课程大纲
COURSE SYLLABUS

1.	**课程代码/名称** **Course Code/Title**	MAT8028 科学计算 MAT8028 Scientific Computing
2.	**课程性质** **Compulsory/Elective**	专业必修课 **Compulsory**
3.	**课程学分/学时** **Course Credit/Hours**	3/48
4.	**授课语言** **Teaching Language**	英文 English
5.	**授课教师** **Instructor(s)**	Alexander Kurganov, 讲席教授 Alexander Kurganov, Chair Professor
6.	**是否面向本科生开放** **Open to undergraduates or not**	是 Yes
7.	**先修要求** **Pre-requisites**	（如面向本科生开放，请注明区分内容。 If the course is open to undergraduates, please indicate the difference.） MA101b& 102b 高等数学 I&II，MA103b 线性代数 I，MA201a 常微分方程 a MA101b& 102b Calculus I&II, MA103b Linear Algebra I, MA201a Ordinary Differential Equations a

8. **教学目标**
Course Objectives

（如面向本科生开放，请注明区分内容。 If the course is open to undergraduates, please indicate the difference.）

教给学生基本的和现代的科学计算方法，提供对基本问题的彻底解决方法，以及数值方法的适用性和优缺点。

To teach the students both basic and modern techniques in scientific computing as well as to provide an in-depth treatment of fundamental issues and methods and the reasons behind success and failure of numerical methods and software.

9. **教学方法**
Teaching Methods

（如面向本科生开放，请注明区分内容。 If the course is open to undergraduates, please indicate the difference.）

理论与编程并重，并辅以前沿课题应用

Teaching in both theory and programming, including applications to cutting edge problems

10. **教学内容**
Course Contents
（如面向本科生开放，请注明区分内容。 If the course is open to undergraduates, please indicate the difference.）

	Section 1	**Principles of Numerical Mathematics**

	a. Well-posedness b. Stability and convergence of numerical methods c. A-priori and a-posteriori analysis d. Sources of error in computational models e. Machine representation of numbers
Section 2	**Polynomial Interpolation** a. Lagrange polynomial interpolation and their Newton forms b. Hermite polynomial interpolation c. Piecewise polynomial interpolation d. Approximation by splines, B-splines
Section 3	**Numerical Differentiation and Integration** a. Finite-difference approximations of derivatives b. Interpolatory quadratures c. Newton-Cote formulae d. Romberg integration e. Automatic integration f. Singular integrals g. Multidimensional numerical integration
Section 4	**Solutions of Linear Systems of Equations** a. Linear Operators on Normed Spaces, vector and matrix norms b. Direct methods - LU factorization; Cholesky factorization c. Iterative methods - Jacobi, Gauss-Seidel, SOR, Conjugate Gradient d. Conditioning and condition number e. Multi-grid methods f. Domain decomposition techniques
Section 5	**Eigenvalue Problem** a. Power method b. Householder's reflection, Given's rotation, and QR factorization c. The singular value decomposition (SVD)

		d. Lanczos' method
	Section 6	**Least Squares Problems and Orthogonal Polynomials in Approximation Theory** a. Least-squares approximation and normal equations b. Orthogonal polynomials c. Gaussian quadrature with orthogonal polynomials d. Rational function approximation e. Approximation by Fourier trigonometric polynomials f. Fast Fourier transforms g. Gaussian quadrature over unbounded intervals h. Approximation of function derivatives (classical finite differences, compact finite differences, pseudo-spectral derivative)
	Section 7	**Solutions of Nonlinear Systems of Equations** a. Fixed-point iterations (the banach fixed-point theorem and convergence results) b. Newton's methods and quasi-Newton's methods c. Steepest descent methods d. Stopping criteria e. Post-processing techniques for iterative methods
11.	**课程考核** **Course Assessment**	
	（①考核形式 Form of examination；②.分数构成 grading policy；③如面向本科生开放，请注明区分内容。If the course is open to undergraduates, please indicate the difference.） 作业（30%）+期中（30%）+期末考试（40%） Assignment (30%) + Mid-term exam(30%) + final-term exam (40%)	
12.	**教材及其它参考资料** **Textbook and Supplementary Readings**	
	参考教材 Textbook： 1. Numerical Mathematics, 2nd Edition, by Alfio Quarteroni, Riccardo Sacco, and Fausto Saleri, Springer, 2007 2、An Introduction to Numerical Analysis, 2nd edition, by Kendall E. Atkinson, John Wiley & Sons,	

1989

3、A First Course in Numerical Methodss, by Uri M. Ascher and Chen Greif, SIAM, 2011

4、A Theoretical Introduction to Numerical Analysis, by Victor S. Ryaben’ kii and Semyon V. Tsynkov, Chapman and Hall/CRC, 2006