

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	岩石物理学基础 Fundamentals of Rock Physics				
2.	授课院系 Originating Department	地球与空间学系 Department of Earth and Space Sciences				
3.	课程编号 Course Code	ESS422				
4.	课程学分 Credit Value	2				
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)	方鑫定, 地球与空间科学系 邮箱: fangxd@sustech.edu.cn 电话: 0755-88015517 办公室: 创园 9 栋 311 Xinding Fang, Department of Earth and Space Sciences Email: fangxd@sustech.edu.cn Tel: 0755-88015517 Office: Innovation Park #9-311				
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	32				32

12. 先修课程、其它学习要求 Pre-requisites or Other Academic Requirements	MA101B 高等数学（上）A、ESS312 连续介质力学基础 MA101B Calculus I A and ESS312 Fundamentals of Continuum Mechanics
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**

本课程为地球物理专业本科生的专业选修课，通过理论讲解结合编程练习来加深学生对理论知识的理解，同时培养学生解决实际问题的能力，从而达到学以致用目的。学生顺利完成本课程后可以初步掌握如何将岩石物理的理论知识应用到具体的地球物理问题分析中。

This is a specialized course for undergraduates in Geophysics. Besides direct instruction, programming exercises for a number of important topics will be given as class assignments in order to enhance students' understanding of the course materials and develop their problem solving skills. On completion of this course, students should be able to apply knowledge gained from this course to specific geophysical problems.

16. **预达学习成果 Learning Outcomes**

学生完成本课程后，将会掌握以下技能：

1. 理解岩石在受力作用下的弹性与非弹性响应；
2. 能够计算包含不同物质（矿物、空洞、裂纹等）的岩石的等效弹性参数；
3. 能够使用 Gassmann 公式进行流体替换来计算不同流体或气体对岩石弹性的影响；
4. 能够基于线性弹性理论进行岩石破坏分析；
5. 能够进行井孔应力分析；
6. 了解用于测量岩石物理性质的常规实验手段和现场方法。

Upon completing the course, students will:

1. Understand the characteristics of rock mechanical behaviour under stress loading/unloading.;
2. Be able to calculate the effective elastic properties of a medium that comprises different materials;
3. Be able to conduct Gassmann fluid substitution;
4. Be able to perform rock failure evaluation based on linear elasticity;
5. Be able to do wellbore stress analysis;
6. Know the conventional laboratory and field methods for measuring rock physical properties.

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：岩石的物理和力学性质（2 学时）

岩石的基本构成，岩石的分类，岩石的尺度问题，岩石的物理性质（孔隙度、渗透率、弹性性质等）

第二章：应力应变基础（4 学时）

应力与应变关系，应力莫尔圆，胡克定律，弹性各向异性，岩石在受力作用下的响应。

第三章：岩石的弹性（8 学时）

等效介质理论，岩石中孔洞、裂纹对弹性的影响，孔隙压力的影响，岩石中孔隙流体对弹性的影响，Gassmann 流体替换公式。

第四章：岩石破坏机制（6 学时）

剪切破坏机制，拉伸断裂，含裂隙或层状结构岩石的破坏机制。

第五章：井孔应力分析（4 学时）

井孔应力分布，井壁崩裂与裂隙产生的条件，井孔应力对岩石弹性性质的影响。

第六章：岩石物理性质的测量（4 学时）

压力试验方法，波动测量方法，动静弹性参数的关系，岩石强度与内摩擦系数的测量。

第七章：地应力及孔隙压力的测量（4 学时）

垂直应力与水平应力的计算方法，水平最小应力与最大应力的测量，孔隙压力的测量与计算。

Chapter 1: Overview of rock physical and mechanical properties (2 hours)

This section will give an overview of the composition of different types of rocks and the characteristics of their physical and mechanical properties (e.g., porosity, permeability, elasticity, etc).

Chapter 2: Stress & Strain (4 hours)

This section will cover the basic theory of elasticity and Hooke's law and discuss the response of rocks under stress loading/unloading.

Chapter 3: Rock elasticity (8 hours)

This section will cover the effective medium theory, the effect of pores/cracks on rock elasticity, pore pressure effect, fluid effect and the Gassmann's relations.

Chapter 4: Rock failure mechanisms (6 hours)

This section will introduce the mechanisms for shear failure, tensile failure and the failure of rocks that contain fractures or laminated structure.

Chapter 5: Borehole stress analysis (4 hours)

This section will discuss borehole stress distribution and its influence on wellbore geometrical and mechanical properties.

Chapter 6: Measurements of rock physical properties (4 hours)

This section will introduce the triaxial compression test method and ultrasonic method for measuring rock physical properties (e.g., elastic moduli, rock strength, and friction angle) and discuss the relationship between static and dynamic elastic moduli.

Chapter 7: Measurements of in situ stresses and pore pressure (4 hours)

This section will introduce the methods for in situ stress calculation and pore pressure estimation.

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

1. The Rock Physics Handbook: Tools for Seismic Analysis of Porous Media. G. Mavko, T. Mukerji, and J. Dvorkin, Cambridge University Press, 2009.
2. Fundamentals of Rock Mechanics. J.C. Jaeger, N.G. W. Cook, and R.W. Zimmerman, Blackwell Publishing, 2007.
3. Petroleum Related Rock Mechanics. E. Fjar, R.M. Holt, A.M. Raaen, R. Risnes, and P. Horsrud, Elsevier Science, 2008.

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				
课堂表现 Class Performance				
小测验 Quiz				
课程项目 Projects				
平时作业 Assignments		60		
期中考试 Mid-Term Test				
期末考试 Final Exam		40		
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

地球与空间科学系本科教学指导委员会