课程大纲
COURSE SYLLABUS

1.	**课程代码/名称** **Course Code/Title**	**MAE5004 高等流体力学 （Advanced Fluid Mechanics）**
2.	**课程性质** **Compulsory/Elective**	研究生核心课程 Graduate core course
3.	**课程学分/学时** **Course Credit/Hours**	3/48
4.	**授课语言** **Teaching Language**	中英双语 Bilingual
5.	**授课教师** **Instructor(s)**	唐欣 助理教授 Xin TANG, Assistant Professor
6.	**是否面向本科生开放** **Open to undergraduates or not**	否
7.	**先修要求** **Pre-requisites**	本科生流体力学或相关课程，高等数学，线性代数，微分方程，或相关课程 Fundamental courses relevant to fluid mechanics, calculus, linear algebra, differential equation.

8. 教学目标
Course Objectives

本课程的目的是使学生加深对流体力学的理性认识，了解流体力学的应用理论、应用领域及流体力学的研究发展情况，掌握流体力学中的思维特点和综合的分析方法，为从事相关的科学研究打下坚实的理论基础。
The course aims to deepen the understanding of fluid mechanics and provide students with fundamental theories, applications, and relevant developments. After the course, students should understand the typical approaches used for the description, analysis, and control of fluid flows, thus laying a solid theoretical foundation for their future studies on fluid flows.

9. 教学方法
Teaching Methods

本课程采用课堂板书讲授为主，少量多媒体教学为辅。
Derivation and explanation aided with multimedia demonstration.

10. 教学内容
Course Contents

Section 1	• Introduction of Fluid Mechanics: definition of fluid, scope of fluid mechanics, continuum assumption, properties of fluid. • 流体力学基本概念：流体定义，学科范畴，连续介质假设，流体性质。 • 教学内容包括：张量初步、流体力学基本概念及运动描述、流体力学基本方程组，量纲分析、势流、粘性流体、湍流等。
Section 2	• Tensor & Field Theory: index notation, tensor operation, definition of field, multi-variable calculus, divergence integral theorem, curl integral theorem. • 张量和场论：张量表示法，基本运算，场的定义，多元微积分，散度积分定理，旋度积分定理。
Section 3	• Fluid Kinematics: Lagrangian & Eulerian description, material derivative, flow visualization, velocity decomposition. • 流体运动学：拉格朗日方法和欧拉方法，物质导数，流动可视化，速度分解定理。
Section 4	• Conservation Law: Reynolds transport theorem, conservation of mass, conservation of momentum, constitutive equation, coordinate transformation. • 流体力学基本方程组：雷诺输运定理，连续性方程，运动方程，本构方程，坐标系变换。

	Section 5	• Bernoulli Equation: derivation of Bernoulli equation, extended Bernoulli equation, Venturi effect, application of Bernoulli equation. • 伯努利方程：伯努利方程推导，伯努利方程扩展，文丘里效应，伯努利方程的应用。
	Section 6	• Fluid Statics: Euler equation, linear fluid motion with constant acceleration, circular fluid motion with constant velocity. • 流体静力学：欧拉静平衡方程，流体的匀加速直线运动，流体的匀速旋转运动。
	Section 7	• Dimensional Analysis and Similarity: definition of dimension, Buckingham's Pi theorem, Rayleigh method, physical similarity, nondimensionalization of governing equation. • 量纲分析和相似原理：量纲定义，白金汉 Pi 定理，瑞利法，物理相似，方程的无量纲化。
	Section 8	• Vortex Dynamics: fundamental definition, vorticity transport equation, Kelvin's theorem, Helmholtz's theorem, velocity induced by vorticity. • 流体的涡旋运动：涡旋基本定义，涡量输运方程，开尔文定理，涡线及涡管强度保持定理，涡量场所诱导的速度场。
	Section 9	• Ideal Fluid: planar potential flow, fundamental solutions, superposition of solutions, conformal transformation, lift theorem. • 不可压缩无粘无旋运动：平面势流，势流基本解，基本解的叠加，保角变换，翼型升力理论。
	Section 10	• Laminar Flow: Couette flow and Poiseuille flow. • 不可压缩粘性层流运动：库埃特流和泊肃叶流。
	Section 11	• Boundary Layer Theory: governing equation of boundary layer, Blasius' solutions, Stokes flow. • 边界层理论：边界层控制方程，布拉修斯解，斯托克斯流。
11.	**课程考核** **Course Assessment**	
	1. 考试 Exam 2. 分数构成 Grading **出勤 Attendance 5%+报告 Presentation 10%，作业 Assignment 15%+期中考试 Mid-Term Exam25%+期末考试 Final Exam 45%**	
12.	**教材及其它参考资料** **Textbook and Supplementary Readings**	
	Textbook: P.K. Kundu, I.M.Cohen, D.R. Dowling, Fluid Mechanics, 6th Edition Reference: G. K. Batchelor, An Introduction to Fluid Dynamics 吴望一，流体力学	