The Hong Kong University of Science and Technology

UG Course Syllabus Template

Chemical Oceanography

OCES 4205

No. of Credits:3

Pre-/co-requisites: OCES 2001 AND OCES 2002

Name:

Prof. Alex S.J. WYATT (AW), Course coordinator

Phone: 3469 2824; Email: wyatt@ust.hk

Office: Room CYT-2010, 2/F, Lifts 35-36, Department of Ocean Science

Prof. Jiying LI (JL)

Phone: 3469 2934; Email: jiyingli@ust.hk

Office: Room CYT-2012, 2/F, Lifts 35-36, Department of Ocean Science

Prof. Ding HE (DH)

Phone: 2358 7346; Email: dinghe@ust.hk

Office: CYT 5002, Department of Ocean Science

Office Hours: By appointment

Course Description

This course focuses on the major biogeochemical processes in the coastal, benthic, and upper ocean pelagic ecosystems that control the abundances, distribution and transformation of chemical substances. The impacts of human activities and climate change on these processes will be discussed. The use of isotope tracers as a tool to investigate the age and sources of water masses will be illustrated.

Intended Learning Outcomes (ILOs)

On successful completion of this course, students are expected to be able to:

1. Demonstrate fundamental understanding of ocean science and technology; and master observational, laboratory, theoretical, and computational techniques in ocean related disciplines.
2. Address challenges in the sustainable management of the ocean by integrating their knowledge, technical skills, and creativity.
3. Employ scientific methods to critically evaluate complex, real-world problems.

4. Communicate effectively in both oral and written formats to convey their scientific knowledge and multi-disciplinary training.
5. Function independently with professionalism and work effectively in teams.
6. Recognize the need for and actively engage in the life-long pursuit of ocean literacy
7. Make informed and responsible decisions regarding the ocean and its resources.

Expected Preparation

In addition to having completed the compulsory pre-requisites Introduction to Oceanography (OCES 2001) and Marine Chemistry (OCES 2002), students need to have at least one year of general chemistry at an undergraduate level; organic chemistry, inorganic chemistry and biochemistry would be helpful. Competence in algebra is necessary; introductory calculus and differential equations are useful for some topics but are not required. A basic background in biological and physical oceanography is expected to be obtained from OCES 2001 and OCES 2002 for students that have not had any oceanography training.

Assessment and Grading

This course will be assessed using criterion-referencing and grades will not be assigned using a curve. Detailed rubrics for each assignment are provided below, outlining the criteria used for evaluation.

Assessments:

Assessment Task	Contribution to Overall Course grade (%)	Due date
Class participation	15%	N/A
MATLAB Assignment	15%	17/04/2025
Assignments	20%	Refer to the schedule
Mid-term Exam	20%	25/03/2025
Final examination	30%	Refer to the exam timetable

Mapping of Course ILOs to Assessment Tasks

Assessed Task	Mapped ILOs	Explanation
Class participation	ILO1, ILO3, ILO4, ILO5, ILO6	This assessment will consist of be a combination of (1) online questions issued via Canvas due prior to lectures and (2) in class quizzes. Students will be expected to score and provide feedback on postgraduate term paper presentations. [ILO3]
MATLAB Assignment	ILO1, ILO3, ILO5, ILO6	A programming assignment will be used to provide basic experience and demonstrate the utility of MATLAB® in oceanographic data management and analysis. A brief primer will be provided in class, but students are expected to learn to use the program through independent study (the answer to almost anything related to

		"How do I XXX in Matlab?" can be found on the internet). [ILO5]
Assignments	ILO1, ILO2, ILO3, ILO4, ILO6, ILO7	Two additional assignments will be delivered covering the course content in Week 6-11 and Week 12-13, respectively.
Mid-term Exam	ILO1, ILO3, ILO6	The Mid-term Exam will consist of multiple-choice and essay style questions covering the assigned reading and course content delivered to that point.
Final examination	ILO1, ILO2, ILO3, ILO4, ILO6, ILO7	The Final Exam will be open book and delivered online via Canvas. It will consist of multiple choice and essay style questions covering the entire course content.

Grading Rubrics

Detailed rubrics for each assignment will be provided. These rubrics clearly outline the criteria used for evaluation. Students can refer to these rubrics to understand how their work will be assessed.

Final Grade Descriptors:

Grades	Short Description	Elaboration on subject grading description
A	Excellent Performance	Demonstrates a comprehensive grasp of subject matter, expertise in problem-solving, and significant creativity in thinking. Exhibits a high capacity for scholarship and collaboration, going beyond core requirements to achieve learning goals.
B	Good Performance	Shows good knowledge and understanding of the main subject matter, competence in problem-solving, and the ability to analyze and evaluate issues. Displays high motivation to learn and the ability to work effectively with others.
C	Satisfactory Performance	Possesses adequate knowledge of core subject matter, competence in dealing with familiar problems, and some capacity for analysis and critical thinking. Shows persistence and effort to achieve broadly defined learning goals.
D	Marginal Pass	Has threshold knowledge of core subject matter, potential to achieve key professional skills, and the ability to make basic judgments. Benefits from the course and has the potential to develop in the discipline.
F	Fail	Demonstrates insufficient understanding of the subject matter and lacks the necessary problem-solving skills. Shows limited ability to think critically or analytically and exhibits minimal effort towards achieving learning goals. Does not meet the threshold requirements for professional practice or development in the discipline.

Course AI Policy

Students may use generative AI tools to support their learning, but **all AI-generated material must be clearly acknowledged and cited**, including the original source material where relevant. Students are responsible for verifying the accuracy of any AI output; generative AI tools are known to omit citations, fabricate references, and provide superficially plausible but incorrect information, particularly on technical topics.

Failure to acknowledge AI use constitutes plagiarism under HKUST's Academic Integrity policy. The minimum penalty is a zero for the assessment and misconduct proceedings may jeopardize academic standing and future studies.

Required Texts and Materials

Primary reference textbook(s):

• Libes, S.M. (2009) Introduction to marine biogeochemistry. Second Edition. Academic

Press, Boston, 928 p. [LIBES]

o Library access: https://lbdiscover.ust.hk/bib/991012845169703412

• Hoefs, J. (2018) Stable Isotope Geochemistry. Eighth Edition. Springer International

Publishing, Switzerland, 437 p. [HOEFS]

o Library access: https://lbdiscover.ust.hk/bib/991012694951003412

Additional textbook(s):

• Emerson, S. and Hedges, J. (2008) Chemical oceanography and the marine carbon cycle.

Cambridge University Press, Cambridge, 475 p. [E&H]

o Library access: https://lbdiscover.ust.hk/bib/991012846066003412

This is an excellent text, but it is more advanced (has some maths) and is terse (heavy reading). We recommend this as primary textbook for all graduate students with a chemical focus and offer it as extra reading material below.

• Sarmiento, J.L. and Gruber, N. (2006) Ocean biogeochemical dynamics. Princeton

University Press, Princeton, New Jersey, 528 p.

o Library access: https://lbdiscover.ust.hk/bib/991012830921203412

This is an advanced text (lots of maths) but selected chapters are very useful (Si cycle, C cycle). In our experience physics students find this very helpful. It is also an excellent reference text.

• Chester, R. and Jickells, T.D. (2012) Marine geochemistry. Third Edition. WileyBlackwell, Chichester, UK, 411 p.

o Library access: https://lbdiscover.ust.hk/bib/991006198239703412

This textbook treats the oceans as a unified system, with detailed descriptions of material transport (sources and sinks) in the oceans. Students interested in global (bio)geochemical cycles will find its integrated treatment of the ocean chemistry very useful.

• Fry, B.J. (2006) Stable isotope ecology. Springer Verlag, New York, 308 p. [FRY]

o Library access: https://lbdiscover.ust.hk/bib/991012692305603412

Excellent primer on the application of stable isotopes to studying ecology.

• A range of reading and web resources will be made available on Canvas (canvas.ust.hk)

prior to each lecture.

Academic Integrity

Students are expected to adhere to the university's academic integrity policy. Students are expected to uphold HKUST's Academic Honor Code and to maintain the highest standards of academic integrity. The University has zero tolerance of academic misconduct. Please refer to Academic Integrity | HKUST – Academic Registry for the University's definition of plagiarism and ways to avoid cheating and plagiarism.

Course schedule

Wk	Date	Topic	Key Text	Instructor
1	4 Feb	Course introduction – what is chemical oceanography?	LIBES Ch.1	AW
	6 Feb	Chemical properties of seawater	LIBES Ch.2-3.3	
2	11 Feb	Major elements and mass balance	LIBES 3.4-4, E&H Ch.2	
	13 Feb	Chemical transformations in the ocean	LIBES Ch.5, E&H Ch.9	
3	18 Feb	Air/sea gas exchange and dissolved gases	LIBES Ch.6, E&H Ch.10	
	20 Feb	Carbonate chemistry: Calcite, alkalinity and pH	LIBES Ch.15, E&H Ch.4	
4	25 Feb	Stable isotopes as biogeochemical tracers **Term Paper topic nomination due**	HOEFS Ch.1-2, E&H Ch.5	
	27 Feb	Compound-specific and radioisotope tracers	E&H Ch.5, handouts	
5	4 Mar	Isotope ecology – a chemical approach to ecology	HOEFS Ch.3, FRY	
	6 Mar	Chemical equilibrium and ion speciation in seawater	LIBES Ch. 5, E&H Ch.3.3	JL
6	11 Mar	Redox reactions in the ocean	LIBES Ch.7, E&H Ch.3.5	
	13 Mar	Nutrients and productivity in the ocean I	LIBES Ch.9-10, E&H Ch.6	
7	18 Mar	Nutrients and productivity in the ocean II	LIBES Ch.9-10, E&H Ch.6	
	20 Mar	Marine biogeochemical cycles – Nitrogen	LIBES Ch.24	
8	25 Mar	**Mid-term Exam**	-	
	27 Mar	Marine biogeochemical cycles – Phosphorous	LIBES Ch.11	
9	**1 Apr**	**MID-TERM BREAK [No class]**	-	
	3 Apr	**MID-TERM BREAK [No class]**	-	
10	8 Apr	Marine biogeochemical cycles – Silica **Assignment 1 due**	LIBES Ch.16	
	10 Apr	Marine biogeochemical cycles – Trace elements	LIBES Ch.12, E&H Ch.12.1	
11	15 Apr	Organic Matter: Production and Destruction	LIBES Ch.8	DH
	17 Apr	Dissolved and particulate organic matter cycling **MATLAB Assignment due**	LIBES Ch.23	
12	22 Apr	The marine carbon cycle and global climate change	LIBES Ch.25	
	24 Apr	Chemical extraction and pollution of the ocean	LIBES Ch.26, Ch.28	
13	29 Apr	Advanced techniques in chemical oceanography **Assignment 2 due**	-	
	1 May	**HOLIDAY [No class]**	-	
14	6 May	Postgraduate Term Paper presentations	-	AW
	8 May	Postgraduate Term Paper presentations Revision	-	