

## 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 <b>Course Title</b>	数值模拟方法基础 Introduction to Numerical Simulation Methods
2.	授课院系 <b>Originating Department</b>	环境科学与工程学院 School of Environmental Science and Engineering
3.	课程编号 <b>Course Code</b>	ESE407
4.	课程学分 <b>Credit Value</b>	3
5.	课程类别 <b>Course Type</b>	专业选修课 Major Elective Courses
6.	授课学期 <b>Semester</b>	秋季 Fall
7.	授课语言 <b>Teaching Language</b>	中文 Chinese
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） <b>Instructor(s), Affiliation &amp; Contact (For team teaching, please list all instructors)</b>	李海龙，环境科学与工程学院，185 8905 7378 Hailong Li, School of Environmental Science and Engineering, 185 8905 7378
9.	实验员/助教、所属学系、联系方式 <b>Tutor/TA(s), Contact</b>	待公布 To be announced
10.	选课人数限额(可不填) <b>Maximum Enrolment (Optional)</b>	

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	34	4	0	10 编程和实例数值计算 10 programming and numerical simulation examples	48
12. 先修课程、其它学习要求 Pre-requisites or Other Academic Requirements	先选课 Co-requisites: 高等数学 Calculus, 线性代数 Linear Algebra, 常微分方程 B Ordinary Differential Equations B, 或数学物理方程 or Equations of Mathematical Physics				
13. 后续课程、其它学习规划 Courses for which this course is a pre-requisite	无 N/A				
14. 其它要求修读本课程的学系 Cross-listing Dept.	无 N/A				

### 教学大纲及教学日历 SYLLABUS

#### 15. 教学目标 Course Objectives

本课程将力图使学生掌握反应扩散方程所描述的各种常见物理过程（热传导、流体流动、多孔介质中的地下水流动以及溶质运移等），常用的离散化方法，包括线性三角形单元有限元法、有限差分法、控制容积法等，非线性的处理，离散后的线性代数方程组的基本性质和结构以及常用的直接解法和迭代解法，并用 Fortran 语言对其中的 LU 直接解法和常用迭代解法进行编程实践，最后以 MARUN 程序为例，介绍地下水流动和溶质运移典型实例。

This course is designed to let students to understand common physical phenomena represented by reaction-convection equations of parabolic type, such as heat conduction, fluid flow, groundwater flow and solute transport in porous media. Some common discretization methods (including finite element method with triangle element, finite difference method, and finite volume method), treatment to nonlinearity, direct and iterative methods for solving system of linear equations will be introduced in this course. In particular, this course will show students how to code up these methods in Fortran like LU decomposition and some common iterative methods for solving linear algebraic systems. Furthermore, typical examples of groundwater flow and solute transport realized by the numerical code MARUN will be demonstrated at the end of this course.

#### 16. 预达学习成果 Learning Outcomes

通过本课程学习，学生将掌握数值模拟的基本原理，了解常见方法和常见商业软件，为在以后的学习和工作中进一步利用各种先进数值模拟方法定量刻画各种复杂的流体流动及其相伴的运移反应过程打下坚实而宽泛的基础。

Having taken this course, students will understand basic principles of numerical simulations, and learn some common methods and commercial software for numerical simulations. This course will build a broad and solid foundation for future study and work for further using advanced numerical methods to solve various complex problems in engineering and environments related to fluid flows, solute transport and reactions.

#### 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.)

序号 NO.	内容 Content	学时 Hours				学时汇总 Sub- total
		理论 Theoretic Teaching	实验 Experiment	实践 Exercise	上机操作 Computer Operation	
1	绪言 Introduction	2	0	0	0	2
2	物理现象的数学描述 Mathematical description of physical phenomena	4	0	0	0	4
3	离散化方法 Discretization methods	6	0	0	0	6
4	热传导方程（地下渗流方程） Heat conduction equation (Groundwater flow equation)	6	0	0	0	6
5	对流与扩散（地下水溶质运移）方程 Convection and diffusion (solute transport in groundwater) equation	6	0	0	0	6
6	流场计算中的若干问题 Several problems in flow field simulations	4	0	0	0	4
7	习题解答、辅导和讨论 Exercise discussion	0	0	4	0	4
8	MARUN 数值模拟程序简介 Introduction to MARUN simulation code	6	0	0	2	8
9	编程和实例数值计算 Programming examples	0	0	0	8	8
总计 Total		34	0	4	10	48

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

教材/Textbook):

S. V. Patankar 帕坦卡著, 张政译, 传热与流体流动的数值计算, 科学出版社, 第1版, 1984.书号 15031.603。

S.V.Patankar, Numerical Heat Transfer and Fluid Flow (1980), ISBN 0-89116-522-3

参考资料/Supplementary Readings:

1. Zheng, C., and G.D. Bennett, 2002, Applied Contaminant Transport Modeling, 2nd edition, John Wiley & Sons, New York, USA, ISBN 0-471-38477-1.

2.李海龙, 2007, 研究生教材《地下水污染与防治》第十二章“污染物运移数值模拟与预测”, 王焰新 编著, 高等教育出版社, 2007。

Li, Hailong, 2007. Numerical model and prediction for groundwater solute transport. Chapter 12 of "Groundwater contamination: prevention and remediation", Text book for university graduates, Edited by Y.X. Wang, Higher education Press, P. R. China (in Chinese).

**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	全程/Full time	10%		
课堂表现 Class Performance	全程/Full time	5%		
小测验 Quiz	无/None			
课程项目 Projects				
平时作业 Assignments	全程/Full time	5%		
期中考试 Mid-Term Test	无/None			
期末考试 Final Exam	2 小时/Two hours	40%		
期末报告 Final Presentation	一周/One week	40%		
其它（可根据需要 改写以上评估方式） Others (The above may be modified as necessary)	有可能改变期末考试和期末报告所占比例或者取消其中一项评估。 The weights of final exam grade and final project grade may be changed depending on the situation.			

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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