Annexe A: New/Revised Course Content in OBTL+ Format

Course Overview

Expected Implementation in Academic Year	AY2020-2021
Semester/Trimester/Others (specify approx. Start/End date)	Semester 2
Course Author * Faculty proposing/revising the course	Jeremie Houssineau
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Course Title	Multivariate Analysis
Course Code	MH4501
Academic Units	4
Contact Hours	57
Research Experience Components	Not Applicable

Course Requisites (if applicable)

Pre-requisites	MH2500 and MH3500 and MH3510
Co-requisites	
Pre-requisite to	
Mutually exclusive to	
Replacement course to	
Remarks (if any)	

Course Aims

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

Course's Intended Learning Outcomes (ILOs)

Upon the successful completion of this course, you (student) would be able to:

ILO 1	Analyze multivariate data and the dependence structure of variates to extract the useful information from a massive dataset
ILO 2	Apply suitable tools for exploratory data analysis, dimension reduction, and classification to formulate and solve real-life problems
ILO 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

Reading and References (if applicable)

TEXT: Applied Multivariate Statistical Analysis, R. A. Johnson and D. W. Wichern, 6th, PearsonPrentice 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.

Planned Schedule

Week or Session	Topics or Themes	ILO	Readings	Delivery Mode	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		

Week or Session	Topics or Themes	ILO	Readings	Delivery Mode	Activities
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		

Learning and Teaching Approach

Approach	How does this approach support you in achieving the learning outcomes?
Lectures	Lectures provide systematic instruction of the course content.
Tutorials	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	This will help to develop problem solving and computing skills, and reinforce the understanding of the concepts and notions.

Assessment Structure

Assessment Components (includes both continuous and summative assessment)

No.	Component	ILO	Related PLO or Accreditation	Weightage	Description of Assessment Component	Team/Individual	Rubrics	Level of Understanding
1	Continuous Assessment (CA): Assignment(Lectures - Assignment)	1, 2, 3	1.a,b,c,d, 2.a,b,c, 4.a, 5.a	15		Individual	Analytic	Extended Abstract
2	Continuous Assessment (CA): Test/Quiz(Mid-semester Quiz - Midterm Examination)	1, 2	1.a,b,c, 2.a,b	25		Individual	Analytic	Relational
3	Summative Assessment (EXAM): Final exam(Final Examination)	1, 2	1.a,b,c, 2.a,b	60		Individual	Analytic	Relational

Description of Assessment Components (if applicable)

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 regularlygive feedback to students on how they are learning in this course.

NTU Graduate Attributes/Competency Mapping

This course intends to develop the following graduate attributes and competencies (maximum 5 most relevant)

Attributes/Competency	Level
Decision Making	Advanced
Digital Fluency	Basic
Learning Agility	Advanced
Problem Solving	Advanced
Sense Making	Advanced

Course Policy

Policy (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. On the use of technological tools (such as Generative AI tools), different courses / assignments have different intended learning outcomes. Students should refer to the specific assignment instructions on their use and requirements and/or consult your instructors on how you can use these tools to help your learning. Consult your instructor(s) if you need any clarification about the requirements of academic integrity in the course.

Policy (General)

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

Policy (Absenteeism)

Policy (Others, if applicable)

Diversity and inclusion policy

Integrating a diverse set of experiences is important for a more comprehensive understanding of science.

It is our goal to create an inclusive and collaborative learning environment that supports a diversity of perspectives and learning experiences, and that honours your identities; including ethnicity, gender, socioeconomic status, sexual orientation, religion or ability.

To help accomplish this:

- If you are neuroatypical or neurodiverse, have dyslexia or ADHD (for example), or have a social anxiety disorder or social phobia;
- If you feel like your performance in the class is being impacted by your experiences outside of class;
- If something was said in class (by anyone, including the instructor) that made you feel uncomfortable;

Please speak to your teaching team, our school pastoral officer or a peer or senior (either in-person or via email) about how we can help facilitate your learning experience.

As a participant in course discussions, you should also strive to honour the diversity of your classmates. You can

do this by: using preferred pronouns and names; being respectful of others opinions and actively making sure all voices are being heard; and refraining from the use of derogatory or demeaning speech or actions.

All members of the class are expected to adhere to the NTU anti-harassment policy. if you witness something that goes against this or have any other concerns, please speak to your instructors or a faculty member.

(2) Assignments
All assignments equally contribute to the CA1 (15% of total score). Late submissions will besubject to mark deduction:Scenario 1: if the assignment is submitted late after the due date but before the solution isreleased, 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 bemarked zero.

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