SIO237A: Introduction to Ocean Optics

INSTRUCTOR:

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Office hours: Immediately after each course meeting for 1 hour and by appointment

PREREQUISITES:

Students admitted to the SIO graduate program or permission of instructor

COURSE DESCRIPTION:

Units: 4; Grade: Letter grade only; Required a passing score on midterm and final exams and participation in lectures.

This course is an introduction to the field of ocean optics which builds on the wealth of historical information on light in the ocean and is representative of the present state of the science of optical oceanography. Optical oceanography is inherently a multidisciplinary science as optical variability in the ocean is driven by a combination of physical, biological, chemical, and geological processes. The course is presented from the perspective of a physicist with background in optics, some knowledge of and interest in physical and biological oceanography, and a realization that the study of optical oceanography is a multidisciplinary venture. The emphasis of discussion is on physical understanding and the level of discussion is directed to students who have had only introductory courses in physics, as can be assumed for any beginning graduate student in oceanography. The layout of the course is intended to carry the students through a logical progression of discussions which begin with comments on the nature of light itself and solar energy falling upon the Earth, followed by a comprehensive survey of physical and conceptual foundations of hydrologic optics including technical diversity of concepts and terminology used in classifying and measuring radiometric quantities and optical properties within natural water bodies. The path of the course continues to include the theory and experimental facts of radiative transfer processes and the propagation of light through the air-water interface and within the water column, as well as the interactions of light with various dissolved and particulate constituents of seawater. The theoretical framework of radiative transfer is presented in an effort to achieve some middle ground between trite approximations of reality and mathematical formulations that can become intimidating to an audience of varied background. The strong flavors of diversity of applications of optical methods in oceanography as well as example frontier research topics are also reviewed. Course meetings consist of lectures by instructor and demonstration of instrumentation and measurement techniques (see Schedule).

COURSE GOALS:

(1) To lay physical and conceptual foundations of ocean optics, the quantitative study of the interactions of light with the Earth's oceans.
(2) To review concepts, terminology, and measurement techniques used to characterize radiative transfer processes, light fields within and leaving the ocean, and inherent and apparent optical properties of the ocean.
(3) To present an integrated and cohesive treatment of the links and interactions between underwater light field characteristics, ocean optical properties, and various constituents of seawater.
(4) To discuss example topics at the frontier of ocean optics and optical applications in oceanography.

READING:

C. Mobley "Light and Water. Radiative Transfer in Natural Waters" Academic Press, 1994.
A comprehensive text on radiative transfer in aquatic enviroments. Part I can serve as a standard reference work on introduction to ocean optics. Required reading: Chapters 1 and 3.

J.T.O. Kirk "Light and Photosynthesis in Aquatic Ecosystems", Cambridge Univ. Press, 1994.
The first part of the book is an introductory text on ocean optics. Recommended reading: Part I.

S. Johnsen “The Optics of Life. A Biologist's Guide to Light in Nature”, Princeton University Press, 2012.
Lucid account of all the essential aspects of light and optical processes in nature, especially as they pertain to biological research. Recommended reading.

N.G. Jerlov “Marine Optics”, Elsevier, 1976.
Classic text in ocean optics.

Handbook of Optics, 2nd edition, McGraw-Hill, Inc. 1995.
Includes a chapter on Optical Properties of Water (Chapter 43 by C. Mobley)

Example textbooks covering basic topics of electromagnetic theory and light:
Hecht, E., Physics, Brooks/Cole Publishing Co, 1994.
Hecht, E., Optics, Addison-Wesley, 1998.

GRADING:

Midterm exam: 40%
Final exam: 60%

ASSIGNMENTS:

Students will receive take-home problem sets for midterm and final exams. Students must work on these exams alone and must return the problem sets with solutions by the deadline.

SCHEDULE:

The course will include mostly lectures by instructor (Lec) and a few meetings in the lab to demonstrate instruments and measurement techniques. Course meetings will take place twice a week of 1 hr 20 min duration each during a 10-week period of the quarter. Days/time will be determined in consultation with students at the beginning of the quarter.

Week	Type of Activity	Topic
1	Lec	The nature of light and solar energy falling upon the Earth
1	Lec	Radiometry: Concepts, terminology, measurement techniques
2	Lec	Radiometry: Concepts, terminology, measurement techniques (contd)
2	Lec	Inherent optical properties: Concepts, terminology, measurement techniques
3	Lec	Inherent optical properties: Concepts, terminology, measurement techniques (contd)
3	Lec	Apparent optical properties: Concepts, terminology, measurement techniques
4	Lec	Apparent optical properties: Concepts, terminology, measurement techniques (contd)
4	Lec	Radiative transfer processes and radiative transfer equation for radiance
5	Lec	Radiative transfer processes and radiative transfer equation for radiance (contd)
5	Lec	Light reflection and transmission through the air-water interface
6	Lec	Light absorption and scattering by seawater constituents
6	Lec	Light absorption and scattering by seawater constituents (contd)
7	Lec	Light absorption and scattering by seawater constituents (contd)
7	Lec	Light fields within the ocean and leaving the ocean
8	Lec	Light fields within the ocean and leaving the ocean (contd)
8	Lab	Demonstration of instrumentation and measurement techniques
9	Lab	Demonstration of instrumentation and measurement techniques (contd)

9	Lec	Frontiers in ocean optics and optical remote sensing
10	Lec	Frontiers in ocean optics and optical remote sensing (contd)
10	Lab	Frontiers in ocean optics and optical remote sensing (contd)