

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	偏微分方程数值解 Numerical Solutions to Partial Differential Equations				
2.	授课院系 Originating Department	数学系 Mathematics				
3.	课程编号 Course Code	MA325				
4.	课程学分 Credit Value	3				
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	中英双语 English & 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)	杨将, 数学系, 副教授 慧园 3 栋 423 yangj7@sustc.edu.cn Yang Jiang, Mathematics, Associate Professor Room 423, Block 3, Wisdom Valley yangj7@sustc.edu.cn				
9.	实验员/助教、所属学系、联系方式 Tutor/TA(s), Contact	无 NA				
10.	选课人数限额(可不填) Maximum Enrolment (Optional)					
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	48				48

12. 先修课程、其它学习要求 Pre-requisites or Other Academic Requirements	偏微分方程 Partial Differential Equations
13. 后续课程、其它学习规划 Courses for which this course is a pre-requisite	有限元方法 Finite Element Methods
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**

教授偏微分方程数值基本解法及其理论

Teach numerical methods for partial differential equations and the underlying theory

16. 预达学习成果 **Learning Outcomes**

掌握偏微分方程数值处理的有限差分方法，学会编程解决问题以及分析所用方法的可行性

Master the finite difference methods for partial differential equations, be able to solve partial differential problems by programming and analyzing the numerical methods

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.)

1. 有限差分逼近：截断误差，差分格式的推导，二阶差分，高阶差分，一般差分格式系数推导（6学时）

Finite difference methods: Truncation errors, Derivation of finite difference, Second order derivatives, Higher order derivatives, A general approach to deriving the coefficients. (6 hours)

2. 稳态和边值问题：热方程，边界条件，稳态问题，有限差分方法，局部截断误差，全局误差，稳定性和相容性，收敛性，二范数稳定性，格林函数和无穷范数稳定性，纽曼边界条件，存在性和唯一性（10学时）

Steady States and Boundary Value Problems: The heat equation, Boundary conditions, The steady-state problem, A simple finite different method, Local truncation error, Global error, Stability and Consistency, Convergence, Stability in the 2-norm, Greens functions and max-norm stability, Neumann boundary conditions, Existence and uniqueness. (10 hours)

3. 椭圆形方程：热传导问题，五点差分格式，未知数排序，精度和稳定性，九点差分格式，线性系统的求解（6学时）

Elliptic equations: Steady-state heat conduction, The 5-point stencil for the Laplacian, Ordering the unknowns and equations, Accuracy and stability, The 9-point Laplacian, Solving the linear system. (6 hours)

4. 解线性方程组：快速求解算法，迭代法，收敛性分析（6学时）

Solve the linear system: Fast solver for the linear system, Iterative methods, Convergence analysis. (6 hours)

5. 常微分方程数值解：常见常微分方程和数值解法（6学时）

Topics on numerical solutions of ordinary differential equations: Brief review on ODE and numerical methods. (6 hours)

6. 扩散方程和抛物问题：局部截断误差和精度阶，线性离散方法，收敛性和稳定性分析，刚度矩阵，高维问题（6

学时)

Diffusion Equations and Parabolic Problems: Local truncation errors and order of accuracy, Method of lines discretizations, Stability theory, Stiffness of the heat equation, Convergence, Multidimensional problems. (6 hours)

7. 平流方程和双曲问题: 平流方程, 常用格式及其稳定性分析, 特征跟踪和插值方法, CFL 条件, 数值算例, 双曲问题及其数值格式, 初边值问题 (8 学时)

Advection Equations and Hyperbolic Systems: Method of lines discretization, The Lax-Wendroff method, Upwind methods, Von Neumann analysis, Characteristic tracing and interpolation, The CFL condition, Numerical methods for hyperbolic systems, IBVP. (8 hours)

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

参考教材 Textbook:

Finite Difference Methods for Ordinary and Partial Differential Equations: Steady-State and Time-Dependent Problems, by Randall J. LeVeque, SIAM, 2007.

偏微分方程数值解 Numerical Solution of Partial Differential Equations: An Introduction, by K. W. Morton, D. F. Mayers, 人民邮电出版社, 2006.

偏微分方程数值解讲义, 李治平 编著, 北京大学出版社, 2010.

偏微分方程的数值方法 Numerical Partial Differential Equations: Finite Difference Methods, by J. W. Thomas, 世界图书出版社, 2005.

偏微分方程数值解法, 陆金甫, 关治 编著, 清华大学出版社, 2004.

其他参考资料 Supplementary Readings:

Finite Difference and Spectral Methods for Ordinary and Partial Differential Equations, by L. N. Trefethen, Cornell University, 1996.

MATLAB Tutorial, to accompany "Partial Differential Equations: Analytical and Numerical Methods", 2nd edition by Mark S. Gockenbach, SIAM, 2010.



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 Class Performance				
小测验		15%		

Quiz

课程项目

Projects

平时作业

Assignments

期中考试

Mid-Term Test

期末考试

Final Exam

期末报告

Final Presentation

其它（可根据需要改写
以上评估方式）

**Others (The above
may be modified as
necessary)**

	15%		
	20%		
	15%		
	35%		

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

