# School of Mathematical Sciences

**TIME SERIES III (STATS 3005)**

**Semester 2, 2004**

**NOTES FOR STUDENTS**

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## Introduction

A time series consists of values of a variable recorded, usually at regular intervals, over a long period of time. Such data arise frequently in econometrics and finance, engineering, medicine, sociology, environmental studies and many other fields. Time series data usually require special methods for their analysis because neighbouring observations are correlated. This means that statistical methods which assume observations are independent are not appropriate.

## Aims and Objectives

The aims of this course are: to indicate the scope and applications of time series; to study statistical methods for the analysis of time series for the purposes of description, forecasting and understanding; to assess the strengths and limitations of the different methods; and to use the statistical and graphical package R for the analysis of time series.

By the end of this course students should be able to:

- provide simple summaries of time series and discuss the main features highlighted by these summaries;
- use time domain methods, in particular ARIMA models, for empirical modelling, determining a possible model and forecasting;
- use spectral analysis as one approach to time series analysis, and explain the strengths and weaknesses of this approach; and
- use R to carry out the above analyses.

## Units Value: 2

## Prerequisites and assumed knowledge

There is a prerequisite of either Mathematics I or Mathematics IM, *and* Statistical Practice I or equivalent course. You will find it an advantage to have completed 4 units of the second year Statistics courses or equivalent.

## Staff

**Lecturer**: Associate Professor Patty Solomon, Room EM 107, Engineering Mathematics Building. Phone: 8303 3033.
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**Tutor**: Mr Simon (Jono) Tuke, Room 206, Main Mathematics Building.
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## Lectures

Mondays and Thursdays at 9.10 am in the Bragg Lecture Theatre. A printed outline and summary with the main points will be provided in the form of lecture slides. These will be supplemented by material presented in lectures, and students should come to lectures prepared to take notes.

## Consulting time

My student consulting hour will be 11 am to 12 pm (noon) on Mondays.

Jono Tuke's student consulting hours will be Wednesdays 1 pm to 2 pm, and Fridays 1pm to 2pm.

## Computing practicals and tutorials

The **first computing practical** will be held in Week 2 in Computing Lab EM126 and will be devoted to a general introduction to R.
The second computing practical will be held in Week 3 and this will introduce you to time series and R. Thereafter, practicals will be held in Weeks 6, 9 and 12.

The **first tutorial** will be held in Week 4. Thereafter, tutorials will be held in Weeks 8 and 11.

*We will be using the statistical and graphical package R, which is a free-ware version of S-PLUS. Both are widely regarded as the most advanced statistical and programming packages for the analysis of statistical data.*

## Assignments (Class Exercises)

There will be 3 assignments. The best 2 assignments will contribute 20% to your final mark, unless your final exam mark out of 100 is higher without the assignment component.

## Examination and Assessment

A two-hour examination will count 80% or 100% of your final raw mark, whichever gives the higher total (as described above). Let $e$ be the mark for the exam out of 100 and $a$ the pooled mark for the best 2 (of 3) assignments out of 20 then your final raw mark out of 100 will be:

$$\max\left\{e, \frac{80}{100}e + a\right\}$$

So students have two chances of redemption in the assessment.
*The exam will be based on the work covered in the lectures, tutorials, practicals, assignments and other set work.*

The Supplementary Examination will be held in December 2004. Please refer to the School Policy on supplementary examinations available from the School website.

## Course outline

**Chapter 1.** Objectives of time series analysis, including description, forecasting and understanding the mechanism generating a series. The basic notions of trend, serial dependence and stationarity. Introduction to the two approaches to time series analysis - time domain methods and frequency domain methods.

**Chapter 2.** Descriptive methods of analysis: plots, smoothing, differencing, the autocorrelation function, the correlogram and the variogram. The periodogram and connection with the autocorrelation function. Estimation and elimination of trend and seasonal components.

**Chapter 3.** Stationary processes and autoregressive moving average (ARMA) models. Modelling and forecasting with ARMA processes.

**Chapter 4.** Spectral analysis: the periodogram revisited, the fast Fourier transform, periodogram averages and other smooth estimates of the spectrum. Time-invariant linear filters.

**Chapter 5.** Nonstationary and seasonal time series models: ARIMA processes. Identification, estimation and diagnostic checking.

**Chapter 6.** Forecasting: extrapolation of polynomial trends, exponential smoothing, and the Box-Jenkins approach.

## References and recommended reading

There are many books on Time Series in the library. There is no set text for this course, but three of the best books at this level are the following:

- *The analysis of time series: an introduction* (6th edition), by Chris Chatfield, Chapman & Hall/CRC, 2003.

  This is a popular introduction to Time Series, and if you want to purchase a book, this may be the best option.

- *Time series: a biostatistical introduction*, by Peter Diggle. Oxford University Press, 1990.

  I like this book on Time Series and will refer to it quite a lot. However, it is rather advanced in some sections and the mathematical treatment tends to be brief. (We are hoping for a new edition from Peter Diggle in a year or two, but in any case the book remains up-to-date and as relevant today as when it was published.)

- *Introduction to time series and forecasting* (2nd edition), by Peter Brockwell and Richard Davis. New York: Springer-Verlag, 2002.

  This is another popular introductory text. I find it less statistical and more mathematical than the other two books, but it contains lots of examples and explanations, and many students find it helpful reading.

These books are in the Reserve Collection and in the Main Collection of the Barr Smith Library.

You may also find the following books useful for the statistical computing aspects of the course:

- *Modern Applied Statistics with S*, (4th edition), by W.N. Venables and B.D. Ripley. Springer, 2002.
- *Introductory Statistics with R*, by Peter Dalgaard. Springer, 2002.

Associate Professor Patty Solomon
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