

STA457H1S/2202H1S
Time Series Analysis

Instructor: K. Knight (office: Sidney Smith 5016G; e-mail: keith@utstat.utoronto.ca) My office is at the west end of the 5th floor.

Office hours: Thursdays from 10am to noon, or by appointment. Do not hesitate to contact me by e-mail as many problems you might encounter can be easily resolved this way.

Textbook: R. Shumway and D. Stoffer: *Time Series Analysis and Its Applications: With R Examples*. Springer. This book is available at the University of Toronto Bookstore and is also available for free download from Springerlink:

link.springer.com/book/10.1007/978-1-4419-7865-3

The textbook will be supplemented by handouts, which will be available through the course's Blackboard site portal.utoronto.ca.

The following books are also good references for this course:

- C. Chatfield: *The Analysis of Time Series: an Introduction (5th edition)*.
- M. Kendall and J.K. Ord: *Time Series (3rd edition)*.
- P. Brockwell and R. Davis: *Introduction to Time Series and Forecasting*.
- P. Brockwell and R. Davis: *Time Series: Theory and Methods*.
- A.C. Harvey: *Time Series Models*.
- P. Diggle: *Time Series: a Biostatistical Introduction*.

All of these books are available in the University of Toronto library system. The second book by Brockwell and Davis is very useful if you are interested in understanding more fully the theory behind time series analysis.

Prerequisites: STA302H (or equivalent) is listed in the calendar as a prerequisite for STA457H1S. If you do not have this prerequisite, you should see the undergraduate coordinator in the Department of Statistical Sciences to obtain a waiver form. Graduate students enrolled in STA2202H1S are exempt from this prerequisite but should be familiar with regression analysis before taking this course.

Evaluation: The main emphasis of the course will be the application of time series methods; however, a solid knowledge of some basic statistical theory is also necessary to understanding the rationale behind the methodology. The course grade will be made up of 3 parts: homework assignments (20%), midterm exam (30%) and a final exam (50%).

- Homework assignments will involve both data analysis and theory problems. Two assignments will be handed in before the midterm and two after.

- Students enrolled in STA2202H1S will typically be required to do some additional work on the homework assignments as well as on the final exam.
- The midterm exam is scheduled for Monday March 6; the exam times and location will be announced later. If this exam is missed due to illness or any other circumstances (with appropriate documentation), the weight from the midterm will be carried over to the final exam.
- The final exam will be held during the April exam period at a date and time to be announced later.
- **Students should familiarize themselves with the University's policies on academic integrity, which can be found at www.artsci.utoronto.ca/osai/students.**

Computing: We will use the software package R extensively in this course both for data analysis as well as some numerical computation. R is free software and can be downloaded (for Windows, Mac, and Linux operating systems) from cran.utstat.utoronto.ca. Of interest to many of you will be RStudio, which provides a very nice environment for using R; information on RStudio (including downloads) can be found at www.rstudio.com.

A useful book that gives a good introduction to R programming is

A First Course in Statistical Programming with R by Braun and Murdoch (Cambridge University Press)

The textbook for this course also provides a lot of examples of R code as will the handouts for the course.

Syllabus: There are two basic approaches to time series analysis: time domain and frequency domain. Many time series analysis books emphasize one approach, most commonly the time domain approach, often to the exclusion of the other, usually because the intended audience; statisticians and econometricians tend to favour the time domain approach while engineers favour the frequency domain. Unfortunately, a very distorted view of time series sometimes results from an overemphasis on one approach. This course will attempt to present both approaches on an equal footing; the main goal of the course is to gain an appreciation of the issues involved in the analysis of time series. The order in which topics are covered will be roughly as follows:

1. Basic descriptive methods: correlogram, partial correlogram and periodogram; methods for removing trend and seasonality.
2. Theory of stationary stochastic processes, spectral decomposition, filtering and smoothing, time series models.
3. Identification of and estimation in time series models, tests for white noise, tests for "unit roots", forecasting, seasonal adjustment.
4. Spectral analysis, nonparametric and parametric spectral estimation.
5. Additional topics (as time permits): ARCH and GARCH models, spurious correlation and cointegration, regression models with autocorrelated errors, signal estimation.

Sta457H1 S 2017 Course Information

This course is an introduction to Time Series with applications to sciences and economics. This course is designed for senior undergraduate students and graduate students of statistics and other related disciplines.

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Office Hours: Wednesdays 3:00pm to 5:00pm at SS6026B.

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Luhui Gan Email: luke.gan@mail.utoronto.ca.

Tianyi Jia Email: Tianyi.jia@mail.utoronto.ca.

TA office hours: TBA.

Lectures Wednesdays 6pm to 9pm; from January 11th to April 5th, except for the reading week (Feb. 22nd). Held in SS2118.

Textbook P.J. Brockwell and R.A. Davis, **Introduction to Time Series and Forecasting, second edition**. Springer-Verlag, 2002.

Readings G. Box, G.M. Jenkins and G. Reinsel, **Time Series Analysis: Forecasting & Control (3rd Edition)**. Wiley, 2008.

Ruey S. Tsay, **Analysis of Financial Time Series, 2nd edition**. Wiley, 2005.

William W.S. Wei, **Time Series Analysis, Univariate and Multivariate Methods**, second edition, Pearson, 2006.

Computing There will be some computing exercises, in the **R** or **ITSM** language. **R** can be downloaded and installed for **free** at www.r-project.org. You can also find an introduction to **R** at the latter website. CD of **ITSM2000** is included in the textbook. There is a tutorial of **ITSM** at Appendix D of the textbook.

Evaluation Final exam: **55%** (Scheduled by the Faculty) Cumulative.

Mid-term test: **35%** (Feb. 15th 6-8pm in class)

There will be no make-up midterms. If you have to miss the midterm, weights will be shifted to the final exam with valid evidences for absence.

HWs: **5%** Three times. The lowest HW score will be dropped.

Data Analysis Report: **5%**.

Syllabus Weeks 1 and 3: Chapter 1.

Weeks 3 and 4: Chapter 2.

Weeks 5 and 6: Chapter 3.

Week 7: Midterm. Includes first three chapters.

Week 8: Chapter 4.

Weeks 9 and 10: Chapter 5.

Weeks 10 and 11: Chapter 6.

Week 12: Chapter 10.3.

I will also cover some other topics regarding computer applications, and introduce you to the R language. Information on these topics will be provided by hardcopy handouts or on the web.