

课程详述

COURSE SPECIFICATION

以下课程信息可能根据实际授课需要或在课程检讨之后产生变动。如对课程有任何疑问，请联系授课教师。

The course information as follows may be subject to change, either during the session because of unforeseen circumstances, or following review of the course at the end of the session. Queries about the course should be directed to the course instructor.

1.	课程名称 Course Title	海水分析化学实验 Experiment of sea water analysis
2.	授课院系 Originating Department	海洋科学与工程系 Department of Ocean Science and Engineering
3.	课程编号 Course Code	OCE312
4.	课程学分 Credit Value	2
5.	课程类别 Course Type	专业选修课 Major Elective Courses
6.	授课学期 Semester	春季 Spring
7.	授课语言 Teaching Language	中文 Chinese
8.	授课教师、所属学系、联系方式 (如属团队授课, 请列明其他授课教师) Instructor(s), Affiliation & Contact (For team teaching, please list all instructors)	郭静, 海洋科学与工程系, 创园 9 栋 602, guoj@mail.sustc.edu.cn Guo Jing, Department of Ocean Science and Engineering, Chuangyuan 9-602 Tel. 18126401114
9.	实验员/助教、所属学系、联系方式 Tutor/TA(s), Contact	
10.	选课人数限额(可不填) Maximum Enrolment (Optional)	10

11. 授课方式 Delivery Method	讲授 Lectures	习题/辅导/讨论 Tutorials	实验/实习 Lab/Practical	其它(请具体注明) Other (Please specify)	总学时 Total
学时数 Credit Hours			64		64
12. 先修课程、其它学习要求 Pre-requisites or Other Academic Requirements	OCE307 化学海洋学				
13. 后续课程、其它学习规划 Courses for which this course is a pre-requisite					
14. 其它要求修读本课程的学系 Cross-listing Dept.					

教学大纲及教学日历 SYLLABUS

15. 教学目标 Course Objectives

本课程的教学目标是：通过实验使学生掌握海水样品以及海洋环境监测中常见和重要化学指标的测定方法以及有代表性常用化学分析仪器的使用方法。本课程是专门对海水样品进行分析监测的一门专业基础课。通过本课程的实验教学，培养学生严谨的科学作风和实事求是的工作态度，以及善于动脑、动手和综合分析问题及解决问题的能力。课程内容选取以下三个模块：容量分析、光电比色分析以及海水环境调查。

容量分析法是分析化学中最基本的分析方法，在海水分析中占有重要的位置。例如海水溶解氧、化学耗氧量、碱度、硬度、氯化物等指标的滴定分析，都是国标标准方法，这类方法的操作也是训练学生提高动手能力，掌握水质分析基本技能的最直接的方法。

分光光度计测定海水中营养盐的光电比色法是海水分析化学实验中最为普及的一种方法。通过海水环境中氨氮、无机磷、硝酸盐、亚硝酸盐等营养元素的测定，要求学生熟练掌握分光光度计的工作原理、使用方法。并在此基础上提出了对某一元素测定时的条件，进行验证性的研究性试验，以锻炼学生具体问题具体分析的科学能力。

通过对海水环境因子的化学分析，对某一水体进行系统而科学的综合评价。内容包括采样、样品处理、待测组分的分类、富集和测定、分析结果的整理等一系列环节。因此，掌握海水调查的基本知识也是必不可少的内容。

The objective of this course is to enable students to master the methods for the determination of important chemicals in seawater and the use of representative chemical analysis instruments. This course is a specialized lab course for students majoring in marine science. The course will train students with rigorous scientific and working attitude, train the students to comprehensively analyze seawater and solve scientific problems in marine science. The course includes three modules: titrimetric analysis, photoelectric colorimetric analysis and basic knowledge of seawater investigation.

Titrimetric analysis is the most basic analytical method in seawater analysis. Titrimetric analysis includes dissolved oxygen, chemical oxygen demand, alkalinity, hardness, chloride and other indicators recommended in the national standard. The operation of such methods is also the most direct way to train students to improve their operational ability and master the basic skills of water quality analysis.

The photoelectric colorimetric method for nutrients analysis in seawater is one of the most popular methods in instrumental analysis. Through the determination of ammonia nitrogen, inorganic phosphorus, nitrate, nitrite and other nutrient elements in seawater, students are required to master the working principle and using spectrophotometer. And on this basis, the conditions for the determination of an element are put forward, and a confirmatory research experiment is carried out, so as to train students' scientific research ability in specific analysis of specific problems.

Through the chemical analysis of seawater environmental factors, the comprehensive evaluation of water environment is only an important part. To make a systematic and scientific evaluation of the seawater, its contents include a series of links such as sampling,

sample processing, classification of components to be tested and results to be analyzed. Therefore, the basic knowledge of sea water survey is also essential.

16. 预达学习成果 Learning Outcomes

海洋是一门综合性非常强的学科，它所涉及的理论知识和实验技能的范围都是非常广泛的。要完成所有的课程任务，学生必须：

(1) 实验前必须认真预习，理解实验原理，熟悉实验步骤及注意事项，做到心中有数。研究性的实验要要求预先完成初步设计方案。

(2) 按时上课,认真听讲。严格按照规范操作进行，要仔细观察，及时记录，勤于思考，学会运用所学的理论知识解释实验现象，研究实验中的问题。

(3) 实验中的现象和测定的数据必须记录在实验记录上，不得涂改。实验结束后，根据实验记录认真整理、分析、归纳、计算，并及时写好实验报告，下次实验交给老师批阅。

学生上完实验课后应具备如下实验操作技能：

(1) 熟练掌握海洋化学指标测定的两大基本方法：容量分析法（电极法、酸碱滴定、氧化还原滴定、沉淀滴定、络合滴定）和仪器分析（主要是分光光度计法、总有机碳分析仪、加速溶剂萃取仪 (ASE)、GC-MS 等）。掌握这些方法的有关原理，适用对象、优缺点等和实验技能。

(2) 掌握常见水质指标的测定原理、试验仪器与试剂、试验步骤、结果处理与讨论，特别是具体方法所适用的对象以及注意事项。

(3) 了解水环境调查的基本操作流程，掌握水样的采集、预处理方法，掌握常见仪器（分光光度计、酸度计、溶解氧仪、总有机碳分析仪、加速溶剂萃取仪 (ASE)、GC-MS 等）的使用方法和注意事项。

(4) 通过研究性的实验设计，了解影响实验结果的海洋环境因子的控制方法，能自行设计较为简单的实验，从而达到能够独立进行科学实验的能力。

Marine science is a very interdisciplinary subject. To complete all course tasks, students must:

(1) preview the experiment carefully and understand the experimental principle; get familiar with the experimental steps and be precautious, Complete preliminary design in advance if needed.

(2) Attend class on time and listen carefully. Strictly follow the standard operation, observe carefully, record in time, diligently think, learn to use the theoretical knowledge learned to explain the experimental phenomenon, and study the problems in the experiment.

(3) Recorded the phenomena and measured data in the experiment; organize, analyze, summarize, and calculate according to the experimental records, and write the experimental report timely.

Students should have the following experimental operation skills after this lab course:

(1) Be proficient in the two basic methods for seawater analysis: Titrimetric analysis (electrode method, acid-base titration, redox titration, precipitation titration, complexometric titration) and instrument analysis (mainly spectrophotometer method, total organic Carbon analyzer, accelerated solvent extraction (ASE), GC-MS, etc.). Master the principles, applicable objects, advantages and disadvantages of these methods and experimental skills.

(2) Master the measurement principles, test instruments and reagents, test procedures, result processing and discussion of common water quality indicators, especially the applicable objects and precautions of specific methods.

(3) Understand the basic operation process of seawater investigation, grasp the collection and pretreatment methods of water samples, and master the common instruments such as spectrophotometer, acidity meter, dissolved oxygen meter,

total organic carbon analyzer, accelerated solvent extraction instrument , GC-MS etc.

(4) Understand the control setup that affect the experimental results, and self-design simple experiments , so as to achieve the ability to conduct scientific experiments independently.

17. 课程内容及教学日历（如授课语言以英文为主，则课程内容介绍可以用英文；如团队教学或模块教学，教学日历须注明主讲人）

Course Contents (in Parts/Chapters/Sections/Weeks. Please notify name of instructor for course section(s), if this is a team teaching or module course.)

一、 海洋化学实验室安全常识培训及实验室常用分析仪器使用规程（4学时）

Lab 1 Safety knowledge training of Marine Chemical Laboratory and introduction to common instruments in the laboratory (4 credit hours)

介绍实验室规则，危险性的种类，防火与防爆，防止烧伤、割伤、腐蚀和烫伤，常见的化学毒物及中毒预防和急救，安全用电常识；课程设置及实验安排；实验记录本及实验报告要求；实验课考核及评分标准；初步介绍实验室常用分析仪器使用规程。

Introduce Marine Chemical Laboratory safety (including types of hazards, fire and explosion prevention, prevention of burns, cuts, corrosion and scald, common chemical poisons and poisoning prevention and first aid, safety of electricity knowledge), course requirement (notebook and report), course schedule and evaluation. The students should learn how to use the common instruments in the laboratory.

二、 电极法测定海水 pH 值、海水电导率和盐度。（4学时）

Lab 2 Electrode analysis of pH, conductivity and salinity of seawater (4 credit hours)

掌握用电位法测定海水 pH 值的方法及原理；熟悉实验方程式，仪器设备，试剂及配制。掌握电导率仪的测定原理及正确操作方法；了解海水电导率与氯度、盐度的关系。

To master the method and principle of measuring the pH value of sea water by electrode method; To be familiar with experimental equations, instruments, reagents and formulations. To learn the measuring principle and correct operation method of conductivity meter; To understand the relationship between the electrical conductivity and the chlorine and salinity.

三、 悬浮物和浊度的测定。（4学时）

Lab 3 Determination of suspended particulates and turbidity in seawater (4 credit hours)

掌握利用过滤称量法测定悬浮物的原理和正常操作方法；掌握利用光度法测定浊度的原理和操作方法，学习绘制标准曲线。

To master the principle and procedure of measuring suspended matter by filtration weighing method; and determine turbidity by photometry. To learn to how to draw the standard curve.

四、 光度法测定阴离子合成洗涤剂 and 挥发性酚。（4学时）

Lab 4 Determination of anionic synthetic detergents and volatile phenols by spectrophotometry (4 credit hours)

掌握利用光度法测定阴离子合成洗涤剂 and 挥发性酚的原理和正常操作方法。

To master the principle and procedure of determination of anionic synthetic detergents and volatile phenols by spectrophotometry.

五、 水中氯化物的测定。（4学时）

Lab 5 Titration analysis of chloride in seawater (4 credit hours)

了解容量分析沉淀滴定法测定水中氯化物的原理。学习滴定分析法的基本操作。掌握银量法测定氯化物的实验操作。

To understand the principle of volumetric analysis (precipitation titration) to determine chloride in water. To learn the basics of titration. To master the experimental operation of the determination of chloride by the silver method.

六、海水中溶解氧的测定。(4学时)

Lab 6 Titration analysis of dissolved oxygen (DO) in seawater (4 credit hours)

了解容量分析氧化还原滴定法测定 DO 的原理。掌握碘量法测定水中 DO 的实验操作、干扰因素和注意事项。了解膜电极法测定 DO 的原理和溶解氧测定仪的使用方法。

To understand the principle of volumetric analysis (redox titration) to determine DO. To master the experimental operation, interference factors and precautions for the determination of DO in water by iodometry. To understand the principle of membrane electrode method for measuring DO and how to use dissolved oxygen analyzer.

七、耗氧量的测定。(4学时)

Lab 7 Titration analysis of Chemical Oxygen Demand (COD) in seawater (4 credit hours)

掌握碱性高锰酸钾容量法测定海水中化学耗氧量的原理及方法。综合分析碘量法测定 DO、碱性高锰酸钾测定 COD 的异同处。

To master the principle and method of measuring COD in seawater by alkaline potassium permanganate volumetric method. A comprehensive analysis of the similarities and differences in the determination of DO by redox titration and COD by alkaline potassium permanganate.

八、氨氮的测定。(4学时)

Lab 8 Photoelectric colorimetric analysis of ammonia and nitrogen (4 credit hours)

学习分光光度计的原理及使用方法，掌握奈氏法测定氨氮的原理和方法。

To learn the principle and method of spectrophotometer, and master the principle and method of measuring ammonia and nitrogen by Nessler method.

九、亚硝酸盐氮和硝酸盐氮的测定。(4学时)

Lab 9 Photoelectric colorimetric analysis of nitrite nitrogen and nitrate nitrogen (4 credit hours)

学习利用光度法测定水中亚硝酸盐氮和硝酸盐氮的原理和步骤。了解硝酸盐、亚硝酸盐、氨态氮的测定之间的关系。

To learn photoelectric colorimetric analysis of nitrite nitrogen and nitrate nitrogen in seawater. To understand the relationship among nitrate, nitrite and ammonia nitrogen.

十、无机磷的测定。(4学时)

Lab 10 Photoelectric colorimetric analysis of inorganic phosphorus (4 credit hours)

熟练掌握分光光度计操作要领。学会用钼蓝光度比色法测定海水中磷酸盐的方法原理和实验条件。

Proficiency in the operation of spectrophotometer. To master the principle and procedure of inorganic phosphorus in seawater by molybdenum blue colorimetric method.

十一、硅酸盐的测定。（4学时）

Lab 11 Photoelectric colorimetric analysis of silicate (4 credit hours)

了解硅钼黄形成机制和稳定条件。学会应用硅钼黄分光光度法测定海水中的硅。

To understand the formation mechanism and stability conditions of silicon molybdenum yellow. To learn to apply silicon molybdenum yellow spectrophotometry to determine the silicon in sea water.

十二、总有机碳的测定。（4学时）

Lab 12 Determination of total dissolved organic carbon (DOC) (4 credit hours)

掌握仪器分析法测定海水样品中的溶解有机碳。

To master instrument analysis of dissolved organic carbon in seawater.

十三、利用手提法提取微藻中的脂类。（4学时）

Lab 13 Manual extraction of lipids(4 credit hours)

了解从海洋微藻中提取脂类的原理。掌握手提法分离提取脂类的操作流程。

To understand the principle of lipid extraction from marine samples. To master the process of lipid extraction manually.

十四、利用加速溶剂萃取(ASE)仪器法提取微藻中的脂类。（4学时）

Lab 14 Lipids from microalgae were extracted by ASE (4 credit hours)

掌握利用加速溶剂萃取 (ASE)从海洋微藻中提取脂类的原理。了解手提法和仪器法分离提取脂类的异同。

To master the principle of lipid extraction from marine samples by ASE. To compare the similarities and differences between hand and instrumental methods for extracting lipids.

十五、利用气相色谱-质谱联用仪测定脂类中 DHA 含量。（4学时）

Lab 15 The content of DHA in lipids was determined by Gas Chromatography Mass Spectrometry (GC-MS) (4 credit hours)

学习气相色谱仪的使用方法。掌握利用气相色谱仪测定脂类中 DHA 含量的操作原理和步骤。

To Learn to use GC-MS and master the principle and procedure of determining DHA content in lipids by GC-MS.

十六、实验回顾与总结。（4学时）

Lab 16 Lab Review (4 credit hours)

学生根据课程内容对实验原理、步骤、实验结果进行回顾，并对本实验相关内容进展扩展，以演讲形式讲解。

The students will summary the lab course by themselves and expand the mind. They will do the presentation with PPT.

18. 教材及其它参考资料 Textbook and Supplementary Readings

自编教材
参考资料:

1. Chemical Oceanography, 4th edition, Frank J. Millero, 2013
2. 海洋化学实验, 石贵勇, 杨颖, 黄希哲, 中山大学出版社, 2018
3. 国家环境保护总局《水和废水检测分析方法》编委会编, 水和废水检测分析方法(第四版), 中国环境科学出版社, 2002年
4. GB/T 12763.4—2007 海洋调查规范第04部分海水化学要素调查
5. GB 17378.4—2007 海洋监测规范第4部分海水分析

课程评估 ASSESSMENT

19. 评估形式 Type of Assessment	评估时间 Time	占考试总成绩百分比 % of final score	违纪处罚 Penalty	备注 Notes
出勤 Attendance		10		
课堂表现 Class Performance		30		
小测验 Quiz				
课程项目 Projects				
平时作业 Assignments		50		
期中考试 Mid-Term Test				
期末考试 Final Exam				
期末报告 Final Presentation		10		
其它(可根据需要 改写以上评估方 式) Others (The above may be modified as necessary)				

20. 记分方式 GRADING SYSTEM

- A. 十三级等级制 Letter Grading
 B. 二级记分制(通过/不通过) Pass/Fail Grading

课程审批 REVIEW AND APPROVAL

21. 本课程设置已经过以下责任人/委员会审议通过
 This Course has been approved by the following person or committee of authority

海洋科学与工程系本科教学委员会
 Department of Ocean Science and Engineering Undergraduate Committee