COURSE OUTLINE: MH4501

Course Title	**Multivariate Analysis**
Course Code	**MH4501**
Offered	Study Year 4, Semester 2
Course Coordinator	PUN Chi Seng (Asst Prof) — cspun@ntu.edu.sg — 6513 7468
Pre-requisites	MH2500 and MH3500 and MH3510
AU	4
Contact hours	Lectures: 39, Tutorials: 12, Laboratories: 6
Approved for delivery from	AY 2020/21 semester 2
Last revised	24 Nov 2020, 10:17

Course Aims

This course focuses on the standard methods of multivariate statistical analysis. Many essential data analysis techniques, such as principal component analysis and discriminant analysis, will be covered. This course equips students with the necessary skills for being data analysts.

Intended Learning Outcomes

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

1. Analyze multivariate data and the dependence structure of variates to extract the useful information from a massive dataset

2. Apply suitable tools for exploratory data analysis, dimension reduction, and classification to formulate and solve real-life problems

3. Implement the multivariate analysis techniques with statistical software such as R in a manner that the methodology adopted is motivated by appropriate statistical theory

Course Content

Multivariate Normal Distribution

Multivariate Inference

Multivariate Analysis of Variance

Principal Component Analysis

Factor Analysis

Canonical Correlation Analysis

Discriminant Analysis

Assessment

Component	Course ILOs tested	SPMS-MAS Graduate Attributes tested	Weighting	Team / Individual	Assessment Rubrics
Continuous Assessment					
Lectures					
Assignment	1, 2, 3	**1.** a, b, c, d **2.** a, b, c **4.** a **5.** a	15	individual	See Appendix for rubric
Mid-semester Quiz					
Midterm Examination	1, 2	**1.** a, b, c **2.** a, b	25	individual	See Appendix for rubric
Examination (2 hours)					
Final Examination	1, 2	**1.** a, b, c **2.** a, b	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

    d. Use computer technology to solve problems, and to communicate mathematical ideas

2. **Creativity**

    a. Critically assess the applicability of mathematical tools in the workplace

    b. Build on the connection between subfields of mathematics to tackle new problems

    c. Develop new applications of existing techniques

4. **Civic-mindedness**

    a. Develop and communicate mathematical ideas and concepts relevant in everyday life for the benefits of society

5. **Character**

    a. Act in socially responsible and ethical ways in line with the societal expectations of a mathematics professional, particularly in relation to analysis of data, computer security, numerical computations and algorithms

Formative Feedback

Through the assignments and the in-class discussion with students, the instructor will regularly give feedback to students on how they are learning in this course.

Learning and Teaching Approach

Lectures (39 hours)	Lectures provide systematic instruction of the course content.
Tutorials (12 hours)	Tutorials and labs consist of practice questions and lab implementation related to the course content. As a result, they provide weekly feedback/knowledge check for the students.
Laboratories (6 hours)	This will help to develop problem solving and computing skills, and reinforce the understanding of the concepts and notions.

Reading and References

TEXT: Applied Multivariate Statistical Analysis, R. A. Johnson and D. W. Wichern, 6th, Pearson Prentice Hall, QA278.J68A, 2007. ISBN: 9780132326803.

REFERENCE: An Introduction to Multivariate Statistical Analysis, T.W. Anderson, Wiley-Interscience, QA278.A551, 2003. ISBN: 978-0-471-36091-9.

Course Policies and Student Responsibilities

(1) General
Students are expected to attend all lectures and tutorials/labs punctually and complete and submit all assignments by due dates. Students are expected to take responsibility to follow up with course notes, assignments and course-related announcements.

(2) Assignments
All assignments equally contribute to the CA1 (15% of total score). Late submissions will be subject to mark deduction:
Scenario 1: if the assignment is submitted late after the due date but before the solution is released, then 30% of the maximum mark will be deducted.
Scenario 2: if the assignment is submitted late after the solution is released, then it will be marked zero.

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
PUN Chi Seng (Asst Prof)	SPMS-MAS-05-22	6513 7468	cspun@ntu.edu.sg

Planned Weekly Schedule

Week	Topic	Course ILO	Readings/ Activities
1	Introduction of Multivariate Analysis and review of Matrix Algebra	1	TEXT Chapter 1 TEXT Chapters 2.1-2.4
2	Population and Sample Statistics	1	TEXT Chapters 2.5-2.6, 3
3	Multivariate Normal Distribution	1	TEXT Chapter 4
4	Multivariate Inference	1, 2, 3	TEXT Chapters 5.1-5.5, 6.1-6.3
5	Multivariate Inference	1, 2, 3	TEXT Chapters 5.1-5.5, 6.1-6.3
6	Multivariate Analysis of Variance	1, 2, 3	TEXT Chapters 6.4-6.6
7	Midterm Examination Principal Component Analysis	1, 2, 3	TEXT Chapters 8.1-8.5
8	Principal Component Analysis	1, 2, 3	TEXT Chapters 8.1-8.5
9	Principal Component Analysis Factor Analysis	1, 2, 3	TEXT Chapters 8.1-8.5 TEXT Chapter 9
10	Factor Analysis	1, 2, 3	TEXT Chapter 9
11	Canonical Correlation Analysis	1, 2, 3	TEXT Chapter 10
12	Discriminant Analysis	1, 2, 3	TEXT Chapters 11.1-11.6
13	Advanced Topics	1, 2, 3	TEXT Chapter 12

Appendix 1: Assessment Rubrics

Rubric for Lectures: Assignment (15%)

Point-based marking

By mark range

Marks	Criteria
> 90%	Able to achieve Intended Learning Outcomes completely
70% to 89%	Able to achieve Intended Learning Outcomes with some minor mistakes
50% to 69%	Able to achieve Intended Learning Outcomes with some glaring mistakes
40% to 49%	Able to achieve only some of Intended Learning Outcomes
< 40%	Unable to achieve Intended Learning Outcomes at all

Rubric for Mid-semester Quiz: Midterm Examination (25%)

Point-based marking

By mark range

Marks	Criteria
> 90%	Able to achieve Intended Learning Outcomes completely
70% to 89%	Able to achieve Intended Learning Outcomes with some minor mistakes
50% to 69%	Able to achieve Intended Learning Outcomes with some glaring mistakes
40% to 49%	Able to achieve only some of Intended Learning Outcomes
< 40%	Unable to achieve Intended Learning Outcomes at all

Rubric for Examination: Final Examination (60%)

Point-based marking

By mark range

Marks	Criteria
> 90%	Able to achieve Intended Learning Outcomes completely
70% to 89%	Able to achieve Intended Learning Outcomes with some minor mistakes
50% to 69%	Able to achieve Intended Learning Outcomes with some glaring mistakes
40% to 49%	Able to achieve only some of Intended Learning Outcomes
< 40%	Unable to achieve Intended Learning Outcomes at all