## EE 562: Random Processes in Engineering Spring 2017

Lecture: W 6:40-9:20 p.m. in OHE 122

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, 4<sup>th</sup> 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,	35%
	6:40 – 8:10 p.m.	
Final	Wednesday, May 3,	40%
	7:00 – 9:00 p.m.	

**Notes**: One 8  $\frac{1}{2}$  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
11.0	Hilbert Spaces
11.1	Definitions and Properties
11.2	The Projection Theorem
11.3	Mean Square Convergence
12.0	Estimation Theory
12.1	Conditional Operations
12.2	Stein's Equation
12.3	Minimum Mean Square Error Estimation
12.4	Linear Minimum Mean Square Error Estimation
12.5	Affine Linear Minimum Mean Square Error Estimation
12.6	Gaussian Examples
12.7	Least Squares Estimation
12.8	Estimation of Parameters of PDF's
13.0	Random Processes
13.1	Introduction
13.2	The Second Moment Theory of Random Processes
13.3	Examples of Random Processes
13.4	Properties of Correlation Functions
14.0	Linear Time Invariant Systems
14.1	Definitions
14.2	Discrete Time Systems
14.2.1	Eigensequences
14.2.2	Fourier Analysis
15.0	Wide Sense Stationary Random Processes
15.1	Definitions
15.2	Power Spectral Density in Discrete Time Systems
16.0	Stochastic Inputs to Linear Shift Invariant Systems
16.1	General Systems
16.2	Wide Sense Stationarity in Linear Shift Invariant Systems
17.0	Spectral Concepts
17.1	Spectral Densities
17.2	Spectral Factorization
18.0	Wiener Filters
18.1	Discrete Case
18.2	Continuous Case
19.0	Wiener Processes

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	

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