Office Hours: Tues, 4:00-5:00 (or by phone), 852 KMEC. Tel: 998-0449.

Texts (all optional):

Bloomfield, "Fourier Analysis of Time Series", Wiley. (Now in second edition, though we will use notation of first edition.)


Shumway and Stoffer, "Time Series Analysis and its Applications: With R Examples", Springer. (We will not follow this text, but it provides a good, modern account of time series).


Course Work:

Weekly written and/or computer exercises (70% of grade).

In-class closed-book final exam (30% of grade).

Computing:

There will be a few computer-based homework problems. To do them, you will need access to statistical software which can compute the fast Fourier transform. I will use R, which can be downloaded for free. More details on using R will be given in handouts. If you prefer to use some other software, you may do so, provided that it has a fast Fourier transform (fft) command, for example, Matlab or Mathematica.

Mathematical Level:

This is an advanced course on the mathematical foundations of time series analysis. Most of the
material to be presented is theoretical, as opposed to applied. There are no formal prerequisites for the course. Nevertheless, I will be assuming a fairly high level of mathematical maturity. You do not need to have a background in advanced mathematics, since I will build everything up from first principles. But you must have both interest and ability in mathematics to do well. For students who want a more applied course, I would suggest that they take STAT-GB.2302 (Forecasting time series data).

**Homework Policy:**

Homeworks are due every week, and will be graded. Any homework assignment which does not receive a perfect score may be revised and resubmitted. I will be happy to give you hints about how to do the problems, once you have struggled with them for some time yourself. Since there will always be someone working on an old homework assignment, I will not hand out solutions to the problems. If there is any element of a homework problem that you do not understand at any stage in the process, I will be more than happy to discuss it with you. If you are sufficiently persistent, you have the opportunity to go into the final exam with a perfect score on all homeworks, and a good understanding of the course material. Feel free to work with your classmates on homework problems, but make sure that you understand everything that was done. Even if you worked with a group, you should submit the homework individually.
Handouts

1: Introduction, Basics [The first few handouts are based on Bloomfield]

2: Elementary Frequency Domain Facts and Techniques

3: Leakage, and its Reduction By Data Windows

4: Properties of the Discrete Fourier Transform

5: Smoothing, Linear Filtering

6: The Fast Fourier Transform

7: The Periodogram of a Noise Series

8: Formulas Involving the Periodogram and Sample Autocovariances

9: The Spectrum

A Brief Introduction to Measure and Integration Theory [won’t be in exam]

10: The Spectral Representation for Weakly Stationary Processes [Start Koopmans]

11: More on Linear Filters

12: Autoregressive and Moving Average Processes in Discrete Time

13: The Linear Prediction Problem

14: Spectrum Estimation

Note: The final handouts cover more recent topics, and do not follow any textbook.

The Basics of ARMA Models [Mostly review]

Nonlinear Models

Conditional Heteroscedasticity and GARCH Models

Chaos and Nonlinear Time Series

The Spectrum of a Weakly Stationary Process [review]

The Bispectrum and Tests for Nonlinearity

Differencing and Unit Root Tests

Introduction to Long Memory Time Series

The ARIMA(0,d,0) Model [with fractional d]

Fractals and Fractional Dimension
Continuous Time Long Memory Models: Fractional Brownian Motion and Fractional Gaussian Noise

The Fractional ARIMA(p,d,q) Model

Whittle’s Approximation to the Likelihood Function

A Semiparametric Long Memory Model [We probably will run out of time about here]

The Yule-Walker Equations

The $AIC_c$ Criterion For Autoregressive Model Selection