材料力学 B 教学大纲

（总学分：5　总上课时数：80　实验课另开）

东南大学土木工程学院

一、课程的性质与目的

本课程是工科一般专业必修的一门重要的学科基础课。本课程的教学目的是：构筑作为工程技术根基的力学知识体系结构；通过揭示杆件强度、刚度、稳定性等知识的发生和发展过程，培养学生分析和解决问题的能力；以理论分析为基础，培养学生的实验动手能力和创新能力；为学习有关的后继课程以及进行研究创新活动打下重要的力学基础。

二、课程内容的教学要求

（1）拉伸、压缩与剪切：明确内力、应力、变形、应变等基本概念，熟练掌握拉压杆件的强度计算理论和方法，能正确分析计算简单的拉压超静定问题。理解剪切和挤压的概念，掌握剪切和挤压的实用计算方法。

（2）扭转：理解切应力互等定理，熟练掌握圆轴扭转的强度和刚度的计算理论和方法，能求解简单的扭转超静定问题。了解非圆截面和薄壁截面杆扭转的应力和变形的计算方法和结论。

（3）弯曲内力和应力：熟练掌握绘制梁的剪力图和弯矩图的方法。理解对称弯曲的概念，熟练掌握对称弯曲梁横截面上正应力和切应力的计算理论和方法，正确进行梁的弯曲强度计算。

（4）弯曲变形：理解梁的挠度和转角的概念，掌握用积分法和叠加法计算梁挠度和转角的方法，能正确进行梁的弯曲刚度计算。能正确分析计算简单的弯曲超静定问题。

（5）应力和应变分析　强度理论：掌握应力状态的概念，熟练掌握平面应力状态下应力分析的解析法和图解法，了解空间应力状态及其应力圆的概念，掌握最大切应力的计算方法。理解广义胡克定律，会计算空间应力状态下的应变能和畸变能。理解材料失效形式和强度理论的概念，掌握应用四个经典强度理论进行复杂应力状态下的强度分析和计算的方法。

（6）组合变形：熟练掌握拉（压）弯组合变形，弯扭组合变形下杆件的强度分析和计算。

（7）压杆稳定：正确建立压杆稳定性的概念，熟练掌握细长压杆临界载荷的欧拉公式及其应用，掌握非细长压杆临界载荷及临界应力的计算方法，能正确进行压杆的稳定性设计计算。了解提高压杆稳定性的措施。

（8）动载荷：掌握构件作等加速运动和匀速转动的应力计算，能正确分析和计算冲击时杆件的应力和变形。

（9）交变应力：理解疲劳破坏的概念，能应用疲劳应力寿命曲线进行构件的常规疲劳强度设计。了解提高构件疲劳强度的措施。

（10）能量方法：理解功能原理，掌握杆件应变能的计算方法。熟练掌握应用莫尔定理计算简单结构位移的方法，掌握用卡氏定理求结构位移的方法。了解功的互等定理和位移互等定理及其应用。

（11）超静定结构：明确超静定结构的概念，熟练掌握解简单超静定梁的变形比较法，理解结构的对称和反对称性质，能用力法解简单结构的超静定问题。

三、能力培养的要求

1. 分析能力的培养：对材料力学的基本概念和基本方法有明确的认识，具备从简单的实际问题中抽象出合理的力学模型，并画出力学计算简图的初步能力。

2. 计算能力的培养：要求学生通过本课程的学习，能正确分析计算杆件的应力、应变和变形，具备对工程中杆件的强度、刚度和稳定性进行分析和计算的能力。对动强度问题有正确的认识，初步具备对杆件进行常规疲劳强度设计的能力。

3. 自学能力的培养：通过本课程的教学，要培养和提高学生对所学知识进行整理、概括、消化吸收的能力，以及围绕课堂教学内容，阅读参考书籍和资料，自我扩充知识领域的能力。

4. 表达能力的培养：主要是通过作业，清晰、整洁地表达自己解决问题的思路和步骤的能力。

5. 创新能力的培养：培养学生独立思考、深入钻研问题的习惯，和对问题提出多种解决方案、选择不同分析计算方法，以及对分析计算进行简化和举一反三的能力。

四、建议学时分配

课 程 内 容	讲 课	习题课或课堂讨论	实 验	上 机
材料力学	**60**	**20**		
绪论	2			
拉伸、压缩与剪切	6	4		
扭转	6			
弯曲内力	4			
弯曲应力	8	2		
弯曲变形	6	4		
应力和应变分析 强度理论	6			
组合变形	4	2		
压杆稳定	4			
动载荷	2			
交变应力	2			
能量方法	6	4		
超静定结构	2	4		
机动	2			

五、考核方式

总评成绩＝平时成绩（包括作业、课堂讨论及小测验）＋期末考试成绩

平时成绩占 20％

期末考试成绩占 80％

六、教材及参考书

1. 孙训方主编.材料力学. 第 5 版.高等教育出版社，2009
2. 刘鸿文主编.材料力学：Ⅰ、Ⅱ.第 4 版 .高等教育出版社，2004
3. 单辉祖编著.材料力学：Ⅰ、Ⅱ. 第 1 版 .高等教育出版社，2002
4. 郭应征、李兆霞主编.应用力学基础.高等教育出版社，2000

Syllabus of Mechanics of Materials

(Credit Hours: 5; Teaching Hours: 80; Laboratory studies separately arranged)

School of Civil Engineering, Southeast University

1. The Nature and Objectives of the Course

Mechanics of materials is a mandatory and disciplinary fundamental course of various engineering majors. The objectives of the course primarily include (a) establishing the mechanical knowledge-base and structure serving as the fundamentals of modern engineering technology, (b) developing students' analytical and problem-solving capabilities via revealing the origin, development and maturing process of subjects such as strength, stiffness and stability of prismatic members, (c) fostering students' hands-on experience and creativity facilitated by solid theoretical analysis, and (d) laying the important mechanical foundation for subsequent mechanical courses and scientific research activities.

2. Teaching Requirements of Course Subjects

Upon completion of the course lectures, the participating students are expected to

(1) Axial Loading & Shear: (a) define the fundamental concepts of internal force, stress, deformation and strain, (b) master both the theory and methodology of the strength analysis of axially loaded prismatic members, (c) accurately analyze and calculate simple statically indeterminate bars subjected to axial loading, and (d) comprehend the concepts of shearing and bearing stresses of simple engineering connectors as well as their calculations.

(2) Torsion: (a) comprehend the theorem of conjugate shear stress, (b) master both the theory and methodology of strength and stiffness analyses of torsional circular shafts, (c) accurately analyze and calculate simple statically indeterminate torsional shafts, and (d) acquaint themselves with the calculation and conclusions of the stress and deformation of non-circular and thin-walled torsional shafts.

(3) Bending internal forces & stresses: (a) master the rendering of both shear and moment diagram, (b) comprehend the concepts of symmetric bending of beams, (c) master the theory and calculation of both normal and shear stresses acting on cross sections of symmetrically bent beams, and (d) accurately perform the strength analysis for beams under symmetric bending.

(4) Bending deflections: (a) comprehend the concepts of deflection and rotation of bending beams, (b) master the methods of integration and superposition for the calculation of both beam deflection and rotation, (c) accurately perform the stiffness analysis for beams under symmetric bending, and (d) accurately analyze and calculate simple statically indeterminate beams under symmetric bending.

(5) Stress and strain analyses & strength theory: (a) master the concept of stress states, (b) master both the analytical and graphic method for the analysis of plane stress states, (c) acquaint themselves with the concepts of general three dimensional stress states and the corresponding stress circles, (d) master the calculation of maximum shear stress, (e) comprehend the general Hooke's law, (f) accurately calculate the strain and distortion energy of three dimensional stress states, (g) comprehend the common failure modes of materials and the concept of general strength theory, and

(h) master the four classical strength theories and their applications to the strength analysis of complex stress states.

(6) Combined loading: master the stress calculation and strength analysis for the combination of (a) axial loading & bending and (b) torsion & bending.

(7) Stability of columns: (a) accurately establish the concept of the stability of columns, (b) master the Euler's formula and its application to the calculation of critical loads and stresses of slender columns, (c) master the calculation of critical loads and stresses for non-slender columns, (d) accurately perform the stability calculation and design of columns, and (e) acquaint themselves with the means of enhancing the stability of columns.

(8) Dynamical loading: (a) master the stress calculation of structural members under constant acceleration and constant rotation and (b) accurately analyze and calculate both the stress and deformation of prismatic bars under impact loading.

(9) Cyclic loading: (a) comprehend the concept of fatigue failure of materials, (b) perform fatigue strength design of structural member using the stress-cycle diagram, and (c) acquaint themselves with the means of enhancing the fatigue modulus of structural elements.

(10) Energy methods: (a) comprehend the principle of work and energy, (b) master the calculation of strain energy, (c) master the calculation of displacements of simple structures by employing Mohr's theorem, (d) master the calculation of displacements of structures by employing Castigliano's theorems, and (e) acquaint themselves with the reciprocal theorems of work and displacement as well as their applications.

(11) Statically indeterminate structures: (a) define the concept of statically indeterminate structures, (b) master the concept of deformation compatibility for simple statically indeterminate beams, (c) identify the property of symmetry and/or anti-symmetry of structures, and (d) solve simple statically indeterminate problems using the force method.

3. Training Expectations of Students' Capabilities

Upon completion of the course lectures, students are expected to achieve

(1) Analytical capability: (a) deterministic knowledge of the fundamental concepts and methodologies typically employed in mechanics of materials and (b) the elementary skills of abstracting rational mechanical model from engineering practical problems and constructing free body diagrams for subsequent analysis.

(2) Calculation capability: (a) decent calculation proficiency on stress, strain, deformation, strength, stiffness and stability and (b) accurate awareness of dynamical strength and fatigue strength design.

(3) Self-learning capability: (a) the capability of comprehending, analyzing and summarizing the knowledge system that have been offered and (b) the necessary skills to actively search and study references about a given subject matter.

(4) Communication capability: necessary capabilities of presenting homework and exam solutions in a comprehensive, neat and well-organized manner.

(5) Innovation capability: (a) a rewarding habit of independent thinking and thorough investigation focusing on a given topic, (b) the capability to come up with multiple solutions or

methodologies, and (c) the ability to simplify, complicate or evolve a given problem.

4. Tentative Allocation of Teaching Hours

Course Topics	Lecture	Exercises & Discussion	Laboratory Study	Computer Problems
Mechanics of Materials	**60**	**20**		
Introduction	2			
Axial Loading & Shear	6	4		
Torsion	6			
Bending Internal Forces	4			
Bending Stresses	8	2		
Bending Deflections	6	4		
Stress and Strain Analyses & Strength Theory	6			
Combined Loading	4	2		
Stability of Columns	4			
Dynamical Loading	2			
Cyclic Loading	2			
Energy Methods	6	4		
Statically Indeterminate Structures	2	4		
To Be Arranged	2			

5. Grading Policy

Final Grade = Routine Performance (including attendances, homework evaluations, classroom discussions and quizzes) + Final Exam

Routine Performance: 10％

Final Exam: 90％

6. Textbook & References

(1) Xunfang Sun, Mechanics of Materials, Higher Education Press, 2009.

(2) Hongwen Liu, Mechanics of Materials I & II, 4th Ed., Higher Education Press, 2004.

(3) Huizu Shan, Mechanics of Materials I & II, Higher Education Press, 2002.

(4) Yingzheng Guo and Zhaoxia Li, Fundamentals of Applied Mechanics, Higher Education Press, 2000.