Academic Year	2018/19	**Semester**	2
Course Coordinator	Roderick Bates		
Course Code	CM4033		
Course Title	Metal Mediated Reactions		
Pre-requisites	CM3021 and CM3031		
No of AUs	3		
Contact Hours	online activities tutorials mid-term assessments	13 hours 22 hours 4 hours	
Proposal Date	22 October 2018		

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.

Intended Learning Outcomes (ILO)

By the end of this course, you (as a student) would be able to:

1. predict the stoichiometry and calculate the oxidation state of mononuclear complexes.
2. draw reasonable mechanisms for reactions involving organotransition metal chemistry, including drawing catalytic cycles where appropriate
3. distinguish between a catalytic and a stoichiometric pathway
4. propose syntheses of molecules of moderate complexity using organotransiton metal chemistry
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. Carbene chemistry
9. Cycloaddition chemistry
10. CH activation chemistry

Assessment (includes both continuous and summative assessment)

Component	Course LO Tested	Related Programme LO or Graduate Attributes	Weighting	Team/Individual	Assessment Rubrics
mid-term 1	all	1a-c; 2a-b; 5a-b	20	individual	see appendix 1
mid-term 2	all	1a-c; 2a-b; 5a-b	20	individual	
final exam	all	1a-c; 2a-b; 5a-b	60	individual	
Total			100%		

Formative feedback

Feedback will be given in three ways:
1. You 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.
2. You will be given written and verbal feedback when mid-term papers are returned.
3. You will be given general feedback following the final exam.

Learning and Teaching approach

Approach	How does this approach support students 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.

Reading and References

Transition Metals in the Synthesis of Complex Organic Moelcules, L. S. Hegedus, University Science Books ISBN-13: 978-1891389597
Organic Synthesis using Transition Metals, R. W. Bates, Wiley ISBN: 978-1-119-97893-0

Course Policies and Student Responsibilities

(1) General

You are expected to complete all online activities in good time and to attend all tutorials punctually. Students are expected to fully participate in all tutorial activities.

(2) Absenteeism

If you miss a tutorial, you are expected to make up for the lost learning activities. If you miss a mid-term exam with approval will either be offered a make-up exam or grading based upon the final.

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
Roderick Bates	CBC04-08	63168907	roderick@ntu.edu.sg
Naohiko Yoshikai	CBC05-18	65927768	nyoshikai@ntu.edu.sg

Planned Weekly Schedule

Week	Topic	Course LO	Readings/ Activities
1	Introduction and Basic Principles	1, 3	online content & tutorial
2	Coupling Reactions	all	online content & tutorial
3	Reactions involving carbon monoxide	all	online content & tutorial
4	Alkene and alkyne insertion reactions	all	online content & tutorial
5	Reactions of alkene complexes, based upon the Wacker concept all	all	online content & tutorial
6	mid-term 1	all	assessment
7	Reactions of alkyne complexes	all	online content & tutorial
8	Reactions of allyl complexes, diene complexes, dienyl complexes and arene complexes	all	online content & tutorial
9	Carbene chemistry	all	online content & tutorial
10	mid-term 2	all	assessment
11	Cycloaddition chemistry	all	online content & tutorial
12	CH activation chemistry	all	online content & tutorial
13	Review	all	tutorial
The above schedule is for illustrative purposes and is subject to the exigencies of the calendar			

Appendix 1: Assessment Criteria for all components

By description and marks

Standards		
Fail standard (3-4 marks)	**Pass standard (5-7 marks)**	**High standard (8-10 marks)**
Calculations yield the wrong answer or yield the right answer just be luck. Mechanistic proposals are poorly though out or are re-hashed from memorised material. Synthetic proposals are poorly thought out and contain obvious errors. Critical factors in reaction schemes are incorrectly identified.	Calculations are usually carried out correctly to give the correct answer. Mechanistic proposals are sound but contain omissions or errors of execution and detail. Synthetic proposals are valid, but lengthy and uninventive with a lack of consideration of alternatives. Identification of critical factors is incomplete or lacking in a strong logical underpinning.	Calculations are always correct and carried out logically. In mechanistic proposals, all steps are reasonable and attention is paid to electron count and oxidation state. Synthetic proposals show a high level of creativity and are well justified. Critical factors and explanations are given logically by careful considerations of the problem in hand.