Course Syllabus

Time and venue: TTh 8–9:20 am, DL 264 (tentative)

Instructor: C. Emre Koksal (koksal.2@osu.edu), DL 712

Web page: Class material will be posted on Carmen

Office Hours: Tuesday 9:30–10:30 or by appointment

Objectives: The objective of this class is to help students develop the understanding and intuition necessary to apply stochastic process models to problems in engineering, science and operations research. It contains simple examples and case studies designed to build insight about the structure of stochastic processes and about the generic effect of these phenomena in real systems. The tools and methods developed are imperative specifically for graduate students to do fundamental research in the broad area of communication and networking.

Prerequisites: ECE 6001 or equivalent; mathematical maturity.

Homework assignments: A total of 7–8 assignments.
Since the primary purpose of the homeworks is to help you solidify your understanding of course material, discussions on assigned problems are encouraged. However, all written work turned in must be your own.

Project assignment: Specify a problem based on an application in engineering (e.g., from your own research), economics, operations research or simply from everyday life. The problem has to be relevant to the concepts we cover in class.
Projects are individual. Each student will 1) return a project report due April 15 and 2) give an in class presentation (to be scheduled for the final two weeks of the class) on the project. The report and the presentation should contain:

(a) A clear description of the problem.
(b) Problem setting and model.
(c) Solution (or effort towards the solution). Any illustration (e.g., numerical evaluation) that helps with intuition.
(d) A summary of the existing approaches if any.
(e) A concluding paragraph of one major insight that highlights the effort.


Almost all of the relevant stuff can also be found in:


**Other References:**


**Grading:**

- Midterm 25%
- Final 35%
- Homeworks 15%
- Project 25%
- Participation 5%

**Attendance:** Attendance is not mandatory. However the student is responsible for all assignments, changes of assignments, announcements and other course related events, which occur in class.

**Disabilities Statement:** Any student who feels s/he may need an accommodation based on the impact of a disability should contact the instructor privately to discuss specific needs. Please contact the OSU Office for Disability Services for assistance in verifying the need for accommodations and developing accommodation strategies.

**Academic Misconduct Statement:** Any student found to have engaged in academic misconduct, as set forth in the Code of Student Conduct Section 3335-23-04, Prohibited Conduct, will be subject to disciplinary action by the university. Academic misconduct is any activity that tends to compromise the academic integrity of the university, or subvert the educational process.
Topical Outline of the Course

• Introduction and review of probability (2-3 lectures)
  – Probability review, expectations (Ch. 1.1-1.5)
  – Basic inequalities (Ch. 1.6, 1.7)
  – Central limit theorem and laws of large numbers (Ch. 1.7, 1.8)

• Renewal processes (5-6 lectures)
  – Strong law for renewal processes (Ch. 5.3)
  – Central limit theorem for renewal processes (Ch. 5.3)
  – Index of dispersion, Internet traffic and long-range dependence
  – Expected number of renewals and Blackwell’s theorem (Ch. 5.6)
  – Multiplexing renewal processes, different limiting regimes
  – Stopping times and Wald’s equality (Ch. 5.5)
  – Renewal reward processes, applications (Ch. 5.4)

• Finite-state Markov chains (5-6 lectures)
  – Introduction and classification of states (Ch. 4.1, 4.2)
  – Perron-Frobenius theory (Ch. 4.3, 4.4)
  – Markov chains with rewards (Ch. 4.5)
  – Markov decision processes and dynamic programming (Ch. 4.6)

• Markov chains with countably-infinite state spaces (2-3 lectures)
  – Introduction and classification of states (Ch. 6.1, 6.2)
  – Branching processes (Ch. 6.7)

• Markov processes (3-4 lectures)
  – Introduction and sampled-time approximation to Markov chains (7.1)
  – Steady-state behavior (Ch. 7.2)
  – Kolmogorov differential equations (Ch. 7.3)
  – Birth-death processes (Ch. 7.5)

• Large deviations and martingales (7-8 lectures)
  – Threshold crossing probabilities (Ch. 9.3)
  – Typical events and Sanov’s theorem
  – Thresholds, stopping rules, and Wald’s identity (Ch. 9.4)
  – Discrete queuing systems and buffer overflows
- Multiplexing traffic sources and effective bandwidths
- Ladder variables and queue waiting times
- Martingales (Ch. 9.6, 9.7)
- Stopping rules and stopped processes (Ch. 9.8)
- Markov-modulated random walks (Ch. 9.11)

*Note:* Ch. *.* refers to the section in Gallager.