TIME SERIES

Autumn Semester 2011

Introduction: This is a Level 6, 15-credit course. It is an option for all Statistics and Mathematics-and-Statistics majors.

Lecturer: Dr Steve Coad, Maths 352, Tel 7882 5484, E-mail d.s.coad@qmul.ac.uk, Webpage http://www.maths.qmul.ac.uk/~coad/MTH6139.

Office hours: Monday, 3.30-4.30, Friday, 12.30-1.30, and by appointment.

Recommended book: Brockwell, P.J. and Davis, R.A. (2002). *An Introduction to Time Series and Forecasting*, 2nd edition. Springer.

Other references: Brockwell, P.J. and Davis, R.A. (1991). *Time Series: Theory and Methods*, 2nd edition. Springer.

Chatfield, C. (2004). *The Analysis of Time Series: An Introduction*, 6th edition. Chapman and Hall.

Diggle, P.J. (1990). *Time Series: A Biostatistical Introduction.* Clarendon Press.

Harvey, A.C. (1993). *Time Series Models*, 2nd edition. Harvester Wheatsheaf.

Shumway, R.H. and Stoffer, D.S. (2006). *Time Series Analysis and its Applications: With R Examples*, 2nd edition. Springer.

Aims: A time series is a collection of observations made sequentially, usually in time. This kind of data arise in a large number of disciplines ranging from economics and business to astrophysics and biology. This course introduces the theory, methods and applications of analysing time series data.

Learning outcomes: After completing this course, students should be able to: understand the important features of a time plot; understand a time series model with deterministic trend and seasonality and a stochastic component, and know the methods for eliminating trend and seasonality; state the definitions of weak and strict stationarity, autocovariance and autocorrelation functions, for stationary time series models; understand autoregressive (AR), moving average (MA) and ARMA models, and evaluate their properties; understand the parameter estimation methods for ARMA models; state the definition of an autoregressive integrated moving average model, evaluate its properties and understand the model-building steps; interpret Minitab output as seen in practicals and exercise sheets.

Lectures: Monday, 12.00, BR 3.02, Thursday, 11.00, Maths 103, and Friday, 3.00, FB David Sizer LT.

Prerequisites: Probability II or Probability Models, and Statistical Modelling I, or equivalent.

Exercise sheets: Fortnightly, starting Thursday 6 October. Solutions handed in late will **not** be accepted. Those handed in on time will normally be marked and returned at the following practical.

Solutions: Solutions will be displayed on the course webpage after the due date for handing the work in.

Practicals: There are six of these, one every fortnight, on Wednesdays at 10.00 and 11.00 in FB 3.44, starting in Week 2. Lecture notes **must** be brought to each practical. The deadline for handing in work is **11.00 on the Thursday one week after the relevant practical**.

Assessment: Unseen examination in May 2012, 80%; Multiple-choice tests in Weeks 7 and 12, 20%. The examination will consist of five questions and you will be asked to attempt all five in two hours.

Syllabus:

(Note that the section numbers given below each list of topics refer to the book by Brockwell and Davis. Also note that the number of lectures in parentheses is approximate.)

Introductory definitions and examples. Simple descriptive techniques: time plot; deterministic trend and seasonality.
Sections 1.1-1.3 (2 lectures)

Elimination of trend in the absence of seasonality: least squares estimation; smoothing by a moving average; differencing. Elimination of trend and seasonality: small trend method; classical decomposition; differencing at lag d.
Sections 1.5-1.6 (6 lectures)

Weak stationarity and autocorrelation: autocovariance and autocorrelation functions; properties. Strict stationarity. MA process: non-uniqueness; invertibility. Linear process. AR process: random walk; explosive MA model and causality. Introduction to ARMA models.
Sections 1.4 and 2.1-2.3 (10 lectures)

Estimation of the mean, and autocovariance and autocorrelation functions. Bartlett's formula. Approximate confidence bounds.
Section 2.4 (3 lectures)

General ARMA process: parameter redundancy; causality; invertibility; autocorrelation and partial autocorrelation functions. Forecasting ARMA processes: one-step-ahead prediction; m-step-ahead prediction; parameter estimation.
Section 2.5, Chapter 3 and Sections 5.1-5.2 (10 lectures)

Autoregressive integrated moving average (ARIMA) model: fitting ARIMA models; seasonal ARIMA model.
Sections 6.1-6.5 (2 lectures)

September 2011