MATH 8090: Time Series Analysis, Forecasting and Control
Fall 2026
MWF 1:25pm – 2:15pm, MARTIN M-104

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Office Hours:

Monday 9:00 AM-10:20 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 provides a modern introduction to statistical modeling, inference, and data analysis for time series data, with an emphasis on connecting statistical theory and methodology with practical applications. Topics include exploratory analysis of temporal data, trend and seasonality, stationary and nonstationary processes, autocorrelation and dependence, `ARMA` *and seasonal* `ARIMA` *models, regression with time-dependent errors, forecasting and forecast evaluation, volatility and* `GARCH` *models, spectral and frequency-domain methods, and state-space models. Selected advanced topics, including multivariate time series and extensions to spatial and spatio-temporal data, will also be introduced. Throughout the course, students will analyze real-world datasets using* `R`*, with an emphasis on model formulation, estimation, diagnostics, prediction, uncertainty quantification, and interpretation. A final project will integrate statistical reasoning, computation, and substantive interpretation through an applied analysis of temporally dependent data.*

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 characterize temporal dependence using concepts such as stationarity, autocovariance, autocorrelation, and partial autocorrelation.
2. Formulate, fit, diagnose, and interpret `ARMA`, `ARIMA`, seasonal, and regression models for time series data, and recognize common forms of nonstationarity.
3. Develop and evaluate forecasts, quantify forecast uncertainty, and critically assess model assumptions and predictive performance.
4. Understand and apply selected advanced time series methods, including volatility models, spectral and frequency-domain methods, state-space models, and multivariate time series models.
5. Recognize connections between temporal, spatial, and spatio-temporal dependence and understand how time series concepts can be extended to more complex dependent data.
6. Use `R` to explore, visualize, model, and analyze real-world time series data, and effectively communicate statistical findings and their practical implications.

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 ~ 89.99	A-
85.00 ~ 87.99	B+
80.00 ~ 84.99	B
78.00 ~ 79.99	B-
75.00 ~ 77.99	C+
70.00 ~ 74.99	C
68.00 ~ 69.99	C-
<= 67.99	F

Artificial intelligence (AI) Statement:

Generative AI tools (e.g., ChatGPT, Claude, Gemini, and GitHub Copilot) are increasingly used in statistical practice and data science. In this course, you are encouraged to learn how to use these tools **responsibly and critically** as part of your workflow.

Acceptable uses of AI include:

- Explaining statistical concepts or `R` syntax;
- Debugging or improving `R` code;
- Brainstorming approaches to data analysis;
- Improving figures, tables, or written presentation;
- Checking grammar and clarity; and
- Exploring alternative methods or interpretations.

However, AI should **support rather than replace your statistical reasoning**. You remain responsible for understanding, verifying, and being able to explain all work that you submit. AI-generated code, calculations, references, and interpretations may be incorrect and should always be checked.

For R Labs: AI tools may be used for assistance, but submitted work should reflect your own understanding, and you should be able to explain your code and statistical conclusions.

For Projects: AI may be used as a supporting tool for coding, brainstorming, visualization, and writing assistance. However, the selection of statistical methods, analysis, interpretation of results, and substantive conclusions must reflect your own work and understanding. Any **substantial use of generative AI** should be briefly acknowledged in your submission (for example, "ChatGPT was used to assist with debugging `R` code and editing the presentation of results.").

Submitting AI-generated analysis or writing **without understanding or verifying it**, fabricating results or references using AI, or using AI to misrepresent someone else's work as your own is not acceptable.

A simple rule: You may use AI as a tool, but you are responsible for the statistical reasoning, accuracy, and integrity of everything you submit.

Key Dates:

Students can use **iROAR** to add courses through **Aug. 25, Tuesday**, to drop courses without record through **Sep. 3, Wednesday**, and to drop with a W grade through **Oct. 28, Tuesday**.

- **Sep. 7**: Labor Day
- **Oct. 12 - Oct. 13**: Fall Break
- **Nov. 25 - Nov. 27**: Thanksgiving

Tentative Schedule:

Week	Date	Topic
1	Aug. 19 & 21	Course Overview and Review of Statistical Concepts
2	Aug. 24, 26 & 28	Modeling Trend and Seasonality with Regression Techniques
3	Aug. 31, Sep. 2 & 4	Stationary Processes: Properties, Mean, and Covariance Functions
4	Sep. 7, 9 & 11	Model-Free Estimation of Stationary Means and Covariances
5	Sep. 14, 16 & 18	ARMA Models: Properties, Identification, and Estimation
6	Sep. 21, 23 & 25	ARMA Models: Inference, Diagnostics, and Model Selection
7	Sep. 28, 30 & Oct. 2	ARMA Models: Prediction, Forecasting, and Modeling Case Study
8	Oct. 5, 7 & 9	Seasonal Models: SARIMA
9	Oct. 14 & 16	Regression with Time Series Errors and Related Topics
10	Oct. 19, 21 & 23	GARCH Models and Applications in Financial Time Series
11	Oct. 26, 28 & 30	Frequency-Domain Analysis of Time Series
12	Nov. 2, 4 & 6	Estimation in the Frequency Domain
13	Nov. 9, 11 & 13	Introduction to State-Space Models
14	Nov. 16, 18 & 20	State-Space Models and Geostatistics
15	Nov. 23	Spatio-Temporal Models
16	Nov. 30, Dec. 2 & 4	Review and Further Topics
17	Dec. 7–11	Final Project