COURSE OUTLINE: MH4500

Course Title	**Time Series Analysis**		
Course Code	**MH4500**		
Offered	Study Year 4, Semester 2		
Course Coordinator	Pan Guangming (Assoc Prof)	gmpan@ntu.edu.sg	6513 2025
Pre-requisites	MH2500 and MH3500 and MH3510		
AU	4		
Contact hours	Lectures: 39, Tutorials: 12, Laboratories: 8		
Approved for delivery from	AY 2020/21 semester 2		
Last revised	7 Dec 2020, 10:35		

Course Aims

This course provides an introduction to various time series models. It aims to develop your understanding of fundamental models in time series analysis and enable you to build time series models for read data.

Intended Learning Outcomes

Upon successfully completing this course, you should be able to:

1. Define time series models
2. Differentiate between stationary and nonstationary models
3. Apply the methods of estimating parameters involved in ARIMA
4. Produce an appropriate ARIMA model for a given data set using R
5. Interpret the results of analysis

Course Content

Time series data examples and the components of a time series

Time series trend models - stationary, sample ACF and ACVF, and modeling the trend and seasonality in a time series

Stationary ARMA models - MA(p), AR(q), ARMA(p,q), ACF and PACF, and to select appropriate models based on SACF and SPACF

Estimation of ARMA models - Invertibility, estimation of AR(q), nonzero mean ARMA, minimum Mean Square Error Prediction, estimation of MA(q) and the Yule–Walker estimation method

Model selection - Model selection by AIC, diagnostic checking, using ACF and PACF of residuals to improve the model

Nonstationary models - Nonstionaary models, ARIMA, and the Box-Cox transformation

SARIMA models - Seasonal ARMA and SARIMA models

GARCH models - Motivation of using ARCH models and GARCH models

Assessment

Component	Course ILOs tested	SPMS-MAS Graduate Attributes tested	Weighting	Team / Individual	Assessment Rubrics
Continuous Assessment					
Tutorials					
Assignment	2, 3, 4	**1.** a, b, c **2.** b **3.** a	10	individual	See Appendix for rubric
Project	2, 3, 4, 5	**1.** a, b, c **2.** b **3.** a	10	team	See Appendix for rubric
Mid-semester Quiz					
Mid-term test	1, 2	**1.** a, b, c **2.** b, d **3.** a	20	individual	See Appendix for rubric
Examination (2 hours)					
Final Examination	1, 2, 3, 4, 5	**1.** a, b, c **2.** b, d **3.** a	60	individual	See Appendix for rubric
		Total	**100%**		

These are the relevant SPMS-MAS Graduate Attributes.

1. **Competence**
   a. Independently process and interpret mathematical theories and methodologies, and apply them to solve problems
   b. Formulate mathematical statements precisely using rigorous mathematical language
   c. Discover patterns by abstraction from examples
2. **Creativity**
   b. Build on the connection between subfields of mathematics to tackle new problems
   d. Critically analyse data from a multitude of sources
3. **Communication**
   a. Present mathematics ideas logically and coherently at the appropriate level for the intended audience

Formative Feedback

Feedback will be given to students through the weekly problem tutorial sets that are covered in tutorial. Common mistakes in the assignment and the midterm test will be discussed in the provided solution sets.

Learning and Teaching Approach

Lectures (39 hours)	Present the key ideas behind mathematical concepts. Present important steps used to solve different types of problems.
Tutorials (12 hours)	Develop proficiency in problem solving skills. Reinforce concepts already covered in the lectures. Give an opportunity for weaker or more reserved students to clarify doubts. Group Project: Train the class on teamwork and cohesion, as well as to boost confidence for weaker students. Develop communications skills. Students will be able to learn the importance of teamwork.
Laboratories (8 hours)	This will help to develop problem solving and computing skills, and reinforce the understanding of the concepts and notions.

Reading and References

B. L. Bowerman and R. T. O'Connell. (1993) Forecasting and Time Series: An applied approach. ISBN: 978-0534409777

G.E. P. Box, G. M. Jenkins and G. C. Reinsel. (1994) Time Series Analysis, Forecasting and Control. Prentics Hall. ISBN: 978-1-118-67502-1

P. J. Brockwell and R. A. Davis (1996) Introduction to Time Series and Forecasting. Duxbury Press. ISBN: 978-0387953519

Course Policies and Student Responsibilities

Absence Due to Medical or Other Reasons

If you are sick and not able to attend a quiz or midterm, you have to submit the original Medical Certificate (or another relevant document) to the administration to obtain official leave. In this case, the missed assessment component will not be counted towards the final grade. There are no make-up quiz or make-up midterm.

Academic Integrity

Good academic work depends on honesty and ethical behaviour. The quality of your work as a student relies on adhering to the principles of academic integrity and to the NTU Honour Code, a set of values shared by the whole university community. Truth, Trust and Justice are at the core of NTU's shared values.

As a student, it is important that you recognize your responsibilities in understanding and applying the principles of academic integrity in all the work you do at NTU. Not knowing what is involved in maintaining academic integrity does not excuse academic dishonesty. You need to actively equip yourself with strategies to avoid all forms of academic dishonesty, including plagiarism, academic fraud, collusion and cheating. If you are uncertain of the definitions of any of these terms, you should go to the Academic Integrity website for more information. Consult your instructor(s) if you need any clarification about the requirements of academic integrity in the course.

Course Instructors

Instructor	Office Location	Phone	Email
Pan Guangming (Assoc Prof)	SPMS-MAS-05-12	6513 2025	gmpan@ntu.edu.sg

Planned Weekly Schedule

Week	Topic	Course ILO	Readings/ Activities
1	Introduction to time series models, four components of a time series	1	Study lecture notes
2	Introduction to time series models, four components of a time series	1	Study lecture notes
3	Stationary, modelling the trend and seasonality in a time series	1, 2	Study lecture notes
4	Stationary, modelling the trend and seasonality in a time series	1, 2	Study lecture notes
5	Stationary ARMA models including AR(p), MA(q) and ARMA(p,q), select appropriate models based on SACF and SPACF	2, 3	Study lecture notes
6	Stationary ARMA models including AR(p), MA(q) and ARMA(p,q), select appropriate models based on SACF and SPACF	2, 3	Study lecture notes
7	Invertibility, Moment method, Yule–Walker estimation method	3, 4	Study lecture notes
8	Invertibility, Moment method, Yule–Walker estimation method	3, 4	Study lecture notes
9	Model selection by AIC, diagnostic checking, nonstationary models, Box-Cox transformation	3, 4	Study lecture notes
10	Model selection by AIC, diagnostic checking, nonstationary models, Box-Cox transformation	3, 4	Study lecture notes
11	Model selection by AIC, diagnostic checking, nonstationary models, Box-Cox transformation	3, 4	Study lecture notes
12	SARIMA models and GARCH models	4, 5	Study lecture notes
13	SARIMA models and GARCH models	4, 5	Study lecture notes

Appendix 1: Assessment Rubrics

Rubric for Tutorials: Assignment (10%)

Point-based marking

Rubric for Tutorials: Project (10%)

Grading Criteria	Exceptional	Effective	Acceptable	Developing
Accuracy	The interpretation is highly accurate, concise and precise.	The interpretation is mostly accurate. Some parts can be better explained or more succinct.	The interpretation is somewhat accurate. However, it contains some inaccuracies, missing points or ideas that are not related to the interpretation.	The interpretation are mostly inaccurate.
Thoroughness	The literature review was comprehensive and rigorous. It includes several different perspectives, including a good spread of the first and latest ideas on the topic.	The literature review was mostly comprehensive and rigorous. It can improve in terms of the selection of the works relating to the topic.	The literature review was adequate. It covers some of the major works relating to the topic. References to primary source is largely missing.	The literature review was not thorough. It is based on a single source of information and/or inaccurate or unreliable secondary sources.
Presentation	Very clear and organized. It is easy to follow your train of thought	Mostly clear and organized. Some parts can have better transitions.	Somewhat clear. It requires some careful reading to understand what you are writing.	Mostly unclear and messy. It is difficult to understand what you are writing as there is no clear flow of ideas.
Originality	Evidence of extensive synthesis of ideas from different perspectives such that there is a very convincing original interpretation and that goes beyond what is already discussed in literature.	Evidence of some synthesis of ideas which lead to an original interpretation. The interpretation is good original summary of what is discussed in literature.	Evidence of an attempt to synthesise ideas. However, the attempt contains some misunderstandings.	No synthesis of ideas or originality. It is a repetition of what people have said or a laundry list of ideas with little interpretation.

Please Note: In principle, students in the same group share the same group marks. However, there can be some individual variation within a group, depending on the evaluation of the tutor and the feedback from the peers. Students may be awarded more marks for showing exemplary contribution to other team members' learning that goes beyond what is required, whereas students who have not contributed sufficiently may receive lower marks than the rest of the team members

Rubric for Mid-semester Quiz: Mid-term test (20%)

Point-based marking

Rubric for Examination: Final Examination (60%)

Point-based marking