Course content for MT5436, Markov Chains and Applications

Prerequisites:

Aims:
This is a graduate level course intended familiarise students with the principal methods of the theory of stochastic processes and to introduce a range of examples of probabilistic methods used to model systems that exhibit random behaviour.

Learning outcomes:
On completion of the course the student should be able to:

- understand the structure and concepts of discrete and continuous time Markov chains with countable state space;
- construct a probability model for a variety of problems;
- understand the basic theory behind Bayesian inference;
- be able to formulate statistical problems such as regression in terms of a Bayesian model;
- understand the concept of Gibbs sampling;
- understand the structure of diffusion processes;
- understand the concept of Brownian motion.

Course content:
Poisson process: Interarrival and waiting times; conditional distribution of the waiting times; non-homogeneous processes; compound Poisson process; generalisation to renewal processes.
Markov processes: Markov chains; classification of states; some limit theorems; stationary distributions; absorption probabilities.
Bayesian inference and sampling: Bayes' theorem; choosing a conjugate prior; discrete data with a Beta prior; normal data with a normal prior; Bayesian linear and nonlinear regression; calculating expected values using Monte Carlo methods; Gibbs sampling in high-dimensional spaces.
Diffusion Processes: Forward and backward diffusion equations; Brownian motion, Wiener processes, Ito's Formula.