Gaussian Processes. Main Course Ideas so Far. Random Processes in Communications.

Lecture Outline

- **Gaussian Processes**
- **Main Ideas so Far**
- **Random Processes in Communications**

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 Course Ideas so Far:

- Analog and digital signals convey information electronically. Key system parameters are data rate and performance.
- Fourier analysis is needed to study modulation, filtering, and channel effects in communication systems.
- PSD and autocorrelation needed to analyze pwoer signals in communication systems.
- Probability theory characterizes random events.
- Random variables map from a probability space to the real line. Characterized by CDF, pdf, or characteristic function.
- Random processes map from a probability space to a set of functions (realizations). WSS processes are characterized by their PSD and autocorrelation. These are used to study filtering and modulation of random processes.
- Gaussian white noise is a common model for noise in communication systems. Determines SNR and probability of bit error.

Random Processes in Communications:

- Sampling a Gaussian Process results in jointly Gaussian random variables. If the autocorrelation at the sample times is the product of the means, the samples are uncorrelated and therefore also independent.

- The signal-to-noise power ratio (SNR) of an analog communication system is determined by computing the integral of the PSD of the signal and the integral of the PSD of the noise.
- In digital communication systems, the bit value is obtained by integrating the received signal, and the probability of bit error is obtained by integrating a Gaussian random process.