

## COURSE OUTLINE: MH3510

Course Title	<b>Regression Analysis</b>		
Course Code	<b>MH3510</b>		
Offered	Study Year 3, Semester 1		
Course Coordinator	Pan Guangming (Assoc Prof)	gmpan@ntu.edu.sg	6513 2025
Pre-requisites	MH2500 and MH3500		
AU	4		
Contact hours	Lectures: 39, Tutorials: 12		
Approved for delivery from	AY 2021/22 semester 1		
Last revised	7 Dec 2020, 10:34		

### Course Aims

This course aims to develop your understanding/grasping of the regression models of summarizing the relationship among variables. Linear regression models are widely used today in business, administration, economics, engineering, and the social, health and biological sciences. You should learn the rigorous way to approach regression models and be able to build regression models for real data.

### Intended Learning Outcomes

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

1. Build multiple regression models
2. Describe the principle of least squares
3. Identify the important predictor variables
4. Conduct one-way ANOVA and two-way ANOVA
5. Explore and analyze real data sets using R
6. Interpret the results of the analysis of data sets

### Course Content

Examples, response variables and predictor variables

Simple linear regression - the least squares method, analysis of variance, hypothesis tests and confidence intervals for regression parameters

Multiple linear regression - the least squares method, analysis of variance, reduced versus full models, confidence intervals for regression parameters and prediction and polynomial regression

Matrices and multivariate random vectors - matrix multiplication and the inverse of a matrix, the rules of expectation and covariance matrices of random vectors and multivariate normal distributions

One-way classification models - factor, treatment and levels, one-way ANOVA and analysis of treatment effects and contrasts

Two-way classification models - factors, treatment and interactions, two-way ANOVA for balanced data structures, analysis of treatment effects and contrasts.

Universal approach to linear modelling - dummy variables, multiple linear regression representation of one-way and two-way models, ANCOVA models and concomitant variables.

Model selection and diagnostics - model selection, residuals plot, leverage and standardized residual

## Assessment

Component	Course ILOs tested	SPMS-MAS Graduate Attributes tested	Weighting	Team / Individual	Assessment Rubrics
<b>Continuous Assessment</b>					
<b>Tutorials</b>					
Assignment	4, 5	1. a, b, c 2. b 3. a	10	individual	See Appendix for rubric
Project	4, 5, 6	1. a, b, c 2. b 3. a	10	team	See Appendix for rubric
<b>Mid-semester Quiz</b>					
Mid-term test	1, 2, 3	1. a, b, c 2. b, d 3. a	20	individual	See Appendix for rubric
<b>Examination (2 hours)</b>					
Final Examination	1, 2, 3, 4, 5, 6	1. a, b, c 2. b, d 3. a	60	individual	See Appendix for rubric
<b>Total</b>			<b>100%</b>		

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

<b>Lectures</b> (39 hours)	Present the key ideas behind mathematical concepts. Present important steps used to solve different types of problems.
<b>Tutorials</b> (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.

## Reading and References

Kuter, M. H. Nachtsheim. C. J. and Neter, J. (2008). Applied linear regression models. ISBN: 9780071145671

Draper, N.R. & Smith, H. (1998). Applied Regression Analysis. Wiley: New York. ISBN: 9780471170822

Mendenhall, W & Sincich, T. (2003) A second Course in Statistics: Regression Analysis. ISBN: 9780321691699

## Course Policies and Student Responsibilities

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 regression models, terminology	1, 2, 3	Study lecture notes
2	Simple regression model: LSE, hypothesis testing	1, 2, 3	Study lecture notes
3	Simple regression model: LSE, hypothesis testing	1, 2, 3	Study lecture notes
4	Simple regression model: LSE, hypothesis testing	1, 2, 3	Study lecture notes
5	Review of matrices, random vectors, multivariate normal distribution	3	Study lecture notes
6	Multiple regression: LSE, ANOVA, reduced model theory	1, 2, 3, 4	Study lecture notes
7	Multiple regression: LSE, ANOVA, reduced model theory	1, 2, 3, 4	Study lecture notes
8	Multiple regression: LSE, ANOVA, reduced model theory	1, 2, 3, 4	Study lecture notes
9	One way ANOVA: Assumptions of the models, analysis of treatment effects Two way ANOVA: interaction, hypothesis testing	3, 4	Study lecture notes
10	One way ANOVA: Assumptions of the models, analysis of treatment effects Two way ANOVA: interaction, hypothesis testing	3, 4	Study lecture notes
11	One way ANOVA: Assumptions of the models, analysis of treatment effects Two way ANOVA: interaction, hypothesis testing	3, 4	Study lecture notes
12	Universal approach to linear modelling, Model selection and diagnostics	5, 6	Study lecture notes
13	Universal approach to linear modelling, Model selection and diagnostics	5, 6	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