COURSE OUTLINE: MH3500

Course Title	**Statistics**		
Course Code	**MH3500**		
Offered	Study Year 2, Semester 2		
Course Coordinator	Yeo Kwee Poo (Asst Prof)	kweepoo@ntu.edu.sg	6513-7456
Pre-requisites	MH2500		
AU	4		
Contact hours	Lectures: 39, Tutorials: 12		
Approved for delivery from	AY 2022/23 semester 2		
Last revised	28 Nov 2022, 22:30		

Course Aims

This course aims to develop your understanding of the statistical concepts of parameter estimation and hypothesis testing that are fundamental for real life applications of statistics as well as for numerous further courses in the curriculum of the statistics track.

Intended Learning Outcomes

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

1. Apply basic probability concepts such as PMF, PDF, CDF, expected values, variance, and moments in a statistical context and perform the involved computations of series and integrals.
2. Use standard probability distributions to model statistical scenarios and to derive useful conclusions from computations based on these distributions.
3. Explain the relevance of the Central Limit Theorem for statistics.
4. Construct parameter estimators using the maximum likelihood method and the method of moments.
5. Rigorously assess the quality of parameter estimators.
6. Analyse the asymptotic properties of parameter estimators.
7. Construct exact and approximate confidence intervals.
8. Explain the purpose and philosophy of hypothesis testing, as well as the meaning of p-values.
9. Given a dataset, create and apply a useful hypothesis test based on these data.
10. Compute the size and power of a hypothesis test.
11. Construct most powerful tests using the Neyman-Pearson Lemma.

Course Content

Review of probability

Random samples, sample mean and sample variance, distributions derived from the normal distribution, Central Limit Theorem and its significance for statistics

Introduction to parameter estimation, quality criteria for parameter estimators

Constructing good estimators: method of moments and maximum likelihood method

Asymptotic properties of estimators, Cramer-Rao bound and efficient estimators

Confidence intervals for estimators

Introduction to hypothesis testing and Fisher-type tests

Neyman-Pearson tests and Neyman-Pearson Lemma

Assessment

Component	Course ILOs tested	SPMS-MAS Graduate Attributes tested	Weighting	Team / Individual	Assessment Rubrics
Continuous Assessment					
Tutorials					
Assignment	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11	**1.** a, b, c **2.** c **3.** a	20	individual	See Appendix for rubric
Mid-semester Quiz					
Short Answer Questions	1, 2, 3, 4, 5	**1.** a, b, c **2.** c **3.** a	20	individual	See Appendix for rubric
Examination (2 hours)					
Short Answer Questions	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11	**1.** a, b, c **2.** c **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

c. Develop new applications of existing techniques

3. Communication

a. Present mathematics ideas logically and coherently at the appropriate level for the intended audience

Formative Feedback

Midterm exam: Feedback on common mistakes and the level of difficulty of the problems is given.

Assignment: Students will receive individual feedback on their performance in the assignments during the tutorial sessions.

Learning and Teaching Approach

Lectures (39 hours)	The lectures cover the basic theory of parametric statistics using the following approach: - Illustration of concepts and theorems by numerous examples - Exercises embedded in lectures that students are encouraged to solve independently before seeing the solution in the lectures - Demonstration of statistical concepts using the software package R
Tutorials (12 hours)	Two types of tutorial problems will be given: 1) Problems that test comprehension of basic definitions and theorems. 2) More advanced problems that either require quite strong computational and reasoning skills or creativity in coming up with mathematical proofs.

Reading and References

John A. Rice: Mathematical Statistics and Data Analysis, Third Edition,
ISBN-13: 978-8131519547
ISBN-10: 8131519546

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 quizzes 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
Yeo Kwee Poo (Asst Prof)	SPMS-MAS-04-16	6513-7456	kweepoo@ntu.edu.sg

Planned Weekly Schedule

Week	Topic	Course ILO	Readings/ Activities
1	Review of probability	1	Study lecture notes
2	Review of probability	1	Study lecture notes
3	Random samples, sample mean and sample variance, distributions derived from the normal distribution, Central Limit Theorem and its significance for statistics	2, 3	Study lecture notes
4	Introduction to parameter estimation, quality criteria for parameter estimators	5	Study lecture notes
5	Constructing good estimators: method of moments and maximum likelihood method	4	Study lecture notes
6	Constructing good estimators: method of moments and maximum likelihood method	4	Study lecture notes
7	Constructing good estimators: method of moments and maximum likelihood method	4	Study lecture notes Midterm Quiz
8	Asymptotic properties of estimators, Cramer-Rao bound and efficient estimators	6	Study lecture notes
9	Asymptotic properties of estimators, Cramer-Rao bound and efficient estimators	6	Study lecture notes
10	Confidence intervals for estimators	7	Study lecture notes
11	Introduction to hypothesis testing and Fisher-type tests	8	Study lecture notes
12	Neyman-Pearson tests and Neyman-Pearson Lemma	9, 10, 11	Study lecture notes
13	Neyman-Pearson tests and Neyman-Pearson Lemma	9, 10, 11	Study lecture notes

Appendix 1: Assessment Rubrics

Rubric for Tutorials: Assignment (20%)
Point-based marking (not rubrics based)

Rubric for Mid-semester Quiz: Short Answer Questions (20%)
Point-based marking (not rubrics based)

Rubric for Examination: Short Answer Questions (60%)
Point-based marking (not rubrics based)