Lecture 15 - EE 179: Introduction to Communications - Winter 2007–2008

PSD, Filtering/Modulation, Gaussian Processes.

Lecture Outline

- **Power Spectral Density**
- **White Noise.**
- **Gaussian Processes**

1. **Power Spectral Density (PSD)**
   - Defined only for WSS processes.
   - The PSD is the Fourier transform of the autocorrelation function: $R_X(\tau) \leftrightarrow S_X(f)$.
   - The expected power in $X(t)$ is the integral of its PSD: $E[X^2(t)]^H = \int S_X(f)df$.

2. **White Noise**
   - White noise is defined as a WSS random process with a flat PSD: $S_W(f) = N_0/2$
   - The autocorrelation of white noise is $R_W(\tau) = N_0/2\delta(\tau)$.
   - White noise is the "most random" of noise since it decorrelates instantaneously.

   %item If we multiple a WSS process $X(t)$ by a cosine with uniformly

3. **Gaussian Random Process**
   - A random process $X(t)$ is Gaussian if for all times T and all functions $g(t)$ we get that $Y_g = \int_0^T g(t)X(t)dt$ is a Gaussian random variable.
   - Filtering a Gaussian process results in another Gaussian process.
   - Samples of a Gaussian random process are jointly Gaussian random variables.
   - Samples of a Gaussian random process that are uncorrelated are also independent.
   - WSS Gaussian processes are stationary.

Main Points:

- PSD of a WSS process is the Fourier transform of its autocorrelation.
- White noise has a flat PSD.
- Integrating a Gaussian process results in a Gaussian random variable.