ISE 409: Time Series Analysis, Spring 2014

Instructor:	Frank E. Curtis
Office:	Mohler 475
Phone:	610.758.4879 (Office), 646.789.5490 (Google Voice)
E-mail:	`frank.e.curtis@gmail.com`
IM:	`frank.e.curtis` (Google Talk)
Web:	`http://coral.ie.lehigh.edu/~frankecurtis`

Description: This course covers the analysis of discrete-time random processes with outcomes defined on continua, i.e., time series. The majority of the course will be devoted to modeling, fitting, and forecasting univariate time series. We will also discuss the extensions of these techniques to multivariate time series and, if time allows, study spectral analysis of time series. The methodology we will use is reasonably sophisticated from a mathematical point of view. However, there will also be a strong emphasis on the application of mathematical principles to the study of real-world time series. The primary practical tool that we will use for this purpose is the software package ITSM accompanying the textbook.

Course Objectives: The objectives of this course are for students to understand the following:

- Fundamental principles underlying the forecasting of random processes.
- Basic techniques of smoothing, fitting, and differencing time series.
- The concepts of stationarity, causality, and invertibility.
- The properties of, and how to model and forecast, (univariate) ARMA processes.
- The extension of ARMA models to ARIMA and SARIMA models.
- The extension of univariate ARMA models to multivariate ARMA models.
- The properties of, and how to model and forecast, state-space models.
- Analyzing, modeling, and forecasting a real-world time series.
- Spectral analysis of time series (if time allows).

Prerequisite: ISE 121: Applied Engineering Statistics (or equivalent).

Lectures: Thursdays, 1:10pm–4:00pm in Mohler 375.

Office Hours: I have reserved Thursdays, 10:00am–12:00pm in Mohler 475 for office hours. I am also available through e-mail (always) and on Google Talk (often). If I do not respond to an e-mail within 24 hours, then please assume that I have not received it and send a follow-up e-mail. If I do not respond on Google Talk, then I am either busy or you are contacting me too late in the day, in which case you can try again the next day (during work hours) or send an e-mail instead. I am also willing to meet at other times, but in such cases please e-mail me in advance to set up a mutually convenient time.

Course Site: Lecture notes will be posted on Course Site prior to each lecture. Homework assignments, solutions, announcements, and other important material will also be posted on Course Site. Important information, corrections, and updates about the course may also be sent by e-mail (via Course Site).

Textbook: The required textbook, from which homework problems will be assigned and along with a hard copy of which you will obtain the required software for the course, is the following.

- Peter J. Brockwell and Richard A. Davis, *Introduction to Time Series and Forecasting*, 2nd ed., Springer Texts in Statistics, Springer Science+Business Media, LLC, New York, NY, USA, 2002.

Course material will also be drawn from the following textbook.

- James D. Hamilton, *Time Series Analysis*, Princeton University Press, Princeton, NJ, USA, 1994.

Reading the textbook is not required, but it is recommended. Note that you are not responsible for material in the textbook that is not covered in lecture.

Software: The ITSM software that accompanies the textbook is required. It is your responsibility to have access to this software. Please do not ask me for copies.

LaTeX: All work must be submitted as documents produced with LaTeX. There are no exceptions to this requirement. Assistance for learning LaTeX will be given in the form of the source for all documents produced for the course. Moreover, I will provide style files and templates for all homeworks and exams, as well as for the project. It is not required that you use the style files and templates provided, but it is highly recommended, especially if you are unfamiliar with LaTeX.

Grading: Your grade will be calculated as follows.

Homeworks:	30%
Midterm Exam:	20%
Final Exam:	20%
Project:	25%
Participation:	5%

Homeworks: There will be a few homework assignments throughout the semester, generally assigned and due every few weeks. Each homework must be submitted electronically. No credit will be given for any late assignment. You are free to consult with other students when working on homework, but the work you turn in must be your own. Please cite any references that you use, including fellow students.

Exams: The midterm will be a cumulative, take-home exam. The final will be a cumulative, closed-book, closed-notes, oral exam.

Project: A project will be assigned and due in the second half of the semester. Projects are to be completed in groups that I will create at the time the project is assigned. Each group will be required to obtain data for a time series, analyze it, and make forecasts. Each group is required to write a report and present their findings and forecasts to the class, the report and presentation each being weighted equally in the overall project grade. Presentations will be scheduled for the last week(s) of the semester.

Participation: Attendance will not be taken. However, participation will factor into your grade. If you are unable to participate in lecture, then participation entails being a presence online (via e-mail or Course Site) or in office hours. In short, if by the end of the semester I do not remember your having been in the course, then your participation grade will suffer.

Collaboration Policy: The sharing of ideas is educationally useful and you are encouraged to discuss assignments with other students. However, plagiarism of any kind is destructive, fraudulent, and unacceptable. You are strictly forbidden to copy another student's written work, whole or in part, and submit that work under your name. You are also strictly forbidden to make trivial or mechanical changes to another student's written work and submit that work under your name. Note that while electronic plagiarism is easier to perform (via copy-and-paste), it is also easier to detect. Plagiarized work will receive no credit and repeat offenses will result in more severe action. A safe way to avoid this issue is to discuss assignments with fellow students, but then write your solutions individually and independently.

Emergencies: Everyone is responsible for all material covered and announcements made in lecture. If you believe you will miss a long period of time in the course due to illness, family emergencies, etc., then please contact me as early as possible. Under no circumstances will I give credit for missed work unless you have discussed your absence with me in advance.

Regrade Requests: If you disagree with a grade you receive on a homework, exam, or project component, then you may submit a regrade request. This request must be in writing and submitted no more than 48 hours after you receive the graded assignment.

Recording Devices: Voice and/or video recording devices may be used only with the approval of everyone in the classroom. Please let me know in advance if you wish to use these types of devices.

Students with Disabilities: If you have a disability for which you are or may be requesting accommodations, please contact me and the Office of Academic Support Services, University Center C212 (610.758.4152) as early as possible in the semester. You must have documentation from Academic Support Services before accommodations can be granted.

Equitable Community Principles: Lehigh University endorses The Principles of Our Equitable Community (http://www4.lehigh.edu/diversity/principles). We expect each member of this class to acknowledge and practice these Principles. Respect for each other and for differing viewpoints is a vital component of the learning environment inside and outside the classroom.

Preliminary Schedule:

Week	Date	Lecture Topic(s)	Notes
1	1/16	Basic Concepts	
2	1/23	Introduction to Time Series	
3	1/30	Stationarity Time Series	
4	2/06	Estimating Mean and Autocorrelation	
5	2/13	Forecasting Stationary Time Series	
6	2/20	ARMA Models	
7	2/27	Forecasting ARMA Processes	
8	3/06	(No lecture)	Spring Break
9	3/13	Midterm Review (and exam)	Midterm Exam
10	3/20	Modeling ARMA Processes	
11	3/27	ARIMA Models	
12	4/03	Multivariate Time Series	
13	4/10	State-Space Models	
14	4/17	Spectral Analysis, Final Review	Project Report due
15	4/24	Project Presentations	
16		(No lecture)	Final Exams