ST.778.W02. Time Series Analysis

Spring 2026
Wed. 6:30 pm – 9:00 pm
Online Synchronous via Zoom (*https://loyola.zoom.us/j/5936425088*)

Instructor: Bu Hyoung Lee, Ph.D.
Office: Knott Hall 316D   Phone: (410) 617-2522   Email: *blee4@loyola.edu*

Class Time: Wed. 6:30 pm – 9:00 pm
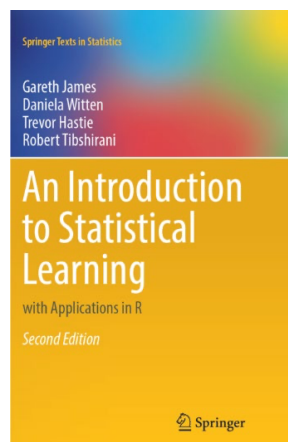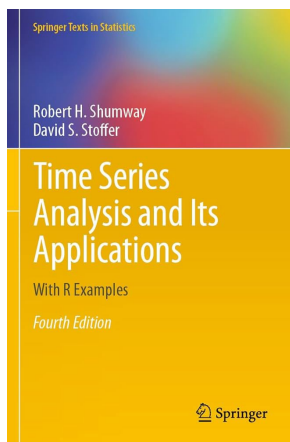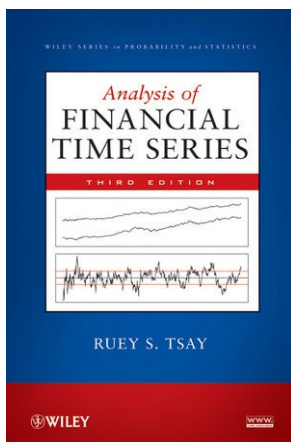**Office Hours:**   Wed. 9:00 pm – 9:30 pm via Zoom or by appointment

Course Description:

Provides a survey of the theory and application of time series analysis and forecasting. Topics covered include autoregressive integrated moving-average (ARIMA) models, seasonal ARIMA models, exogenous-variable (ARIMAX) models, conditional volatility (ARCH-GARCH) models, state-space models, nonlinear threshold autoregressive (TAR) models, unit roots and cointegration, structural breaks and outliers, and frequency domain methods. The empirical applications in the course are drawn primarily from economics and environmental science. Their analyses are performed using statistical software – R.

Textbooks:

1. Tsay, R. S. (2010), *Analysis of Financial Time Series (3rd ed.)*, Hoboken, NJ: Wiley.
   ISBN-13: 9780470414354
   Supplements: *https://faculty.chicagobooth.edu/ruey-s-tsay/research/analysis-of-financial-time-series-3rd-edition*
2. Shumway, R. H. and Stoffer, D. S. (2017), *Time Series Analysis and Its Applications with R Examples (4th ed.)*, New York, NY: Springer.
   ISBN-13: 9783319524511
   Supplements: *https://github.com/nickpoison/tsa4*
3. James, G., Witten, D., Hastie, T., and Tibshirani, R. (2021), *An Introduction to Statistical Learning with Application in R (2nd ed.)*, New York, NY: Springer.
   ISBN-13: 9781071614174
   Supplements: *https://www.statlearning.com*

Schedule & Topics: Consult the course schedule.

Statistical Software: *R, version 4.4.3. or later*

R is an open-source programming language for statistical computing and graphics. You can download the base R (for PC, Mac, or Linux) and packages from a CRAN mirror, *https://cloud.r-project.org*. For effective R coding, you may need an advanced text editor, for example, R Studio (*https://posit.co/download/rstudio-desktop*), Emacs (*http://www.gnu.org/software/emacs*), Notepad++ (*https://notepad-plus-plus.org*), etc.

Grading:

Two Exams	50% (25% each)	
Data Analysis Project	20%	
Homework	30%	

Final Grade Determination:

A	A^-	B^+	B	B^-	C^+	C	F
[92,100]	[90,92)	[87,90)	[83,87)	[80,83)	[77,80)	[70,77)	[0,70)

Catalog Description of Grades:

A: ***Excellent***.   Denotes high achievement and indicates intellectual initiative beyond the objectives of the course.

B: ***Good***.   Denotes work that meets course objectives and the intellectual command expected of a graduate student.

C: ***Satisfactory***.   Denotes work of inferior quality compared to the objectives of the course. It is the lowest passing grade.

F: ***Failure***.

Homework Assignments:

*   All due dates are presented in the course schedule table.
*   Each homework problem set will be posted on ***Moodle*** at least a week before the due date. It is your responsibility if you miss or misread the assignments.
*   Each submission must meet the format guidelines below:
    a) Only digitally typed documents are acceptable. Use the 8½ × 11 (letter size) layout with a one-inch margin & single space. Also, use the following fonts:

        11-point "Times New Roman" for statements &
        10-point "Courier New" for R scripts and outputs.
    b) Write your full name and the HW number on the top left corner of the first page.
    c) Neat and organized comments and/or explanations to questions that need to be addressed in writing. Also, show clear and complete work, including ***all*** relevant steps, procedures, figures, and tables.
    Note.   Do ***NOT*** copy and paste any unorganized and messy work, e.g., entire datasets, warning/error messages, tentative/temporary outcomes.
    Note.   *Failure to follow these criteria may result in loss of credit, regardless of the correctness of your solution and answer.*
*   You must work ***independently***. Use statistical approaches and programming techniques that you have learned from ST710 & ST778. Do ***NOT*** rely solely on ChatGPT or similar LLMs. These models could lead to misunderstandings of key concepts and result in incomplete or incorrect approaches.
*   Upload your homework document (saved as a single ***PDF*** file) and R source code (saved as a single ***R*** file) electronically on ***Moodle*** (under the submission link) ***by 11:59 pm*** on the due date.
*   Late homework will ***NOT*** be accepted unless extenuating circumstances are present.
*   The lowest score among the ***six*** homework assignments will be dropped.

Exams:

Consult the course schedule. Further information will be announced later.

Data Analysis Project (DAP):
- You may work with *one partner* if you wish. Each DAP group must submit *one* copy of the DAP proposal & presentation for grading. The due dates are presented in the course schedule table.
- A DAP *proposal* (as an *online posting*, less than 150 words) must include a brief description of your analytic approach to a data set. Further information will be provided later.
- A DAP *presentation* (as a single *PowerPoint* file, less than 15 pages) must include an introduction, research questions, analytic results, and conclusions. The R source code will be collected in a separate file.

Note. If you miss a homework assignment, an exam, or the DAP work without any legitimate excuses, you will receive a *zero* for that specific item. In these cases, you should discuss your situation with Prof. Lee as soon as possible. An official letter, document, or written evidence to verify your excuse may be required.

Students with Disabilities:
To request academic accommodations due to a disability, please contact Disability and Accessibility Services (DAS), Maryland Hall 141, at *das@loyola.edu* or call (410) 617-7380. If you already registered with DAS and requested an accommodations letter (and DAS has sent the letter to Prof. Lee via email), please schedule a brief meeting with Prof. Lee to discuss the accommodations you might need in this class.

Honor Code:
The Honor Code states that all students of the Loyola Community have been equally entrusted by their peers to conduct themselves honestly on all academic assignments and tests. Loyola students have a collective and individual responsibility for the ethical welfare of their academic community. All outside resources or information used should be clearly acknowledged. If there is any doubt or question regarding the use and documentation of outside sources for academic assignments, your instructor should be consulted. Please refer to the Honor Code for more information and further clarification of the standards, types of violations, adjudication process, and sanctions that may be imposed for violations.

Note. The academic *penalties* for an honor code violation must be:
1) Final course grade *F* imposed by the instructor &
2) Additional sanctions decided by the University.

Title IX:
Loyola University Maryland is committed to a learning and working environment free from sexual and gender-based misconduct including sexual harassment, sexual assault, fondling, incest, statutory rape, domestic violence, dating violence, stalking, and sexual exploitation. Reports of such offenses are taken seriously, and Loyola encourages students experiencing sexual misconduct to report the incident in accordance with the University's policy on *Reporting Sexual Misconduct.* Because of the University's obligation to respond to reports of sexual misconduct, mandated reporters including faculty members, are required to report incidents of sexual misconduct to the Title IX coordinator even if the reporting party requests confidentiality. Information about confidential resources that are not required to report sexual misconduct to the Title IX coordinator may be found on the *Title IX reporting resources page*. For more information about policies and resources or reporting options, please review the *Title IX web page*. Loyola is also committed to an environment free of other forms of harassment and discrimination. For information about policies and reporting resources, please review the Bias Related Behaviors Process and Policy in the *Community Standards* for policies related to students and the *harassment and discrimination policy* for policies related to employees.

Counseling Center:

 The Loyola Counseling Center supports the emotional well-being of the student body and is committed to a respectful understanding and honoring of the social, emotional, and cultural contexts represented by each individual student. The counseling center provides brief individual and group counseling, emergency and crisis intervention, and comprehensive referral services for those in need of longer-term therapy. Relevant updates and more information can be found on *www.loyola.edu/counselingcenter* or by calling (410) 617-2273. To make an appointment, call (410) 617- 2273. For after-hours emergencies, call our after-hours counselor at (410) 617-5530 or Campus Police at (410) 617-5911.

Writing Center:

 The Loyola Writing Center is open seven days a week for both face-to-face and Zoom appointments. The complete schedule of hours is posted on *https://www.loyola.edu/department/writing-center/about/location-hours*. For questions, or help making an appointment, students can email *lwc@loyola.edu*.

ST.778.W02: Tentative Course Schedule (Updated on Wednesday, 01/14/26)

Week	Date	Topics	Assignments (due by 11:59 pm)
1	Jan. 14	Topic #1: **Stationarity & ARMA** Read AFTS Sections 2.1–2.6 / TSAR Sections 3.1–3.5	
2	Jan. 21	Topic #2: **Unit Roots & ARIMA** Read AFTS Section 2.7 / TSAR Sections 3.6–3.7 & 5.2	
3	Jan. 28	Topic #3: **Seasonality & SARIMA** Read AFTS Section 2.8 / TSAR Section 3.9	*HW#1*
4	Feb. 4	Topic #4: **Heteroscedasticity & ARCH/GARCH** Read AFTS Sections 3.1–3.5 / TSAR Section 5.3	*HW#2*
5	Feb. 11	Topic #5: **Nonlinear Models** Read AFTS Sections 4.1–4.2 / TSAR Section 5.4	
6	Feb. 18	Topic #6: **Deep Learning – LSTM** Read ISLR Sections 10.5 & 10.9.6	*HW#3*
7	Feb. 25	*Midterm Exam (Take Home, Two Hours)*	
8	Mar. 4	*Spring Break (No Class)*	
9	Mar. 11	Topic #7: **Multivariate TS – ARIMAX** Read AFTS Section 2.9 / TSAR Sections 3.8, 5.5–5.6, & 6.6	
10	Mar. 18	Topic #8: **Multivariate TS – VAR** Read AFTS Sections 8.1–8.2 / TSAR Sections 5.5–5.6	*HW#4*
11	Mar. 25	Topic #9: **State Space Models & Kalman Filter** Read AFTS Sections 11.1–11.3 / TSAR Sections 6.1 & 6.3	
12	Apr. 1	Topic #9: *Continued* Read AFTS Sections 11.4–11.7 / TSAR Sections 6.2 & 6.4	*HW#5*
13	Apr. 8	Topic #10: **Frequency Domain Methods** Read TSAR Chapter 4	*DAP Proposal*
14	Apr. 15	*TBA*	*HW#6*
15	Apr. 22	*DAP Presentation*	*DAP PPT (Tue. April 21)*
16	Apr. 29	*Final Exam (Take Home, Three Hours)*	

AFTS: Tsay, R. S. (2015), *Analysis of Financial Time Series (3rd ed.)*.

TSAR: Shumway, R. H. and Stoffer, D. S. (2017), *Time Series Analysis and Its Applications with R Examples (4th ed.)*.

ISLR: James, G., Witten, D., Hastie, T., and Tibshirani, R. (2021), *An Introduction to Statistical Learning with Application in R (2nd ed.)*.