

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	地球动力学基础 Fundamentals of Geodynamics
2.	授课院系 Originating Department	地球与空间科学系 Department of Earth and Space Sciences
3.	课程编号 Course Code	ESS414
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	中英双语 English & 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) Instructor(s), Affiliation & Contact (For team teaching, please list all instructors)	杨亭, 地球与空间科学系 邮箱: yangt3@sustech.edu.cn 电话: 0755-88018637 办公室: 创园 9 栋 304A Ting Yang, Department of Earth and Space Sciences Email: yangt3@sustech.edu.cn Tel: 0755-88018637 Office: Innovation Park #9-304A
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	习题/辅导/讨论	实验/实习	其它(请具体注明)	总学时
	Lectures	Tutorials	Lab/Practical	Other (Please specify)	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	MA101B 高等数学(上)A、PHY103B 大学物理(上)B MA101B Calculus I A and PHY103B General Physics I B				
13. 后续课程、其它学习规划 Courses for which this course is a pre-requisite					
14. 其它要求修读本课程的学系 Cross-listing Dept.					

教学大纲及教学日历 SYLLABUS

15. 教学目标 Course Objectives

本课程首先介绍地球动力学的基本研究思路与方法；之后，对地球的内部结构、热状态、形状与重力场等进行了简单的介绍，并穿插地介绍了板块构造与地幔柱、地幔对流、岩石圈板块挠曲模型、断层作用等重要地球动力学模型。

During this course, the lecturer will first introduce the basic research strategies and methods of Geodynamics. Following that, the lecturer will briefly introduce the internal structure, thermal state, and shape and gravity field of the Earth. Several important geodynamic models, including plate tectonics, mantle hot plume, mantle convection, lithospheric flexure, faulting will also be introduced during this course.

16. 预达学习成果 Learning Outcomes

学生完成本课程后，将会掌握以下知识：

1. 地球系统的主要观测及理解地球演化的模型化思维；
2. 地球的内部结构，包括波速、密度、热结构等；
3. 作为地表运动的一级近似的板块构造模型的条件与不足；
4. 地幔对流与地幔热柱的基本概念；
5. 地球的形状与重力场及其解释；
6. 岩石圈的挠曲；
7. 断层作用。

Upon completing the course, students will master the following knowledge:

1. The main observations about the Earth's dynamic system, understanding the Earth's dynamic system through models;
2. Internal structures of the Earth, including seismic-wave velocity, density, temperature;
3. Basic concepts of plate tectonics, a first-order kinematic model of Earth's surface motion;
4. Mantle convection and mantle hot plumes;
5. Shape and gravity field of the Earth and their geodynamic explanations;
6. Basic concepts of lithospheric flexure;
7. Basic concepts of faulting.

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.)

第一章：引言（2学时）

地球动力学系统及其主要观测，研究地球动力学系统的模型化思维：构建地球动力学模型。

第二章：地球内部基本圈层结构及其物理性质（4学时）

地壳、地幔、地核，PREM模型（波速，密度，弹性模量，压强），地球横向不均匀性。

第三章：板块构造与地幔热柱模型（6学时）

岩石圈与软流圈，古地磁、海底扩张与板块构造，离散、汇聚与走滑型板块边界，热点与地幔柱，大陆裂谷、大陆碰撞与威尔逊循环模型。

第四章：地球热状态（8学时）

地表大地热流，能量守恒与平流扩散方程，稳态传导方程与地温曲线，月球的地温曲线，半空间冷却模型，海洋岩石圈厚度、热流、地形随年龄关系。

第五章：地球的形状与重力场（6学时）

旋转椭球体与离心力，重力测量与自由空气异常，布格重力异常，大地水准面。

第六章：地幔对流（12学时）

质量守恒，应力应变基础，动量守恒，流函数，冰后回弹与地幔粘度，Stokes流与热柱形状，自然对流与Rayleigh-Taylor不稳定性，板块俯冲。

第七章：岩石圈的弹性与挠曲（6学时）

2D弯曲与挠曲变形，垂向加载下的岩石圈挠曲，均衡，补偿与导纳。

第八章：断层作用（4学时）

断层分类，断层上的应力与摩擦，断层划分的Anderson原理。

Chapter 1: Introduction (2 hours)

Solid Earth's dynamic system and its main observations; the strategy in geodynamic studies: modeling.

Chapter 2: Solid Earth's structure, composition and physical properties (4 hours)

Crust, mantle and core; PREM model (seismic-wave velocity, density, elastic modulus, pressure); lateral heterogeneity of the solid Earth.

Chapter 3: Plate tectonics and mantle plume (6 hours)

Lithosphere and asthenosphere; paleomagnetism, seafloor spreading and plate tectonics; divergent, convergent, and transforming plate boundaries; hotspot and mantle hot plume; continental rifts, continental collision, and Wilson Cycle.

Chapter 4: Earth's thermal state (8 hours)

Surface heat flow; energy conservation and advection-diffusion equation; steady-state thermal conduction equation and geotherm; the Moon's geotherm; half-space cooling model, oceanic lithosphere's thickness, surface heat flow, and topography as a function of seafloor age.

Chapter 5: The shape and gravity field of the Earth (6 hours)

Spheroid and Centrifugal force; gravity measurements free-air gravity anomaly; Bouguer gravity anomaly; geoid.

Chapter 6: Mantle convection (12 hours)

Conservation of the mass; basics of strain rate and stress; conservation of the momentum; stream function; glacial isostatic adjustment and mantle viscosity; Stokes flow and shape of the plume; Thermal convection and Rayleigh-Taylor instability; plate subduction.

Chapter 7: Lithospheric flexure (6 hours)

2D flexure and flexure deformation; lithospheric flexure under vertical load; isostasy, compensation, and admittance.

Chapter 8: Faulting (4 hours)

Classification of faults; friction and stress on faults; Anderson theory of faulting.

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

1. Turcotte, D., and Schubert, D., Geodynamics, 3rd ed. Cambridge University Press, 2014.
2. Fowler, C., The Solid Earth: An Introduction to Global Geophysics, 2nd ed. Cambridge University Press, 2005.
3. Grotzinger J, Jordan T H, Press F., Understanding earth. Macmillan, 2010.
4. Taras G., Introduction to numerical geodynamic modelling. Cambridge University Press, 2009.

课程评估 ASSESSMENT

19. 评估形式 Type of	评估时间 Time	占考试总成绩百分比 % of final	违纪处罚 Penalty	备注 Notes
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Assessment	score		
出勤 Attendance	10		
课堂表现 Class Performance			
小测验 Quiz			
课程项目 Projects			
平时作业 Assignments	40		
期中考试 Mid-Term Test			
期末考试 Final Exam			
期末报告 Final Presentation	50		
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

地球与空间科学系本科教学指导委员会