LNMIIT
The LNM Institute of Information Technology

Digital Communication
Mid Term Exam

Date: 5th Oct. 2018 **Time: 90 Minutes** **Max Marks. 30**

Instructions: 1). Please check there must be six questions in the paper, printed on both sides.
2). All questions are compulsory.

1. (a) A random binary data sequence 110100101 is to be transmitted by using Unipolar RZ line code. Sketch the line coded waveform. [2]
   (b) Derive $S_y(f)$, the PSD of Unipolar RZ line coding scheme. Sketch this PSD and find its bandwidth. [3]

2. A television signal (video and audio) has bandwidth of 4.5 MHz. This signal is sampled, quantized, and binary coded to obtain a PCM signal
   a) Determine the sampling rate if the signal is to be sampled at a rate 25% above the Nyquist rate. [2]
   b) If the samples are quantized into L = 2048 levels, determine the number of binary digits required to encode each sample. [1]
   c) Determine the number of binary digits per second (bits/s) required to encode this signal. [1]
   d) Find the minimum bandwidth required to transmit this signal. [1]

3. For a 16-QAM signal configuration, assuming all the symbols are equiprobable, determine the symbol error probability of the optimum receiver for an AWGN channel. [5]

4. We are required to transmit 2.08×10^6 binary digits per second with probability of error $(P_b) \leq 10^{-6}$. Two possible schemes are considered:
   (a) B-PSK
   (b) 16-PSK
   The channel noise power spectral density (PSD) is $S_n(\omega) = 10^{-8}$. Determine the transmission bandwidth and the signal power required at the receiver input in each case. $[Q(4.7) \approx 10^{-6}, Q(4.6) \approx 2 * 10^{-6}]$. [5]

5. The following four waveforms are used for signaling in a digital communication system:

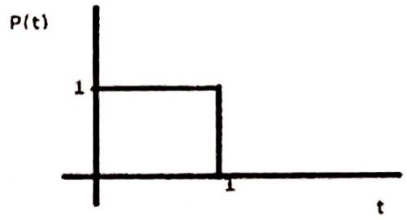
$$S_1(t) = u(t) - 1.5u(t-1) + 0.5u(t-2),$$
$$S_2(t) = -0.5u(t) + 1.5u(t-1) - u(t-2),$$
$$S_3(t) = -u(t-1) + u(t-2),$$
$$S_4(t) = 0.5u(t) + 0.5u(t-1) - u(t-2),$$

   where u(·) is the unit step function. Determine the signal space representation of the four signals $S_k(t)$, k = 1, 2, 3, 4 by using two basis functions defined as [5]

$$f_1(t) = u(t) - u(t-1),$$
$$f_2(t) = u(t-1) - u(t-2).$$

6. (a) Consider a signal s(t) that is contaminated by AWGN with power spectrum $S_n(f) = N_o/2$. Both signal and noise are input into a linear time invariant filter with impulse response h(t). The output of the filter due to signal is $S_o(t)$ and the output of the filter due to noise is $n_o(t)$. Derive the impulse response (h(t)) of the filter that is matched to this signal and maximizes the output signal-to-noise ratio. [3]

(b) Let $g(t) = p(t) * p(t)$, where $'*'$ denotes the convolution operator and $p(t)$ is shown below:



Find the impulse response of the filter matched to signal $S(t)$, where $S(t) = g(t) - [\delta(t-2) * g(t)]$. [2]