ESE 520 **Probability and Stochastic Processes** **Fall 2024**

Instructor: Vladimir P. Kurenok, Green 2153, (314) 935 7145

Webpage: https://sites.wustl.edu/vladimirkurenok/

E-mail: kurenokv@wustl.edu – E-mail is my preferable way of communication; all e-mails should be answered typically on the same day they were received. Please keep e-mails to essential communications.

Office Hours: MW 1pm-3pm and by appointment

Prerequisite: ESE 326 and ESE 318 or equivalent, or consent of instructor

Lecture: TR 4pm – 5:20 pm in Wrighton 300

AI's: Chengyu Li; lichengyu@wustl.edu

Xiaozhu Cao; c.xiaozhu@wustl.edu

Xudong He; h.xudong@wustl.edu

Junyuan Yao; junyuan.yao@wustl.edu

Shubham Natraj; n.shubham@wustl.edu

AI office hour: Monday 10-11am in Green 2120A (Xiaozhu)

Tuesday 11:30am-12:30pm in McKelvey 1037 (Chengyu)

Wednesday 8-9am in McKelvey 1030 (Xudong)

Wednesday 11:30am-12:30pm in Green 2120A (Shubham)

Thursday 12noon-1pm in Green 2120A (Junyuan)

There will be two main sources of information supplementing the class lecture:

1. Lecture notes of the instructor, provided to you on Canvas.
2. Textbook: *Probability and Random Processes for Electrical and Computer Engineers,* by John A. Gubner, Cambridge University Press, 2006.

Outline of the course:

● Introduction. Probability space (Ω, F, P) [sections from the textbook: 1.1-1.3];

● Conditional probability, Bayes' formula, Independence, Borel σ-algebras [1.5-1.6];

● Random variables and their probability distributions: general theory [2.1-2.3, 4.1, and 5.1-5.3];

● One-dimensional random variables and their probability distributions. Examples [2.1-2.3, 3.2, 4.1, 5.1-5.3];

● Random vectors and their probability distributions. Multidimensional cdf's and density functions 7.1-7.2];

● Functions of jointly continuous random vectors. Conditional densities [5.4, 7.4, 7.5, 9.1, 9.2];

● Expectation and its properties [2.4, 3.4, 7.3, 4.4];

● Covariance and correlation of two random variables and their properties. Covariance matrix [2.4, 4.4];

● Characteristic and moment-generating functions and their properties [3.1, 4.3, 9.3];

● The concept of conditional expectation: definition and properties [3.5, 7.3];

● Conditional expectation as the best least squares estimator [9.4, 9.5];

● Convergence of random variables. Law of large numbers [3.3];

● Convergence of distributions: Central limit theorem [5.6];

● Introduction to stochastic processes: general theory and facts [10.1-10.2];

● Poisson process and its role in probability and applications [11.1, 11.4];

● Gaussian processes and their role in probability and applications [10.3-10.4];

● Wiener process and white noise representation [10.5-10.6, 11.3];

● Markov processes: Chapman-Kolmogorov equations, homogeneous Markov chains, transition probability functions, classification of states, stable probability distributions [chapter 12] – *depending on how much time will remain*;

Homework: Homework will be assigned throughout the course on a bi-weekly basis and the problems will be posted on the course web page under the name "Homework". *Homework will be due on a day indicated on a particular HW. Tentative due dates are given in the course*

schedule and we will try to follow them. All HWs are to be submitted ELECTRONICALLY to Canvas using the link provided. **No late homework will be accepted** unless there will be a valid excuse.

We anticipate having six HW sets in total to be due during the course. You may discuss the problems amongst yourselves, but make sure to produce by the end individual write-ups, as the identical copies will not be accepted.

Exams: There will be three midterm exams, no final exam. The schedule is given below:

Exam1	September 24, Tuesday
Exam2	October 29, Tuesday
Exam3	December 5, Thursday

All exams are given in Wrighton 300.

All exams will be closed book and no classroom notes exams, but the students are allowed to bring to an exam a standard one-sided sheet of their own notes, hand-written only. No solutions of particular problems are allowed. Those sheets must be submitted along with the exam.

Attendance: Students are expected to attend every class. Failure to appear for an exam without a valid excuse will result in a grade 0 for this exam. Students should be aware that if there is a make-up exam then it tends to be more difficult than the original one since it is impossible to write two exams in identical difficulty and an instructor never wants to penalize those who take the original exams by having make-ups be easier. I might also keep the attendance record as a factor in determining borderline grades.

Grading: Your grade will be based on three exams (26% each), graded homework (20%) and course evaluations (2%). The letter grades will be assigned as follows:

A - [90%, 100%]

B - [80%, 90%)

C - [68%, 80%)

D - [55%, 68%)

F - below 55%

I might use “+” and “-“grades as well.

Other remarks: Cell phones and other electronic devices should be **turned off** during the regular lecture time.

Additional resources for students: https://provost.wustl.edu/syllabi-resources-and-template-language-danforth-campus/

Web page: On Canvas https://mycanvas.wustl.edu/