 0.8 & k = 0 \\ 0.2 & k = -1 \end{cases}$$

$$p_{r(k)} = 0 \, for \; |k| > 1$$

   i. Design a three-tap zero forcing equalizer so that the equalizer output is 1 at k = 0 and 0 at k = ±1
   ii. Calculate P_{eq} (k) for k = ±2, ±3. [8]
5. A signal band limited to 1MHz is sampled at a rate of 50% higher than Nyquist rate and quantized into 256 levels using a μ-law quantizer with μ=255.
   (a) Determine the signal to quantization noise ratio.
   (b) The SNR found in
      i. was unsatisfactory.

It must be increased at least by 10dB.Would you be able to obtain the desired SNR without increasing the transmission bandwidth, if it was found that a sampling rate 20% above the Nquist rate is adequate. If so, explain how. What is the maximum SNR that can be realized in this way. [16]

6. (a) Explain with neat block diagram Adaptive Delta Modulator Transmitter and Receiver.

   (b) Explain the advantages of Adaptive Delta Modulation over Delta Modulation and how is it achieved. [8+8]

7. (a) Binary data has to be transmitted over a telephone link that has a usable band width of 3000hz a maximum achievable signal-to-noise power ratio 6db at its o/p.

      i. Determine maximum signaling rate and the probability of error if a coherent ASK scheme is used for transmitting binary data through the channel.

      ii. If the data rate is maintained at 300 bits/sec, calculate the error of probability. [4+4]

   (b) Explain the working principle of a PSK. [8]

8. (a) Explain the encoding principle in convolutional code. [8]

   (b) The generator polynominal of (15,7) cyclic code is g(x)= $1+x^4+x^6+x^7+x^8$ Find the code vector (in systematic form) for the message polynominal D (x) = $x^2+x^3+x^4$. [8]

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