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	计算流体力学 Computational Fluid Dynamics
2.	授课院系 Originating Department	力学与航空航天工程系 Department of Mechanics and Aerospace Engineering
3.	课程编号 Course Code	MAE403
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	秋季 Fall
7.	授课语言 Teaching Language	英文 English
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）	王连平 讲座教授，力学与航空航天工程系 wanglp@sustech.edu.cn Dr. Lian-Ping Wang, Chair Professor, Department of Mechanics and Aerospace Engineering wanglp@sustech.edu.cn
9.	实验员/助教、所属学系、联系方式 Tutor/TA(s), Contact	待公布 To be announced
10.	选课人数限额(可不填) Maximum Enrolment（Optional）	

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**	流体力学（MAE303） 或 工程流体力学（MAE207） Fluid Mechanics(MAE303) OR Engineering Fluid Mechanics (MAE207)
13.	后续课程、其它学习规划 **Courses for which this course is a pre-requisite**	无 NA
14.	其它要求修读本课程的学系 **Cross-listing Dept.**	无 NA

教学大纲及教学日历 SYLLABUS

15. 教学目标 **Course Objectives**

Direct numerical simulations of complex flows are now viewed as a third pillar for scientific discovery, due to high-speed computers and advanced algorithms. In many fields including multiphase flows, direct numerical simulation provides a rigorous research tool by solving first-principle governing equations. High-performance fluid-flow simulation is an area of rapid growth and is interdisciplinary covering physics of fluid flows, algorithms, and parallel implementation, etc. This course is designed for students to quickly learn and compare various simulation methods and to obtain some hands-on experience.

16. 预达学习成果 **Learning Outcomes**

Overview of computational methods for viscous flows including finite difference, finite-volume, finite element, spectral, and mesoscopic Boltzmann-equation based methods. Treatment of fixed and moving solid-fluid and fluid-fluid boundaries. Example codes to study physical and numerical issues such as numerical convergence, accuracy, and stability.

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.)

Course structure: The course will meet with the usual lecture format. Homework sets will be assigned (approximately weekly), graded, and returned. During the later part of the course a computer project will be assigned which will be due at the end of the course. The results will be presented to the class during the final weeks as well as in a final written report submitted to the instructor. A midterm exam will be given in the 10th week (4/22 – 4/24). There will be no final exam.

Topics to be covered:

Section 1 (3 credit hours)	Introduction to computational fluid dynamics Introduction to Fortran Access MAE department cluster
Section 2 (3 credit hours)	Overview of fluid mechanics governing equations and boundary conditions Basic Unix commands and editor
Section 3 (3 credit hours)	Overview of partial differential equations Taylor expansions, truncation error Demonstration of NCL
Section 4 (3 credit hours)	Finite difference method Finite-Volume method

	Time integration methods Von-Neumann stability analysis
Section 5 (4 credit hours)	Numerical methods for 1D transient diffusion problem Time integration methods Von-Neumann stability analysis Solving a tridiagonal system of equations
Section 6 (4 credit hours)	Numerical methods for Laplace's and Poisson equations Direct methods Iterative methods Multigrid method
Section 7 (4 credit hours)	Numerical methods for Burgers' equation Upwind scheme and numerical viscosity The Lax-Wendroff scheme Flux limiters, ENO, WENO
Section 8 (4 credit hours)	Finite-difference method for 2D Navier-Stokes equations The staggered grid layout Boundary conditions 2D cavity flow code
Section 9 (3 credit hours)	Assigning the computer project Grid generation
Section 10 (2 credit hours)	Midterm exam
Section 11 (3 credit hours)	Immersed boundary method Regularized Delta function Direct forcing method
Section 12 (3 credit hours)	Kinetic description of fluid flow: the Boltzmann equation Hermite expansion Chapmann-Enskog analysis
Section 13 (3 credit hours)	Introduction to lattice Boltzmann method Collision models Standard 2D and 3D lattices
Section 14 (2 credit hours)	First project presentation I
Section 15	Treatment of no-slip boundary conditions in LBM

(2 credit hours)	Example codes of LBM
Section 16 (2 credit hours)	Final Project Presentation II

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

J.H. Ferziger and M. Peric, Computational Methods for Fluid Dynamics, 3rd edition, Springer, 2002;

R.H. Pletcher, J.C. Tannehill, and D.A. Anderson, Computational Fluid Mechanics and Heat Transfer, 3nd ed., CRC Press, 2013.

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**		10		
课堂表现 **Class Performance**				
小测验 **Quiz**				
课程项目 **Projects**		10		
平时作业 **Assignments**		30		
期中考试 **Mid-Term Test**		20		
期末考试 **Final Exam**		30		
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

力学与航空航天工程系教学指导委员会 The commission of teaching instruction in department of mechanics and aerospace engineering