MATH 446/546 Introduction to Time Series

Instructor Information

Name:	Matthew Dixon
Telephone:	650-704-2977 (cell)
Email:	matthew.dixon@iit.edu
Class Schedule:	M-W 5-6:15pm (hybrid)
Office hours:	TBC (format TBC)
Office:	RE 111b
TA:	Yuan Yin (yyin22@hawk.iit.edu)

Course Description for Bulletin:
This course introduces the basic time series analysis and forecasting methods. Topics include stationary processes, ARMA models, spectral analysis, model and forecasting using ARMA models, nonstationary and seasonal time series models, multivariate time series, state-space models, and forecasting techniques. Credit may not be granted for both MATH 446 and MATH 546. (3-0-3)

Enrollment:
Elective for B.S. in Statistics, B.S. in Applied Math, M.S. in Applied Math, Ph.D. in Applied Math, and all the professional master programs of the AMATH.

Textbook: Brockwell, Peter J. and Davis, Richard A. (2002). Introduction to Time Series and Forecasting, 2nd edition. Springer-Verlag, New York.

References:

1. Box, G.E.P., Jenkins, G.M. and Reinsel, G.C. (1994). Time Series Analysis: Forecasting and Control, 3rd Edition, Prentice Hall, New Jersey.
2. Chatfield, C. (1996). The Analysis of Time Series, 5th edition, Chapman and Hall, New York.
3. Shumway, R.H., Stoffer, D.S. (2006). Time Series Analysis and Its Applications (with R examples). Springer-Verlag, New York.
4. James D. Hamilton (1994). Time Series Analysis, 1st Edition, Princeton University Press.
5. Galit Shmueli and Kenneth C. Lichtendahl Jr (2016). Practical Time Series Forecasting with R: A Hands-On Guide, 2nd Edition, Axelrod Schnall Publishers.

Software: R

Prerequisites:
MATH 475 or ECE 511 with min. grade of C.
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Objectives:

1. Students will learn about important time series models and their applications in various fields.
2. Students will be able to formulate real life problems using time series models.
3. Students will be able to use statistical software to estimate the models from real data, and draw conclusions and develop solutions from the estimated models.
4. Students will learn to use visual and numerical diagnostics to assess the soundness of their models.
5. Students will learn to communicate the statistical analyses of substantial data sets through explanatory text, tables and graphs.
6. Students will learn to combine and adapt different statistical models to analyze larger and more complex data.

Lecture schedule:

2 x 75 minutes lectures per week

Course Outline:

Lectures	**Hours**
1. Introduction	(2 hours)
● Examples of time series	
● Stationary models and autocorrelation function	
● Estimation and elimination of trend and seasonal components	
2. Stationary Process and ARMA Models	(5 hours)
● Basic properties and linear processes	
● Introduction to ARMA models, properties of sample mean and autocorrelation function	
● Forecasting stationary time series	
● ARMA(p, q) processes, ACF and PACF	
● Forecasting of ARMA processes	
3. Spectral Analysis	(3 hours)
● Spectral densities	
● Time-invariant linear filters	
● The spectral density of an ARMA process	
4. Modeling and Forecasting with ARMA Processes	(5 hours)
● Preliminary estimation	
● Maximum likelihood estimation	
● Diagnostics	
● Forecasting	
● Order selection	
5. Nonstationary and Seasonal Time Series Models	(4 hours)
● ARIMA models	
● Identification techniques	
● Unit roots in time series	
● Forecasting ARIMA models	
● Seasonal ARIMA models	
● Regression with ARMA errors	
6. Multivariate Time Series	(3 hours)
● Second-order properties of multivariate time series	

- Estimation of the mean and covariance
- Multivariate ARMA processes
- Best linear predictors of second-order random vectors
- Modeling and forecasting

7. State-Space Models (3 hours)
   - State-space representations
   - The basic structure model
   - State-space representation of ARIMA models
   - The Kalman Recursions
   - Estimation for state-space models
8. Forecasting Techniques (3 hours)
   - The ARAR algorithm
   - The Holt-Winter algorithm
   - The Holt-Winter seasonal algorithm
9. Estimation of time series models (2 hours)

Assessment:

Homework	20%
Group Project	15%
Quizzes & Class attendance	15%
Mid-term Exam	20%
Final Exam	30%
Grade scale:	A-E

Syllabus prepared by:
Lulu Kang and Tomasz R. Bielecki
Date:
V1: Nov.28, 2018

Course & Instructor Policies

Exam dates: TBA.
Withdrawal dates: Contact Instructor for further information.
Late work: At the discretion of the instructor and automatically subject to a 10% penalty unless due to verifiable medical emergency.
Special assignments: N/A
Class attendance: It is the responsibility of the student to ensure that they keep abreast of the class material, both through actively partaking in live online sessions and watching any additional pre-recorded video recordings. Short quizzes may be frequently assigned without notice, therefore live online class attendance is important.
Classroom conduct: Cell phones to be in mute mode and the student is asked to reduce the amount of background noise as much as possible. Examples include music, radio, and other distracting sounds.
Discipline: The instructor reserves the right to ask any student disrupting the class to leave the session.

Illinois Tech's Sexual Harassment and Discrimination Information:

Sexual harassment, sexual misconduct, and gender discrimination by any member of the Illinois Tech community is prohibited. This includes harassment among students, staff, or faculty. Sexual harassment by a faculty member or teaching assistant of a student over whom they have authority or by a supervisor of a member of the faculty or staff is particularly serious. Such conduct may easily create an intimidating, hostile, or offensive environment.

Illinois Tech encourages anyone experiencing sexual harassment or sexual misconduct to speak with the Title IX Office for information on the resolution process and support options.

You can file a complaint electronically at iit.edu/incidentreport, which may be completed anonymously. You may also file a complaint in-person by contacting the Title IX Coordinator, Virginia Foster at 312.567.5725/ foster@iit.edu or the Deputy Title IX Coordinator 312. 567.5726/ eespeland@iit.edu.

If you are not ready to file a formal complaint but wish to learn about your rights and options, you may contact Illinois Tech's Confidential Advisor service at 773.907.1062. You can also contact a licensed practitioner in Illinois Tech's Student Health and Wellness Center at 312.567.7550

For a comprehensive list of resources regarding counseling services, medical assistance, legal assistance and visa and immigration services, you can visit the Title IX Office's website at https://web.iit.edu/hea/resources

ADA Syllabus Statement: Reasonable accommodations will be made for students with documented disabilities. In order to receive accommodations, students must obtain a letter of accommodation from the Center for Disability Resources and make an appointment to speak with me [the instructor] as soon as possible. The Center for Disability Resources (CDR) is located in 3424 S. State St., room 1C3-2 (on the first floor), telephone 312-567-5744 or disabilities@iit.edu.