BHARATI VIDYAPEETH'S COLLEGE OF ENGINEERING FOR WOMEN, PUNE-43

Department of Electronics and Telecommunication Engineering

UNIT TEST I – Digital Communication

Time: 1 Hour **Class: T.E. I & II** **Max. Marks: 30**

Q.1) (a) A compact disc (CD) records audio signals digitally by using PCM. Assume the audio signal B.W. to be 15 kHz.

(I) Find Nyquist rate.

(II) If the Nyquist samples are quantized into L = 65,536 levels and then binary coded, determine the number of binary digits required to encode a sample.

(III) Determine the number of bits/s required to encode the audio signal.

(IV) For practical reasons, the signals are samples at a rate well above Nyquist rate at 44,100 samples/ s. If L = 65,536, determine the number of bits/s required to encode the signal and transmission B.W. of encoded signal. **[8]**

(b) A 1 kHz signal of voice channel is sampled at 4 kHz using 12 – bit PCM and a DM system. If 25 cycles of voice signal are digitized, then find the following in each case

(I) Signaling rate

(II) B.W. required

(III) Number of bits required to be transmitted

(IV) Comment on the results **[7]**

(Q. 2) (a) 24 voice signals are sampled uniformly and then Time Division Multiplexed. The sampling operation uses flat-top samples with 1 μs duration. The multiplexing operation included provision for synchronization by adding an extra pulse of sufficient amplitude and also 1 μs duration. The highest frequency component of each voice signal is 3.4 kHz. assuming f_s of 8 kHz, calculate the spacing between successive pulses of the multiplexed signal. Repeat your calculation assuming the use of Nyquist rate sampling. **[8]**

Given the data stream 1110010100, sketch the transmitted sequence of pulses for each of the following line codes:

(a) Unipolar nonreturn-to-zero

Given the data stream 1110010100, sketch the transmitted sequence of pulses for each of the following line codes:

(a) Unipolar nonreturn-to-zero

(b) Polar nonreturn-to-zero

(c) Unipolar return-to-zero

(d) Bipolar return-to-zero

(e) Manchester code

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(b) Explain the sampling theorem for low pass signals in time domain. Also explain the reconstruction of signals from samples. **[7]**

(Q.2) (a) A compact disc (CD) records audio signals digitally by using PCM. Assume the audio signal B.W. to be 15 kHz.

(I) Find Nyquist rate.

(II) If the Nyquist samples are quantized into L = 65,536 levels and then binary coded, determine the number of binary digits required to encode a sample.

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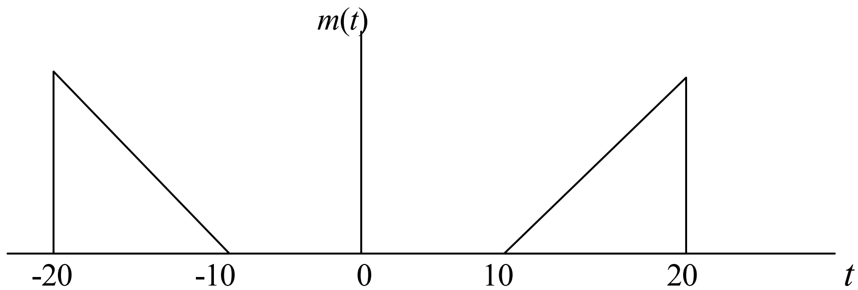
(Q.1) (a) A bandpass signal *m*(*t*) with a spectrum is shown in the figure given below. Check the bandpass sampling theorem by sketching the spectrum of the ideally sampled signal $m_s(t)$ when f_s = 25, 45 and 50 kHz. Indicate if and how the signal can be recovered. **[8]**



(b) Differentiate between Natural, Ideal and Flat – Top sampling, diagrammatically with application and waveforms. Comment on recovery of baseband signal. **[7]**

(Q.2) (a) Given the data stream 10110100, sketch the transmitted sequence of pulses for each of the following line codes:

(I) Unipolar RZ **(II)** Unipolar NRZ **(III)** Polar RZ **(IV)** Polar NRZ

(V) Bipolar NRZ (AMI) **(VI)** Split-phase Manchester **(VII)** Polar quaternary NRZ **[7]**

(b) Consider an audio signal with spectral components limited to the frequency band 300 Hz to 3.3 kHz. Assume that a sampling rate of 8 kbps will be used to generate a PCM signal. Assume that the ratio of the peak signal power to average quantization noise power at the output to be 30 dB. Also assume that the signals amplitude and power are normalized.

(I) What is the minimum number of uniform quantization levels needed, and what is the minimum number of bits per sample needed?

(II) Calculate the system bandwidth (as specified by the main spectral lobe of the signal) required for the detection of such a PCM signal. **[8]**

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Time: 1 Hour 30 Min **Class: T.E. I & II** **Max. Marks: 50**

Q.1) Explain the closed loop synchronisation. Draw block diagram of early-late synchroniser. (8-M)

Q.2) Explain scrambler and unscrambler. (8-M)

Q.3) Draw the block diagram of integrate and dump filter. Derive the expression for probability of error of matched filter. (8-M)

Q.4) State basic principles of MSK with block schematic and suitable waveform. (10-M)

Q.5) Write the comparison between QPSK and MSK. (Minimum 8 Points) (8-M)

Q.6) Derive the expression for probability of error of BFSK. Draw the signal space diagram for the BFSK. (8-M)

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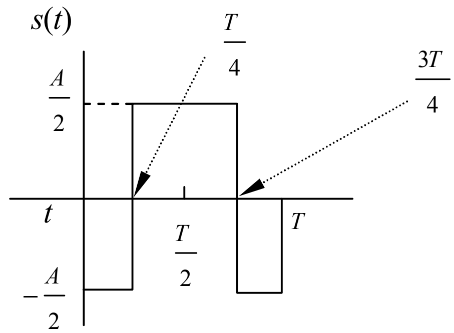
UNIT TEST I – Digital Communication

Time: 1 Hour 30 Min **Class: T.E. I & II** **Max. Marks: 50**

1. Consider the signal $s(t)$ shown below



(a) Determine the impulse response of a filter matched to this signal and sketch it as a function of time.
(b) Plot the matched filter output as a function of time.
(c) What is the peak value of the output? (8)

2. A binary PCM system using polar NRZ signaling operates just above the error threshold with an average probability of error equal to 10^{-6}. Suppose that the signaling rate is doubled. Find the new value of the average probability of error. (7)

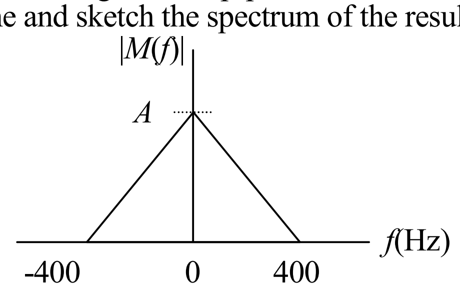
3. Given the data stream 1110010100, sketch the transmitted sequence of pulses for each of the following line codes:
   (a) Unipolar NRZ
   (b) Polar NRZ
   (c) Unipolar RZ
   (d) Bipolar RZ (8)

4. A linear delta modulator is designed to operate on speech signals limited to 3.4 kHz. The specifications of the modulator are as follows:
   (a) $f_s = 10 f_{Nyquist}$, where $f_{Nyquist} = 2 f_{m\,(\text{speech signal})}$ (b) $\Delta = 100\ mV$

The modulator is tested with a 1-kHz sinusoidal signal. Determine the maximum amplitude of this test signal required to avoid slope overload. (7)

5. A voice signal (300 Hz to 3.3 kHz) is digitized such that the quantization distortion $\leq \pm 0.1$ % of the peak – to – peak signal voltage. Assuming $f_s = 8$ ksamples/s and multilevel PAM waveform with 32 levels, find the theoretical minimum system bandwidth that avoids ISI. (10)

6. The figure shown below shows the idealized spectrum of a message signal $m(t)$. The signal is sampled at a rate equal to 1 kHz using flat – top pulses, with each pulse being of unit amplitude and duration 0.1 ms. Determine and sketch the spectrum of the resulting PAM signal. (10)



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Time: 1 Hour 30 Min **Class: T.E. I & II** **Max. Marks: 50**

Q.1) D.M. Sytem is designed to operate at 3 times the Nyquist rate for the signal with 3KHz bandwidth. The quantising step size is 250 mV.
a) Determine the maximum apmlitude of 1KHz input sinusoid for which the delta modulator does not show slope overload.
b) determine the post filtered output SNR for the signal in part (a). (8-M)

Q.2) Write the properties of line coder. Derive the PSD equation for bipolar NRZ. (8-M)

Q.3) Draw AT &T and CCITT hierarchy. (8-M)

Q. 4) With mathematical representation of QPSK signal, draw the signal space diagram of QPSK signal. Write the expression of all the message points in the diagram. Differentiate QPSK with OQPSK. (8-M)

Q.5) If a digital message input data rate is 8kbps and average energy per bit is 0.01 unit, find
a) bandwidht required for transmission of message through BPSK, QPSK, FSK, MSK.
b) put these schemes in order of their susceptibility to noise after calculating minimum separation in signal space. (8-M)

Q.6) In a digital communication system, the bit rate of NRZ data stream is 1Mbps and carrier frequency of 100 MHz. Compute the symbol rate of transmission bandwidht requirement of channel for
a) QPSK b) BPSK. (10-M)