

UNIVERSITY of TORONTO at SCARBOROUGH  
Department of Physical & Environmental Sciences  
September 2012  
Environmental Science EES C19

The world's oceans constitute more than 70 % of the earth's surface environments. This course will introduce students to the dynamics of ocean environments, ranging from deep ocean basins, to marginal seas, to the coastal ocean. The physical nature of ocean systems, their origins, and their importance in the global hydro-climatic system will be examined first; we will then focus on the primary physical mechanisms that control ocean dynamics. We will then examine the major oceanic circulations. The interactions that occur between the various fluid motions and the solid boundary, particularly around the edge of the continents will be a focus and a primary goal will be to examine the effects that the continent boundaries have on these fluid motions.

Instructor: Prof. Mathew Wells

Office: SW627B

Office hours Mondays 10-12 am - For all detailed questions please come to my office hours. I will only answer short emails from official UofT accounts, and anything that requires a detailed answer I'll ask you come to the course office hours.

The course will be organized around: (a) a 2-hour lecture each week; (b) a 1-2-hour tutorial/ practical class most weeks where the assignments will be discussed. I will be posting lectures on blackboard usually the day before classes.

Lectures:

Tuesday 1300-1500 h Room: BV 363

Tutorials/Practicals/Seminars:

Tuesday 1500-1700 h Room: AA 205 or in computer labs

Course Grade:

Mid-Term Test 15 %

Assignments (4) 40 % - note that last assignments will be penalized.

Final Examination 45 %

## TENTATIVE COURSE OUTLINE

### **September 3 Orientation**

#### ENVIRONMENTAL CHALLENGES IN OCEANOGRAPHY

Climate Change

Overfishing and the Exclusive Economic zone (EEZ)

Marine pollution and shipping

#### INTRODUCTION TO MARINE SYSTEMS (Physical)

The World Ocean  
Ocean Morphology  
Sea Water: Physical & Chemical Properties  
Halocline, Pycnocline, Thermocline

**September 10 FORCES ON THE GLOBAL OCEAN 1: WIND**

Surface Currents & Ekman Circulation  
Inertial Currents and Geostrophic Currents  
Oceanic Fronts  
Gyres, Rings, Eddies

ASSIGNMENT1 issued: Waves and Ocean Currents  
Computer lab tutorial on Java Ocean Atlas

**September 17 FORCES ON THE GLOBAL OCEAN 2: WAVES**

Wind Waves in Ocean Current Systems  
Wave Generation & Propagation: Wind Waves & Swell  
Wave Breaking & Decay, Wave Boundary Layers  
Wave Guides & Kelvin Waves  
Rossby Waves  
Tsunamis

**Sept 24 FORCES ON THE GLOBAL OCEAN 3: Thermo-Haline Circulation**

Hydrostatic Pressure & Horizontal Pressure Gradients  
Barotropic & Baroclinic States  
Coriolis Effect  
Geostrophic Currents & Gyres

**October 1 FORCES ON THE GLOBAL OCEAN 4: OCEANIC TIDES**

Equilibrium Theory of Tides  
Tidal Constituents & Dynamical Theory of Tides  
Amphidromic Systems, Tidal Currents  
Forcing of Real Tides & Tidal Asymmetries  
ASSIGNMENT 2 issued: TIDES

**October 8 OCEAN CURRENT SYSTEMS I:**

Atlantic Ocean  
North Atlantic Gyre  
The North Atlantic Oscillation  
Arctic and Southern Oceans  
Sea ice dynamics

October 15 – Reading week

**October 22 OCEAN CURRENT SYSTEMS II:**

Pacific Ocean  
The Equatorial Current Systems  
The Subtropical Gyres  
The Equatorial Undercurrent  
El Nino Southern Oscillation (ENSO)  
Indian Ocean  
Tropical Monsoon  
In class midterm scheduled during tutorial.

**October 29 OCEAN WATER MASSES**

Heat Budget & Conservation of Salt  
Upper & Intermediate Water Masses  
Deep and Bottom Water Masses  
Ocean Mixing

ASSIGNMENT 3 issued: OCEAN CURRENTS

**November 5 MARINE-FRESHWATER INTERFACE: ESTUARIES**

Morphology & Estuary Types  
Estuarine Processes  
Environmental Problems  
ASSIGNMENT 4 issued: Student Reports on Ocean Currents

**November 12 DISTRIBUTION OF BIOLOGY**

Phytoplankton and Zooplankton, Red Tides  
Oxygen and Nutrient distributions  
Upwellings zones, CO<sub>2</sub> uptake in ocean

**November 19** 15 minute Student Presentations on Ocean Currents

**November 26** 15 minute Student Presentations on Ocean Currents  
Course Review during tutorial

TEXTBOOK

Two texts from the UK Open University that will be used in this course as the textbook. You can buy them from Amazon but these two books are available online through the U of T library website

Ocean circulation –

<http://simplelink.library.utoronto.ca/url.cfm/51807>

Waves, tides, and shallow-water processes -

<http://simplelink.library.utoronto.ca/url.cfm/51808>

Other useful texts are "Regional Oceanography: an Introduction" by Matthias Tomczak and Stuart Godfrey. A PDF version of this book is available at <http://gyre.umeoce.maine.edu/physicalocean/Tomczak/regoc/pdfversion.html>

A more technical book is "Introduction to Physical Oceanography" by Robert Stewart.

A PDF version of this book is available at [http://oceanworld.tamu.edu/resources/ocng\\_textbook/PDF\\_files/book\\_pdf\\_files.html](http://oceanworld.tamu.edu/resources/ocng_textbook/PDF_files/book_pdf_files.html)

and the online version is available at

[http://oceanworld.tamu.edu/resources/ocng\\_textbook/contents.html](http://oceanworld.tamu.edu/resources/ocng_textbook/contents.html)

We are also able to access the online "Encyclopedia of Ocean Sciences". The encyclopedia was published in 2001 and is the most up-to-date resource on oceanography available. Here is a link to the encyclopedia

<http://simplelink.library.utoronto.ca/url.cfm/282540>