

## The syllabus of Scientific Computing

| 课程基本信息 (Course Information)        |  |                      |                |                 |   |
|------------------------------------|--|----------------------|----------------|-----------------|---|
| 课程代码<br>(Course Code)              | MA233  | 学时<br>(Credit Hours) | 64             | 学分<br>(Credits) | 4 |
| 课程名称<br>(Course Name)              | (中文) 科学计算  |                      |                |                 |   |
|                                    | (英文) Scientific Computing  |                      |                |                 |   |
| 课程属性<br>(Course Type)              |  |                      |                |                 |   |
| 开课院系<br>(School)                   | Department of Mathematics  |                      | 开课学期<br>(Term) | Fall            |   |
| 先修课程<br>(Prerequisite course)      | Calculus, linear algebra   |                      |                |                 |   |
| 授课教师<br>(Instructors)              | Xiaoqun Zhang  |                      |                |                 |   |
| 课程简介<br>(Description)<br>300-500 字 | <p>The course is an introduction to numerical methods with emphasis on algorithms, analysis of algorithms, and computer implementation issues. We will focus on the topics such as solution of nonlinear equations; interpolation and curve fitting; numerical differentiation and integration; solving ordinary differential equation; solving linear systems by direct methods and iterative methods; matrices eigenvalues and eigenvectors.</p> <p>The class will combine both lectures and computer lab sessions in order to not only introduce the basic concepts and theoretical foundations but also improve computing skills. Throughout the course, both theoretical and computation problems will be assigned every two weeks. Finally there will be two written exams: midterm and final exam. At the end of course, letter grade will be assigned based on written and computational homework, classroom performance, research project report and the two written exams.</p> |                      |                |                 |   |
| 课程教学大纲 (course syllabus)           |  |                      |                |                 |   |

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| <p>*学习目标<br/>(Learning Outcomes)</p>                         | <p>After completing the course, students should:</p> <ol style="list-style-type: none"> <li>1. learn to identify the types of problems that require numerical techniques for their solution and see examples of the error propagation that can occur when numerical methods are applied.</li> <li>2. learn typical techniques for estimating error bounds for the approximations.</li> <li>3. Implementation of numerical algorithms</li> </ol> |                            |   |  |  |                                    |
| <p>*教学内容、进度安排及要求<br/>(Class Schedule &amp; Requirements)</p> | <p>教学内容<br/>topics</p>  | <p>学时<br/>Credit hours</p> | <p>教学方式<br/>Teaching methodology</p>                          | <p>作业及要求<br/>tasks</p>   | <p>基本要求<br/>Intended learning outcomes</p> | <p>考查方式<br/>Assessment methods</p> |
| <p>Mathematical and programming preliminaries</p>            | <p>4</p>  | <p>Lecture and lab</p>     | <p>2 computational exercises</p>                              | <p>Learn basis Matlab command and complete simple programming task</p>   | <p>homework</p>                            |                                    |
| <p>Solution of nonlinear equations: (6 lecture hours)</p>    | <p>6</p>  | <p>Lecture</p>             | <p>10 theoretical exercises and 2 programming assignments</p> | <p>Learn how to solve nonlinear equation of a single variable with different methods and their error analysis</p>              | <p>homework</p>                            |                                    |
| <p>Interpolation and approximation (12 lecture hours)</p>    | <p>12</p>   | <p>Lecture and lab</p>     | <p>10 theoretical exercises and 2 programming assignments</p> | <p>Polynomial Interpolation: Lagrange Interpolation Existence and uniqueness. Newton Divided differences. Error estimates.</p> | <p>homework</p>                            |                                    |
| <p>Numerical differentiation and integration.</p>            | <p>12</p>   | <p>Lecture and lab</p>     | <p>10 theoretical exercises and 2 programming</p>             | <p>Numerical differentiation formula and error</p>   | <p>homework</p>                            |                                    |

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|  |  |    |                    | assignments  | estimates:<br>Numerical<br>integration<br>formula and<br>error<br>estimates:<br>Newton-Cotes<br>formulas.<br>Romberg<br>formula,<br>Gauss<br>quadrature |          |
|  | Initial-value<br>problems for<br>ordinary<br>differential<br>equations   | 4  | lecture            | 3 theoretical<br>exercises and<br>2<br>programming<br>assignments  | Elementary<br>theory and<br>Euler's method.<br>High-order<br>Taylor methods<br>and<br>Runge-Kutta<br>method.  | homework |
|  | System of<br>Linear<br>Equations:  | 16 | Lecture and<br>lab | 10 theoretical<br>exercises and<br>2<br>programming<br>assignments | Direct<br>method,<br>Matrix<br>factorization;<br>Iterative<br>method  | homework |
|  | Approximation<br>theory  | 2  | lecture            | 3 theoretical<br>exercises and<br>2<br>programming<br>assignments  | Discrete and<br>continuous<br>method  | homework |
|  | Approximating<br>Eigenvalues   | 2  | lecture            | 3 theoretical<br>exercises and<br>2<br>programming<br>assignments  | Power method  | homework |
| 考核方式<br>(Assessment<br>methods and<br>Grading) | <ul style="list-style-type: none"> <li>➤ Written homework and classroom performance: 10%.</li> <li>➤ Computational homework: 15%</li> <li>➤ Midterm: 25%</li> <li>➤ Final written exam: 50%</li> </ul> |    |                    |  |   |          |
| 教材或参考资<br>料<br>(Textbooks &                    | <ul style="list-style-type: none"> <li>➤ Numerical Analysis (7th) by R. Burden and J. Faires.</li> <li>➤ W. Cheney, D. Kincaid, Numerical mathematics and computations, 5th</li> </ul>                 |    |                    |  |   |          |

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| Other Reading Materials) | Ed., Thomson, Brooks/Cole.<br><br>➤ Applied Numerical Methods Using MATLAB, Won Y. Yang, Wenwu Cao, Tae-Sang Chung, John Morris, Wiley<br><br>➤ Numerical Computing with MATLAB by Cleve Moler (available online) |
| 备注<br>(Notes)            | (英文)  |