EE 5140: Digital Modulation and Coding
Quiz I - Sep 6, 2016

Remarks

- You are allowed to bring one formula sheet (hand-written).
- If anything is not clear, make/state your assumptions and proceed.

Problems

1. (10 marks) Consider the pulse $p(t) = \text{sinc}(\alpha t)\text{sinc}(\beta t)$ where α and β have to be determined.

   (a) How should α and β be chosen such that $p(t)$ satisfies Nyquist criterion with excess bandwidth parameter 0.5 for the data rate of 40 Mbps using 16-QAM constellation. Specify the bandwidth occupied for this case.

   (b) How should α and β be chosen such that $p(t)$ satisfies Nyquist criterion simultaneously for both the following cases: 40 Mbps using 16-QAM and 8 Mbps using 8-PAM. Specify the bandwidth occupied in this case.

2. (5 marks) Consider a pulse $p(t)$ which supports a symbol rate of 1 symbol/second. Let the bandwidth occupied by the linearly modulated waveform using pulse $p(t)$ is 5 Hz.

   (a) We want to support bit rate of 30 Mbps using a bandwidth of 15 MHz. We employ suitably time-scaled version of the pulse $p(t)$ for modulation. Find the smallest value of M such that we can modulate with $M-$QAM symbols to meet above bandwidth/data-rate requirements.

   (b) With $\{b(n)\}$ denoting the transmitted symbols, write the explicit expression for the linearly modulated waveform $x(t)$ for the specifications given in part (a).

3. (15 marks) Consider the complex envelope $x(t)$ with spectrum $X(f) = \begin{cases} 1, & 0 \leq f \leq 10 \\ 0 & \text{Otherwise.} \end{cases}$

   (a) Plot the corresponding spectrums of the in-phase signal $x_c(t)$ and quadrature signal $x_s(t)$. Plot real and imaginary parts separately.

   (b) Consider the real passband signal $u_p(t)$ with spectrum specified for positive frequencies as $U_p(f) = \begin{cases} -2, & 90 \leq f \leq 100 \\ 2, & 100 < f \leq 110 \\ 0, & \text{Other positive frequencies.} \end{cases}$
   Write an explicit time domain relationship between $x(t)$ and $u_p(t)$.

   (c) Suppose $u_p(t)\cos(200\pi t)$ is passed through an ideal low pass filter with cutoff frequency 20. Find the corresponding output.