Course Name: Tropical Oceanography
Number of credits: 3

Period: Spring semester

Coordinator	**Mohd Fadzil Mohd Akhir**
Credits	3 credit hours
Lecturers	**Mohd Fadzil Mohd Akhir, Ong Meng Chuan, Nur Hidayah Roseli, Fatin Izzati Minhat**
Level	MSc and PhD
Host institution	Institute of Oceanography and Environment, Universiti Malaysia Terengganu
Course duration	1 semester (the classes will be scheduled in accordance with the university timetable)

Summary

The course Tropical Oceanography is an important element for students majoring in Master or PhD in Marine Science and Oceanography. The course aims to provide students with scientific and technological knowledge in preparing them for careers related to marine and ocean environment. This course will focus on ocean physico-chemical and bio-geochemical processes as well as the interactions between the atmosphere and ocean and how this coupled process drives the upwelling and ocean productivity in the tropical regions. This course also will explore the current impact that is affecting our oceanographic system that includes atmosphere–ocean climate system, ocean pollution and geomorphological changes. The course concludes with the role of the climate change and the connection between human activity and the current warming trend. This evidence of changes in many facets of oceanography sciences will be explored through global ocean data and field data analysis. Specific focus will also be addressed on communication skills to support planning and management related to the ocean adaptation towards future climate change.

Target student audiences

Master or PhD students majoring in “Marine Science” and “Oceanography”

Prerequisites

Required courses (or equivalents):

- Marine Science
- Oceanography
- Biology Marine
- Marine Geoscience
- Fisheries
- Environmental Science and Technology

Aims and objectives

The aim of the course is to provide students with scientific and technological knowledge on the dynamic processes and interactions in a tropical oceanographic region focusing on upwelling system, ocean productivity and geomorphologic changes as well as developing verbal and written communication skills in adressing issue related to ocean climate changes, its adaptation and planning strategies.

The objectives of the course are:

- To introduce students to the concepts of physical processes and the interactions between the atmosphere and ocean and how this coupled process influence the upwelling system and ocean productivity in the tropical regions.
- To introduce students to the seawater chemistry, marine pollution and nutrient dynamics as well as ocean productivity in the marine environment.
- To introduce students to the geological features, events and phenomena that related to changes in depositional system and environment.

- To explore the seawater properties in a upwelling region through World Ocean Database and field data analysis.
- To develop skills in communication and planning strategies for future ocean climate change adaptation.

The Authentic Tasks are:

None

General learning outcomes:

By the end of the course, successful students will:

- acquire knowledge on the key concepts of physical processes and air-sea interaction in driving the upwelling system in tropical ocean.
- acquire knowledge regarding the component of seawater chemistry that related to ocean pollution, nutrient dynamics and ocean productivity in tropical region.
- acquire knowlegde on geological features, events and phenomena that that related to geomoprhological changes.
- be able to describe the upwelling system of tropical ocean in which physical, chemical, and geological factors are inter-related through ocean processes, nutrient dynamics, and ocean productivity.
- develop skills in analyzing seawater properties in upwelling region by using World Ocean Database data and in-situ measurement.
- understand how to process core sediment data used for lithology studies and explaining the changes in depositional systems and environment.
- be able to critically evaluate the connection between human activity and the current warming trend in addressing the past, present and future climate change issues.
- be able to articulate scientific arguments and communicate professionally in addressing the planning and adaptation strategies related to climate change issues.

Overview of sessions and teaching methods

The course will make most of interactive and self-reflective methods of teaching and learning, where involving hybrid methods of lectures (online or standing lectures), followed by tutorial or practical, group discussion, presentation and report writing based on case study.

The lectures will focus on several key topics related to upwelling system and ocean productivity in three oceanographic sub-fileds; physical oceanography, chemical oceanography and geological oceanography.

Practical and tutorial will be an individual work. For the practical work, students will learn how to obtain seawater properties data from World Ocean Database in upwelling region and analyse the data in Ocean Data View software. Students will be assigned to report the results and discussion on the seawater characteristics in different upwelling system and relate it with physical processes of oceanic and atmospheric circulation during El Nino event. They will also have tutorial on how to assess ocean productivity through nutrients and chlorophyll-a data as well as understand clearly step on how to process and analyse core sediment data for lithology studies. Student should watch videos or face to face demo by lecturer and do the in-class assignment.

Students will be assigned to a case study on the topics related to climate change. This will invlove interactive group discussion and presentation as well as individual report writing. Students should discuss about the issues and design the adaptation strategies plan for their chosen topic. Before the discussion is made, student must do some research on their own to collect the materials and information. The materials and information gained will be discussed during the discussion and presented in an interactive way. After the discussion and presentation, each student must write an individual report for the case study. The report should highlight (but not restricted to) the main issues caused by climate change, how it will impact human and adaptation planning strategies.

Course Outline

The course will cover the following aspects:

Topic 1. Introduction to Tropical Oceanography. This content of the course aims to discuss the history of ocean exploration and the important discoveries of tropical ocean. Since the discovery of oceans, many techniques and methods have been applied to understand the oceanic systems. The simple ocean observation in the past has now evolved to relay on advance instrumentation that has been used in ocean science today. The data from ocean observations are currently being store under the World Ocean Database for accessibility between regions.

Topic 2. Physical Processes of South China Sea. The semi enclosed basin of South China Sea is a unique oceanic system of its own. The ocean dynamic and circulation in this region is a direct effect of coupled atmosphere-ocean relations. Monsoon has great affect on both water characteristic and ocean dynamics of this region.

Topic 3. Upwelling Dynamics and Processes. The coastal upwelling dynamics are processes that involve the air-sea interactions. The constant changes of sea surface temperature, salinity and other related parameters produce multi-temporal patterns of the oceanic system. This pattern can be observed, analysed and predicted through numerical modelling analysis. The product of ocean model will be useful for understanding future climate impacts on ocean.

Topic 4. Tropical Ocean and Climate Change. The climate change has major effects on tropical ocean processes and productivity. The changes of ocean productivity will indirectly affect the food security and marine health within the region. Hence better understanding on the future changes of ocean productivity may help stake holders plan and manage resources from the ocean better.

Topic 5. Seawater Chemistry. Seawater compositions which include the micro and macro nutrients is related to the source of minerals found in the ocean basin and land surrounding it. These nutrients each have their own important cycle that involve in the air-sea interaction processes.

Topic 6. Ocean Productivity. The primary productivity of the ocean is closely related to the biological component of the ocean. The productivity of the ocean relay on the complex interaction between seawater chemistry process and ocean currents. The more productive the ocean is, the healthier the marine environments within the ocean. Hence, by calculating the net primary production (NPP), we can compare environmental health status between oceans.

Topic 7. Marine Pollution. There are various types of pollution that affect the marine environments today. These pollutions may originate from different resources which came from the land and the sea itself. The impact of these pollution to organisms and marine environment may differ depending on the both the source and type of pollutants.

Topic 8. Introduction to Geological Oceanography. The geological oceanography introduces the basic geomorphological features that can be found within our modern ocean. Since the formation of the first ocean some 4 billion year ago, the feature of planet Earth has changed and evolved to the world that we know today. Several geological events have taken place in our ocean throughout the geological time scale that help shape the world map we see today.

Topic 9. Major Geological Events. The theory of plate tectonic has only come to centre stage at mid-1950s. It is a young science compared to another geological related field. The theory has suggested that the lithosphere of the planet move and will keep on moving. Other than changes in the lithosphere, major geological events related to the ever-changing Earth have taken over the geological time. This includes the Snowball Earth and Hot houses events.

Topic 10. Paleoceanography. The Quaternary is the last period on the geological time scale which see the evolution and advancement of modern human. The global sea level changes during this period had facilitated the migration and distribution of modern flora and fauna through the formation of land bridges during sea level fall and isolating island during sea level rise. There are many factors affecting sea level changes at global and local scale. Hence understanding the past changes of sea levels may help us predict the future better.

Literature

- Tom Garrison. (2001). Essentials of Oceanography (2nd edition). USA.
- Robert H. Stewart, 2007. Introduction To Physical Oceanography. Dept. of Oceanography, Texas A & M University.
- John. H. Sampson and J. Sharples, 2012. Introduction to the Physical and Biological Oceanography of Shelf Seas. Cambridge University Press
- Riley, J. P. and R. Chester, 1971. Introduction to Marine Chemistry. Academic Press. London.
- Seibold, E. & Berger, W. H. 2010. The sea floor: An introduction to marine geology. Springer

Course workload

The table below summarizes course workload distribution:

Activities	Learning outcomes	Assessment	Estimated workload (hours)
In-class activities (53 hours)			
Lectures	Understanding theories and concepts, in the physical, chemical and geological oceanography in tropical area.	Final Exam	32
Tutorial/ Practical	Ability to understand and use suitable tools and methods for oceanographic data processing and analysis.	Class participation, in-class assginments and practical report	18
Interactive group discussion and presentation – based on case study	Ability to critically and creatively discuss key concepts in addresing climate change issues on tropical ocean	Member participation, accuracy and comprehensiveness of the information presented, preparedness, visibility and informativeness of the presentation	3
Independent work (74 hours)			
Lectures	Understanding theories and concepts, in the physical, chemical and geological oceanography in tropical area.	Final Exam	38
Tutorial/ Practical	Ability to understand and use suitable tools and methods for oceanographic data processing and analysis.	Class participation, in-class assginments and practical report	18
Interactive group discussion and presentation - based on case study	Ability to critically and creatively discuss key concepts in addresing climate change issues on tropical ocean.	Member participation, accuracy and comprehensivene	12

		ss of the information presented, preparedness, visibility and informativeness of the presentation	
Individual written report – based on case study	Ability to articulate scientific arguments in addresing past, present and future climate change issues on tropical ocean and come out with well designed of adapatation planning strategies	Quality of written report, relevant topic, completeness, accuracy of the information presented and well-organized	6
Total			***127***

Grading

The students' performance will be based on the following:

Assessment

- Progress assessment (40%)
  - Practical exercise (10%): each student must do in-class practical and submit the practical report regarding seawater properties in the upwelling region.
  - Tutorial (20%): student must watch two videos or face to face lab demo on how to process and analyze nutrient and chlorophyll data, and core sediment data. Each student must do the in-class assignment for both videos/ demos.
  - Case study (10%): Student will be divided into a group of 3 – 4 and do the interactive discussion and presentation. Each group must select relevant topic related to climate change issues for the activities.

- Final assesment (60%):
  - Written report (10%): Based on the selected topic on the case study above, student must write less than 2000 words of report. The report must highlight (but not limited) to the main issues in the selected topic, how it will impact human and adaptation planning strategies.
  - Final examination (50%): Each student must sit for final examination to complete the course.

Evaluation

A (80% - 100%)
A- (75% - 80%)
B+ (70% - 75%)
B (65% - 70%)
B- (60% - 65%)
C+ (55% - 60%)
C (50% - 55%)
C- (45% - 50%)
D (40% - 45%)
F (0% - 40%)