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

Course Overview

Expected Implementation in Academic Year	AY2025-2026
Semester/Trimester/Others (specify approx. Start/End date)	Semester 1 Semester 2
Course Author * Faculty proposing/revising the course	Philip Grant, Mihaiela Stuparu
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Course Title	ORGANIC REACTION MECHANISMS & SYNTHESIS
Course Code	CM3031
Academic Units	3
Contact Hours	42
Research Experience Components	Not Applicable

Course Requisites (if applicable)

Pre-requisites	CM2031 or by permission
Co-requisites	
Pre-requisite to	
Mutually exclusive to	
Replacement course to	
Remarks (if any)	

Course Aims

This core chemistry course aims to develop your understanding of fundamentals of organic chemistry concepts that are essential for future advance chemistry courses and any practicing chemists. This course is also great preparation for a PhD and a career in chemistry research.

On completing this course, you have extended your understanding of organic reaction mechanisms beyond the first- and second-year contents to more advanced chemistry. You will understand issues of selectivity and specificity, especially in terms of regio-, stereo-, and chemo-selectivity and specificity. You will be able to propose syntheses of molecules of higher complexity.

Course's Intended Learning Outcomes (ILOs)

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

ILO 1	explain basic concept of chirality.
ILO 2	describe and rationalise 1,3-allylic strain reactions.
ILO 3	describe and rationalise the conformation and addition reactions based on carbonyl molecules.
ILO 4	describe and rationalise stereoselective aldol reactions.
ILO 5	describe and rationalise reactions on monocyclic and bicyclic rings over cyclic stereocontrol.
ILO 6	define the various types of pericyclic reaction; define such terms as conrotatory", "suprafacial", etc; explain and apply the Woodward-Hoffmann Rules.
ILO 7	state that the outcomes of pericyclic reactions may be understood in terms of frontier orbital interactions.
ILO 8	predict and rationalise the outcomes of Diels-Alder cycloadditions, including stereospecificity, regioselectivity, and stereoselectivity.
ILO 9	predict and rationalise the outcomes of other cycloaddition reactions, including 1,3- dipolar and [2+2] cycloadditions, cheletropic reactions, and the ene reaction.
ILO 10	predict and rationalise the outcomes of electrocyclic reactions.
ILO 11	predict and rationalise the outcomes of [1,n]-, [2,3]- and [3,3]-sigmatropic rearrangements.
ILO 12	state the synthetic importance of cycloaddition and rearrangement reactions.
ILO 13	design and propose synthetic pathway to new molecules.

Course Content

1. 1,3-Allylic strain: lowest-energy conformation; cis/trans substituents; Houk model
2. Conformation and addition reactions of carbonyls: Felkin-Anh model; effect of electronegative atoms; chelation control
3. Stereoselective aldol reaction: stereoselective aldol reactions; control of enolate geometry; Zimmerman-Traxler model
4. Cyclic stereocontrol: reactions on monocyclic rings; reactions on bicyclic rings
5. Introduction: Isomerism; Selectivity; Selectivity
6. Diels-Alder Cycloaddition: The basic reaction and its disconnection; Substituted dienes and dienophiles and their effect on reaction rates; Regioselectivity; Stereoselectivity and Stereoselectivity (exo/endo) governed by secondary orbital interactions and chirality of starting materials.
7. Other Cycloadditions: 1,3-Dipolar cycloadditions; [2+2] cycloadditions; Cheletropic reactions; More than 6e cycloadditions; Photochemical cycloadditions
8. Woodward- Hoffmann Rules as applied to cycloadditions; Frontier Molecular Orbital Theory applied to cycloadditions
9. Electrocyclic Reactions: Occurrence with 2, 3, 4, etc. electron pairs; Direction of equilibrium; Con- and dis-rotatory reaction; Woodward-Hoffmann Rules as applied to electrocyclic reactions.
10. Simgatropic Rearrangements: Prototropic and sigmatropic rearrangements; [1,3], [1,5], [1,7] hydrogen shifts; Cope, Claisen and related rearrangements; Orbital involvement; Chair-shaped transition states; Stereochemical control; Woodward-Hoffmann Rules as applied to electrocyclic simgatropic rearrangements.

Reading and References (if applicable)

Organic Chemistry, Clayden, Greeves, Warren; Oxford University press ISBN: 9780199270293

Planned Schedule

Week or Session	Topics or Themes	ILO	Readings	Delivery Mode	Activities
1	Introduction, 1,3-Allylic strain	1,2			Lecture, Responseware, Assignment
2	1,3-Allylic strain, Conformation and addition reactions of carbonyls	2,3			Lecture, Responseware, Assignment
3	Tutorials	1-3			Lecture, Responseware, Assignment
4	Stereoselective aldol reactions	4			Lecture, Responseware, Assignment
5	Cyclic stereocontrol	5			Lecture, Responseware, Assignment
6	Tutorials	4,5			Lecture, Responseware, Assignment
7	Midterm 1	1-5			Assignment
8	Cycloaddition Reactions	6,7			Lecture, Responseware, Assignment
9	Woodward-Hoffmann Rules	8,9			Lecture, Responseware, Assignment
10	Electrocyclic Reactions	10,11			Lecture, Responseware, Assignment
11	Tutorials	6-11			Lecture, Responseware, Assignment

Week or Session	Topics or Themes	ILO	Readings	Delivery Mode	Activities
12	Simgatropic Rearrangements	12,13			Lecture, Responseware, Assignment
13	Midterm 2	6-13			Assignment

Learning and Teaching Approach

Approach	How does this approach support you in achieving the learning outcomes?
Lectures	Face to face lectures will be conducted for ILO 1 – 13. This is to allow you to interact directly with the instructor. Students could also immediately clarify their doubts/questions during the lectures. You will be spending time to learn detailed organic chemistry principles, structures and reactions. This will enable you to possess the ability for designing new organic chemistry experiments and addressing scientific problems in organic chemistry.
Tutorials	TAs will provide materials containing concepts taught in classes and cover related applications derived from corresponding lectures. You will be assigned to a small group for interactive discussions toward some representative questions, which will help you develop your own critical thinking capability and problem solving skills.
Homework	You will work independently, apply the knowledge you learn to solve scientific problems, develop self-discipline to take initiative and responsibility for completing a task.

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): Others(Homework)	6-12	Competence, Creativity	10		Individual	Analytic	Multistructural
2	Continuous Assessment (CA): Test/Quiz(Midterm Test 1)	6-13	Competence, Creativity	10		Individual	Analytic	Multistructural
3	Continuous Assessment (CA): Test/Quiz(Midterm Test 2)	1-5	Competence, Creativity, Communication	20		Individual	Analytic	Multistructural
4	Summative Assessment (EXAM): Final exam()	1-13	Competence, Creativity, Communication	55		Individual	Analytic	Multistructural
5	Continuous Assessment (CA): Class Participation(Quiz)	1-13	Competence, Creativity	5		Individual	Analytic	Multistructural

Description of Assessment Components (if applicable)

Formative Feedback

Formative feedback: Lecturers and TAs will be closely working with you to monitor your learning progress. They will provide you with timely feedback to improve your understanding and design. Furthermore, you can feel free to express your ideas and discuss them with lecturers and TAs as course progresses. You will have opportunities to practise the key learning aspects during lectures and tutorials.

After each item of CA, you will be given written and/or verbal feedback on your work. An examiner report will be provided to you after the final exam, as a way to allow you to reflect on the areas for improvement and allow you to achieve intended learning outcomes 1-13.

NTU Graduate Attributes/Competency Mapping

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

Attributes/Competency	Level
Curiosity	Advanced
Learning Agility	Advanced
Critical Thinking	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 complete all online activities in good time

Policy (Absenteeism)

If you miss a lecture, you are expected to make up for the lost learning 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 original Medical Certificate to the school (the medical certificate mentioned above should be issued in Singapore by a medical practitioner registered with the Singapore Medical Association.)

If you miss the mid-term exam with approval, you will be graded based upon the final.

Policy (Others, if applicable)

Diversity and Inclusion Policy

Integrating a diverse set of experiences is important for a more comprehensive understanding of science and engineering. It is our goal to create an inclusive and collaborative learning environment that supports a diversity of perspectives and learning experiences. 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 your performance in the course is being impacted by your experiences outside of class
- If something was said in the course (by anyone, including instructor/supervisor) that made you uncomfortable.

Please e-mail our Associate Chair (Students & Continuing Education) at ac-cceb-stud@ntu.edu.sg 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, actively making sure all voices are being heard, and refraining from the use of derogatory or demeaning speech or actions.

All members of the course are expected to strictly adhere to the student code of conduct (https://www.ntu.edu.sg/life-at-ntu/student-life/student-conduct). If you witness something that goes against this or has any other concerns, please speak to your instructors or a faculty member.

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