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**	有限元方法：理论与实践 The Finite Element Method-- Theory and Practice
2.	**授课院系 Originating Department**	数学系 Department of Mathematics
3.	**课程编号 Course Code**	MAT7037
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 Spring
7.	**授课语言 Teaching Language**	根据学生的情况可以是英文、中文或者两者相结合。 English, Chinese, or both
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）**	李景治博士，数学系 Dr. Jingzhi Li, Department of Mathematics
9.	**实验员/助教、所属学系、联系方式 Tutor/TA(s), Contact**	To be announced 待公布
10.	**选课人数限额(可不填) Maximum Enrolment （Optional）**	50

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	MA302 泛函分析或者 MA325 偏微分方程的数值解 MA302 Functional Analysis 或者 MA325 Numerical Solutions to Partial Differential Equations
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

To introduce the basic concepts in finite element which forms the basis for all applications of scientific calculation, applied mathematics. The emphasis is on applications. The basic teaching goal is making student understand variational principle, finite element technique and how to use software solving pde problem The basic aim is to teach students to handle the basic theory and fundamental methods and technologies for finite element, to train students' scientific thinking and problem analysis and problem solving skills, and to lay a good foundation for the subsequent courses.

本课程介绍有限元的最基本概念，它们是科学计算与应用数学的基石。本课程也为进一步学习其他计算过程， 打下良好的基础。本课程还重点介绍了一些基本的概率方法和技巧， 且强调它们的实际应用解释。基本教学目标是掌握变分原理，有限元空间选取，解得唯一性与收敛性判断和应用常用软件解 PDE 方法。基本目标是教会学生处理有限元问题基本理论和基本方法技巧,培养学生的科学思维和分析解决问题的能力,并为后续课程打下良好的基础。

16. 预达学习成果 Learning Outcomes

After completing this course, students should master the basic concepts and methods in finite element. After learning this course, the students should be familiar with a range of finite element methods and techniques for solving basic pde function. In particular, after learning this course, the students should be able

1. to master the basic knowledge, deeply to understand and master the nature of the definitions, theorems, variational principle, finite element technique. After the study, the students should be able not only to remember the above concepts and the finite element theory, but also deeply to understand how to use finite element method slove real problem ;
2. to master the basic variational skills and be able to do it correctly;
3. to train the ability of thinking and to enhance the ability to do research ;
4. to improve the ability of solving practical problems. After learning this course, students should be able to use the learned knowledge to establish a suitable model and to solve the life related mathematical problems.

完成本课程后,学生应掌握有限元的基本概念和方法，熟悉各种有限元方法和技巧，并能解决现实生活提出的问题，了解其特性。特别是,在学习本课程后,学生应该能够

1.掌握基本知识,深入理解和掌握定义,定理,原则和公式本质。学习后,学生应该能够不仅记住概念，也要学会基本变分原理，有限元的技巧， 同时也能深刻理解如何利用有限元解决问题。

2.掌握基本技能, 并能正确的进行变分

3.培养思维能力，提高对事物的观察，比较,和概括的能力。

4.提高解决实际问题的能力。学习本课程后,学生应该能够使用学到的知识对实际问题建立合理模型， 从而解决相关的数学问题。

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.)

Part I. The Basic Framework for Stationary Problems（10H）:
1. Some model PDEs;
2. The weak form of a BVP;
3. The Galerkin method;
4. Piecewise polynomials and the finite element method;
5. Convergence of the finite element method;
Part II. Data Structures and Implementation（14H）:
6. The mesh data structure;
7. Programming the finite element method: Linear Lagrange triangles;
8. Lagrange triangles of arbitrary degree;
9. The finite element method for general BVPs;
Part III. Solving the Finite Element Equations（16H）:
10. Direct solution of sparse linear systems;
11. Iterative methods: Conjugate gradients;
12. The classical stationary iterations;
13. The multigrid method;
Part IV. Adaptive Methods（6H）:
14. Adaptive mesh generation;
15. Error estimators and indicators; Bibliography; Index.

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

Textbook：
Understanding and Implementing the Finite Element Method, SIAM press, 2010, by Mark S. Gockenbach

References
- 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.

- 偏微分方程数值解讲义，李治平 编著，北京大学出版社, 2010.

- 偏微分方程数值解法，陆金甫，关治 编著，清华大学出版社, 2004.

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

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

- R. J. LeVeque, Numerical Methods for Conservation Laws, Birkhauser-Verlag, 1990.

- 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 | 评估时间 | 占考试总成绩百分比 | 违纪处罚 | 备注

Type of Assessment	Time	% of final score	Penalty	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		10%		
期中考试 Mid-Term Test		30%		
期末考试 Final Exam		50%		
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