MATH 8090: Time Series Analysis, Forecasting and Control
Fall 2025
TR 12:30pm – 1:45pm, MARTIN M-204

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Office Hours:

Monday 9:00 AM-10:15 AM, Tuesday 9:00 AM-10:15 AM, and Thursday 1:50 PM-2:30 PM, and by appointment

Course Description (note that differs from Clemson University Catalog System):

This graduate-level course focuses on statistical modeling and data analysis for time series data. Topics include trend and seasonality estimation, stationary and nonstationary processes, `ARMA` *and seasonal* `ARIMA` *modeling, regression with time series errors,* `GARCH` *models, spectral analysis, and state-space models. Students will gain hands-on experience applying these methods to real-world datasets using* `R`*, learning how to select, fit, and evaluate models for forecasting and interpretation. The course concludes with a final project that integrates multiple techniques into a practical analysis.*

Reference Books:

- *Introduction to Time Series and Forecasting,* 2_{nd} Edition, **Peter Brockwell and Richard Davis, 2016** [Link]
- *Time Series Analysis and Its Applications With* `R` *Examples,* 4_{th} Edition, **Robert Shumway and David Stoffer, 2017** [Link]
- *Time Series Analysis with Applications in* `R`*,* 2_{nd} Edition, **Jonathan Cryer and Kung-Sik Chan, 2008** [Link]
- *Time Series Analysis: Forecasting and Control,* 5_{th} Edition, **George Box, Gwilym Jenkins, Gregory Reinsel, Greta Ljung, 2015** [Link]
- *Analysis of Financial Time Series,* 3_{rd} Edition, **Ruey Tsay, 2010** [Link]

Statistical Software: The R project for Statistical Computing (`https://www.r-project.org/`) and `RStudio` (`https://rstudio.com/products/rstudio/`), an integrated development environment (IDE) for `R`.

Prerequisites:

- Basic calculus, matrix algebra and elementary probability and statistics
- Basic statistical computing knowledge: `R/Rstudio` will be used in class

Course Objectives:

Upon successful completion of this course, students should be able to:

1. Understand and solve problems involving stationary time series models.
2. Become proficient with `ARMA` modeling, and interpret autocorrelation and partial autocorrelation functions.
3. Recognize forms of nonstationarity and apply appropriate modeling approaches.
4. Understand the concepts and applications of spectral analysis, state-space models, and multivariate time series analysis.
5. Apply statistical inference methods to draw conclusions from time series data.

Attendance:

This course will be taught **in-person** and regular attendance is expected. Students are free to leave if the instructor is more than **15 minutes** late to class.

Course Grading:

- Students will be expected to demonstrate ability in computation, critical statistical thinking, and clear communication of statistical methods and results. Grades will be weighted as follows:

Homework	20%
Exam I	25%
Exam II	25%
Final Project	30%

- Final course grades will be assigned using the following grading scheme:

>= 90.00	A
88.00 $\sim$ 89.99	A-
85.00 $\sim$ 87.99	B+
80.00 $\sim$ 84.99	B
78.00 $\sim$ 79.99	B-
75.00 $\sim$ 77.99	C+
70.00 $\sim$ 74.99	C
68.00 $\sim$ 69.99	C-
<= 67.99	F

Artificial intelligence (AI) Statement:

The use of artificial intelligence (AI) tools to complete assignments in this course is prohibited. AI-generated mathematical/statistical solutions do not demonstrate a student's understanding of mathematical/statistical processes and are, therefore, unacceptable. The submission of AI-generated responses will be considered a violation of the academic integrity policy.

Key Dates:

Students can use **iROAR** to add courses through **Aug. 26, Tuesday**, to drop courses without record through **Sep. 3, Wednesday**, and to drop with a W grade through **Oct. 28, Tuesday**.

- **Sep. 1**: Labor Day
- **Oct. 13 - Oct. 14**: Fall Break
- **Nov. 26 - Nov. 28**: Thanksgiving

Make-up Work Due to Missed Attendance:

1. Students should speak with their course instructors regarding any scheduled absence as soon as possible and develop a plan for any make-up work.
2. In the event of an emergency, the student should make direct contact with the course instructor, preferably before a class or an exam takes place. It is the student's responsibility to secure documentation of emergencies, if required.
3. Course instructors must implement fair grading procedures and provide an opportunity to make up missed assignments and examinations that does not unfairly penalize the student. Issuing specific dates by which make up work must be submitted without confirmation from the student could constitute unfair penalization, as students with illness (including COVID-19-related illness) may not always respond in a timely manner. Such make-up work shall be at the same level of difficulty with the missed assignment or examination. Course instructors shall hold all students to the same standard for making up missed assignments or examinations.
4. While course instructors should seek to make reasonable accommodation for a student involved in University-sponsored activities, students should understand that not every course can accommodate absences and that absences do not lessen the need to meet all course objectives.

Notification of Absence:

1. The Notification of Absence module in Canvas allows students to quickly notify instructors (via an email) of an absence from class and provides for the following categories: court attendance, death of family member, illness (or COVID-19 related isolation), illness of family member, injury, military duty, religious observance, scheduled surgery, university function, unscheduled hospitalization, other anticipated absence, or other unanticipated absence. The notification form requires a brief explanation, dates and times. Based on the dates and times

indicated, instructors are automatically selected, but students may decide which instructors will receive the notification. This does not serve as an "excuse" from class, and students are encouraged to discuss the absence with their instructors. If a student is unable to report the absence electronically, he/she may call the Office of Advocacy and Success at 656- 0935 for assistance and guidance.

2. The Office of Advocacy and Success also assists students in identifying various appropriate methods of documenting absences and assists families in using the electronic Notification of Absence system when students are unable to do so themselves.

Class Participation:

Due to the possibility that students might shift to online learning while in isolation/quarantine, class participation grades need to be structured in ways that do not penalize students that are suddenly unable to attend class in person. Instructors are encouraged to shift class participation assessment and point/grade allocation to other engaged activities that all students can accomplish, even those accessing the course remotely.

Policies on Incompletes and Medical Withdrawals:

1. Issuing an "Incomplete" grade (I) to a student is an option if a student is unable to complete makeup work in a timely manner due to COVID-19 related illness or other issues. An Incomplete indicates that a relatively small part of the semester's work remains undone. It is not intended for students who are failing a course otherwise. In the event that an Incomplete is appropriate, students will contact instructors in a timely manner so that instructors can provide a reasonable opportunity to complete remaining work. Instructors and students will work together to resolve the Incomplete grade as soon as possible, not to exceed thirty days from the first day of classes in the next scheduled session (excluding summer sessions and regardless of the student's enrollment status). More information on an Incomplete grade can be found in the Undergraduate Catalog.

2. Sometimes due to illness (including COVID-19 related illness) or other life circumstances, students may not be able to complete academic work for the term and will need to withdraw from all classes. The Division of Undergraduate Studies will process medical withdrawals. Students should contact the Division by sending an email from their Clemson email address to Lisa Traynham at lltrayn@clemson.edu.

If you report testing positive for COVID or have been asked to quarantine/isolate because of exposure to the virus, it will be up to you to inform your instructor that you will be moving to online only instruction for at least the next two weeks. Students are directed to use the Notification of Absence module in Canvas to initiate this notification. Additional communication via email is encouraged; you should follow up with your instructor to develop a continued plan of study.

Academic Integrity Statement:

"As members of the Clemson University community, we have inherited Thomas Green Clemson's vision of this institution as a 'high seminary of learning.' Fundamental to this vision is a mutual commitment to truthfulness, honor, and responsibility, without which we cannot earn the trust

and respect of others. Furthermore, we recognize that academic dishonesty detracts from the value of a Clemson degree. Therefore, we shall not tolerate lying, cheating, or stealing in any form. In instances where academic standards may have been compromised, Clemson University has a responsibility to respond appropriately to charges of violations of academic integrity."

Please refer to the current Graduate School Policy Handbook for the graduate academic integrity policy.

Disability Access Statement:

It is university policy to provide, on a flexible and individualized basis, reasonable accommodations to students who have disabilities. Students with disabilities requesting accommodations should make an appointment with Disability Services (656-6848), to discuss specific needs within the first month of classes. Students should present a Faculty Accommodation Letter from Student Disability Services when they meet with instructors. Accommodations are not retroactive and new Faculty Accommodation Letters must be presented each semester.

Title IX Statement:

Clemson University is committed to a policy of equal opportunity for all persons and does not discriminate on the basis of race, color, religion, sex, sexual orientation, gender, pregnancy, national origin, age, disability, veteran's status, genetic information or protected activity (e.g., opposition to prohibited discrimination or participation in any complaint process, etc.) in employment, educational programs and activities, admissions and financial aid. This includes a prohibition against sexual harassment and sexual violence as mandated by Title IX of the Education Amendments of 1972. The University is committed to combatting sexual harassment and sexual violence. As a result, you should know that University faculty and staff members who work directly with students are required to report any instances of sexual harassment and sexual violence, to the University's Title IX Coordinator. What this means is that as your professor, I am required to report any incidents of sexual harassment, sexual violence or misconduct, stalking, domestic and/or relationship violence that are directly reported to me, or of which I am somehow made aware. There are two important exceptions to this requirement about which you should be aware: Confidential Resources and facilitators of sexual awareness programs such as "Take Back the Night and Aspire to be Well" when acting in those capacities, are not required to report incidents of sexual discrimination. Another important exception to the reporting requirement exists for academic work. Disclosures about sexual harassment, sexual violence, stalking, domestic and/or relationship violence that are shared as part of an academic project, a research project, classroom discussion, or course assignment, are not required to be disclosed to the University's Title IX Coordinator. This policy is located at `http://www.clemson.edu/campus-life/campus-services/access/non-discrimination-policy.html`. Ms. Alesia Smith is the Executive Director for Equity Compliance and the Title IX Coordinator. Her office is located at 223 Holtzendorff Hall, phone number is 864.656.3181, and email address is alesias@clemson.edu.

Inclement Weather:

Any exam that was scheduled at the time of a class cancellation due to inclement weather will be given at the next class meeting unless contacted by the instructor. Any assignments due at the

time of a class cancellation due to inclement weather will be due at the next class meeting unless contacted by the instructor. Any extension or postponement of assignments or exams must be granted by the instructor via email or Canvas within 24 hours of the weather related cancellation.

Academic Continuity Plan for this Class:

Clemson has developed an academic continuity plan for academic operations. Should University administration officially determine that the physical classroom facility is not available, class will be conducted in a virtual (online) format. The University issues official disruption notifications through email/ www/ test notification / social media. When notified, use one of the following links to navigate for Clemson Canvas, where you will find important information about how we will conduct class:

- Primary access link: www.clemson.edu/canvas
- Secondary access link, if needed: https://clemson.instructure.com/
- You can also use the Canvas Student App.

Our activities for teaching and learning will occur through our Canvas course. This includes: assignments, quizzes

Tentative Schedule:

Week	Dates	Topic
1	Aug. 21	Course Overview and Review of Statistical Concepts
2	Aug. 26 & Aug. 28	Modeling Trend and Seasonality with Regression Techniques
3	Sept. 2 & Sept. 4	Stationary Processes: Properties, Mean, and Covariance Functions
4	Sept. 9 & Sept. 11	Estimating Mean and Covariance of Stationary Processes
5	Sept. 16 & Sept. 18	ARMA Models: Properties, Model Selection, and Diagnostics
6	Sept. 23 & Sept. 25	ARMA Models: Prediction, Estimation, and Inference
7	Sep. 30 & Oct. 2	ARMA Case Study and ARIMA Models
8	Oct. 7 & Oct. 9	Seasonal Models: SARIMA
9	Oct. 16	Regression with Time Series Errors and Related Topics
10	Oct. 21 & Oct. 23	GARCH Models and Their Applications in Financial Time Series
11	Oct. 28 & Oct. 30	Frequency-Domain Analysis of Time Series
12	Nov. 4 & Nov. 6	Estimation in the Frequency Domain
13	Nov. 11 & Nov. 13	Introduction to State-Space Models
14	Nov. 18 & Nov. 20	State-Space Models and Multivariate Time Series Models
15	Nov. 25	Multivariate Time Series Models and Spatial-Temporal Models
16	Dec. 2 & Dec. 4	Review and Further topics