

## 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 <b>Course Title</b>	结构力学 <b>Structural Mechanics</b>				
2.	授课院系 <b>Originating Department</b>	海洋科学与工程系 Department of Ocean Science and Engineering				
3.	课程编号 <b>Course Code</b>	OCE 405				
4.	课程学分 <b>Credit Value</b>	3				
5.	课程类别 <b>Course Type</b>	专业选修课 Major Elective Courses				
6.	授课学期 <b>Semester</b>	秋季 Fall				
7.	授课语言 <b>Teaching Language</b>	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) <b>Instructor(s), Affiliation &amp; Contact</b> (For team teaching, please list all instructors)	白勇 海洋科学与工程系 创园 9 栋 511, 0755-88018769 Dr. Yong Bai, Department of Ocean Sciences and Engineering Chuang Yuang 9-511, 0755-88018769				
9.	实验员/助教、所属学系、联系方式 <b>Tutor/TA(s), Contact</b>	无 NA				
10.	选课人数限额(可不填) <b>Maximum Enrolment (Optional)</b>					
11.	授课方式 <b>Delivery Method</b>	讲授 <b>Lectures</b>	习题/辅导/讨论 <b>Tutorials</b>	实验/实习 <b>Lab/Practical</b>	其它(请具体注明) <b>Other (Please specify)</b>	总学时 <b>Total</b>
	学时数 <b>Credit Hours</b>	48				48

12. 先修课程、其它学习要求 <b>Pre-requisites or Other Academic Requirements</b>	
13. 后续课程、其它学习规划 <b>Courses for which this course is a pre-requisite</b>	
14. 其它要求修读本课程的学系 <b>Cross-listing Dept.</b>	

**教学大纲及教学日历 SYLLABUS**

**15. 教学目标 Course Objectives**

通过本课程的学习，使学生了解杆件结构的组成规律,提高结构计算能力，为毕业后从事结构设计、施工和科研工作打好理论基础，培养学生对工程结构进行分析和计算的能力。

Through the study of this course, students can understand the composition of the beam structure and improve the structural computing ability. This course developments trends to lay the foundation for ocean science work in the future and trains students' ability to analyse the engineering structure.

**16. 预达学习成果 Learning Outcomes**

掌握以下内容：结构力学的基本理论，基本方法-经典的力法、位移法及能量法，海洋结构中杆及杆系的弯曲、扭转与稳定性问题。

Master the following knowledge and technology: Basic theories of ocean engineering structural mechanics. The classical force method, displacement method and energy method. The bending, torsion and stability of the beam.

**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.)**

Topic	hours	Note
1. 课程及大纲简介 Syllabus and class introduction	3	
2. 梁的弯曲理论 Beam bending theory	6	
3. 杆的扭转理论 Rod twisting theory	6	
4. 力法和位移法 Force method and displacement method	6	
5. 期中考试 Mid-Term	2	
6. 能量法 Energy method	6	
7. 矩阵法 Matrix method	6	
8. 杆的稳定性 Rod stability	6	
9. 结构的塑性分析和极限荷载 Plastic analysis of structures and ultimate loads	3	
10. 期末展示 Final Presentation	4	

**Session 1 Syllabus and class introduction**

第一部分 教学大纲及课程简介

Questions:

问题:

1. What is the analytical or computing model of a structure?
2. What is the relationship and difference between the model and its realistic structure?
3. Why we have to simplify actual structures into analytical models?

1. 什么是结构计算模型和分析模型?
2. 结构模型和实际模型之间的关系?
3. 为什么需要把实际结构简化为分析模型?

Readings:

参考教材:

1. Descloux J (1973)Methods des elements finis. Department de mathematiques. Lausanne,Suisse
2. Shames IH,Dym CL(1991)Energy and Finite Element Methods in Structural Mechanics. Taylor&Francis.
3. Slivker VI (1982) Variational methods in elasticity and plasticity. Pergamon press, Oxford New York Toronto Paris Frankfurt

Session 2 Beam bending theory

第二部分 梁的弯曲理论

Questions:

问题:

1. Why the moment diagram for a certain straight segment of a member may be constructed by the method of superposition of a simple beam with the same span and subjected to the same loads?
2. Why, generally the maximum bending moment in each span of a multispan beam is smaller than that in a series of simple beams with the same spans?

- 1、为什么构件某一直线段的弯矩图可以用相同跨度、相同荷载作用下的简支梁的叠加法来构造?
- 2、为什么通常多跨梁每跨的最大弯矩比一系列相同跨的简单梁的最大弯矩小?

Readings:

参考教材:

1. Shirong LI; Zeqing WAN; Xuan WANG (2015) Homogenized and classical expressions for static bending solutions for functionally graded material Levinson beams.
2. TORABIZADEH Mohammad Amin (2013) Geometrically Nonlinear Bending Analysis of Metal-Ceramic Composite Beams under Thermomechanical Loading.
3. WANG Li-min; FENG Ying; CHEN Fan-xiu; WANG Hai-ying; WANG Dong-xu(2013) Elasto-Plastic Test of Q235 Steel Bending Beam With Cracking Resistance.
4. Jiang-bo SHA;T.H.YIP; M.H.TEO(2011) FEM modelling of single-core sandwich and 2-core multilayer beams containing foam aluminum core and metallic face sheets under monolithic bending.

Session 3 Rod twisting theory

第三部分 杆件扭转理论

Questions:

问题:

1. What is the definition of a twisting rod?
  2. Why take a downward concentrated load of unit magnitude as the foundation of the construction of a twisting rod?
  3. What is the difference between an internal force diagram and a twisting rod?
- 1、扭转杆件的定义?
  - 2、为什么要以向下的单位集中荷载为基础构件扭转杆件?
  - 3、内力图和扭转杆的区别?

Readings:

参考教材:

1. V. G. A. Goss; G. H. M. Heijden; J. M. T. Thompson; S. Neuki(2005) Experiments on snap buckling, hysteresis and loop formation in twisted rods.
2. Vladimir Kobelev(2016) Isoperimetric inequality in the periodic Greenhill Problem of twisted elastic rod.
3. G.H.M. van der Heijden; J.M.T. Thompson(2000) Helical and Localised Buckling in Twisted Rods: A Unified Analysis of the Symmetric Case.

Session 4 Force method and displacement method

第四部分 力法和位移法

Questions:

问题:

1. What is the sign convention about the internal forces and displacements of a member ends in displacement method?
  2. How many kinds of primary unknowns are there for displacement method?
  3. How to select primary structure and primary system when using displacement method to analyse a statically indeterminate structure?
- 1、在位移法中,关于杆件内力和位移的符号约定是什么?
  - 2、位移法有几种主要未知数?
  - 3、用位移法分析超静定结构时,如何选择基本结构和基本系统?

Readings:

参考教材

1. 1.R Brakaspathy; A Jothi; Surjit Singh(1987) Force field calculations of acetonitrile using CNDO/force method.
2. R Brakaspathy; A Jothi; Surjit Singh(1985) Determination of force fields for two conformers of nitromethane by cndo /Force method.
3. Hu Cheng(2012) Difference and Application of Matrix Displacement Method and Finite Element Method in the Truss Structure Analysis.

Session 5 Energy method

## 第五部分 能量法

### Questions:

#### 问题:

1. What is the difference between the consideration of selecting primary structure and primary system used in force method and that used in energy method?
2. Whether or not energy method can be used to analyse a statically determinate structure?
3. Why can we say that the energy method equations are actually the equations for equilibrium?

- 1、力和能量法在考虑基本结构和基本系统的选择时，有什么不同？
- 2、能量法能否用于超静定结构的分析？
- 3、为什么我们能说能量法方程实际上是平衡方程？

### Readings:

#### 参考教材

1. Jesús Ildefonso Díaz(2008) Estimates of the Location of a Free Boundary for the Obstacle and Stefan Problems Obtained by Means of Some Energy Methods.
2. Michel Bruneau(1996) Some aspects of energy methods for the inelastic seismic response of ductile SDOF structures.
3. Lihui Wang(2011) The energy method to predict disc cutter wear extent for hard rock TBMs.
4. Sidney A. Guralnick(1988) Energy Method for Incremental Collapse Analysis of Framed Structures.

## Session 6 Matrix method

## 第六部分 矩阵法

### Questions:

#### 问题:

1. What is the sign convention about the end forces and displacements of a member in matrix method?
2. How much property is there for an element stiffness matrix?
3. Whether or not a statically determinate structure can be analysed by the matrix method?

- 1、矩阵法中关于杆件的端部力和位移的符号约定是什么？
- 2、一个单元刚度矩阵有多少性质？
- 3、用矩阵法分析超静定结构是否可行？

### Readings:

#### 参考教材:

1. Cheng Bing He(2010) An Increment Transfer Matrix Method for the Torsional Vibration Response of Steam Turbo-Generator Shaft System.
2. Sheng Hai Hu(2014) Research on Lower-Order Body Matrix Method and the Configuration Transformation of Planar Metamorphic Mechanism
3. Guo-Sheng Liu(2013) Numerical analysis of electrical logging-while-drilling tool using propagator matrix method

## Session 7 Rod stability

### 第七部分 杆件稳定性

#### Questions:

##### 问题:

1. Whether the instability of an unstable system can be changed by adding or discarding binary system in turn from it?
2. What is the rod stability system?
3. Why rod stability system can be used to engineering structure?

- 1、一个不稳定系统的不稳定性是否可以通过依次添加或减去分叉系统来改变?
- 2、什么是杆件稳定体系?
- 3、为什么稳定体系可以用做工程结构?

#### Readings:

##### 参考教材:

1. Vladimir I. Andreev (2015) On the Stability of Rod with Variable Cross-section.
2. Marzio Lembo (2003) On the stability of elastic annular rods
3. Mourad Chamekh (2014) Stability of elastic rods with self-contact

## Session 8 Plastic analysis of structures and ultimate loads

### 第八部分 结构极限强度和塑性分析

#### Questions:

##### 问题:

1. How many categories are there of commonly used framed structures?
2. What kinds of supports for plane structures are usually simplified into?
3. What are the conformation, the characteristics of restricting movement and restraint reactions of the supports?

- 1、常用框架结构有多少种?
- 2、平面结构的支承通常简化为什么?
- 3、支座的形式、约束运动的特性和约束反力是什么?

#### Readings:

1. Jiangang Wei(2014) Studies of In-Plane Ultimate Loads of the Steel Truss Web-RC Composite Arch
2. Fuyun Huang(2016) Study on preloading reduction of ultimate load of circular concrete-filled steel tubular columns
3. Ferhat Fedghouche (2012) Minimum cost design of reinforced concrete T-beams at ultimate loads using Eurocode2

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

《结构力学》白勇自编教材

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		10		
课堂表现 Class Performance		10		
小测验 Quiz				
课程项目 Projects				
平时作业 Assignments		20		
期中考试 Mid-Term Test		20		
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

海洋科学与工程系本科教学委员会  
 Department of Ocean Science and Engineering Undergraduate Committee