CALIFORNIA POLYTECHNIC STATE UNIVERSITY
San Luis Obispo, California

STAT 405 – Applied Probability Models

Fall 2017

1. **Catalog Description**

STAT 405 Applied Probability Models (4)
Advanced probability models, their simulation and application. Poisson processes, Markov chains, random walks, and continuous-time Markov processes. Monte Carlo integration and simulation methods, including Markov chain Monte Carlo and Gibbs sampling.. Prerequisite: CPE/CSC 101 or CSC 232 or CPE/CSC 235; MATH 206 or MATH 244; and STAT 305 or STAT 350 or STAT 426.

2. **Required Background and/or Experience**
CPE/CSC 101 or CSC 232 or CPE/CSC 235; MATH 206 or MATH 244; and STAT 305 or STAT 350 or STAT 426.

3. **Expected Outcomes**
The student should be able to:

   a. apply Markov chains and random walks to model discrete-time phenomena;
   b. apply Poisson and Markov processes to model continuous-time phenomena;
   c. simulate probability models by writing original computer code; and
   d. implement Monte Carlo methods, including Markov chain Monte Carlo (MCMC) and Gibbs sampling, in a modern computing environment

4. **Text and References**

Text: Ross, S., *Introduction to Probability Models,* 11th ed., Academic Press, 2014.

5. **Minimum Student Materials**
Calculator and access to Matlab, R, or equivalent software for student use in preparing assignments and taking exams.

6. **Minimum University Facilities**
Access to Matlab, R, or equivalent software in the classroom, data projection capability, and chalkboard for instructional use.

7. Expanded Description of Content and Method

Content:	*Number of Lectures*
1) Review of basic concepts of probability	3
events, random variables, major probability distributions (binomial, Poisson, exponential, normal), expected value and standard deviation	
2) Markov chains	8
transition probabilities, transition matrix, Chapman-Kolmogorov equations, initial distributions, unconditional distributions, regular and irreducible chains, stationary distributions, absorbing states, mean time to absorption, absorption probabilities, common models (e.g., queues), recurrence and transience	
3) Random walks	4
Gambler's Ruin (general case), arcsine laws, recurrence v. transience in 1, 2, 3+ dimensions	
4) Poisson processes	7
relation to other distributions (exponential, gamma, uniform, binomial); splitting, superposition, compound, non-homogeneous; spatial Poisson processes	
5) Continuous-time Markov processes	4
infinitesimal parameters, generator matrix; birth and death processes; Kolmogorov forward and backward equations; stationary distributions	
6) Monte Carlo methods	7
Markov chain Monte Carlo, Gibbs sampling, other advanced simulation techniques	
7) Optional topics	3
renewal theory, queueing theory, branching processes, Brownian motion	
Total	36

8. Method of Evaluating Outcome

Daily problem assignments, computer-based projects, scheduled tests, and a final examination.