

## 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.	<b>课程名称 Course Title</b>	计算方法 Computational Methods
2.	<b>授课院系 Originating Department</b>	地球与空间科学系 Department of Earth and Space Sciences
3.	<b>课程编号 Course Code</b>	ESS205
4.	<b>课程学分 Credit Value</b>	3
5.	<b>课程类别 Course Type</b>	专业基础课 Major Foundational Courses
6.	<b>授课学期 Semester</b>	春季 Spring
7.	<b>授课语言 Teaching Language</b>	中英双语 English & Chinese
8.	<b>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 &amp; Contact (For team teaching, please list all instructors)</b>	杨剑, 地球与空间科学系 邮箱: yangj36@sustech.edu.cn 电话: 0755-88018694 办公室: 创园9栋411 Jian Yang, Department of Earth and Space Sciences Email: yangj36@sustech.edu.cn Tel: 0755-88018694 Office: Innovation Park #9-411
9.	<b>实验员/助教、所属学系、联系方式 Tutor/TA(s), Contact</b>	待公布 To be announced
10.	<b>选课人数限额(可不填) Maximum Enrolment (Optional)</b>	

11. 授课方式 Delivery Method	讲授	习题/辅导/讨论	实验/实习	其它(请具体注明)	总学时
	Lectures	Tutorials	Lab/Practical	Other (Please specify)	Total
学时数 Credit Hours	48				48

12. 先修课程、其它学习要求 Pre-requisites or Other Academic Requirements	
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

本课程为学生了解和应用数值计算与数据分析方法，解决实际物理问题提供基础知识和基本训练。该课程将介绍数值计算的基本概念和主要方法，通过原理讲解、实例分析和上机操作相结合的方式使学生能够掌握利用数值计算解决简单物理问题的思路和技巧。

This course is meant to be a combination of lectures and hands-on sessions on a variety of computational techniques commonly used in physics. The course will introduce basic concepts and a variety of important techniques for numerical computations and data analysis. By the end of this course, students should be able to use computational techniques to solve simple real-world physical problems, and should also have an understanding of how to choose and evaluate appropriate methods for a given problem.

#### 16. 预达学习成果 Learning Outcomes

学生完成本课程后，将会：

1. 掌握 MATLAB 的使用；
2. 基本具备利用数值计算方法解决真实物理问题的能力；
3. 了解基本的计算方法，具备选取和评估不同数值方法的能力；
4. 具备清晰有效的编程和程序调试能力。

Upon completing the course, students will able to:

1. Use MATLAB;
2. Use computational techniques to solve real-world physical problems;
3. Have a working familiarity of some basic numerical methods, including an understanding of how to choose and evaluate appropriate methods for a given problem;
4. Use effective and clear programming and debugging strategies.

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.)**

本课程分为课程讲授和期末报告两部分。课程讲授包含以下十一章内容，以简单的物理问题为实例，将教师讲授和上机操作相结合，共 44 学时；期末报告以学生个人或团队合作完成项目并陈述的形式开展，共 4 学时。

**第一章：课程简介；MATLAB 的使用和编程规范；误差的定义、来源与分析（2 学时）**

**第二章：各类插值法（4 学时）**

线性插值、多项式插值、分段插值等方法。

**第三章：数据拟合方法（4 学时）**

最小二乘法原理；线性和非线性数据拟合；多变量拟合。

**第四章：傅里叶变换（2 学时）**

介绍傅里叶变换的原理；快速傅里叶变换方法和应用。

**第五章：数值微分（4 学时）**

介绍几种基本的导数的数值算法；包括向前法、向后法、高阶法等。

**第六章：数值积分（4 学时）**

数值积分的基本原理；介绍 Newton 积分、Gauss 积分、Romberg 积分等。

**第七章：数值求根法（4 学时）**

迭代法、割线法、最速下降法等。

**第八章：线性方程组的数值解法（6 学时）**

Gauss 消元法、矩阵三角分解法、迭代法、松弛法。

**第九章：常微分方程的数值解法（6 学时）**

Euler 法及其改进、Runge-Kutta 法、介绍各种方法的收敛性和稳定性。

**第十章：偏微分方程的数值解法（2 学时）**

介绍波动方程、扩散方程、Laplace 方程的解法。

**第十一章：随机过程和蒙特卡洛方法（6 学时）**

介绍随机过程现象和统计规律；蒙特卡洛方法的原理和应用。

**期末报告：（4 学时）**

学生个人或团队合作完成项目并陈述。

This course will be divided into two parts, lectures and final presentation. The lectures will include eleven chapters, as well as hands-on sessions to solve simple physics problems (44 hours). The final presentation will have students to present their projects (4 hours).

**Chapter 1: Introduction; Basics of MATLAB and programming; Definition, source and analysis of errors (2 hours)**

**Chapter 2: Interpolation (4 hours)**

Linear interpolation, polynomial interpolation, piecewise interpolation.

**Chapter 3: Data fitting (4 hours)**

Least-square method, linear and non-linear data fitting, multi-variant fitting.

**Chapter 4: Fourier transform (2 hours)**

Basics of Fourier transform, fast Fourier transform and its applications.

**Chapter 5: Numerical derivatives (4 hours)**

Introduction to several finite difference methods: forward and backward methods, higher-order approximations for derivatives and etc.

**Chapter 6: Numerical integration (4 hours)**

Principles of numerical integration, Newton's method, Gaussian method, Romberg's method and etc.

**Chapter 7: Root finding (4 hours)**

Newton-Raphson method, Secant method, steepest descent method and etc.

**Chapter 8: Linear equations (6 hours)**

Gaussian elimination, pivoting, LU decomposition, relaxation method.

**Chapter 9: Ordinary differential equations (6 hours)**

Euler method, Runge-Kutta method, convergence and stability of different methods.

**Chapter 10: Partial differential equations (2 hours)**

Solution to wave equation, diffusion equation and Laplace equation.

**Chapter 11: Random processes and Monte Carlo methods (6 hours)**

Introduction to random processes and statistical mechanics, Monte Carlo simulation.

**The final presentation: (4 hours)**

Students to present their projects.

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

1. Alejandro L. Garcia (2000), Numerical Methods for Physics, 2<sup>nd</sup> Edition, Addison-Wesley, ISBN 0-13-906744-2.
2. Darren Walker (2016), Computational Physics: An introduction, Mercury Learning and Information, ISBN 978-1-942270-73-7.
3. 徐萃薇、孙绳武编著 (2015), 计算方法引论 (第四版), 高等教育出版社, ISBN 978-7-04-041889-7.

**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				

课堂表现 <b>Class Performance</b>	10		
小测验 <b>Quiz</b>			
课程项目 <b>Projects</b>			
平时作业 <b>Assignments</b>	30		
期中考试 <b>Mid-Term Test</b>			
期末考试 <b>Final Exam</b>	30		
期末报告 <b>Final Presentation</b>	30		
其它（可根据需要 改写以上评估方式） <b>Others (The above may be modified as necessary)</b>			

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**



SUSTech Southern University of Science and Technology