Fundamentals of Digital Communications
Problem Class 6
Random Processes

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Problem 6.1

A zero-mean white noise process $n(t)$ with double-sided power spectral density (PSD) $N_0/2$ is passed through a linear filter that is characterized by an impulse response $h(t)$.
(a) Find the autocorrelation function and PSD of the output signal $x(t)$ of the filter.
(b) Compute the first and second-order moments of the filter output (mean value and variance).

Problem 6.2

A transmitted (baseband) signal with PAM, PSK, or QAM modulation can be expressed as

$$v(t) = \sum_{n=-\infty}^{\infty} a_n g_T(t - nT)$$

where $\{a_n\} \in \mathbb{C}$ represents the (PAM, PSK, or QAM modulated) information symbols, $g_T(t)$ describes the pulse shape, n is a symbol index, and T is the symbol interval.
(a) The signal $v(t)$ can be seen as a sample function of a (continuous-time) random process, because the symbol sequence $\{a_n\}$ is a random sequence representing the information sequence. Determine the power spectral density (PSD) of the random process.
(b) Consider the information sequence $\{a_n\}$ is constructed from a binary antipodal modulation scheme (i.e. $a_n \in \{\pm 1\}$) and its symbols are uncorrelated. Again, determine the PSD of the random process.
(c) Compute the PSD, when $g_T(t)$ is a rectangular pulse

$$g_T(t) = \begin{cases} A & 0 \leq t \leq T \\ 0 & \text{elsewhere} \end{cases}$$

(d) Compute the PSD, when $\{a_n\}$ represents (binary) OOK modulation, i.e. $a_n \in \{0, 1\}$.