University of Illinois at Urbana-Champaign
Department of Electrical and Computer Engineering

ECE 459: Communications I

Fall 2004

Problem Set 10

Pulse Amplitude Modulation, Pulse Code Modulation

Issued: Thursday, December 2nd. **Due:** Never.

Reading from Lathi: Sampling and Pulse Amplitude Modulation: Chapter 6, Section 6.1 and Chapter 7, Section 7.3; Quantization and Pulse Code Modulation: Chapter 6, Section 6.2.

Reading from Haykin (3rd Edition): Sampling and Pulse Amplitude Modulation: Chapter 6, Sections 6.1–6.4; Quantization and Pulse Code Modulation: Chapter 6, Sections 6.7–6.10.

Announcement: The Final Exam will be held on Monday, December 13th, from 1:30pm to 4:30pm in 165 Everitt Laboratory. The exam will cover all material from the beginning of the term. For the exam, you can bring *three* 8.5×11-inch double-sided sheets of *handwritten* notes. Calculators are allowed but will not be necessary.
A copy of an old final exam will be available from `http://courses.ece.uiuc.edu/ece459/fall04/`. This sample exam does not necessarily resemble this year's exam (also notice that the material covered in this old final exam is slightly different from the material covered in this year's final exam).

Problem 10.1

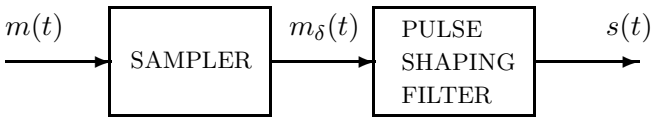
Problem 6.1-2 from Lathi, p. 289.

Problem 10.2

Problem 6.1-5 from Lathi, p. 290.

Problem 10.3

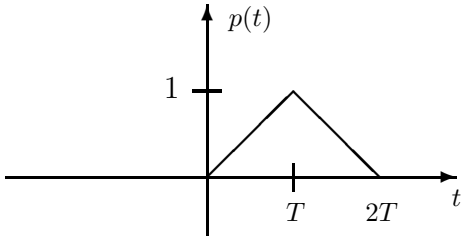
Consider the pulse amplitude modulation (PAM) scheme shown below.



The output of the sampler is given by

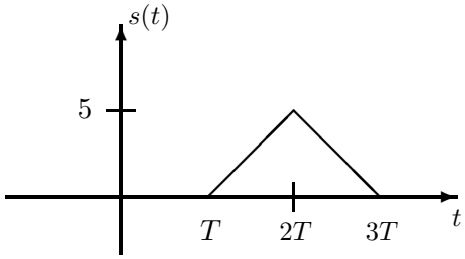
$$m_\delta(t) = \sum_{k=-\infty}^{+\infty} m(kT)\delta(t - kT)$$

(where T is the sampling period) and the output of the pulse shaping filter is given by $s(t) = m_\delta(t) * p(t)$, where $p(t)$ is the following pulse.



(a) Suppose that $m(t) = \cos 2\pi t$ and that the sampling period is $T = \frac{1}{8}$s. Sketch the resulting transmitted signal $s(t)$ for $0 \leq t \leq 1$s.

(b) Suppose instead that the message signal $m(t)$ is bandlimited with bandwidth W Hz and that sampling is performed exactly at the Nyquist rate of $m(t)$ (i.e., $T = \frac{1}{2W}$). Furthermore, we are given that the transmitted signal $s(t)$ looks as follows.



Find the corresponding message signal $m(t)$. Is your answer unique?

Problem 10.4

Problem 7.3-4 from Lathi, pp. 349–350.

Problem 10.5

Problem 6.2-2 from Lathi, p. 289 (in part (d), ignore the question about the minimum bandwidth required).

Problem 10.6

Problems 6.2-6 from Lathi, p. 292.