New Graduate Course Proposal

Course name: Stochastic Processes with Applications

Instructor: Feng Fu

ORC Description: Stochastic models are central to the study of many problems in physics, engineering, finance, evolutionary biology, and medicine. This course introduces concepts and techniques in probability theory and key methods for stochastic processes, along with their applications to the natural sciences.

Textbook: The Elements of Stochastic Processes, Norman T. J. Bailey, John Wiley & Sons, Inc. (1963)

Syllabus

Week 1: Basic concepts of probability & generating function approach
Day 1: Introduction & examples
Day 2: Definitions & elementary results
Day 3: Generating functions

Week 2: Random walks
Day 4: Gambler's ruin
Day 5: Extensions & recurrence
Day 6: Random walks on graphs

Week 3: Markov chains
Day 7: Transition matrices, classification of states of a Markov chain & recurrence
Day 8: Recurrent Markov chains & limit theorems
Day 9: Martingales

Week 4: Branching processes
Day 10: Discrete branching processes
Day 11: Generating function approach & extinction probabilities
Day 12: Multi-type branching processes

Week 5: Markov processes in continuous time
Day 13: The Poisson process
Day 14: Random-variable technique
Day 15: General theory

Week 6: Birth and death processes I
Day 16: Homogeneous birth and death processes
Day 17: The effect of immigration
Day 18: General multiplicative processes

Week 7: Birth and death processes II
Day 19: The Pólya process
Day 20: Non-homogeneous birth-and-birth processes
Day 21: General stochastic population growth models

Week 8: Diffusion processes
Day 22: Diffusion limit of a random walk
Day 23: Diffusion limit of a discrete branching process
Day 24: Applications to population growth

Week 9: Non-Markov processes
Day 25: Renewal theory and related concepts
Day 26: Renewal equations and generalizations
Day 27: Applications of renewal processes