课程大纲
COURSE SYLLABUS

1.	**课程代码/名称** **Course Code/Title**	岩石力学 （Rock Mechanics）
2.	**课程性质** **Compulsory/Elective**	专业选修课 （specialized elective course）
3.	**课程学分/学时** **Course Credit/Hours**	3/48
4.	**授课语言** **Teaching Language**	英语 (English)
5.	**授课教师 Instructor(s)**	方鑫定 (Fang, Xinding)
6.	**先修要求** **Pre-requisites**	本课程需要有微积分、线性代数和弹性力学基础并具备基本的编程能力，部分课程作业需要使用 MATLAB 来完成。 Prerequisites: calculus, linear algebra, linear elasticity, and basic programming skills. Some of the assignments will be given in the form of MATLAB exercises.

7. 教学目标 Course Objectives

本课程为地球物理学、地质学、岩土工程等相关专业研究生的选修课。本课程主要讲述岩石力学与岩石物理学的基本理论、实验方法以及在地学问题中的应用。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） 了解用于测量岩石力学性质的常规实验手段和现场方法以及地应力和孔隙压力的计算方法。

This is a specialized course for students in Geophysics, Geology, Civil Engineering or other related areas. 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 mechanical properties and the approaches for determining in situ stresses and pore pressure.

8. 教学方法 Teaching Methods

本课程注重知识的实用性，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，从而达到学以致用的目的。学生顺利完成本课程后可以初步掌握如何将岩石力学的理论知识应用到具体的地球物理和地质力学问题分析中。

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 and geomechanical problems.

9. 教学内容 Course Contents

Section 1	岩石的物理力学性质 (Overview of rock physical and mechanical properties) week: 1 内容：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） 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.).
	Section 2	岩石力学基础（Rock mechanics basics） week: 2-4 内容：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。 This section will cover the basic theory of elasticity and Hooke's law and discuss the response of rocks under stress loading/unloading.
	Section 3	岩石的弹性（Rock elasticity）week: 5-8 内容：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。 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.
	Section 4	岩石破坏机制 (Rock failure mechanisms) week: 9-11 内容: 剪切破坏机制（Mohr-Coulomb 模型和 Drucker-Prager 模型），拉伸断裂，含裂隙或层状结构岩石的破坏机制。 This section will introduce the mechanisms for shear failure (Mohr-Coulomb failure criterion and Drucker-Prager failure criterion), tensile failure and the failure of rocks that contain fractures or laminated structure.
	Section 5	井孔应力分析（Borehole stress analysis）week: 12 内容：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。 This section will discuss borehole stress distribution and its influence on wellbore geometrical and mechanical properties.
	Section 6	岩石力学性质的测量（Measurements of rock mechanical properties）week: 13-14 内容：压力试验方法，波动测量方法，动静态弹性参数的关系，岩石强度与内摩擦系数的测量。 This section will introduce the triaxial compression test method and ultrasonic method for measuring rock mechanical properties (e.g., elastic moduli, rock strength, and friction angle) and discuss the relationship between static and dynamic elastic moduli.
	Section 7	地应力及孔隙压力的测量（Measurements of in situ stresses and pore pressure）week: 15-16 内容：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 This section will introduce the methods for in situ stress calculation and pore pressure estimation.

10. 课程考核 Course Assessment

课程最终成绩根据六次作业和期末考试综合评定（课程作业 60%+期末考试 40%）。每个作业都会需要通过编程计算来解决一些小问题。

Assessment will be based on six assignments (60%) and final exam (40%).

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

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