Communications Engineering

Course No: 16:332:421 - (Fall 2006)

Quiz 2

Instructions : *Answer all questions.* **Maximum Marks: 25**. *The points for each question are listed below in parentheses. You are allowed a total time of* **1 hour and 20 minutes**.

1. An analog signal is sampled at a sampling rate of $8\,KHz$. It is then quantized using a total of 64 representation levels, followed by binary encoding into bits. The digitized information (bits) is then transmitted over a baseband M-ary PAM system, i.e., M is the number of amplitude levels that the pulse amplitude modulator produces. Find the minimum bandwidth required for distortionless transmission for the following cases: **(8)**

   (a) $M = 2$

   (b) $M = 4$

2. A binary PAM wave is to be transmitted over a baseband channel with an absolute maximum bandwidth of $60\,KHz$. The bit rate of the system is $100\,Kbps$. If we are to design a raised cosine spectrum that satisfies these requirements, find the *rolloff factor* α of the raised cosine pulse ? **(4)**

3. Find an expansion in terms of an orthonormal set of basis functions for the collection of signals $\{s_i(t)\}_{i=1}^{i=4}$, where the signal $s_i(t)$ is of the form **(5)**

$$s_i(t) = \begin{cases} \sqrt{\frac{2E}{T}}\cos(2\pi\frac{t}{T} + i\frac{\pi}{4}), & 0 \le t \le T \\ 0, & \text{otherwise} \end{cases}$$

4. Consider an additive white Gaussian noise (AWGN) process $w(t)$ with zero mean and power spectral density of height 1. The process $w(t)$ is projected onto a set of orthonormal basis functions $\{\phi_j(t)\},\ j = 1, \cdots, N,\ 0 \le t \le T$. The projection of $w(t)$ onto the basis $\phi_j(t)$ is defined as **(8)**

$$w_j = \int_0^T w(t)\phi_j(t)dt$$

   (a) Find the mean, variance and distribution of the random variable w_j

   (b) Find the covariance $Cov(w_j\, w_k)$ between the random variables w_j and w_k

   (c) Are the random variables w_j and and w_k independent?

Good luck!