Probability and Random Processes
EE 5300-001 – CRN-11431 – Fall 2019
Syllabus

Tuesday, August 27, 2019

R. von Borries
Department of Electrical & Computer Engineering
The University of Texas at El Paso, El Paso, Texas 79968, USA
rvonborries@utep.edu

1 General Information

- **Course ID:** Probability and Random Processes, EE 5300-001, CRN-11431
- **Time:** Tuesday and Thursday, 12:00 pm – 1:20 pm
- **Textbook:** [Kay05, Textbook] and [uMa, Matlab].
- **Lecture Room:** Classroom Building C302
- **Prerequisites:** EE 3384 Probabilistic Methods in Engineering and Science, or STAT 3330 Probability.
- **Instructor:** von Borries – rvonborries@utep.edu
- **Office:** Engineering Building 313
- **Office Hours:** TR from 1:30 pm to 3:00 pm, MW from 7:30 pm to 9:00 pm
- **Version:** Monday, September 2, 2019

2 Catalog Description

This course gives an introduction to probability and random processes for first-year graduate students in electrical engineering. The topics discussed here include an introduction to probability, random variables, functions of random variables, expectation, parameter estimation, power spectral density, random processes.

3 Textbook and Technical Computing Language

Probability and Random Processes EE 5300 has two required resources: (1) the textbook Intuitive Probability and Random Processes Using Matlab by Steven M. Kay [Kay05, Textbook] (available at UTEP's bookstore); and (2) the software `Matlab` for numerical computation and visualization [uMb, Matlab on MathWorks]. The textbook is published by Springer and `Matlab` is developed by The MathWorks, Inc.

The `Matlab` software will be used by the students to solve homework problems, and by the instructor to explain concepts and find numerical solutions to problems. The `Matlab` software is available from the Engineering Technology Center (ETC) at the Engineering building E351D, College of Engineering, located between the Engineering and Classroom buildings on the 3rd floor, `http://etc.utep.edu`, e-mail: `etchelpdesk@utep.edu`.

4 Student Learning Outcomes

1. apply knowledge of basic probability to solve problems in the description of single and multiple random variables, conditional probability, parameter estimation.
2. formulate and apply limit theorems to approximate probabilities and moments of independent identically distributed (iid) random variables.
3. identify, and formulate different types of iid stationary random processes, and estimate their moments (mean and covariance sequences).
4. solve problems involving wide sense stationary random processes, autocorrelation sequences and power spectral densities.
5. solve problems involving the output of linear shift invariant systems to wide sense stationary random processes (autocorrelation sequence and power spectral density), Wiener filtering problems.
6. identify, formulate and solve problems in Gaussian, Poisson and Markov random processes.
7. use scientific programming language to interpret mathematical equations, to illustrate, describe, simulate and solve theoretical and real-world problems, in probability and random processes.
8. use scientific programming language to analyze and interpret random variables and random processes.

5 Contents

This course gives an introduction to probability and random processes for first-year graduate students in electrical engineering. The topics discussed here include an introduction to probability, random variables, functions of random variables, expectation, parameter estimation, power spectral density, and random processes. Computer simulations in `Matlab` are used to study probability and random processes [uMb, Matlab on MathWorks], [uMa, Matlab on Youtube].

- **Chapters 1 to 14** Background in Probability – Random variables, multiple random variables; probability mass function (pmf) and probability density function (pdf); cumulative distribution function; marginal pmfs and pdfs; conditional probability; Bayes' theorem; mean, variance and moments of a random variable; estimating means and variances; transformation of random variables; mixed random variables; characteristic functions; Cauchy-Schwarz inequality; Chebyshev inequality; `Matlab`.
- **Chapter 15** Limit theorems – Convergence and approximation of a sum; law of large numbers; central limit theorem.
- **Chapter 16** Basic random processes – Definition; types of random processes; stationarity; joint moments.
- **Chapter 17** Wide sense stationary (WSS) random processes – Definition; autocorrelation sequence (ACS); ergodicity and temporal averages; power spectral density (PSD); estimation of the ACS and PSD.
- **Chapter 18** Linear systems and wide sense stationary random processes – Random process at output of linear system; interpretation of the PSD; Wiener filtering.
- **Chapter 20** Gaussian random processes – Definition; linear transformations; nonlinear transformations; continuous-time definitions and formulas; examples.
- **Chapter 21** Poisson random processes – Derivation of Poisson counting random process; interarrival times; arrival times; compound Poisson random process.
- **Chapter 22** Markov Chains – Definitions; computation of state probabilities; ergodic Markov chains; steady-state characteristics; K-state Markov chains.

6 Evaluation

Activity	%
Exam I	20
Comprehensive Final	20
Homework	50
Participation	10

Exam I and Comprehensive Final will be taken in the classroom.

7 Grading

$A = 100 - 90\%$, $B = 90 - 80\%$, $C = 80 - 70\%$, $D = 70 - 60\%$ and $F = 60 - 0\%$.

8 Attendance

Class attendance is mandatory and will be monitored. Any student who has more than two unexcused absences will be dropped out of the EE 5300. It is student's responsibility to sign the attendance sheet provided by the instructor for each class.

9 UTEP E-mail Account

Student's UTEP e-mail address is required for the instructor to communicate with the student and vice-versa. It is student's responsibility to have a UTEP e-mail account working properly. By the end of the first week of classes, every student should have received at least one e-mail message from the instructor. If an e-mail problem is detected (if no EE 5300 e-mail message is received by the end of the first week of classes), the student should request assistance from UTEP's help desk to fix the problem with the UTEP's e-mail account.

10 Accommodations and Support Services

If you have a disability and need classroom accommodations, please contact *The Center for Accommodations and Support Services (CASS)* at 747-5148, or by email at `cassutep.edu`, or visit their office located in UTEP Union East, Room 106. For additional information, please visit the CASS website at `www.sa.utep.edu/cass`.

11 Academic Integrity

Please review the policy on academic integrity available at https://www.utep.edu/student-affairs/osccr/student-conduct/academic-integrity.html.

References

[CB02] G. Casella and R. L. Berger. *Statistical Inference*. Duxbury, Pacific Grove, CA, 2nd edition, 2002.

[Ibe08] O. Ibe. *Markov Processes for Stochastic Modeling*. Academic Press, San Diego, CA, 2008.

[Kar75] S. Karlin. *A First Course in Stochastic Processes*. Academic Press, San Diego, CA, 2nd edition, 1975.

[Kay93] S. M. Kay. *Fundamentals of Statistical Signal Processing: Estimation Theory*, volume 1. Prentice Hall, Upper Saddle River, NJ, 1993.

[Kay05] S. M. Kay. *Intuitive Probability and Random Processes Using Matlab*. Springer, New York, NY, 2005.

[Ros08] J. S. Rosenthal. *A First Look at Rigorous Probability Theory*. World Scientific, Hackensack, NJ, 2nd edition, 2008.

[SW11] H. Stark and J. W. Woods. *Probability, Statistics, and Random Processes*. Prentice Hall, Upper Saddle River, NJ, 4*th* edition, 2011.

[uMa] https://www.youtube.com/user/MATLAB?feature=watch. MathWorks. Matlab videos. Introductory and advanced Matlab tutorials.

[uMb] http://www.mathworks.com/access/helpdesk/help/techdoc/matlab.html. MathWorks. Matlab documentation.

12 Calendar

EE 5300, TR 12:00 pm to 1:20 pm

August

M	T	W	R	F	S	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

2019

September

M	T	W	R	F	S	S
						1
	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

2019

October

M	T	W	R	F	S	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

2019

November

M	T	W	R	F	S	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27			30	

2019

December

M	T	W	R	F	S	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

2019

Exam I: October 17, Thursday
Material between 8/27 and 10/15

Comprehensive Final: December 10, Tuesday
1:00 pm to 3:45 pm
All the material between 8/27 and 12/5

Labor Day – University Closed
September 2, Monday

Thanksgiving Holiday – University Closed
November 28 and 29

Course Drop/Withdrawal Deadline
November 1