COURSE OUTLINE: MH1300

Course Title	**Foundations of Mathematics**		
Course Code	**MH1300**		
Offered	Study Year 1, Semester 1		
Course Coordinator	Ng Keng Meng (Assoc Prof)	kmng@ntu.edu.sg	6513 8656
Pre-requisites	None (A-level Mathematics or equivalent)		
AU	4		
Contact hours	Lectures: 39, Tutorials: 12		
Approved for delivery from	AY 2022/23 semester 1		
Last revised	27 Jul 2022, 10:05		

Course Aims

This course aims to develop and equip you with the necessary skills for a mathematically related job. You should demonstrate a basic understanding of fundamental mathematical concepts and processes such as such as formal mathematical proofs. You should also learn the rigorous way to approach mathematical problems and to be familiar with the process of abstracting from examples, as these skills are essential for all future mathematics courses. You should develop critical analytical skills for a career in a mathematical related job. You will acquire the communication skills necessary to communicate technical ideas, both written and verbal, to a broad audience.

Intended Learning Outcomes

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

1. Distinguish between the different kinds of mathematical statements.
2. Apply the rules of elementary logic to correctly formulate mathematical arguments.
3. Apply truth tables to decide logical equivalence and the validity of arguments.
4. Differentiate between the different kinds of quantified statements.
5. Decide the truth of quantified statements.
6. Derive the different ways to prove a quantified statement.
7. Apply different proof techniques in various situations, including direct proofs, indirect proofs, proof by cases, proof by contraposition and proof by contradiction.
8. Distinguish between the different proof techniques above and judge when each method is more suitable than another.
9. Explain how to disprove a given mathematical statement.
10. Recall proof by mathematical induction.
11. Give examples of when strong mathematical induction is preferred over the regular form of induction.
12. Employ the use of the Well-ordering principle in problems.
13. Describe the concept of a sequence and distinguish it from a series.
14. Describe the notion of a set and apply the different set operations to reason about them.
15. Apply the algebraic method and the element method to prove statements about sets.
16. Solve problems using the concept of relations and equivalence relations.
17. Describe the equivalence classes of a given equivalence relation.
18. Rediscover functions as relations.
19. Judge when a given function is injective, surjective or bijective.

20. Explain the concept of function composition and inverse.
21. Differentiate natural numbers and other systems of numbers.
22. Perform basic arithmetical operations on complex numbers.
23. Produce the complex roots of a given complex value.
24. Administer the Division and Euclidean algorithms to solve for various quantities such as the greatest common divisor and apply them to linear combinations.
25. Solve simple equations involving modulo arithmetic.
26. Independently describe underlying mathematical concepts and solve related, but not previously encountered problems.

Course Content

Elementary logic, mathematical statements, quantified statements

Sets, operations on sets, Cartesian products, properties of sets

Natural numbers, integers, rational numbers, real numbers, complex numbers

Relations, equivalence relations, equivalence classes

Functions, injective and surjective functions, inverse functions, composition of functions

Division algorithm, greatest common divisor, Euclidean algorithm, fundamental theorem of arithmetic, modulo arithmetic

Assessment

Component	Course ILOs tested	SPMS-MAS Graduate Attributes tested	Weighting	Team / Individual	Assessment Rubrics
Continuous Assessment					
Lectures					
Assignment	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26	**1.** a, b **2.** a, c **3.** a, b **5.** a	10	individual	See Appendix for rubric
In-class activities	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	**1.** a, b, c **2.** a, b	15	individual	See Appendix for rubric
Mid-semester Quiz					
Short Answer Questions	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	**1.** a, b, c **2.** a	25	individual	See Appendix for rubric
Examination (2 hours)					
Short Answer Questions	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26	**1.** a, b, c **2.** a, b, c	50	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

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

3. Communication

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

b. Work in teams on complicated projects that require applications of mathematics, and communicate the results verbally and in written form

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

For the midterm and final exams, feedback on the common mistakes are given on NTULearn after the grades are announced.

For the HW, tutors will discuss and answer any questions about mistakes.

Learning and Teaching Approach

Lectures (39 hours)	Lectures will be designed to be interactive and students are expected to engage in the in-class activities.
Tutorials (12 hours)	Tutorials are designed for students to clear up doubts about the problems posed. Students are expected to work through the problems on their own before each tutorial session

Reading and References

• Main Textbook – Discrete Mathematics with Applications, Susanna S. Epp, Thomson Brooks, 4th Edition. ISBN 9780495391326
• Reference – Discrete Mathematics, Richard Johnsonbaugh, Pearson New International Holding, 7th Edition. ISBN 9781292022611
• Reference – Discrete Mathematics with its Applications, Kenneth Rosen, McGraw Hill. ISBN 9781260091991

Course Policies and Student Responsibilities

(1) General

Students are expected to complete all assigned pre-class readings and activities, attend all tutorial classes punctually and take all scheduled assignments and tests by due dates. Students are expected to participate in all tutorial discussions and activities.

(2) Absenteeism

Absence from the midterm without a valid reason will affect your overall course grade. Valid reasons include falling sick supported by a medical certificate and participation in NTU's approved activities supported by an excuse letter from the relevant bodies. There will be no make-up opportunities for CA components.

All homework assignments must be submitted to your tutor by the end of the tutorial session. Failure to do so will affect your score.

(3) Collaboration

Collaboration is encouraged for your homework because peer-to-peer learning helps you understand the subject better and working in a team trains you to better communicate with

others. As part of academic integrity, crediting others for their contribution to your work promotes ethical practice.
You must write up your solutions by yourself and understand anything that you hand in.
If you do collaborate, you must write on your solution sheet the names of the students you worked with. If you did not collaborate with anyone, please explicitly write, “No collaborators." Failure to do so constitutes plagiarism.

Use of materials outside the course is strongly discouraged. If you use outside source, you must reference it in your solution.

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
Ng Keng Meng (Assoc Prof)	MAS-05-09	6513 8656	kmng@ntu.edu.sg

Planned Weekly Schedule

Week	Topic	Course ILO	Readings/ Activities
1	Elementary Logic	1, 2, 3, 4, 5, 6, 26	Lecture Notes
2	Elementary Logic	1, 2, 3, 4, 5, 6, 26	Lecture Notes
3	Elementary Logic	1, 2, 3, 4, 5, 6, 26	Lecture Notes
4	Mathematical Proof	7, 8, 9, 10, 11, 12, 26	Lecture Notes
5	Mathematical Proof	7, 8, 9, 10, 11, 12, 26	Lecture Notes
6	Mathematical Proof	7, 8, 9, 10, 11, 12, 26	Lecture Notes
7	Mathematical Proof	7, 8, 9, 10, 11, 12, 26	Lecture Notes
8	Mathematical Proof Midterm Test	7, 8, 9, 10, 11, 12, 26	Lecture Notes
9	Mathematical Proof	7, 8, 9, 10, 11, 12, 26	Lecture Notes
10	Sets, relations and functions	13, 14, 15, 16, 17, 18, 19, 20, 26	Lecture Notes
11	Sets, relations and functions	13, 14, 15, 16, 17, 18, 26	Lecture Notes
12	Systems of numbers	21, 22, 23, 24, 25, 26	Lecture Notes
13	Systems of numbers	21, 22, 23, 24, 25, 26	Lecture Notes

Appendix 1: Assessment Rubrics

Rubric for Lectures: Assignment (10%)

Point-based marking

Rubric for Lectures: In-class activities (15%)

Point based marking. Students will be graded on their performance in quizzes held during lectures, which will be implemented via online polling platforms such as WooClap and Kahoot.

Rubric for Mid-semester Quiz: Short Answer Questions (25%)

Point-based marking

Rubric for Examination: Short Answer Questions (50%)

Point-based marking