课程大纲
COURSE SYLLABUS

1.	**课程代码/名称** **Course Code/Title**	**Computational Geodynamics 计算地球动力学**
2.	**课程性质** **Compulsory/Elective**	Major Elective 专业选修
3.	**课程学分/学时** **Course Credit/Hours**	2 / 32
4.	**授课语言** **Teaching Language**	English 英语
5.	**授课教师** **Instructor(s)**	Jason Phipps Morgan
6.	**是否面向本科生开放** **Open to undergraduates or not**	No 否
7.	**先修要求** **Pre-requisites**	（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.） None 没有先修课程要求

8. 教学目标
Course Objectives

（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.）

这门课将面向学生介绍计算地球动力学的艺术 – 创建支配热传输和流体流动的微分方程并探索其数值解和可视化。 课程将引导每个学生独立编写热液流动和热传输程序。 本课程的编程语言为 MATLAB，教学语言主要为英语。 本课程不需要先修课程，但要求学生愿意学习使用 MATLAB。 课程涉及的主题包括：用于初步开发并应用于一维和二维热传导问题的有限差分方法介绍，以及有限元方法。 课程将介绍基本算法，包括用于对典型的数值计算进行显著提速和并行的常用技术（分块等）。 如果时间允许，我们将在课程的最后几周介绍一种 "无网格 "数值方法--平滑粒子流体动力学方法。

This class will introduce students to the art of computational geodynamics — creating, visualizing, and exploring numerical solutions to the differential equations that govern heat transport and fluid flow. During the course, each student will be guided in making their own program for hydrothermal fluid flow and heat transport. The course's programming language is MATLAB, and instructional language is primarily English. There are no prerequisites to the course, but a willingness to learn and use MATLAB is required. Topics to be covered include an introduction to finite difference methods, which will be initially developed and applied to 1-D and 2-D heat conduction problems, and finite element methods. Basic algorithms will be covered, including common techniques (blocking, etc.) used to greatly speed and parallelize typical numerical calculations. If time permits, we will introduce a 'meshless' numerical method, smoothed particle hydrodynamics, in the last weeks of the course.

9. 教学方法
Teaching Methods

（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.）

主要为理论讲授，遵循教材编排循序渐进，结合自编讲义和多媒体教学优势进行实际教学。主要教授计算地球动力学的基本理论和建模方法（一维、二维有限差分法和有限元法），以及如何熟练运用 MATLAB 编写相应的计算程序。

Following the chapters of the textbook, lectures will be given to students. Self-written lecture notes and multimedia teaching methods will be integrated into the course. This course will mainly focus on the basic theories and modelling techniques of computational geodynamics (1-D and 2-D finite difference methods and finite element methods) and how to write computational programs in MATLAB accordingly.

10. 教学内容
Course Contents
（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.）

Section 1	Week 1 Intro to finite difference methods – heat conduction (2 hours) 第一周（2 学时）有限差分法介绍 – 热传导
Section 2	Week 2 Finite difference methods – transient heat conduction, control volume approach (2 hours) 第二周（2 学时）有限差分法 – 瞬态热传导，控制体积有限元法
Section 3	Week 3 Intro to Finite Element methods (2 hours) 第三周（2 学时）有限元法介绍
Section 4	Week 4 Finite Element 1-D Time-dependent heat transport (2 hours) 第四周（2 学时）一维有限元法 – 随时间变化的热传导
Section 5	Week 5 Finite Element 1-D Numerical Integration (2 hours) 第五周（2 学时）一维有限元法数值积分
Section 6	Week 6 Finite Element 1-D Shape Functions (2 hours) 第六周（2 学时）一维有限元法形函数
Section 7	Week 7 Finite Element 2-D Heat Transport (2 hours) 第七周（2 学时）二维有限元法 – 热传导
Section 8	Week 8 Finite Element 2-D Mesh Generation and Plotting (2 hours) 第八周（2 学时）二维有限元法网格生成和制图
Section 9	Week 9 Finite Element Sparse Matrix Assembly and Blocking (2 hours) 第九周（2 学时）有限元法稀疏矩阵的构成及分块
Section 10	Week 10 Finite Element Porous Flow (2 hours) 第十周（2 学时）有限元法 – 多孔流
Section 11	Week 11 Finite Element Hydrothermal Code (2 hours) 第十一周（2 学时）有限元法 – 流体热力模型
Section 12	Week 12 Testing and Code-Verification (2 hours) 第十二周（2 学时）代码测试以及代码验证

	Section 13	Week 13 Introduction to Smoothed Particle Hydrodynamics (SPH) (2 hours) 第十三周（2 学时）平滑粒子流体动力学（SPH）介绍
	Section 14	Week 14 SPH Hydrothermal code (2 hours) 第十四周（2 学时）SPH 下的流体热力模型
	Section 15	Week 15 Further discussions on various numerical methods, pros and cons (2 hours) 第十五周（2 学时）各种数值方法的讨论，优势及不足
	Section 16	Week 16 Review and summary (2 hours) 第十六周（2 学时）复习和总结

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.）

出勤 Attendance 10%； 平时作业 Assignments 60%； 期末报告 Final Presentation 30%。

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

Introduction to Numerical Geodynamic Modelling, Taras Gerya
Lecture notes written by Jason Morgan