School of Mathematics

Course 452 — Stochastic processes in space and time 1998-99
(Optional JS & SS Mathematics, SS Two-subject Moderatorship)

Lecturer: Professor J. Haslett & Dr. Kris Mosurski (Statistics)

Requirements/prerequisites: 251

Duration: 24 weeks

Number of lectures per week: 3

Assessment: a small number of class exercises will be compulsary and will carry 10% of the marks

End-of-year Examination: One 3-hour examination

Description:
Remarks: This course will run in 1994/5 and in 1996/7. The course has been substantially revised in 1994/5. Students will be expected to be able to carry out a number of computer based exercises.

Introduction:
Stochastic Processes are widely used to model processes which change randomly in time. They form the basis of most forecasting procedures. Additionally they provide the basis for the understanding phenomena from congestion to evolution. Generalisations allow the modelling of processes which change randomly in space. These have gained wide application in image processing, in exploration geology and in environmental studies. Further generalisation of the concept of 'space' have recently allowed much wider application and research in stochastic models is very active indeed. This course will provide an introduction to the general concepts such as stationarity and Markov processes and will subsequently concentrate on the models underlying linear processes as used in time series modelling, in spatial regression and in geostatistics.

Michaelmas:
Introduction to Stochastic Processes - sequences of events governed by probabilistic laws. Random walks. Markov Chains. Markov Processes. Branching Processes. Brownian Motion. Applications in industry, science and sociology.

Hilary and Trinity:
Linear models with general covariance structure. Conditional and marginal distributions, correlation and partial correlation. Linear transformations. Mahalanobis distance. Review of the theory of optimal estimation and prediction. Application to linear regression through weighted and general least squares. Application to multivariate data. Discussion of residuals. Time series models. Application to forecasting. The variogram, the autocorrelation function and the partial autocorrelation function in the identification of models. Residuals. Introduction to ARIMA processes and to state-space models. This part of the course will be illustrated by

data on global warming and on currency price variations. Regression with spatially correlated errors. Economic data will be used for illustration. Geostatistical models. Kriging. Data from soil science will be the basis for the examples discussed.

TEXTS:

Cox, D.R. and Miller, H.D., "The Theory of Stochastic Processes", Methuen. Bhat, U.N., "Elements of Applied Stochastic Processes", Wiley.

Karlin, S. and Taylor, H.M. "A First Course in Stochastic Processes", The Academic Press.

Taylor, H.M. and Karlin, S., "Introduction to Stochastic Modelling", The Academic Press.

Chatfield, C., "Analysis of Time Series - An Introduction", Fourth ed., Chapman and Hall.

Cryer, J.D., "Time Series Analysis", Duxbury Press, Boston.
Raftery, A.E., "Time Series Analysis", European Journal of Operation Research, Vol. 20, pp 127-137, 1985.

Ripley, B.D "Spatial Statistics", Wiley, in particular Chap 4.

Hohn, M.E. "Geostatistics and the Petroleum Industry" Van Nostrand Reinhold Matheron, G "The Theory of Regionalised Variables and Its Applications",
Lecture Notes, published by Ecole Nationale Superieure des Mines de Paris Journel, A and Huijbergt, Ch. "Mining Geostatistics", Academic Press.

Haslett, J and Hayes, K. Residuals for the Linear Model with Arbitrary Covariance Function; research paper Department of Statistics, TCD, 1994.

June 10, 1998