In the Name of God

Communication Systems (25751-4)

Problem Set 08

Fall Semester 1402-03

Department of Electrical Engineering

Sharif University of Technology

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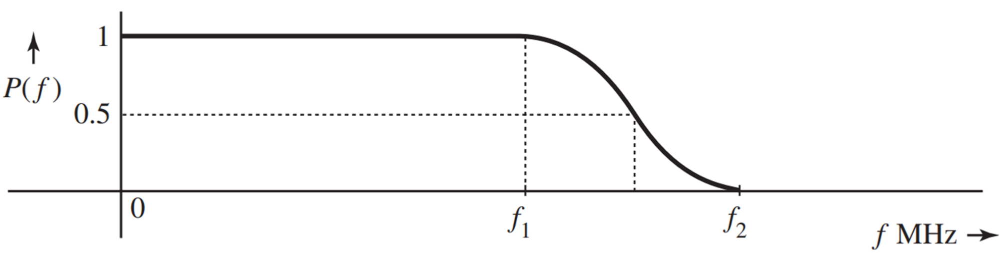
Due on Dey 22, 1402 at 23:55

1 Bandwidth of PAM Signal

1. Consider a PAM scheme with $M = 8$ that utilizes a pulse-shape satisfying Nyquist's first criterion.
   (a) Determine the minimum transmission bandwidth required to transmit data at a rate of $R_b = 318$ kbit/s with zero ISI.
   (b) Determine the transmission bandwidth if the raised cosine pulse with a roll-off factor $r = 0.25$ is used in the PAM scheme.
2. Now we set $M = 16$.
   (a) What is the theoretical minimum system bandwidth needed for a 10 Mbits/s signal using 16-level PAM without ISI?
   (b) How large can the filter roll-off factor be if the allowable system bandwidth is 1.375 MHz?

2 Transmission with PAM

A 16-level PAM baseband transmission at the data rate of 640 Mbit/s is to be transmitted by means of Nyquist's first criterion pulses with $P(f)$ shown below. The frequencies f_1 and f_2 (in Hz) of this spectrum are adjustable. The channel available for transmission of this data has a bandwidth of 120 MHz. Determine f_1, f_2, and the roll-off factor for this transmitter.



3 Error Probability for Polar and Bipolar Signals

1. Compute decision threshold and error probability for polar signal with probability p_1 for transmitting one and p_0 for transmitting zero.
   Note that after demodulation and detection in the receiver the received signal sampled at kT_s is in a form as below. N is a Gaussian random variable with zero mean and σ_n^2 variance.
   $$R(kT_s) = \pm A_p + N$$
2. Compute decision threshold and error probability if $p_0 = p_1 = \frac{1}{2}$.
3. Repeat parts 1, 2 if N is a Laplace random variable with the following pdf:
   $$f_N(n) = \frac{1}{2b} \exp(\frac{-|n|}{b})$$

4 Binary Polar Video Signal

A video signal has a bandwidth of 4.5 MHz, average power of 0.8 W, and peak voltages of ±1.2 V. This signal is sampled, uniformly quantized, and transmitted via binary polar baseband modulation. The sampling rate is %25 above the Nyquist rate.

1. If the required SNR for video quality is at least 53 dB, determine the minimum binary pulse rate (in bits per second) for this baseband transmission.
2. Find the minimum bandwidth required to transmit this signal without ISI when a raised-cosine pulse shape with roll-off factor $r = 0.3$ is used.

5 Multiple Access Control

6 messages for transmission arrive at different multiple access wireless nodes at times $t = [0.8, 0.9, 1.4, 2.9, 3.8, 4.4]$ and each transmission requires exactly $T = 1$ time unit.

1. Suppose all nodes are implementing the ALOHA protocol. For each message, indicate the time at which each transmission begins. Which messages transmit successfully?
2. Suppose all nodes are implementing the Slotted Aloha protocol with slot boundaries at $t = 1, 2, 3, \ldots$. For each message, indicate the time at which each transmission begins. Which messages transmit successfully?
3. Suppose all nodes are implementing Carrier Sense Multiple Access (CSMA), but without collision detection. Suppose that the time from when a message transmission begins until it is beginning to be received at other nodes is 0.4 time units. (Thus if a node begins transmitting a message at t=2.0 and transmits that message until t=3.0, then any node performing carrier sensing in the interval [2.4, 3.4] will sense the channel busy.) For each message, indicate the time at which each message transmission begins, or indicate that message transmission does not begin due to a channel that is sensed busy when that message arrives. Which messages transmitted successfully?
4. Suppose all nodes are implementing Carrier Sense Multiple Access (CSMA), with collision detection (CSMA/CD). Suppose that the time from when a message transmission begins until it is beginning to be received at other nodes is 0.4 time units, and assume that a node can stop transmission instantaneously when a message collision is detected. (Thus if a node begins transmitting a message at t=2.0 and transmits that message until t=3.0, then any node performing carrier sensing in the interval [2.4, 3.4] will sense the channel busy.) For each message, indicate the time at which each message transmission begins, or

indicate that message transmission does not begin due to a channel that is sensed busy when that message arrives. Which messages transmitted successfully? At what time did each message stop transmitting due to a collision?