3.7 STA 8202- STOCHASTIC PROCESSES

Hours: 45 Lecture Hours

Prerequisites:

STA 8101 - Statistical Inference, STA 8102 - Probability and Measure Theory and STA 8103 - Linear Models

Purpose of the Course

This course is designed to introduce students to ideas of stochastic modelling in the context of practical problems in industry, business and science. It aims to give a firm foundation of the relevant theory and to develop the ability to formulate practical problems in terms of appropriate stochastic models, and, where appropriate, use the models for forecasting.

Expected Learning Outcomes of the Course

On successful completion of this course students should be able to:

- Apply the theory of Markov processes in continuous time and discrete state space, including the global balance equations for equilibrium and the detailed balance equations for reversible processes;
- Formulate practical problems in terms of appropriate stochastic models;
- Apply a selection of advanced time series models, including hidden Markov models, AR models and transfer function models;

Course Contents

Discrete and continuous stochastic processes. Applied stochastic processes including Markov process theory, the Poisson process and continuous time Markov chains, convergence stability analysis of discrete Markov chains; birth and death processes and models of queues, renewal processes, regenerative and renewal-reward processes. Martingale theory, Brownian motion, diffusion and jump processes. Linear systems theory, and AR models, transfer function modelling, hidden Markov models. Stochastic Systems: The study of random processes, emphasizing Operational Research applications, including Queue theory, renewal and semi-Markov processes and reliability theory. Examples of applications are drawn from a variety of areas including operations research, mathematical biology, etc.

Mode of Delivery

The course will be a mixture of lectures, discussion of research papers, case studies, tutorials or group discussions etc. Students will also be required to undertake a certain amount of independent study as directed by the instructor. The format will be three (3) lecture hours per week including discussion of research papers, tutorials or group discussions, case studies and independent study.

Assessment

Assessment will comprise Continuous Assessment and End of Semester Examination. Continuous Assessment will comprise two Continuous Assessment Tests, a number of group projects to test

the students' ability to apply stochastic models to real phenomena plus an individual project that will test the student's ability to formulate a selected stochastic model to study a substantive real life problem. The marks will be distributed as follows:

Continuous Assessment:	40%
End of Semester Examination	60%

Core Reading Materials

1. Ross, S. M., (2007). Introduction to Probability Models; 9th Edition; London: Academic Press; (The relevant sections of earlier editions are just as good for the purposes of this course.) ISBN: 0125980620, 9780125980623.
2. Tijms, H. C., (2003). A First Course in Stochastic Models; 8th Edition; Chichester: Wiley; DOI: 10.1002/047001363X.

Recommended Reading Materials

1. Durrett R., (2010). Probability: Theory and Examples. 4th Edition. Cambridge University Press.
2. Grimmett, G. and Stirzaker, D., (2001). Probability and Random Processes; 3rd Edition; Oxford: Oxford University Press; ISBN: 0198572220
3. Meyn S., Tweedie R, (1993). Markov chain and stochastic stability, Springer-Verlag.
4. Zucchini, W. and MacDonald, I.L., (2009). Hidden Markov Models for Time Series: An Introduction using R; 6th Edition; Boca Raton: Chapman and Hall/CRC (2009); ISBN: 978-3-642-10382-7, ISBN: 978-3-642-10383-4

Journals

1. *Stochastic Processes and their Applications Journal* - Elsevier
2. *Journal of the American Statistical Association*, American Statistical Association
3. *Journal of Probability and Statistics*, Brazilian Statistical Society
4. *Journal of Theoretical Probability*, Springer
5. *Probability Theory and Related Fields*, Springer

Theory of Probability and its Applications, Society for industrial and applied mathematics.