# EE 562: Random Processes in Engineering
# Spring 2017

**Lecture:** W 6:40-9:20 p.m. in OHE 100D

**Instructor:** Christopher Wayne Walker, Ph.D.
Office: PHE 414
Office Hours: Monday 5:00 – 6:00 p.m., Wednesday 5:15 – 6:30 p.m.
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**Discussion:** 3:30 – 4:20 p.m. in OHE 100B
**TA**: Huo Chen
Office Hours: TBD

**Course web page**: http://www.cwwphd.com

**Text:** Required: Probability, Statistics, and Random Processes for Engineers, 4th edition,
Authors: Henry Stark and John W. Woods

First Lecture: Wednesday, January 11
Last Lecture: Wednesday, April 26
No class: Wednesday, March 15 (Spring Recess)

**Course Grading Policy:**

| **Method** | **Date** | **Weight** |
|---|---|---|
| Homework | As assigned in class | 25% |
| Midterm | Wednesday, March 8, 6:40 – 8:10 p.m. | 35% |
| Final | Wednesday, May 3, 7:00 – 9:00 p.m. | 40% |

**Notes**: One 8 ½ x 11 sheet of notes (front and back) is allowed on the Midterm. Two such sheets are allowed on the Final. Calculators are allowed on all exams. No computers or cell phones are allowed on exams nor is any device allowed that has internet capability.

**Contact Information**: You are welcome to consult with me or your TA during office hours. Please consult with the TA only during his office hours (he is busy with studies like you are). If my office hours are not convenient for you or else you have a question that needs addressing before you can see me then you are welcome to call or email me. Email is the preferred method of contact if I can answer your question with an email response, but if we need to have more interaction then you are welcome to call me at my office. If you call and I cannot speak with you immediately then I will set up a time to call you back to discuss any issues or concerns you may have. I want this course to be a positive learning experience for you so please make sure you get all your questions answered.

**Homework**: Homework will be assigned regularly. You may work with others on the homework assignments but the work you hand in must be your own and not copied from another student. Late homework is not accepted.

# EE 562 Outline

Spring 2017

Inst: C.W. Walker

| Section | Title |
|---|---|
| 1.0 | Introduction to Random Processes |
| 2.0 | Random Vectors |
| 2.1 | Definition of Correlation Matrices |
| 2.2 | Properties of Correlation Matrices |
| 2.3 | Linear Transformations of Random Vectors |
| 3.0 | Gaussian Random Vectors |
| 3.1 | Gaussian Random Variables |
| 3.2 | Gaussian Random Vectors |
| 3.3 | Characteristic Function of a Gaussian Random Vector |
| 3.4 | Density Function of a Gaussian Random Vector |
| 4.0 | Analysis of Correlation Matrices |
| 4.1 | Decomposition of a Correlation Matrix |
| 4.2 | The Spectral Decomposition of a Correlation Matrix |
| 5.0 | Spectral Shaping Problem |
| 6.0 | Causal Solution to Spectral Shaping |
| 6.1 | Direct Method for Causal Factorization |
| 6.2 | Row Operation Method for Causal Factorization |
| 7.0 | Spectral Whitening |
| 8.0 | Projections and Karhunen-Loeve Expansions |
| 8.1 | Projection of Random Vectors |
| 8.2 | Karhunen-Loeve Expansions |
| 9.0 | Random Sequences and Convergence Concepts |
| 9.1 | Random Sequences |
| 9.2 | Convergence Concepts |
| 10.0 | Hypothesis Testing and Detection Theory |
| 10.1 | Hypothesis Testing and the Neyman-Pearson Proposal |
| 10.2 | Detection Theory |
| 10.2.1 | Correlation Detection in White Noise |
| 10.2.2 | Correlation Detection in Colored Noise |
| 10.2.3 | Perfect Decisions |
| 10.3 | Some Practical Detection Schemes |

| Section | Title |
|---|---|
| 20.0 | Mean Square Calculus |
| 20.1 | Mean Square Continuity |
| 20.2 | Mean Square Derivatives |
| 20.3 | Mean Square Integrals |
| 21.0 | Ergodicity |
| 21.1 | Ergodic in Mean |
| 21.2 | Ergodic in Correlation |
| 21.3 | Ergodic in Mean Square |
| 21.4 | Ergodic in Distribution |
| 22.0 | Karhunen-Loeve Expansion |
| 23.0 | Stochastic Differential Equations |
| 24.0 | LMMSE Estimation and Karhunen-Loeve Expansion |
| 25.0 | Bandpass Systems |
| 25.1 | Representations of Bandpass Systems |
| 25.2 | Representations of Linear Bandpass Systems |
| 25.3 | Response of a Bandpass System to a Bandpass Signal |
| 25.4 | Representation of Bandpass Stationary Stochastic Processes |
| 25.4.1 | Properties of the In-phase and Quadrature Components |
| 25.4.2 | Representation of White Noise |
| 26.0 | Miscellaneous Topics |
| 26.1 | The Poisson Process |
| 26.2 | Sampling Theorem for Bandlimited WSS Random Processes |
| 26.3 | Simulation of Random Events |
| 26.3.1 | Simulation of Discrete Random Variables |
| 26.3.2 | Simulation of Continuous Random Variables |
| 26.3.3 | Variance Reduction Techniques |
| 26.3.3.1 | Antithetic Variables |
| 26.3.3.2 | Importance Sampling |
| 26.3.4 | Kalman Filtering |

The above outline is tentative and may change if circumstances warrant.