UNIVERSITY OF THE PHILIPPINES DILIMAN
SCHOOL OF STATISTICS
TM KALAW STREET, UP DILIMAN
QUEZON CITY PHILIPPINES

STAT 268: ADVANCED TIME SERIES ANALYSIS **COURSE SYLLABUS**

Instructor:	Assoc Prof Peter Julian Cayton, PhD	Consultation Hours:	Weekdays, 1:00-5:00pm
Email:	pacayton@up.edu.ph	Faculty Office:	(UPD) Faculty Room 417, 4th Floor, UP School of Statistics, UP Diliman

COURSE GOALS

The course covers a survey of advanced methodologies in time series analysis. The course builds from a student's strong background in time series analysis and expands their skills to tackle more complex problems in extracting insights from time series data.

At the end of the course, the student is expected to be able to:

I. Analyze the interactions and correlations of multiple time series data,
II. Build sophisticated time series model systems through state space modeling,
III. Perform analysis and prediction with nonlinear and nonparametric time series methodologies,
IV. Analyze the periodic features of time series data thru frequency domain analysis,
V. Analyze the nature of interventions in time series data, and
VI. Discern which advanced time series methodology applies to a specific problem.

COURSE REQUIREMENTS:

Online Exercises. They are preferred to be given after a specific set of topics.

GRADING FORMULA: Final Grade = (Sum of exercise scores)/(Total number of points of all exercises) x 100%

GRADING SCALE

[96.00, ∞)	1.00	[72.00, 78.00)	2.00
[90.00, 96.00)	1.25	[66.00, 72.00)	2.25
[84.00, 90.00)	1.50	[60.00, 66.00)	2.50
[78.00, 84.00)	1.75	[0.00, 60.00)	INC

CLASS RULES AND POLICIES

1. Cellphones and other electronic devices should be turned off or silent during class sessions. Classroom decorum should always be observed. You are free to mute and stop your camera to settle your personal or emergency businesses then turn up again. The instructor reserves the right to send a student that disturbs a class out of the session.
2. If students are caught cheating in any form concerning the requirements of the course, they will receive a grade of 5.00 and their case will be sent to the Student Disciplinary Tribunal for further action by the University.
3. The instructor will be creating online facilities for our class on UVLE (https://uvle.upd.edu.ph). Please wait for announcements on the coming days for the details of these group pages.
4. Any communication about the course can only be conducted during consultation hours by sending communications through email or the UVLE messaging facility. Instructors will not be communicated through personal Facebook, nor other means not mentioned.
5. The course pack contains the following materials:
   1) the course syllabus and schedule of activities,
   2) lecture videos for viewing,
   3) the main readings of discussion, and

4) Data for discussions and exercises

6. Additional materials will be available in UVLE.
7. Exercise papers will be accessible in UVLE and the deadline is two weeks from the first release of the exercise.
8. A passing standing is defined as having a grade of 60 or higher given the graded requirements. Otherwise, it would be a failing standing.
9. If you are to drop the course, please accomplish the necessary online forms on or before the date of last day of dropping. Pay the necessary amount and provide me the instructor's copy for my record purposes and to officially give you a grade of DRP in the course.
10. An INC grade would require you to complete the requirement that you have missed or gain extra points thru extra work. You have 2 semesters to complete your deficiencies.
11. For publicly available computing, students may use Google Colab with R language, accessible thru these links: https://colab.research.google.com/#create=true&language=r, or this short URL https://colab.to/r.
12. Course Materials and Assessments: The materials provided to you are for educational purposes only. Please do not share these materials with anyone else without the teacher's permission. No part of it can be reproduced for commercial distribution through manual and electronic means without the knowledge of the authors or copyright owners.
13. Classroom AI Policy: Recent developments in artificial intelligence, e.g. ChatGPT, have made it as a powerful tool to improve a student's writing and delivery of ideas. Students may use AI tools to improve their work; however, it should not be used as substitute to the student's own writing. The student bears responsibility to the veracity of written statements they submit under their name in their requirements. They are also responsible for editing and proper referencing of their written works to academic standards. The instructor reserves the right to assess the work thru certified anti-plagiarism software, e.g., Turnitin, to check for academic integrity. For more information, please also refer to the UP AI policy: https://up.edu.ph/up-principles-for-responsible-artificial-intelligence/.

TENTATIVE COURSE SCHEDULE AND OUTLINE (Sequences and dates may change as we go along the course)

Topics	Reference
PROLOGUE: Review of Introductory Time Series Analysis	
Week 1: Introductory Time Series Analysis 1.1 Syllabus of the Course 1.2 Stochastic Processes 1.3 Autocorrelations and Partial Autocorrelations 1.4 White Noise, Stationary, and Nonstationary Time Series 1.5 ARIMA Models 1.6 Dynamic Regression Models 1.7 GARCH Models	FPP2 RUGARCH
PART I: Interrupted Time Series Analysis	
Week 2: Interrupted Time Series Analysis 2.1 Basic Ideas in Interrupted Time Series Analysis 2.2 Intervention Models 2.3 Estimation of Intervention Models thru Software	ITSASP TSAAR: Sec. 11.1 ITSARP ITSAOUP
EXERCISE 1: Answer problems using methods from Part I	
PART II: Frequency Domain and Spectral Analysis	
Week 3: Introduction to Spectral Analysis 3.1 Spectral Representation and Spectral Distribution 3.2 Spectral Densities of the ARMA process	TSAAR: Ch. 13 & 14 TATSAIR: Ch. 6 & 7 TSDAAUR: Ch 6 & 7
Week 4: Estimating the Spectrum 4.1 Smoothing the Sample Spectral Density 4.2 Interval Estimation for the Spectrum	

4.3 Example Estimation thru Software	
EXERCISE 2: Answer problems using techniques from Part II	
PART III: Vector Models for Multivariate Time Series	
Week 5: Vector Autoregression (VAR) Models 5.1 Estimation and Diagnostics 5.2 Granger Causality 5.3 Impulse Response Functions 5.4 Forecast Error Variance Decomposition	AICTSR: Ch. 2 MTSA: Ch. 1, 2, & 4
Week 6: Structural VAR Models 6.1 Estimation and Diagnostics 6.2 Impulse Response Functions 6.3 Forecast Error Variance Decomposition	
Week 7: Cointegration and Vector Error Correction Models 7.1 Cointegration 7.2 Univariate Error Correction Model 7.3 Vector Error Correction Model	AICTSR: Ch. 4, 7, & 8 MTSA: Sec. 5.5 – 5.10.
EXERCISE 3: Answer problems using methods from Part III	
PART IV: Multivariate GARCH Models	
Week 8: Multivariate GARCH Models 8.1 Estimating Multivariate Volatility Models 8.2 Diagnostic Checks 8.3 Multivariate GARCH and Correlation Models	MTSA: Sec 7.1 - 7.7
EXERCISE 4: Answer problems using methods from Part IV	
PART V: State Space Models	
Week 9: Linear Gaussian State Space Model I 9.1 The General Linear Gaussian State Space Model 9.2 The Kalman Filter Algorithms 9.3 Forecasting with State Space Models	TSASSMR: Ch 8 & 9 TSASSM: Ch 3 STATESPACER
Week 10: Linear Gaussian State Space Model II 10.1 Example: Trend & Seasonal Component Models 10.2 Example: ARIMA Models 10.3 Example: Regression Models 10.4 Example: Dynamic Factor Models	
EXERCISE 5: Answer problems using methods from Part V	
PART VI: Nonlinear & Nonparametric Time Series Analysis	
Week 11: Threshold Models 11.1 Exploring Nonlinearities in Time Series 11.2 Threshold AR (TAR) Models 11.3 Model Diagnostics	TSAAR: Ch 15
EXERCISE 6: Answer problems using methods from Week 11	
Week 12: Nonparametric Regression for Time Series 12.1 Introduction 12.2 Nonparametric Time Series Analysis 12.1 Software Implementation	ANR: Ch 7 NLTSR
Week 13: Bootstrap and Boosting in Time Series 13.1 Residual-Based Bootstrap 13.2 Block Bootstrap 13.3 Dependent Wild Boostrap 13.4 Bagged Forecasts 13.5 XGBoost for Time Series	AIBMAR: Ch 5 FPP2: Section 11.4 XGBOOST
EXERCISE 7: Answer problems using methods from Weeks 12 & 13	

Main References for the Course:

(STATESPACER): Beijers D (2023). statespacer: State Space Modelling in R. R package version 0.5.0, https://dylanb95.github.io/statespacer/.

(NLTSR): Bjornstad ON (2018). nlts: Nonlinear Time Series Analysis. R package version 1.0-2, <https://CRAN.R-project.org/package=nlts>.

(TATSAIR): Chatfield C & Xing H (2019). The analysis of time series: an introduction with R, Seventh Ed. CRC Press.

(XGBOOST): Chen T & Guestrin C (2016). XGBoost: A Scalable Tree Boosting System. In Proceedings of the 22nd ACM SIGKDD International Conference on Knowledge Discovery and Data Mining (KDD '16). Association for Computing Machinery, New York, NY, USA, 785–794. https://doi.org/10.1145/2939672.2939785.

(AIBMAR): Chernick MR & LaBudde RA (2011). AN INTRODUCTION TO BOOTSTRAP METHODS WITH APPLICATIONS TO R. Wiley.

(TSAAR): Cryer JD & Chan K-S (2008). Time Series Analysis With Applications in R, Second Edition. Springer Science+Business Media, LLC.

(TSASSM): Durbin J & Koopman SJ (2012). Time Series Analysis by State Space Methods, Second Edition. Oxford University Press

(ITSARP): English, Patrick, The its.analysis R Package – Modelling Short Time Series Data (June 6, 2019). Available at SSRN: https://ssrn.com/abstract=3398189 or http://dx.doi.org/10.2139/ssrn.3398189

(RUGARCH): Ghalanos A (2014), rugarch: Univariate GARCH Models, R package version 1.4-0.

(TSASSMR): Hagiwara J (2021). Time Series Analysis for the State-Space Model with R/Stan. Springer.

(ANR): Hardle W (1994). Applied Nonparametric Regression. Humboldt-Universitet zu Berlin.

(FPP2): Hyndman RJ, & Athanasopoulos G (2018) Forecasting: principles and practice, 2nd edition, Melbourne, Australia: OTexts. OTexts.com/fpp2. Accessed on 26 July 2019.

(ITSASP): McDowall D, McCleary R, Meidinger EE, & Hay RA Jr (1980). Interrupted Time Series Analysis. SAGE PUBLICATIONS.

(ITSAOUP): McDowall D, McCleary R, & Bartos BJ (2019). Interrupted Time Series Analysis. Oxford University Press.

(AICTSR): Pfaff B (2008). Analysis of Integrated and Cointegrated Time Series Analysis with R. Springer.

(TSDAAUR): Shumway RH & Stoffer DS (2019). Time series: a data analysis approach using R. CRC Press.

(MTSA): Tsay RS (2014). Multivariate Time Series Analysis. Wiley.