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	Goto Atsushi, Lu Yunpeng
Course Author Email	agoto@ntu.edu.sg; yplu@ntu.edu.sg
Course Title	PHYSICAL & BIOPHYSICAL CHEMISTRY 1
Course Code	CM2041
Academic Units	3
Contact Hours	39
Research Experience Components	Not Applicable

Course Requisites (if applicable)

Pre-requisites	CM1021 or CM1041 or CM9001 or CM5000 or CY1101 or CM1001 or (BS1012 and BS1022) or by permission
Co-requisites	
Pre-requisite to	
Mutually exclusive to	
Replacement course to	
Remarks (if any)	

Course Aims

On completing this course, you will understand the basic principles in physical and biophysical chemistry and how these principles can be applied to explain and predict chemical changes. You will grow rigorous analytical ability to study chemistry based on scientific calculations and reasoning. You will appreciate the power of physical chemistry in chemical research and industry activities.

Course's Intended Learning Outcomes (ILOs)

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

ILO 1	Thermodynamics: Explain the differences between ideal gas and real gas from microscopic point of view
ILO 2	Thermodynamics: Calculate real gas state variables based on several real gas equations
ILO 3	Thermodynamics: Explain the real gas behaviour based on calculation results
ILO 4	Thermodynamics: Describe thermodynamics first law in close system
ILO 5	Thermodynamics: Calculate internal energy change and enthalpy change in close system in a thermodynamic process
ILO 6	Thermodynamics: Describe spontaneity in physical and chemical processes
ILO 7	Thermodynamics: Describe Carnot Cycle of Heat Engine and derive Clausius equality/inequality
ILO 8	Thermodynamics: Explain spontaneity based on universe entropy change
ILO 9	Thermodynamics: Apply thermodynamics second law to calculate entropy change for several thermodynamic processes
ILO 10	Thermodynamics: Identify the physical meaning of thermodynamics third law
ILO 11	Thermodynamics: Give the definition of free energy and explain its usage to predict spontaneity
ILO 12	Thermodynamics: Apply Gibbs energy to study chemical equilibrium
ILO 13	Kinetics: Describe the rate of chemical reactions using differential equations.
ILO 14	Kinetics: Describe the rate of chemical reactions in the integrated forms.
ILO 15	Kinetics: Explain the concept of rate determining step.
ILO 16	Kinetics: Explain the concept of steady-state approximation.

ILO 17	Kinetics: Explain the concept of equilibrium.
ILO 18	Kinetics: Explain the mechanism and rate of sequential reactions.
ILO 19	Kinetics: Explain the mechanism and rate of chain reactions.
ILO 20	Kinetics: Explain the mechanism and rate of enzyme catalysis and inhibition.
ILO 21	Interfaces: Explain the electronic properties of molecules
ILO 22	Interfaces: Explain the interaction between molecules
ILO 23	Interfaces: Explain the concept of the surface tensions and contact angles.
ILO 24	Interfaces: Explain the concept of the adsorption and desorption at the interface.
ILO 25	Interfaces: Explain the concept of colloids.
ILO 26	Interfaces: Explain the concept of electric double layer.
ILO 27	Interfaces: Describe the mechanisms of the formation of micelles and biological membranes

Course Content

Thermodynamics:

1. Real Gas and Its State Equations

2. Thermodynamics First Law and Its Applications

3. Thermodynamics Second and Third Laws and Applications

4. Free Energy and Chemical Equilibrium

Kinetics:

5. Rates of Chemical Reactions

6. Kinetics of Complex Reactions

Interfaces:

7. Molecular Interactions and Surfaces

8. Self-assemblies

Reading and References (if applicable)

Recommended textbook: David W. Ball, Physical Chemistry, 2nd Ed (2015), Cengage Learning; ISBN-10: 1-133-95843-5

Recommended textbook: Peter Atkins & Julio De Paula, Physical Chemistry, 9th Ed (2010), Oxford University Press; ISBN: 978-0-19-954337-3

Planned Schedule

Week or Session	Topics or Themes	ILO	Readings	Delivery Mode	Activities
1	Real Gas and Its State Equations	1-3	Lecture Notes, Chapter 1 in textbook “Physical Chemistry” by David Ball. Chapter 1 in textbook “Physical Chemistry by Atkins & Julio		
2	1) Real Gas and Its State Equations, 2) Thermodynamics First Law and Its Applications	1-5	Lecture Notes, Chapter 1 and 2 in textbook “Physical Chemistry” by David Ball. Chapter 1 and 2 in textbook “Physical Chemistry by Atkins & Julio		
3	Thermodynamics First Law and Its Applications	4,5	Lecture Notes, Chapter 2 in textbook “Physical Chemistry” by David Ball. Chapter 2 in textbook “Physical Chemistry by Atkins & Julio		
4	1) Thermodynamics First Law and Its Applications, 2) Thermodynamics Second and Third Laws and Applications	4-7	Lecture Notes, Chapter 2 and 3 in textbook “Physical Chemistry” by David Ball. Chapter 2 and 3 in textbook “Physical Chemistry by Atkins & Julio		
5	Thermodynamics Second and Third Laws and Applications	6-9	Lecture Notes, Chapter 3 in textbook “Physical Chemistry” by David Ball. Chapter 3 in textbook “Physical Chemistry by Atkins & Julio		

Week or Session	Topics or Themes	ILO	Readings	Delivery Mode	Activities
6	1) Thermodynamics Second and Third Laws and Applications, 2) Free Energy and Chemical Equilibrium	9-11	Lecture Notes, Chapter 3 and 6 in textbook “Physical Chemistry” by David Ball. Chapter 3 and 6 in textbook “Physical Chemistry by Atkins & Julio		
7	Free Energy and Chemical Equilibrium	11,12	Lecture Notes, Chapter 6 in textbook “Physical Chemistry” by David Ball. Chapter 6 in textbook “Physical Chemistry by Atkins & Julio		
8	Differential and Integrated Rate laws	13,14	Lecture Notes, Chapter 20 in textbook “Physical Chemistry” by Atkins & Julio Chapter 6 in textbook “Physical Chemistry by Atkins & Julio		
9	Reaction mechanisms and Sequential reaction and equilibrium	15-18	Lecture Notes, Chapter 20 in textbook “Physical Chemistry” by Atkins		
10	Chain reaction	19	Lecture Notes, Chapter 20 in textbook “Physical Chemistry” by Atkins		
11	Enzyme catalysis	20	Lecture Notes, Chapter 20 in textbook “Physical Chemistry” by Atkins Atkins		

Week or Session	Topics or Themes	ILO	Readings	Delivery Mode	Activities
12	Molecular Interactions and Surfaces	21-24	Lecture Notes, Chapters 16 and 22 in textbook “Physical Chemistry” by Atkins		
13	Self-assemblies	25-27	Lecture Notes, Chapter 17 in textbook “Physical Chemistry” by Atkins		

Learning and Teaching Approach

Approach	How does this approach support you in achieving the learning outcomes?
Lectures	You will be spending time to learn details for the course content in lecture theatre. Topics in course content will be introduced in lecture. Application questions will be discussed and explained.

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(Midterm 1)	1-12	Competence, Creativity	15		Individual	Analytic	Multistructural
2	Continuous Assessment (CA): Test/Quiz(Midterm 2)	13-20	Competence, Creativity	15		Individual	Analytic	Multistructural
3	Summative Assessment (EXAM): Final exam()	All	Competence, Creativity	60		Individual	Analytic	Multistructural
4	Continuous Assessment (CA): Class Participation()	All	Competence and Creativity	10		Individual	Analytic	Multistructural

Description of Assessment Components (if applicable)

Formative Feedback

You will be given feedback in three ways:

1. By response to postings on the course discussion board.

2. Through the marking of the mid-term.

3. General feedback will be provided to the students following the final exam.

NTU Graduate Attributes/Competency Mapping

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

Attributes/Competency	Level
Curiosity	Basic
Decision Making	Basic
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)

You are expected to attend all lecture classes punctually or watch the recorded lecture videos and take all scheduled tests.

Policy (Absenteeism)

Absence from the midterm 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 activities supported by an excuse letter from the relevant bodies. There may be make-up opportunities for CA components.

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.

Last Updated Date: 03-10-2025 11:04:11

Last Updated By: Natasha Bhatia (Dr)