Communications Engineering

Course No: 16:332:421 - (Fall 2007)

Quiz 1

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. Consider a PCM system employing on-off keying, i.e., a bit 1 is represented by a pulse of height A for a duration of 1 second and a bit 0 is represented by a pulse of height $-A$ for a duration of 1 second. The signals are transmitted over an AWGN channel with zero mean and power spectral density 1/2. A receiver is designed as shown in Figure 1 to decide if a 0 or 1 was transmitted. (**10**)

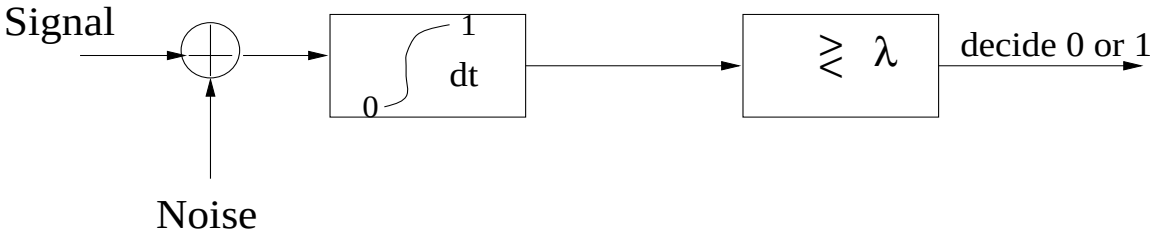

Figure 1: Receiver for the PCM System with On-off Keying

   (a) Assuming that the probability of transmitting a bit 0 is $p_0 = 1/3$ and that of transmitting a bit 1 is $p_1 = 2/3$, derive the optimum threshold λ that minimizes the probability of error.
   (b) If the bit transmissions are equally likely, i.e., $p_0 = p_1 = 1/2$, evaluate the minimum average probability of error in terms of the the complementary error function erfc(x) which is given as

$$\text{erfc}(x) = \frac{2}{\sqrt{\pi}} \int_x^\infty \exp(-z^2) dz$$

2. A video signal has a maximum frequency of of $50\,KHz$. It is sampled according to the Nyquist criterion and then quantized using 10 bits per sample, followed by binary pulse coded modulation for transmission. In the absence of additive noise, what is the minimum bandwidth required for distortionless transmission? (**5**)

3. 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 ? (**5**)

4. X is a random variable with PDF given as (**5**)

$$f_X(x) = \frac{1}{2\sqrt{2\pi}} e^{-\frac{(x-2)^2}{8}} \quad -\infty \leq x \leq \infty$$

   Find the PDF of $Y = 2X + 10$

Good luck!