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

Course Overview

The sections shown on this interface are based on the templates UG OBTL+ or PG OBTL+
If you are revising/duplicating an existing course and do not see the pre-filled contents you expect in the subsequent sections e.g. Course Aims, Intended Learning Outcomes etc. please refer to Data Transformation Status for more information.

Expected Implementation in Academic Year	AY2025-2026
Semester/Trimester/Others (specify approx. Start/End date)	Semester 2
Course Author * Faculty proposing/revising the course	Wu Guohua (Assoc Prof)
Course Author Email	guohua@ntu.edu.sg
Course Title	Algebra III
Course Code	MH4220
Academic Units	4
Contact Hours	51
Research Experience Components	Not Applicable

Course Requisites (if applicable)

Pre-requisites	MH1201 and (MH3200 or MH3220)
Co-requisites	
Pre-requisite to	
Mutually exclusive to	MH4200
Replacement course to	MH4200
Remarks (if any)	

Course Aims

This is a prescribed elective course for you 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 constructions and extensions. It will be essential for advanced courses in algebraic number theory, algebraic geometry, elliptic curves and cryptography.

Course's Intended Learning Outcomes (ILOs)

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

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

Reading and References (if applicable)

Reference: Abstract Algebra, Third Edition, by David S. Dummit and Richard M. Foote, John Wiley and Sons, Inc. Hoboken, NJ, 2004. ISBN10 : 0471433349

NOTE: The above readings comprise the foundational readings for the course and more up-to-date relevant readings will be provided when they are available.

Planned Schedule

Week or Session	Topics or Themes	ILO	Readings	Delivery Mode	Activities
1	Field extensions	1, 2, 5	Chapter 13, section 1	In-person	
2	Algebraic extensions	1, 2, 5	Chapter 13, section 2	In-person	
3	Splitting fields and algebraic closures	1, 4, 5	Chapter 13, section 4	In-person	
4	Separable extensions	1, 4, 5	Chapter 13, section 5	In-person	
5	Normal extensions	1, 2, 5	Chapter 13, section 5	In-person	Quiz
6	Test for irreducibility	1, 2, 5	Chapter 9, section 4	In-person	
7	Cyclotomic extensions	1, 2, 3, 5	Chapter 13, section 6	In-person	
8	Fundamental theorem of Galois Theory	1, 2, 5	Chapter 14, section 2	In-person	
9	Finite fields	1, 4, 5	Chapter 14, section 3	In-person	
10	Galois groups of polynomials	1, 4, 5	Chapter 14, section 6	In-person	Mid-term Test
11	Insolvability of quintic	1, 4, 5	Chapter 13, section 7	In-person	
12	Computation of Galois groups over rationals	1, 4, 5	Chapter 13, section 8	In-person	Presentation
13	Transcendental extensions	1, 4, 5	Chapter 13, section 9	In-person	

Learning and Teaching Approach

Approach	How does this approach support you in achieving the learning outcomes?
Lectures	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	Algebra III is a continuation of Algebra II, but with focus on advanced topics and methods. It needs 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.

Assessment Structure

Assessment Components (includes both continuous and summative assessment)

No.	Component	ILO	Related PLO or Accreditation	Weightage	Team/Individual	Rubrics	Level of Understanding
1	Continuous Assessment (CA): Presentation()	3, 4, 5	Not Applicable	15	Individual	Analytic	Relational
2	Continuous Assessment (CA): Test/Quiz(Quiz)	1, 2, 3	Not Applicable	15	Individual	Analytic	Multistructural
3	Continuous Assessment (CA): Test/Quiz(Mid-term Test - Short Answer Questions)	1, 2, 3	Not Applicable	20	Individual	Analytic	Multistructural
4	Summative Assessment (EXAM): Final exam(Short Answer Questions)	1, 2, 3, 4, 5	Not Applicable	50	Individual	Analytic	Multistructural

Description of Assessment Components (if applicable)

The final exam will be a comprehensive exam for all the concepts and methods being taught in the whole semester. Oral presentations will motivate students to explore related topics. Quiz in week 5 will be on the basics of field extensions, and Mid-term test in week 10 will be focused on the Galois's correspondence theorem, to test students' understanding of the topics.

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.

NTU Graduate Attributes/Competency Mapping

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

Attributes/Competency	Level
Communication	Intermediate
Creative Thinking	Advanced
Curiosity	Advanced
Problem Solving	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)

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.

Policy (Absenteeism)

You are expected to attend the midterms and presentations. A student who is absent from midterm test without valid Leave of Absence will be given zero mark. In case of valid reason for absence, the total course marks would subsequently be rescaled to a base of 100%. There will be no make-up opportunities for in-class activities.

If you are sick and unable to attend your class, you have to:
1. Send an email to the instructor regarding the absence.
2. Submit the Medical Certificate* or official letter of excuse to your Home school.

* The medical certificate mentioned above should be issued in Singapore by a medical practitioner registered with the Singapore Medical Association.

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.

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.