南方科技大学 SOUTHERN UNIVERSITY OF SCIENCE AND TECHNOLOGY

# 课程详述
# COURSE SPECIFICATION

以下课程信息可能根据实际授课需要或在课程检讨之后产生变动。如对课程有任何疑问，请联系授课教师。

The course information as follows may be subject to change, either during the session because of unforeseen circumstances, or following review of the course at the end of the session. Queries about the course should be directed to the course instructor.

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| 1. | **课程名称 Course Title** | **无机化学 II**<br>**Inorganic Chemistry II** |
| 2. | **授课院系**<br>**Originating Department** | 化学系 Department of Chemistry |
| 3. | **课程编号**<br>**Course Code** | CH211 |
| 4. | **课程学分 Credit Value** | 4 |
| 5. | **课程类别**<br>**Course Type** | 专业基础课 Major Foundational Courses |
| 6. | **授课学期**<br>**Semester** | 春季 Spring |
| 7. | **授课语言**<br>**Teaching Language** | 英文为主，辅以必要的中文专业词汇<br>English, and some Chinese translation whenever necessary |
| 8. | **授课教师、所属学系、联系方式（如属团队授课，请列明其他授课教师）**<br>**Instructor(s), Affiliation& Contact**<br>**（For team teaching, please list all instructors）** | 何振宇，副教授，化学系<br>HO Chun-Yu, Associate Professor, Chemistry<br>jasonhcy@sustech.edu.cn |
| 9. | **实验员/助教、所属学系、联系方式**<br>**Tutor/TA(s), Contact** | 待公布 To be announced |
| 10. | **选课人数限额(可不填)**<br>**Maximum Enrolment（Optional）** | 30 |

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| 11. | 授课方式<br>Delivery Method | 讲授<br>Lectures | 习题/辅导/讨论<br>Tutorials | 实验/实习<br>Lab/Practical | 其它(请具体注明)<br>Other（Please specify） | 总学时<br>Total |
| | 学时数<br>Credit Hours | 64 | | | | 64 |

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| 12. | 先修课程、其它学习要求<br>Pre-requisites or Other Academic Requirements | 无机化学 I（CH209） |
| 13. | 后续课程、其它学习规划<br>Courses for which this course is a pre-requisite | 本课程为化学专业基础课，化学专业必修课，材料相关专业选修课<br>This course should be taken by everyone contemplating doing Chemistry in the following years. It should however also be suitable for students majoring in Materials. |
| 14. | 其它要求修读本课程的学系<br>Cross-listing Dept. | |

## 教学大纲及教学日历 SYLLABUS

**15. 教学目标 Course Objectives**

Inorganic chemistry deals with the properties of all of the elements in the periodic table.

Our aim is to provide a comprehensive and contemporary introduction to the diverse and fascinating discipline of inorganic chemistry. A foundation of inorganic and organometallic chemistry principles and theory followed by descriptive chemistry of the elements will also be included.

无机化学涉及元素周期表中所有元素的性质。

我们的目标是提供更全面和现代的无机化学（金属有机化学和配位化学知识）的学科介绍，这包括一些无机和金属有机化学原理和理论的基础。

**16. 预达学习成果 Learning Outcomes**

In this particular part of the Inorganic Chemistry Course, the students should have basic understanding of the Organometallic Transformations and Catalysis at the end of this course.

在无机化学课程的这个特定部分，学生应该对本课程结束时的有机金属转化和催化有基本的了解。

**17. 课程内容及教学日历 （如授课语言以英文为主，则课程内容介绍可以用英文；如团队教学或模块教学，教学日历须注明主讲人）**
**Course Contents (in Parts/Chapters/Sections/Weeks. Please notify name of instructor for course section(s), if this is a team teaching or module course.)**

The core course coordinator is Prof. Jason C.-Y. Ho.

The course content included but not limited to how the electron counts and complex structural features may affect the reaction pathways, and it will illustrate how the combinations may achieve the desired selectivity and reactivity.

Those will be distributed in the Fall semester throughout accordingly.

The course consists of 4 credits, which will focus on

**A) Coordination Chemistry (12 hrs)**

- Basis of Coordination Chemistry (6 hrs)

Werner Theory, Difference between original formulation with modern formulation, Coordination Numbers, Relationship between coordination numbers with geometries, Nomenclature, Naming of coordination compounds with various rules, Structure and Isomerism, Structural or constitutional isomers including Hydrate isomers, Ionization isomers, Linkage isomers and Coordination isomers; and Stereo or configurational isomers including Diasteromers or geometric isomers and Enantiomers or optical isomers

- Bonding (6 hrs)

Valence bond theory, Structural relationship with different hybridization schemes, Crystal field theory Octahedral crystal field, Tetrahedral crystal field, Square planar crystal field, Understanding of crystal field concept and stabilization energy in different geometries, Ligand field theory, Molecular orbitals from s interactions, □ -interactions with □ -donor ligand, □ -interactions with □ -acceptor ligand, Understanding of ligand field concept by the interaction between ligand group orbitals and metal orbitals; comparison of crystal filed theory and ligand filed theory.

**B) Organometallic Chemistry (16 hrs)**

- Introduction on Organometallic Chemistry (4 hrs: basic idea and the general)

- Electron counting (4 hrs, distributed equally: 18 electron rule, conformation, structures)

The 18-electron rule is a rule used primarily for predicting and rationalizing formulae for stable metal complexes, especially organometallic compounds. The rule is based on the fact that the valence shells of transition metals consist of nine valence orbitals (one s orbital, three p orbitals and five d orbitals), which collectively can accommodate 18 electrons as either bonding or nonbonding electron pairs. This means that, the combination of these nine atomic orbitals with ligand orbitals creates nine molecular orbitals that are either metal-ligand bonding or non-bonding.

Electron counting is a formalism used for classifying compounds and for explaining or predicting electronic structure and bonding. Many rules in chemistry rely on electron-counting

- Common organometallic complexes (8 hrs, distributed equally: H, C, pi, CO and Carbene)

Transition metal hydrides are chemical compounds containing a transition metal bonded to hydrogen. Most transition metals form hydride complexes and some are significant in various catalytic and synthetic reactions. The term "hydride" is used loosely: some so-called hydrides are acidic (e.g., H2Fe(CO)4), whereas some others are hydridic, having H−-like character (e.g., ZnH2).

Transition metal alkene complex is a coordination compound containing one or more alkene ligands. Such compounds are intermediates in many catalytic reactions that convert alkenes to other organic products.

Metal carbonyls are coordination complexes of transition metals with carbon monoxide ligands. Metal carbonyls are useful in organic synthesis and as catalysts or catalyst precursors in homogeneous catalysis, such as hydroformylation and Reppe chemistry. In the Mond process, nickel carbonyl is used to produce pure nickel. In organometallic chemistry, metal carbonyls serve as precursors for the preparation of other organometalic complexes.

In organometallic species, metal complexes with the formulae LnMCRR' are often described as carbene complexes. Such species do not however react like free carbenes and are rarely generated from carbene

precursors, except for the persistent carbenes. The transition metal carbene complexes can be classified according to their reactivity, with the first two classes being the most clearly defined:

Fischer carbenes, in which the carbene is bonded to a metal that bears an electron-withdrawing group (usually a carbonyl). In such cases the carbenoid carbon is mildly electrophilic.

Schrock carbenes, in which the carbene is bonded to a metal that bears an electron-donating group. In such cases the carbenoid carbon is nucleophilic and resembles Wittig reagent (which are not considered carbene derivatives).

**C) Reactions (12 hrs)**

- Fundamental steps in Organometallic Chemistry (4 hrs, distributed equally: substitution, associative and dissociative mechanism)

Associative substitution describes a pathway by which compounds interchange ligands. The terminology is typically applied to coordination and organometallic complexes, but resembles the Sn2 mechanism in organic chemistry. The opposite pathway is dissociative substitution, being analogous to the Sn1 pathway. Intermediate pathways exist between the pure associative and pure dissociative pathways, these are called interchange mechanisms.

- Oxidative addition & reductive elimination (4 hrs, distributed equally)

Oxidative addition and reductive elimination are two important and related classes of reactions in organometallic chemistry. Oxidative addition is a process that increases both the oxidation state and coordination number of a metal centre. Oxidative addition is often a step in catalytic cycles, in conjunction with its reverse reaction, reductive elimination.

- Insertion and β-elimination (4 hrs, distributed equally)

β -Hydride elimination is a reaction in which an alkyl group bonded to a metal centre is converted into the corresponding metal-bonded hydride and an alkene. The alkyl must have hydrogens on the β-carbon. For instance butyl groups can undergo this reaction but methyl groups cannot. The metal complex must have an empty (or vacant) site cis to the alkyl group for this reaction to occur.

**D) Catalysis (20 hrs)**

- Applications and Catalysis (including: Hydrogenation, Dimersol Processes, Hydrovinylation, Polymerization, Heck Reactions, Olefin Metathesis, Cycloisomerization, and Monsanto Process).

**E) Basic Compound Characterization (4 hrs)**

- Basic characterization methods, (4 hrs, distributed equally: NMR, IR, MS for Organometalic compounds)

核心课程协调人是 Jason C.-Y. Ho 教授。

课程包括 4 学分，重点将放在配位化学（12 小时），有机金属化学（16 小时），反应（12 小时），催化领域（20 小时）和化合物表征（4 小时）。

课程内容包括但不限于电子数量和复杂结构特征如何影响反应路径，它将说明这些组合如何达到所需的选择性和反应性。See the English version for details.

**18. 教材及其它参考资料 Textbook and Supplementary Readings**

1. L. M. Garey and A. T. Donald, Inorganic Chemistry, Fourth Edition Pearson Education (原版) [无机化学 第四版 (影印版), Higher education Press 高等教育出版社]

2. P. W. Atkins, T. L. Overton, J. P. Rourke, M. T. Weller, and F. A. Armstrong Inorganic Chemistry, Fifth Edition 2010, W. H. Freeman and Company New York

3. F. A. Cotton, G. Wilkinson, C. A. Murillo, M. Bochmann, Advanced Inorganic Chemistry, 6th Edition,

Wiley-VCH, NY

4. Wiley-VCH 出版第六版的 Advanced Inorganic Chemistry（编著者：F. A. Cotton, G. Wilkinson, C. A. Murillo, M. Bochmann）

5. 培生公司 2011 年出版的 Inorganic Chemistry 第四版（编著者：G. L. Miessler 和 D. A. Tarr）

## 课程评估 ASSESSMENT

19.

| 评估形式 Type of Assessment | 评估时间 Time | 占考试总成绩百分比 % of final score | 违纪处罚 Penalty | 备注 Notes |
|---|---|---|---|---|
| 出勤 Attendance | | | | |
| 课堂表现 Class Performance | | | | |
| 小测验 Quiz | | | | |
| 课程项目 Projects | | | | |
| 平时作业 Assignments | | | | |
| 期中考试 Mid-Term Test | | | | |
| 期末考试 Final Exam | 2hrs | 60 | | |
| 期末报告 Final Presentation | | | | |
| 文献摘要 Digest of Literature | | PBL and related items 40 | | |



20. 记分方式 GRADING SYSTEM

√ A. 十三级等级制 Letter Grading
☐ B. 二级记分制（通过/不通过） Pass/Fail Grading

## 课程审批 REVIEW AND APPROVAL

21. 本课程设置已经过以下责任人/委员会审议通过
This Course has been approved by the following person or committee of authority

化学系教学指导委员会
Teaching Committee of the Chemistry Department