COURSE OUTLINE: MH4200

Course Title	**Abstract Algebra II**		
Course Code	**MH4200**		
Offered	Study Year 4, Semester 1		
Course Coordinators	Wu Guohua (Assoc Prof)	guohua@ntu.edu.sg	6513 7186
	Wang Huaxiong (Assoc Prof)	hxwang@ntu.edu.sg	6513 7472
Pre-requisites	MH1201 and MH3200		
AU	4		
Contact hours	Lectures: 39, Tutorials: 12		
Approved for delivery from	AY 2024/25 semester 1		
Last revised	29 Nov 2022, 16:23		

Course Aims

This is a prescribed elective course for students in the pure mathematics track, aims at understanding basics in field extensions and Galois theory. The course will lead you to various constructions of fields that are common to diverse mathematical objects, and group theory for these extensions. It will be essential for advanced courses in algebraic number theory, algebraic geometry, elliptic curves and cryptography.

Intended Learning Outcomes

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

1. State basic definitions field extensions, splitting fields, normal extensions, separable extensions, and explain them to a layman
2. Prove unsolvability of trisecting an angle, doubling a cube, squaring a circle
3. Compute Galois group for various field extensions
4. Explain the reason for quadratic equations cannot be solved explicitly using radicals
5. Prove or disprove statements related to field extensions and Galois groups

Course Content

Field extensions, splitting fields, normal extensions, separable extensions

Tests for irreducibility of a polynomial

Groups acting on a field, fixed fields

Galois extension, with examples, Cyclotomic field extensions

Primitive elements, traces

Galois Correspondence

Fundamental Theorem of Algebra and 2-Sylow groups

Radical extensions and compass and ruler constructions.

Galois representation and connections with elliptic curves

Assessment

Component	Course ILOs tested	SPMS-MAS Graduate Attributes tested	Weighting	Team / Individual	Assessment Rubrics
Continuous Assessment					
Tutorials					
Presentation	3, 4, 5	**1.** b **3.** a **4.** a **5.** a	15	individual	See Appendix for rubric
Test	1, 2, 3	**1.** b **5.** a	15	individual	See Appendix for rubric
Mid-semester Quiz					
Short Answer Questions	1, 2, 3	**1.** b **3.** a	20	individual	See Appendix for rubric
Examination (2 hours)					
Short Answer Questions	1, 2, 3, 4, 5	**1.** b **3.** a	50	individual	See Appendix for rubric
		Total	**100%**		

These are the relevant SPMS-MAS Graduate Attributes.

1. Competence

b. Formulate mathematical statements precisely using rigorous mathematical language

3. Communication

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

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

Attending lectures, reading lecture notes and related chapters in reference book, and working through weekly tutorial problems and discussing with instructors and peers, you will be able meet learning outcomes 1,2,3,4,5.

After each test, instructors will discuss the test solution to highlight strength and weakness of students. The Examiner's report will be uploaded to NTULearn to provide feedback on the strength and weakness of students in the module.

Learning and Teaching Approach

Lectures (39 hours)	Traditional teaching approach: lecture in the classroom. Theory and examples will be provided and discussed. Some activities will be conducted during lectures, such as proving and deriving results, finding examples from other subjects, computing Grobner basis, etc.These will enhance learning and understanding of the concepts and techniques.
	Attend lectures and review lecture notes before coming to class and make sure you understand the last lecture.
	Regularly summarize theorems, examples and methods, and link theorems in this course to those examples you have seen in other subjects.
	Study consistently. Have a study plan (includes the test-dates) and avoid last-minute work or study
Tutorials (12 hours)	Abstract Algebra III is a continuation of Abstract Algebra II, but with focus on advanced topics and methods. It needs Abstract Algebra II as a foundation, and practice in Algebra II will be helpful for taking Algebra III.
	Weekly assignments will be uploaded in NTULearn one week in advance before tutorial session so that you have time to read, think and work through the problems to enhance understanding the concepts and methods in both theory and calculating.
	In the tutorial, we will work on hard problems and leave easy problems for you to practice. You are encouraged to ask questions to clarify doubts.
	You are encouraged to consult with instructors and classmates, and talk about mathematics with your classmates.
	Read, think and work the tutorial questions before tutorials will help you to understand the abstract concepts and methods introduced in the class.
	Regularly summarize the theorems, methods and examples in your own words. Once you can formulate mathematics by yourself, you will be more motivated to capture more advanced topics in mathematics.

Reading and References

Reference: Abstract Algebra, Third Edition, by David S. Dummit and Richard M. Foote, John Wiley and Sons, Inc.

ISBN 10: 0470386282 / ISBN 13: 9780470386286

Course Policies and Student Responsibilities

You are expected to attend all classes punctually and take all scheduled assignments, tests, presentations by due dates. You are expected to take
responsibility to follow up with course notes, assignments and course related
announcements. You are expected to participate in all discussions, presentations and activities. You are expected to attend the midterms. In case of medical leaves, You should provide a satisfying medical certificate on time.

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
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Planned Weekly Schedule

Week	Topic	Course ILO	Readings/ Activities
1	Field extensions	1, 2, 5	Chapter 13, section 1
2	Algebraic extensions	1, 2, 5	Chapter 13, section 2
3	Splitting fields and algebraic closures	1, 4, 5	Chapter 13, section 4
4	Separable extensions	1, 4, 5	Chapter 13, section 5
5	Normal extensions	1, 2, 5	Chapter 13, section 5
6	Test for irreducibility	1, 2, 5	Chapter 9, section 4
7	Cyclotomic extensions	1, 2, 3, 5	Chapter 13, section 6
8	Fundamental theorem of Galois Theory	1, 2, 5	Chapter 14, section 2
9	Finite fields	1, 4, 5	Chapter 14, section 3
10	Galois groups of polynomials	1, 4, 5	Chapter 14, section 6
11	Insolvability of quintic	1, 4, 5	Chapter 13, section 7
12	Computation of Galois groups over rationals	1, 4, 5	Chapter 13, section 8
13	Transcendental extensions	1, 4, 5	Chapter 13, section 9

Appendix 1: Assessment Rubrics

Rubric for Tutorials: Presentation (15%)

Criteria	Fail to meet standard (0 - 3) (Prestructural)	Nearly Meet Standard (4 – 6) (Unistructural)	Meet Standard (7 - 9) (Multi-structural)	Exceed Standard (10 - 12) (Relational)	Far Exceed Standard (13 - 15) (Extended)
Organization and Structure	No clear structure showing in the presentation. Topics presented are incoherent. No clear distinction between parts on motivation, main results, and conclusion.	Somewhat structured presentation Distinct parts on motivation, main results, conclusions, etc. are indicated but the contents in each part are unstructured	Structured presentation Distinct parts on motivation, results, conclusions, etc. are indicated, with contents mostly organized. Key conclusions are not specified in a direct way	Well-structured presentation Distinct parts on motivation, results, conclusions, etc. are indicated and the contents in each part content is well- structured The key conclusions are clear	Above standard structured presentation. Content of motivation, results, conclusions, etc. are well organized throughout the entire presentation. The presented contents are not only comprehensive, and the presentation is efficient.
Analytical Thinking	Part of the understanding of concepts, methods and proofs are not correct	The understanding are correct, but could not provide the motivation behind these concepts and basic ideas of proofs	The understanding are correct and clear, and can provide motivation behind these concepts and proofs. Need to show the relations between these and other relevant topics	The understanding are correct and clear, and can provide enough knowledge of the role of these topics in the whole subject. The presentation does not mention the current research on these topics	The understanding are correct and clear, and can provide thorough knowledge of the position of these topics in the whole subject. The presentation digs into the updated research on the topics presented
Effectiveness of oral presentation and Q&A	Does not present ideas effectively, (pace, tone and presentation style) and cannot keep the attention of audience through most of the presentation.	Communicates ideas somewhat effectively (pace, tone and style). Maintain the attention of audience in some parts of the presentation.	Communicate ideas in an effective and understandable manner throughout most of the presentation. Motivate the interest of the audience and keep their attention for the major part of the presentation	Explain difficult methods in an effective and understandable way. Motivate interest of the audience, and engage the audience throughout the presentation	Far exceed expectations of a fourth year student in communicating complex scientific concepts. Motivate the interest to further topics extending the presented contents
Individual Contribution and Q&A	No effective contribution in the presentation The Q&A session shows little knowledge on the chosen topic.	Some contribution of proofs and methods shown in the presentation The Q&A session only shows one	Interesting contribution of proofs and methods shown in the presentation The Q&A session reflects more than one	Provide motivation of proofs and methods shown in the presentation The Q&A session reflects depth of knowledge, not	Provide new proofs and methods shown in the presentation The Q&A session reflects coherence, fluency, and

		aspect of the chosen topic and shows limited knowledge of the chosen topic	aspect of the chosen topic, but does not show connection with related topics.	only in an individual topic, but in the whole area.	depth of knowledge in the whole area. Show new perspectives on the topic presented.

Rubric for Tutorials: Test (15%)

Point-based Marking. Marks will be awarded to analytical, logical and correct justification, or

computation, or examples

Rubric for Mid-semester Quiz: Short Answer Questions (20%)

Point-based Marking. Marks will be awarded to analytical, logical and correct justification, or

computation, or examples

Rubric for Examination: Short Answer Questions (50%)

Point-based Marking. Marks will be awarded to analytical, logical and correct justification, or

computation, or examples