THE STATE UNIVERSITY OF NEW JERSEY

# RUTGERS

College of Engineering
Department of Electrical and Computer Engineering

**332:322** **Principles of Communications Systems** **Spring**

Problem Set 5

**Reading: Haykin 3.1–3.4**

1. **Nyquist 101:** Specify the Nqyusit rate and Nyquist interval for each of the following signals. Note that $sinc(x) \equiv \frac{\sin(\pi x)}{\pi x}$.

   (a) $g(t) = sinc(200t)$

   (b) $g(t) = sinc^2(200t)$

   (c) $g(t) = sinc(200t) + sinc^2(200t)$

2. **Nyquist 102:** Suppose we have samples of a signal $a_k = g(k\Delta)$ where $\Delta$ is shorter than the Nyquist interval for the bandlimited function $g(t)$. Derive an explicit time-domain expression for how we recover the function $g(t)$ from the samples $\{a_k\}$.

3. **Nyquist Grad School:** Does the Nyquist Sampling Theorem apply to strictly time limited signals? If not why not? If so, why? This problem is a bit subtle so think carefully and analytically (and justify any assumptions).

4. **Pulse Modulation**

   (a) What is Pulse Amplitude Modulation? Provide a pictorial example.

   (b) What is Pulse Position Modulation? Provide a pictorial example.

   (c) What is Pulse Frequency Modulation? Provide a pictorial example.

   (d) What is Pulse Width Modulation? Provide a pictorial example.

   (e) Consider a full wave rectified AM signal $r(t) = m(t)\cos 2\pi f_c t$ where we assume $m(t) \geq 0\ \forall t$. Assuming the highest frequency content of $m(t)$ is much less than $f_c$, can $r(t)$ be considered the approximate result of a pulse modulation method applied to $m(t)$? If so, which one?

5. **Problem 3.5 in Haykin**