科学计算选讲课程教学大纲

Course Outline

<table>
<tr><td colspan="6">课程基本信息（Course Information）</td></tr>
<tr><td>课程代码
（Course Code）</td><td>MA430</td><td>*学时
（Credit Hours）</td><td>32</td><td>*学分
（Credits）</td><td>2</td></tr>
<tr><td rowspan="2">*课程名称
（Course Title）</td><td colspan="5">（中文）科学计算选讲</td></tr>
<tr><td colspan="5">（英文）Topics in Scientific Computing</td></tr>
<tr><td>*课程性质
（Course Type）</td><td colspan="5">选修课</td></tr>
<tr><td>授课对象
（Target Audience）</td><td colspan="5"></td></tr>
<tr><td>*授课语言
(Language of Instruction)</td><td colspan="5">中英文双语</td></tr>
<tr><td>*开课院系
（School）</td><td colspan="5">数学科学学院</td></tr>
<tr><td>先修课程
（Prerequisite）</td><td colspan="5"></td></tr>
<tr><td>授课教师
（Instructor）</td><td colspan="2"></td><td>课程网址
(Course Webpage)</td><td colspan="2"></td></tr>
<tr><td>*课程简介（Description）</td><td colspan="5">科学计算选讲为数学科学学院和致远学院高年级本科生的选修课。学生应先修计算方法和数值线性代数相关的课程。
科学计算选讲课程涵盖双曲、抛物和椭圆类偏微分方程的数值方法。课程讨论时间依赖问题的数值方法、稳定性和收敛性分析、截断误差分析；学习变系数和非线性问题的数值方法和适定性分析；针对椭圆方程，课程学习界面和边界条件的物理意义、有限差分和有限元离散，还讨论了边界积分方法和快速算法的相关内容，如奇异积分的处理、镜像法和快速的 Ewald 求和算法。
本课程以课堂教学为主，学生课后通过计算机编程的撰写实验报告形式完成大作业。通过本课程学习，学生进一步学习各种类型偏微分方程的数值方法和理论分析方法，并锻炼编程实践的能力。</td></tr>
<tr><td>*课程简介（Description）</td><td colspan="5">The Topics in Scientific Computing is a course for senior undergraduate from School of Mathematical Sciences and Zhiyuan College. Students should learn computational methods and numerical linear algebra before taking this course.
The course covers numerical methods for hyperbolic, parabolic and elliptic partial differential equations. It discusses numerical methods for time-dependent problems, stability and convergence analysis, truncation error analysis; it also describes numerical methods and well-posedness for problems with variable coefficients and nonlinearity; for elliptic equations, the course discusses physical significance of interface and boundary conditions, finite difference and finite element methods, boundary integral methods and fast algorithms such as methods for</td></tr>
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<tr><td></td><td>singular integrals, methods of image charges, and Ewald summations .
The course is taught in class. Students should finish projects after classes by writing computer programs and experimental reports. By the course, students further learn numerical analysis of partial differential equations of different types, and receive training in computer programming.</td></tr>
<tr><td colspan="2">课程教学大纲（course syllabus）</td></tr>
<tr><td>*学习目标(Learning Outcomes)</td><td>1．学会基本偏微分方程的计算和数值分析方法
2．学会编写计算机程序验证算法</td></tr>
<tr><td>*教学内容、进度安排及要求
(Class Schedule &Requirements)</td><td>
<table>
<tr><th>教学内容</th><th>学时</th><th>教学方式</th><th>作业及要求</th><th>基本要求</th><th>考查方式</th></tr>
<tr><td>Time-dependent equations: Fourier series, first-order wave equations, convergence and stability, truncation error, heat equation, explicit and implicit methods</td><td>8</td><td>教学</td><td>大作业 1</td><td>认真听讲，独立完成作业</td><td></td></tr>
<tr><td>Well-posed problems: Well-posedness, scalar differential equations, systems of differential equations, problems of variable coefficients, nonlinear problems</td><td>6</td><td>教学</td><td>大作业 1</td><td>认真听讲，独立完成作业</td><td></td></tr>
<tr><td>Stability and convergence: Stability and convergence for problems of constant coefficients, energy method for variable coefficients, splitting methods, nonlinear problems</td><td>6</td><td>教学</td><td>大作业 2</td><td>认真听讲，独立完成作业</td><td></td></tr>
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	Elliptic equations: Interface and boundary conditions, electrostatics, finite difference, finite element, sparse matrix, boundary element, singular integrals	6	教学	大作业 3	认真听讲，独立完成作业	
	Fast algorithms: Method of image charges, Ewald sums, particle-Mesh Ewald, fast multipole	6	教学	大作业 3	认真听讲，独立完成作业	
*考核方式 (Grading)	课程大作业 70%+课堂表现 30%					
*教材或参考资料 (Textbooks & Other Materials)	B. Gustafsson, H.O. Kreiss and J. Oliger, Time Dependent Problems and Difference Methods, Wiley, 1995. K.W. Morton & D.F. Mayers, Numerical Solution of Partial Differential Equations, Cambridge 2005. The Numerical Solution of Integral Equations of the Second Kind, Cambridge 1997. Wei Cai, Computational Methods for Electromagnetic Phenomena, Cambridge, 2013 J. D. Jackson, Classical Electrodynamics, Wiley/Higher Education Press, 2001 Allen and Tildesley, Computer Simulation of Liquids, Oxford, 1987					
其它 （More）						
备注 （Notes）						

备注说明：

1．带*内容为必填项。

2．课程简介字数为 300-500 字；课程大纲以表述清楚教学安排为宜，字数不限。