Annexe A: New/Revised Course Content in OBTL+ Format

Course Overview

Expected Implementation in Academic Year (New format)	AY2025-2026
Semester/Trimester/Others (specify approx. Start/End date)	Semester 2
Course Author * Faculty proposing/revising the course	Patrick Martin
Course Author Email	pmartin@ntu.edu.sg
Course Title	OCEANOGRAPHY
Course Code	ES4901
Academic Units	3
Contact Hours	39
Research Experience Components	Not Applicable

Course Requisites (if applicable)

Pre-requisites	ES1007 / CY1007
Co-requisites	None
Pre-requisite to	N/A
Mutually exclusive to	N/A
Replacement course to	N/A
Remarks (if any)	

Course Aims

The oceans cover 75% of our planet's surface area, and consequently play a major role in the Earth System. They also present a fascinating environment that is physically, chemically, and biologically different from the land environment we humans are used to. The objectives of this course are to provide a strong foundation in the principles of oceanography, with a primary focus on physical and chemical oceanography at a global scale, and throughout the full depth of the ocean. The course will begin by considering physical ocean circulation, including interactions between the ocean and climate. We will then examine ocean chemistry and its interactions with ocean biology, especially nutrient cycling, biological production and decomposition, and ocean carbon uptake. As part of that, we will consider how chemical tracers can shed light on oceanographic processes. This course is aimed at postgraduate students: if you are doing research work relating to physical, chemical, or biological oceanography then this course will provide foundational knowledge and analysis skills to help you with your research. If you are an MSc by Coursework student, then this course will deepen your expertise in ocean sciences to set you up for a possible career path in environmental science-related work that may involve ocean-related issues

Course's Intended Learning Outcomes (ILOs)

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

ILO 1	Explain global patterns of ocean circulation, and identify and trace different water masses based on their physical and chemical properties;
ILO 2	Interpret distributions of oceanographic tracers to diagnose processes and estimate their rates;
ILO 3	Analyse the coupling between the ocean biogeochemical cycles of carbon and several nutrient elements;
ILO 4	Analyse and interpret real-world oceanographic data;
ILO 5	Explain the connections and interactions between physical, chemical, and biological oceanographic processes;

Course Content

Global-scale surface ocean circulation and geostrophic currents; Global-scale overturning (thermohaline) circulation; Physical and chemical properties of seawater; Ocean biogeochemical cycles of carbon and nutrients; Seawater carbonate system chemistry

Reading and References (if applicable)

Oceanography as a field is too diverse for a single textbook to cover everything that we talk about in detail, and the course does not attempt to follow any particular book. The following are useful resources that cover individual aspects:

Emerson & Hedges 2009, "Chemical Oceanography and the Marine Carbon Cycle", ISBN 978-0-521-83313-4

Ocean Circulation (Open University Press, 2001)

Seawater: Its Composition, Properties and Behaviour (Open University Press)

Libes 2011 "Introduction to Marine Biogeochemistry", 2nd Edition, ISBN 978-0-12-088530-5

Garrison 2007, *Oceanography: An Invitation to Marine Science* (Brooks and Cole).

In addition, topical research papers will be read and discussed as a class. The papers will vary from year to year depending on recent research.

NOTE: The above listing comprises the foundational readings for the course and more up-to-date relevant readings will be provided when they become available

Planned Schedule

Week or Session	Topics or Themes	ILO	Delivery Mode	Activities	Readings
1	Introducing the ocean, properties of seawater, concept of salinity	1,2,4,5	In-person	Lecture/problem set	Varies by year depending on recent research
2	Surface ocean circulation (and atmospheric circulation)	1,2,4,5	In-person	Lecture/problem set	Varies by year
3	Deep ocean circulation and water masses	1,2,4,5	In-person	Lecture/problem set	Varies by year
4	Forces and geostrophic motion	1,2,4,5	In-person	Lecture/problem set	Varies by year
5	Biological carbon and nutrient cycling	2,3,4,5	In-person	Lecture/problem set	Varies by year
6	Biological carbon and nutrient cycling	2,3,4,5	In-person	Lecture/problem set	Varies by year
7	ODV practical	1,2,3,4,5	In-person	Computer practical	N/A
8	Water mass project oral presentations	1,2,3,4,5	In-person	Presentations	N/A
9	Tracers and the conveyor-belt circulation	1,2,3,4,5	In-person	Lecture/problem set	Varies by year
10	ODV practical	1,2,3,4,5	In-person	Computer practical	N/A
11	Why is the ocean salty? Geochemical mass balance	2,4,5	In-person	Lecture/problem set	Varies by year
12	The carbonate system	2,3,4,5	In-person	Lecture/problem set	Varies by year
13	Optical oceanography	1,2,3,4,5	In-person	Lecture/problem set	Varies by year

Learning and Teaching Approach

Approach	How does this approach support you in achieving the learning outcomes?
Mixed lecture / problem exercise classes	Most classes in this course consist of a mixture of lecture and practical exercises to perform calculations or interpret data. This will challenge you to apply theoretical knowledge to practical scenarios and test your understanding.
Computer practicals	We will conduct two computer practical sessions, which each run for a full Lecture + Tutorial slot. You will work with global oceanographic data products in Ocean Data View software, to understand global-scale patterns in physical, chemical, and biological processes.
Water mass project	Through this independent project you will independently research physicochemical seawater properties around the world to track down the identity of the water mass you have been assigned. You will then need to delve into the oceanographic literature to understand the physical and chemical oceanographic processes in your particular region that make your water mass have these properties, and to get familiar with the types of research questions and methods that are relevant in that region.
Take-home problem sets	As part of the assessment, you will be given two practical problem sets with short-answer questions for which you will need to do perform calculations and provide short discussion to explain your results. This will help to deepen your knowledge of oceanographic data analysis and of the physical and chemical processes that are relevant.
Mixed lecture / problem exercise classes	Most classes in this course consist of a mixture of lecture and practical exercises to perform calculations or interpret data. This will challenge you to apply theoretical knowledge to practical scenarios and test your understanding. The course includes two computer practical sessions in which you will work with global oceanographic data products in Ocean Data View software.

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): Report/Case study(Written report on water mass project)	1, 2, 3, 5		50		Individual	Analytic	Extended Abstract
2	Continuous Assessment (CA): Oral Test(Oral presentation on water mass project)	1, 2, 3, 5		20		Individual	Holistic	Relational
3	Continuous Assessment (CA): Others(Data analysis problem sets)	2, 3, 4, 5		30		Individual	Analytic	Multistructural

Description of Assessment Components (if applicable)

1. Written report on water mass project: You will be given a set of physicochemical water properties, and you need to identify, based on independent literature review, where in the world this water mass is found. You need to write a report to outline the evidence for your water mass identification, complete with appropriate literature citations and relevant figures or tables. You then need to review the state of our knowledge of the physical and chemical oceanography of that water mass/region in terms of the main aspects covered in class (surface geostrophic circulation, deep-water formation/upwelling, carbon and nutrient biogeochemistry), again referring to appropriate primary research literature. The written report should be in the region of 3,000 words, excluding the reference list.

2. Oral presentation about the water mass project: You should give a 10 min presentation on your water mass project in which you should (a) identify your water mass, explaining what your evidence is from the physicochemical properties you were given, and (b) summarise the results of one recent (past 10 years) original research paper that you have come across that studies this particular water mass or the general region where this water mass is found. The paper can cover any aspect of oceanography that is of interest to you, i.e. physical, chemical, or biological oceanography. You should explain what the research team did, what motivated this research, what the results were, and discuss in what ways this research is novel/important (or, if you think the research was not well conducted, explain your criticism).

3. Data analysis problem sets: You will be given two problem sets to work on in your own time during the course. These problem sets will require you to analyse data / perform calculations and show your results.

Formative Feedback

1. All classes (lectures and tutorials) will involve in-class discussion and pen-and-paper or computer calculation exercises. Participation in these discussions and exercises will give you feedback on your understanding of the topics.

2. The presentations for your water mass project will be given in the class after recess week. You will be given feedback on the presentation and on the accuracy of your water mass identification, which will help ensure that you are on track with the written report.

3. The problem sets will be returned to you as soon as they are graded with written feedback.

4. You will be given written feedback on your project report.

NTU Graduate Attributes/Competency Mapping

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

Attributes/Competency	Level
Care for Environment	Advanced
Communication	Advanced
Curiosity	Intermediate
Digital Fluency	Basic
Critical Thinking	Intermediate

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 complete all assigned readings, activities, assignments, attend all classes punctually and complete all scheduled assignments by due dates. You are expected to take responsibility to follow up with assignments and course related announcements. You are expected to participate in all project critiques, class discussions and activities.

Policy (Absenteeism)

In-class activities make up a significant portion of your course grade. Absence from class without a valid reason will affect those parts of your grade that depend on in-class activities. 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 will be no make-up opportunities for in-class activities.

Policy (Others, if applicable)

Diversity and inclusion policy
Integrating a diverse set of experiences is important for a more comprehensive understanding of science.

It is our goal to create an inclusive and collaborative learning environment that supports a diversity of perspectives and learning experiences, and 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 like your performance in the class is being impacted by your experiences outside of class;
If something was said in class (by anyone, including the instructor) that made you feel uncomfortable;

Please speak to your teaching team, our school pastoral officer Christina Tee Siew Khiaw or a peer or senior

(either in-person or via email) 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 class are expected to adhere to the NTU anti-harassment policy. 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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