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 1
Course Author * Faculty proposing/revising the course	Sumod Pullarkat, Zhang Zhengyang
Course Author Email	sumod@ntu.edu.sg; zhang.zy@ntu.edu.sg
Course Title	FOUNDATIONS OF CHEMISTRY I
Course Code	CM1001
Academic Units	4
Contact Hours	59
Research Experience Components	Not Applicable

Course Requisites (if applicable)

Pre-requisites	
Co-requisites	
Pre-requisite to	
Mutually exclusive to	CY1101 Molecule, BS1012 Foundations of Chemistry I, BS1022 Laboratory for Foundations of Chemistry I
Replacement course to	
Remarks (if any)	

Course Aims

The course covers fundamental concepts and organizing principles of chemistry that provide the foundation for many aspects of chemical science and related fields. It aims to bring Freshmen students in science and engineering to the same level of command of basic chemistry that is essential to progress to advanced courses. The concepts espoused in the course will be illustrated and connected with real world applications whenever relevant. Practical work is at the heart of chemistry. The laboratory component of this course aims to expose you to chosen experiments which will help you gain familiarity with a variety of skills, laboratory techniques and equipment and instill in you the ability to work independently as well as part of a team.

Course's Intended Learning Outcomes (ILOs)

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

ILO 1	Explain Bonding and Molecular Structure: (a) Analyze the formal charge, oxidation state, valency, and coordination number of atoms in molecules and ions. (b) Explain the concept of the Octet rule and provide examples of molecules/ions that follow/do not follow the principle by drawing the Lewis structure. (c) Explain the concept of resonance. (d) Determine the electron pair geometry and molecular geometry based on VSEPR theory (e) Calculate the net reaction enthalpy based on bond energy of reactants and products. (f) Analyze the hybridization of atoms in molecules and ions. (g) Explain and illustrate the orbital diagram of molecules and ions including multiple bonds. (h) Construct molecular orbital diagram of diatomic molecules and ions by applying the basic principles learned. (i) Analyze the frontier orbitals, magnetic nature, bond order of molecules and ions based on the Molecular Orbital theory.
ILO 2	Apply theoretical knowledge gained on molecular structure and properties towards the interpretation of Nuclear Magnetic Resonance (NMR) and Infra-red (IR) spectrum of simple organic molecules.
ILO 3	Kinetics: Simple Rates and Mechanisms of Chemical Reactions (a) Determine and discuss the key factors affecting reaction rates. (b) Express rate through a rate law and determine its components; Calculate how concentrations change as a reaction proceeds. (c) Associate the effect of concentration and temperature on rate, and how catalysts increase reaction rates.

ILO 4	Thermochemistry: Energy Flow and Chemical Change (a) Identify forms of energy and their interconversion. (b) Discuss the First Law of Thermodynamics. (c) Differentiate heat, Q, from work, W, and understand what a state function is. (d) Analyse internal energy, E, versus enthalpy, H, and the major types of calorimetry. (e) Apply Hess's Law to calculate an unknown change in enthalpy, ΔH.
ILO 5	Basic Thermodynamics: Entropy, Free Energy, and Reaction Direction (a) Discuss the Second Law of Thermodynamics, and how to predict spontaneous change. (b) Calculate the change in entropy of a reaction. (c) Define entropy, free energy and work. (d) Analyze the relation between free energy, equilibrium, and reaction direction.
ILO 6	Basic Quantum Theory and the Hydrogen Atom (a) Discuss light as electromagnetic waves & photons; discuss how Einstein explained the photoelectric effect; and encountering discontinuous energy in quantized atomic spectra. (b) Analyse the wave-particle duality for subatomic particles, the significance of the Schrödinger equation, and the interpretation of the wavefunction. (c) Solve the Schrödinger equation for a particle in a one-dimensional box and use it to estimate quantized energy levels in various situations. (d) Analyze the solutions of the Schrödinger equation for the hydrogen atom and construction of atomic orbitals.
ILO 7	Employ in an actual laboratory setting the various analytical and experimental techniques, methods and equipment commonly used in chemical science. Perform basic chemistry lab experiments, analyze, interpret, and present experimental data.

Course Content

1. Bonding and Molecular Structure 2. Valence Bond Theory and Molecular Orbital Theory 3. Basics of NMR and Infra-red Spectroscopy 4. Kinetics: Simple Rates and Mechanisms of Chemical Reactions. 5. Thermochemistry: Energy Flow and Chemical Change. 6. Basic Thermodynamics: Entropy, Free Energy, and Reaction Direction. 7. Basic Quantum Theory and the Hydrogen Atom. 8. Basic Laboratory Techniques for the Chemistry Laboratory

Reading and References (if applicable)

Recommended textbook: For General Chemistry: Chemistry & Chemical Reactivity, 10th Ed (2019), Kotz/Treichel (KT), Cengage Learning Asia Pte. Ltd., ISBN 978-1-337-39907-4. Chemistry: The Molecular Nature of Matter and Change, 8th Ed (2018), Silberberg/Amateis (SA); McGraw-Hill Education; ISBN 978-I-259-92175-9 For NMR and IR spectroscopy: Organic Chemistry, 8th Ed (2014), Wade (WD), Pearson Education Ltd, ISBN 978-1-29202-165-2. For Physical Chemistry: Elements of Physical Chemistry, 7th Ed (2016), Atkins / de Paula (AdP); Oxford University Press; ISBN: 9780198727873

Planned Schedule

Week or Session	Topics or Themes	ILO	Readings	Delivery Mode	Activities
1	Bonding and Molecular Structure	1		In-person	Lecture, pre-recorded lectures, recommended text (see readings and references), other relevant materials and exercises posted on NTULearn
2	Valence Bond Theory and Molecular Orbital Theory	1		In-person	Lecture, pre-recorded lectures, recommended text (see readings and references), other relevant materials and exercises posted on NTULearn
3	Basics of NMR and Infra-red Spectroscopy	2		In-person	Lecture, pre-recorded lectures, recommended text (see readings and references), other relevant materials and exercises posted on NTULearn

Week or Session	Topics or Themes	ILO	Readings	Delivery Mode	Activities
4	Kinetics: Simple Rates and Mechanisms of Chemical Reactions.	3	SA Ch 16	In-person	
5	Thermochemistry: Energy Flow and Chemical Change.	4	SA Ch 6	In-person	
6	Basic Thermodynamics: Entropy, Free Energy, and Reaction Direction	5	SA Ch 20	In-person	
7	Basic Quantum Theory and the Hydrogen Atom	6	AdP Ch 12 & 13	In-person	

Learning and Teaching Approach

Approach	How does this approach support you in achieving the learning outcomes?
Lectures (39 hours)	The lectures will convey key concepts in organic, inorganic, selected topics in spectroscopy and physical chemistry thus providing critical information and background on how the concepts come about, with relevant theories and illustrative examples. The concepts will also be further illustrated with worked examples and with real world applications to show the relevance and importance of learning chemistry and its links to other disciplines.
Tutorials (5 hours)	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. A group member will be randomly selected to present the answers. TAS will assist in clarifying key concepts if necessary and rectifying errors when answers are presented.
Laboratory (15 Hours)	Laboratory session will consist of three main parts. Pre-laboratory exercises will involve online pre-lab quiz to be attempted prior to a lab session and consists of risk assessment and questions based on the lab manual to ensure that students have read and understood the respective experimental description before starting the actual lab session. During the actual lab session, you will typically work in pairs and conduct the assigned experiment under the supervision of laboratory TAs following the instructions provided in the lab manual. This will train you in applying concepts learned to real life situations. Subsequent to the lab session you are to submit an individual post-lab report in the prescribed format which will help to develop your critical thinking ability, ability to assimilate, evaluate and present the data gathered during a lab experiment.

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): Test/Quiz(Midterm Test I)	1, 2	Competence, Creativity	15	Individual	Analytic	Not Applicable
2	Continuous Assessment (CA): Test/Quiz(Midterm Test II)	3,4,5	Competence, Creativity	15	Individual	Analytic	Not Applicable
3	Continuous Assessment (CA): Class Participation()	1-6	Competence, Creativity	5	Individual	Analytic	Not Applicable
4	Continuous Assessment (CA): Others(Lab)	7	Competence, Creativity	15	Individual	Analytic	Not Applicable
5	Summative Assessment (EXAM): Final exam()	1-6	Competence, Creativity	50	Individual	Analytic	Not Applicable

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 of concepts. Furthermore, you will be given opportunities to express your ideas and discuss them with lecturers and TAs.

Summative Feedback: Summative feedback on laboratory reports and mid-term tests will be given. For laboratory reports, you will be provided with comments on mistakes, areas of improvement and examples of good practice in scientific writing etc.

This will help you to achieve the intended learning outcomes listed above.

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
Learning Agility	Basic
Problem Solving	Basic
Critical Thinking	Basic

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 read the lecture/pre-tutorial/laboratory materials prior to the respective lecture/tutorial/laboratory session. This will help you to learn much more efficiently as you will already have an impression on the topics to be covered. For laboratory sessions, besides reading the laboratory manual and understanding the experimental procedure, you should also complete the pre-lab quiz (online) and risk assessment component of the lab report in which you should list possible hazards and their prevention steps. You should also read through the recommended textbooks as outlined in the references. Where relevant students are expected to go through the preparatory course and course materials provided which will help to refresh your memory on concepts learned previously or basic concepts that you are expected to know coming into this Freshman year course.

Policy (Absenteeism)

Absence from laboratory and assessments without a valid reason will affect your overall course grade. Valid reasons include falling sick supported by a medical certificate and participation in NTU's approved official activities supported by an excuse letter from the relevant bodies and should be submitted to the school. If you miss a lecture, the onus is on you to watch the recorded lecture and clarify any doubt you may still have with the instructor.

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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