南方科技大学 SOUTHERN UNIVERSITY OF SCIENCE AND TECHNOLOGY

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**	科学计算 Scientific Computing
2.	**授课院系 Originating Department**	数学系 Department of Mathematics
3.	**课程编号 Course Code**	MAT8006
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**	英文 English
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）**	Alexander Kurganov, 教授, 数学系, alexander@sustc.edu.cn Alexander Kurganov, Professor, Department of Mathematics, alexander@sustc.edu.cn
9.	**实验员/助教、所属学系、联系方式 Tutor/TA(s), Contact**	待公布 To be announced
10.	**选课人数限额(可不填) Maximum Enrolment （Optional）**	

11.		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
	授课方式 Delivery Method					
	学时数 Credit Hours	48				48

12.	先修课程、其它学习要求 **Pre-requisites or Other Academic Requirements**	常微分方程 A（MA201a） Ordinary Differential Equations A（MA201a）
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**

教授基本数值方法，理论及其在现代科学计算中的应用。

Teaching basic numerical methods, theory and their applications in modern scientific computing.

16. **预达学习成果 Learning Outcomes**

After completing this course, students should master the basic concepts and methods in modern scientific computing, in both theory and programming.

完成本课程后,学生应掌握现代科学计算的基本概念和方法，包括理论以及编程实现。

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.)

Section 1, Principles of Numerical Mathematics（2H）
Well-posedness
Stability and convergence of numerical methods
A-priori and a-posteriori analysis
Sources of error in computational models
Machine representation of numbers

Section 2, Polynomial Interpolation （4H）
Lagrange polynomial interpolation and their Newton forms
Hermite polynomial interpolation
Piecewise polynomial interpolation
Approximation by splines, B-splines

Section 3, Numerical Differentiation and Integration （4H）
Finite-difference approximations of derivatives
Newton-Cote formulae

Section 4, Solutions of Linear Systems of Equations（8H）
Linear Operators on Normed Spaces, vector and matrix norms
Direct methods - LU factorization; Cholesky factorization
Iterative methods - Jacobi, Gauss-Seidel, SOR, Conjugate Gradient
Conditioning and condition number
Multi-grid methods
Domain decomposition techniques

Section 5, Eigenvalue Problem（4H）
Power method
Householder's reflection, Given's rotation, and QR factorization
The singular value decomposition (SVD)
Lanczos' method

Section 6, Least Squares Problems and Orthogonal Polynomials in Approximation Theory（13H）
Least-squares approximation and normal equations

Orthogonal polynomials
Gaussian quadrature with orthogonal polynomials
Rational function approximation
Approximation by Fourier trigonometric polynomials
Fast Fourier transforms
Gaussian quadrature over unbounded intervals
Approximation of function derivatives (classical finite differences, compact finite differences, pseudo-spectral derivative)

Section 7, Solutions of Nonlinear Systems of Equations （5H）
Fixed-point iterations (the banach fixed-point theorem and convergence results)
Newton's methods and quasi-Newton's methods
Steepest descent methods
Stopping criteria
Post-processing techniques for iterative methods

Section 8, Numerical Methods for Ordinary Differential Equations（8H）
Initial value problems
One-step methods
Linear multistep methods
Runge-Kutta methods
Stability and stiffness
Finite-difference method for boundary value problems
Local truncation error, global error
Stability, consistence, and convergence

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

参考教材 Textbook：

1、A first course in Numerical Analysis, 2nd edition, by Anthony Ralston and Philip Rabinowitz, Dover Publications INC, 2001.

2、Iterative Methods for Sparse Linear Systems, 2nd edition, by Yousef Saad, Society for Industrial and Applied Mathematics 2003.

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

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

5、数值分析，张平文，李铁军 编著，北京大学出版社, 2007

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				
小测验 Quiz				
课程项目 Projects				
平时作业 Assignments		20%		
期中考试 Mid-Term Test		30%		
期末考试 Final Exam		40%		

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)**				

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