

课程大纲

COURSE SYLLABUS

1.	课程代码/名称 Course Code/Title	MAT7087 计算流体力学与深度学习 MAT7087 Computational Fluid Dynamics and Deep Learning
2.	课程性质 Compulsory/Elective	选修 Elective
3.	课程学分/学时 Course Credit/Hours	3/48
4.	授课语言 Teaching Language	中文 Chinese
5.	授课教师 Instructor(s)	吴开亮副教授 Kailiang Wu, Associate 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	<p>(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.)</p> <p>本科生需先修以下课程 (Pre-requisites for undergraduates):</p> <p>MA305 数值分析</p> <p>MA305 Numerical Analysis</p>
8.	教学目标 Course Objectives	<p>(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.)</p> <p>掌握流体力学方程的基本数值方法、深度学习的基本知识、数据驱动的深度学习方法及其在计算流体力学中的应用。</p> <p>Master some fundamental numerical methods for fluid dynamic equations, some basic knowledge of machine learning, data-driven deep learning methods and their applications in computational fluid dynamics.</p>
9.	教学方法 Teaching Methods	<p>(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.)</p> <p>专题性质授课, 从基本知识和经典方法开始介绍, 并辅以最新方法和前沿课题应用</p> <p>Teaching in topics, from the basic knowledge and classical methods to modern methods and frontier problems</p>
10.	教学内容 Course Contents	<p>(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.)</p>
	Section 1	计算流体力学简介 (2 学时) Introduction to Computational Fluid Dynamics (2-hour lectures)
	Section 2	双曲型守恒律 (2 学时) Hyperbolic Conservation Laws (2-hour lectures)

Section 3	有限差分法（3 学时） Finite Difference Methods (3-hour lectures)
Section 4	黎曼问题和有限体积法（5 学时） Riemann Problems and Finite Volume Methods (5-hour lectures)
Section 5	高分辨率格式与限制器（3 学时） High-Resolution Schemes and Limiters (3-hour lectures)
Section 6	ENO 和 WENO 格式（3 学时） ENO and WENO Schemes (3-hour lectures)
Section 7	间断 Galerkin 方法（4 学时） Discontinuous Galerkin Methods (4-hour lectures)
Section 8	高阶时间离散（3 学时） High-Order Time Discretization (3-hour lectures)
Section 9	机器学习简介（2 学时） Introduction to Machine Learning (2-hour lectures)
Section 10	深度神经网络（4 学时） Deep Neural Network (4-hour lectures)
Section 11	深度学习与数据驱动方法（4 学时） Machine Learning and Data-Driven Methods (4-hour lectures)
Section 12	计算流体力学中的深度学习方法（4 学时） Deep Learning Methods in Computational Fluid Dynamics (4-hour lectures)
Section 13	物理信息神经网络与数据驱动建模（3 学时） Physics-Informed Neural Network and Data-Driven Modeling (3-hour lectures)
Section 14	多维流体力学系统及其方法（6 学时） Multidimensional Fluid Dynamic Systems and Methods (6-hour lectures)
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（50%）+期末考试（50%） Assignment (50%) + Final Exam (50%)
12. 教材及其它参考资料 Textbook and Supplementary Readings	
	1. Eleuterio F. Toro, Riemann Solvers and Numerical Methods for Fluid Dynamics: A Practical Introduction. Springer Science & Business Media, 2013. 2. Jan S. Hesthaven, Numerical Methods for Conservation Laws: From Analysis to Algorithms, Society for Industrial and Applied Mathematics, 2017. 3. Ian Goodfellow, Yoshua Bengio, and Aaron Courville, Deep Learning, The MIT Press, Cambridge, MA, USA, 2016. 4. Ke-Lin Du and Madisetti NS Swamy, Neural Networks and Statistical Learning, Springer Science &

Business Media, 2013.

5. A. Chorin and J. Marsden, A Mathematical Introduction to Fluid Mechanics, Springer-Verlag, 2000.
6. R. J. LeVeque, Finite Volume Methods for Hyperbolic Problems, Cambridge University Press, 2002.