MA413 Time Series & Random Processes in Linear Systems (Online)

Instructor Information	Wanchunzi Yu Home Institution: Bridgewater State University Email: wyu@bridgew.edu		
Term	June 27, 2022 - July 22, 2022	**Credits**	4 units
Course Delivery	The class will be delivered in the format of online. Other than recorded lecture videos, the instructor will arrange 4 hours' real-time interactions with students per week (via discussion forum, zoom meeting, and WeChat). The workload students are expected to complete to properly pass this course is about 15 hours per week.		
Required Texts (with ISBN)	Time Series Analysis Univariate and Multivariate Methods, 2nd Edition, by William W.S. Wei ISBN-13: 978-0321322166 ISBN-10: 0321322169		
Prerequisite	Financial Mathematics related courses are needed before enrolling in this lesson		

Course Overview

Time Series & Random Process in Linear System is a course designed for students of Mathematics, Financial Mathematics, Statistics, Data Science and related majors. The course will cover both various of time series models and the application with real life-time series data ranging from financial time series to climate time series. Interpretation and conclusion of the analysis results of real-life examples are also importation.

Course Goals

Upon successful completion of this course, students will be conversant with

- main concepts of Time Series theory and methods of analysis
- analysis and modeling of stochastic processes of ARMA models
- seasonal ARIMA models
- autoregressive models
- co-integration and error correction models
- Spectrum analysis
- forecasting using transfer function models
- working with real-life economic time series data using the statistical software

Course Structure

1. Asynchronous Hours: Monday through Friday, total 25 hours Pre-recorded videos will be posted on SJTU online learning platform.
2. Synchronous Hours (Beijing Time):
   a) Required tutorial meeting: Wednesday: 8 :00 – 9:00 pm
   b) Office hour: Thursday: 9:00 – 10:00 am
   c) Optional open office hour: Wednesday: 11:00 am – 12:00 pm
      Thursday: 11:00 am – 12:00 pm

Grading Policy

Attendance	20%
Assignment 1	15%
Assignment 2	15%
Midterm Exam	25%
Final Group Project	25%

Grading Scale is as follows

Number grade	Letter grade	GPA
90-100	A	4
85-89	A-	3.7
80-84	B+	3.3
75-79	B	3
70-74	B-	2.7
67-69	C+	2.3
65-66	C	2
62-64	C-	1.7
60-61	D	1
≤59	F (Failure)	0

Class Schedule

Date	Lecture	Online Teaching Arrangement
Day 1	1.1 Introduction 1.2 Examples and Scope of This Book 2.1 Stochastic Processes 2.2 The Autocovariance and Autocorrelation Functions	Approximately 90 minutes pre-recorded video lectures
Day 2	2.3 The Partial Autocorrelation Function 2.4 White Noise Processes 2.5 Estimation of the Mean, Autocovariances, and Autocorrelations	Approximately 70 minutes pre-recorded video lectures
Day 3	2.6 Moving Average and Autoregressive Representations of Time Series Processes 2.7 Linear Difference Equations 3.1 Autoregressive Processes	Approximately 70 minutes pre-recorded video lectures plus 60 minutes online interaction via Zoom
Day 4	3.2 Moving Average Processes 3.3 The Dual Relationship Between AR(p) and MA (q) Processes 3.4 Autoregressive Moving Average ARMA (p, q) Processes	Approximately 70 minutes pre-recorded video lectures
Day 5	4.1 Nonstationary in the Mean 4.2 Autoregressive Integrated Moving Average (ARIMA) Models 4.3 Nonstationary in the Variance and the Autocovariance	Approximately 70 minutes pre-recorded video lectures
Day 6	5.1 Introduction 5.2 Minimum Mean Square Error Forecasts 5.3 Computation of Forecasts	Approximately 70 minutes pre-recorded video lectures
Day 7	5.4 The ARIMA Forecast as a Weighted Average of Previous Observations 5.5 Updating Forecasts 5.6 Eventual Forecast Functions	Approximately 70 minutes pre-recorded video lectures
Day 8	6.1 Steps for Model Identification 6.2 Empirical Examples 6.3 The Inverse Autocorrelation Function (IACF)	Approximately 70 minutes pre-recorded video lectures plus 60 minutes online interaction via Zoom
Day 9	7.1 The Method of Moments 7.2 Maximum Likelihood Method	Approximately 70 minutes pre-recorded video lectures

Day 10	7.3 Nonlinear Estimation 7.4 Ordinary Least Squares (OLS) Estimation in Time Series Analysis 7.5 Diagnostic Checking	Approximately 70 minutes pre-recorded video lectures
Day 11	8.1 General Concepts 8.2 Traditional Methods 8.3 Seasonal ARIMA Models	Approximately 90 minutes pre-recorded video lectures
Day 12	**Midterm Exam Review**	Approximately 70 minutes pre-recorded video lectures
Day 13	**Midterm Exam**	Exam via Zoom
Day 14	11.1 General Concepts 11.2 Orthogonal Functions 11.3 Fourier Representation of Finite Sequences 11.4 Fourier Representation of Periodic Sequences	Approximately 70 minutes pre-recorded video lectures
Day 15	11. 5 Fourier Representation of Nonperiodic Sequences 11.6 Fourier Representation of Continuous-Time Functions 11.7 The Fast Fourier Transform	Approximately 70 minutes pre-recorded video lectures
Day 16	12.1 The Spectrum 12.2 The Spectrum of Some Common Processes 12.3 The Spectrum of Linear Filters 12.4 Aliasing	Approximately 70 minutes pre-recorded video lectures
Day 17	13.1 Periodogram Analysis 13.2 The Sample Spectrum 13.3 The Smoothed Spectrum 13.4 ARMA Spectral Estimation	Approximately 70 minutes pre-recorded video lectures
Day 18	14.1 Single-Input Transfer Function Models 14.2 The Cross-Correlation Function and Transfer Function Models 14.3 Construction of Transfer Function Models	Approximately 70 minutes pre-recorded video lectures plus 90 minutes online interaction via Zoom
Day 19	14.4 Forecasting Using Transfer Function Models 14.5 Bivariate Freqency-Domain Analysis 14.6 The Cross-Spectrum and Transfer Function Models 14.7 Multiple-Input Transfer Function Models	Approximately 90 minutes pre-recorded video lectures
Day 20	**Final Group Project Presentation**	Presentation via Zoom