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 2
Course Author * Faculty proposing/revising the course	Anuvab Das
Course Author Email	anuvab.das@ntu.edu.sg
Course Title	METAL MEDIATED REACTIONS
Course Code	CM4033
Academic Units	3
Contact Hours	39
Research Experience Components	Not Applicable

Course Requisites (if applicable)

Pre-requisites	(CM3021 and CM3031) or by permission
Co-requisites	
Pre-requisite to	
Mutually exclusive to	
Replacement course to	
Remarks (if any)	

Course Aims

In this course, you will build upon your understanding of organic chemistry and organometallic chemistry developed in core courses in earlier years. You will bring together knowledge from the separate core courses to understand how this knowledge can be used for the synthesis of both simple and complex molecules using the chemistry of transition metals. Where relevant, you will study examples taken from the pharmaceutical and other industries to illustrate how the chemistry can be applied at scale and how issues such as IP and green metrics impact the process. The course will use the flipped classroom method to promote critical thinking and creativity.

Course's Intended Learning Outcomes (ILOs)

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

ILO 1	Predict the stoichiometry and calculate the oxidation state of organometallic complexes.
ILO 2	Draw reasonable mechanisms for reactions involving organotransition metal chemistry, including drawing catalytic cycles where appropriate.
ILO 3	Distinguish between a catalytic and a stoichiometric pathway.
ILO 4	Propose syntheses of molecules of moderate complexity using organotransiton metal chemistry.
ILO 5	Identify critical factors in chemical transformations involving organotransition metal chemistry, thereby being able to identify flaws in reaction proposals.

Course Content

1. Introduction and Basic Principles: Structures and Fundamental Reactions of Organotransition Metal Complexes
2. Coupling Reactions
3. Reactions involving Carbon Monoxide
4. Alkene and Alkyne Insertion Reactions
5. Reactions of Alkene Complexes, based upon the Wacker concept
6. Reactions of Alkyne Complexes
7. Reactions of Allyl Complexes, Diene Complexes, Dienyl Complexes and Arene Complexes
8. Chemistry of Metal-Ligand Multiple Bonds
9. Cycloaddition Chemistry
10. C–H activation Chemistry

Reading and References (if applicable)

Transition Metals in the Synthesis of Complex Organic Molecules, L. S. Hegedus and B. C. G. Söderberg, University Science Books (ISBN-13: 978-1891389597)

Organic Synthesis using Transition Metals, R. W. Bates, Wiley (ISBN: 978-1-119-97893-0)

The Organometallic Chemistry of the Transition Metals, R. H. Crabtree, Wiley (ISBN: 978-1119465881)

Organotransition Metal Chemistry – From Bonding to Catalysis, J. F. Hartwig, University Science Books (ISBN: 978-1891389535)

Planned Schedule

Week or Session	Topics or Themes	ILO	Readings	Delivery Mode	Activities
1	Introduction and Basic Principles	1, 3		Online	In-person tutorial
2	Coupling Reactions	All		Online	In-person tutorial
3	Reactions involving Carbon Monoxide	All		Online	In-person tutorial
4	Alkene and Alkyne Insertion Reactions	All		Online	In-person tutorial
5	Reactions of Alkene Complexes	All		Online	Tutorial
6	Continuous Assessment Test 1	All		In-person	Assessment
7	Reactions of Alkyne Complexes	All		Online	In-person tutorial
8	Reactions of Allyl Complexes, Diene Complexes, Dienyl Complexes, and Arene Complexes	All		Online	In-person tutorial
9	Chemistry of Metal-Ligand Multiple Bonds	All		Online	In-preson tutorial
10	Cycloaddition Chemistry	All		Online	In-person tutorial
11	C–H Activation Chemistry	All		Online	In-person tutorial

Week or Session	Topics or Themes	ILO	Readings	Delivery Mode	Activities
12	Oral Presentation	All		In-person	Assessment
13	Continuous Assessment Test 2	All		In-person	Assessment

Learning and Teaching Approach

Approach	How does this approach support you in achieving the learning outcomes?
Flipped Classroom	Content will be delivered online. Narrated slides will be leavened with questions for interactive answers or for further consideration. Tutorials will involve group-based problem solving with supervision by facilitators. Questions will be designed to promote both critical thinking and creativity.
Literature Review	The aim of literature review is to encourage the students to have more critical thinking - in terms of reading and writing. In particular, students are to critically read and identify the purpose of individual article, and research on the relevant background and related information online. For the critical writing part, only when fully understand the context of the article, students are able to evaluate and critique in the quality of the article.
Oral Presentation	It is done in a group of 2-4 students, whereby the group members will be assigned a topic by the instructor. The presentation ends with questions and answer session, to probe students' understanding on their topic. The Q&A session is also open to all participants, where all students will be given the opportunity to interact with each other. The learning outcomes of the oral presentation is multiple-pronged. Firstly, the students must learn to work in a group, mimicking their future work place and scenario. Also, an oral presentation is one of the way to conveys information. This will be important for students as a future worker to present, inform or persuade a new idea/ product.

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): Test/Quiz(Continuous Assessment Test 1)	All	Competence, Creativity	30		Individual	Holistic	Not Applicable
2	Continuous Assessment (CA): Test/Quiz(Continuous Assessment Test 2)	All	Competence, Creativity	40		Individual	Holistic	Not Applicable
3	Continuous Assessment (CA): Presentation(Oral Presentation)	All	Communication, Competence, Creativity	20		Team	Holistic	Not Applicable
4	Continuous Assessment (CA): Report/Case study(Literature Review)	All	Communication, Competence, Creativity	10		Individual	Holistic	Not Applicable

Description of Assessment Components (if applicable)

Formative Feedback

Formative feedback: Lecturer(s) will be closely working with students to monitor their learning progress. Students will be given instant feedback during tutorials. You will interact with the facilitator face to face, both individually and in small groups, during tutorials to ensure that you are employing logical approaches to problem solving.

Summative Feedback: Summative feedback on mid-term tests, literature review and oral presentation will be given. Students will be provided with comments on common mistakes, and areas of improvement.

NTU Graduate Attributes/Competency Mapping

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

Attributes/Competency	Level
Collaboration	Basic
Communication	Basic
Creative Thinking	Intermediate
Curiosity	Intermediate
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)

Your learning is your own responsibility; what has been set up is aids and an environment conducive for that. You are expected to complete all assigned activities by due dates, attend all tutorials punctually and take all scheduled assessments and tests. You are expected to take responsibility to follow up with assignments and course related announcements.

Policy (Absenteeism)

If you miss a tutorial, you are expected to make up for the lost learning activities. If you miss a continuous assessment exam, with approval, you will be offered a make-up exam. No make-up will be provided for oral presentation.

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 to your 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 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 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 have any other concerns, please speak to your instructors or a faculty member.

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Last Updated By: Natasha Bhatia (Dr)