Appendix B-3: Mechanics of Materials Syllabus

Appendix B-3

Mechanics of Materials Syllabus

course title	Mechanics of Material					Course number	9034112021
Applicable specialties	Civil engineering (construction engineering☑, road and bridge engineering☑, urban rail transit engineering☑), urban underground space engineering, water conservancy and hydropower engineering						
Nature of the course	General education course □ subject foundation course☑ professional core course (elective □ required □) independent development course (required □ elective □) concentrated practice course □						
Unit offering the course	School of Civil Engineering						
Total class hours	**105**	credit	3.5	Contact hours	56	Self-study hours	**49**
Prerequisite courses	Advanced Mathematics, University Physics, Theoretical Mechanics						
Textbooks and so on teaching materials	Course materials: Materials Mechanics I (6th edition), edited by Sun Xunfang and Fang Xiaoshu, Higher Education Press 1. Materials Mechanics (I) (5th edition), edited by Liu Hongwen, Higher Education Press, 2011 2. Study Methods and Problem Solutions of Material Mechanics, edited by Gu Zhirong and Wu Yongsheng, Tongji University Press, first edition 2000. Course website: None						

1. Course Introduction

Mechanics of Materials is an ancient yet ever-renewing discipline, serving as a crucial foundational course for civil engineering, urban underground space engineering, and hydraulic and hydroelectric engineering. Through this course, students are required to master the strength and stiffness calculations of four basic deformations of members, as well as the strength calculations of simple composite deformations and the stability calculations of axially loaded members. They should be able to use conditions of strength, stiffness, and stability for member verification, section design, and load determination; understand the mechanical properties of elastic and plastic materials. Students will learn to calculate principal stresses in plane stress states, understand how strength theory determines failure modes for different materials; grasp the concept of compression member stability and apply Eulers formula. This course lays a solid foundation for subsequent courses such as structural mechanics, elasticity theory, structural design, and soil mechanics.

2. The graduation requirements supported by this course and the implementation path

(1) The graduation requirements that this course can support

Number	Graduation requirement indicators	Specific content of graduation requirement indicators
1	Graduation requirement 2.2	It can analyze the complex engineering problems of civil engineering and judge the key links of problem solving.
2	Graduation requirements 12.1	Under the background of social development, they can recognize the necessity of autonomous and lifelong learning and have the awareness of autonomous learning and lifelong learning.

(2) The implementation path of graduation requirement indicators in this course

1. Course objectives

Through the theoretical teaching of this course, students will have basic knowledge and ability, cultivate their innovative consciousness of daring to practice and scientific rigorous research attitude, and organically combine knowledge transmission, ability cultivation and value shaping. The specific course objectives are as follows:

Course objective 1: Understand the research tasks and basic assumptions of material mechanics course, master the calculation methods of internal forces, stresses and deformations under the four basic deformation forms of members; master the analysis of principal stresses in the combination stress state unit body for strength verification; understand the stability analysis method of compression members.

Course objective 2: When learning the knowledge of material mechanics and its application, fully understand the importance of lifelong learning, cultivate self-learning ability and improve self-learning consciousness.

2. The corresponding relationship between the teaching objectives of the course and the graduation requirements

Graduation requirement indicators	Course teaching objectives

Graduation requirement 2.2	Course Objective 1
Graduation requirements 12.1	Course objective 2

3. Intended learning outcomes

(1) intended learning outcomes

Intended learning outcomes of the course

train objective / blocks of knowledge	knowledge point	Initial level	Degree of requirement	Intended learning outcomes	program objective
1. Introduction and basic concepts	Learning tasks and basic assumptions	L1	L2	**1.** Understand the task of material mechanics, basic assumptions, geometric characteristics of members and basic deformation forms.	1
2. Axial tension and compression	Calculate the axial force diagram and draw the axial force diagram	L1	L2	**2.** Understand the concept, classification and symbol of internal force; apply section method to calculate internal force; practice axial force calculation and make axial force diagram.	1
	Hookes Law and strain calculation	L1	L 2	**3.** Understand the stress-strain relationship of Hooks Law to calculate the strain and elongation of the member.	1
	Mechanical properties of materials	L1	L2	**4.** Understand the mechanical properties curve of low carbon steel and ash cast iron when stretching and compressing, determine the plastic characteristics of materials with control indicators, and explain the phenomenon of stress concentration.	1
	Tensile strength verification	L1	L2	**5.** Understand the stress distribution of the cross-section of the tension and compression rod and the calculation formula. Combine the axial force diagram to calculate the maximum	1

train objective / blocks of knowledge	knowledge point	Initial level	Degree of requirement	Intended learning outcomes	program objective
				working positive stress, and establish the strength condition to analyze the safety of the rod.	
3. Twisting and section geometry properties	Draw the torque diagram	L1	L2	**6.** Remember the torque symbol (right hand spiral method); apply the section method to make the torque diagram;	1
	Calculation of the extreme moment of inertia	L1	L3	**7.** Understand the concept and calculation of extreme moment of inertia.	1
	Shear stress strength condition	L1	L2	**8.** Understand the formula, distribution law and strength condition of torsional stress in circular shaft section.	1
4. Bending internal force, stress and displacement	Shear diagram and bending moment diagram	L1	L2	**9.** Describe the concept of pure bending and transverse bending; use shear equation and bending moment equation to calculate bending internal forces and make diagrams.	1
	Calculation of static moment and inertial moment	L1	L3	**10.** Understand the common section geometric characteristics such as centroid, static moment, moment of inertia, polar moment of inertia and other concepts.	1
	Normal stress strength condition	L 2	L2	**11.** Describe the positive stress distribution law of the cross section when the beam is bent; determine the maximum working stress, and analyze the strength of the member.	1、2
	Shear stress strength	L2	L3	**12.** Describe the distribution law of shear stress on the cross	1

train objective / blocks of knowledge	knowledge point	Initial level	Degree of requirement	Intended learning outcomes	program objective
	condition			section when the beam is bent; and apply the strength condition to carry out relevant calculations.	
	Approximate differential equation and integral of beam deflection curve	L1	L3	**13.** The displacement and rotation of the beam are obtained by applying the approximate differential equation of the flexural curve.	1
	The deflection and rotation of the beam are calculated according to the superposition principle	L1	L3	**14.** The principle of superposition is applied to find the deflection and rotation.	1
	Beam stiffness verification	L2	L 3	**15.** Correctly calculate the stiffness condition of the beam.	1
5. Stress state and strength theory	Method of analysis of plane stress state	L1	L3	**16.** Understand the concept of stress state; apply the unit body to calculate the stress of any inclined section. Understand the physical meaning of Moire stress circle, calculate the magnitude of principal stress and the position of principal plane based on Moire circle.	1
	Analysis of principal stress state of space stress	L1	L2	**17.** Understand the stress and strain relationship of isotropic materials under spatial stress state.	1
	Theory of strength and its application	L1	L3	**18.** Understand the four strength theories and their application conditions, establish strength conditions based on considerable stress, and	1

train objective / blocks of knowledge	knowledge point	Initial level	Degree of requirement	Intended learning outcomes	program objective
				explain the reasons for material failure or failure.	
6. Combined deformation	Basic concepts of combination deformation, processing principles and key points of solution	L1	L3	**19.** Understand the determination method of neutral axis in the section of inclined curved members, how to determine the position of dangerous points, the effect of stress superposition; the concept and calculation method of section core.	1
	Practical calculation method of connecting parts	L1	L3	**20.** Understand the practical calculation method of shear and compression engineering of connectors, and discuss the strength of joints.	1
7. Press rod stability	Derivation of the Euler formula for bar stability	L1	L3	**21.** Understand the concept of stable equilibrium and unstable equilibrium, and correctly choose the length coefficient of the bar.	1
	The calculation method of critical force of slender bar with different end constraints	L1	L2	**22.** The critical force of stability of a bar is calculated by using Eulers formula.	1
	Stability calculation of the pressure rod	L1	L3	**23.** Understand the concept of critical stress, stiffness and the application range of Eulers formula; use the stability factor related to stiffness for stability calculation.	1、2

(2) Detailed rules for teaching links

Teaching content (knowledge points)	Class hours	Expected learning outcomes	Implementation link	instructional strategies

Teaching content (knowledge points)	Class hours	Expected learning outcomes	Implementation link	instructional strategies
Learning tasks and basic assumptions	2	Understand the task of material mechanics, basic assumptions, geometric characteristics and basic deformation forms of members.	In-class teaching	lecture Problem-oriented guidance
Calculate the axial force diagram and draw the axial force diagram	2	Understand the concept, classification and symbol of internal force; apply section method to calculate internal force; practice axial force calculation and make axial force diagram.	In-class teaching In-class test after-class assignments	lecture Problem-oriented guidance give an example
Hookes Law and strain calculation	2	Understand the stress-strain relationship of Hooks Law to calculate the strain and elongation of the member.	In-class teaching homework	lecture Problem-oriented guidance give an example
Mechanical properties of materials	2	Understand the mechanical properties curve of low carbon steel and ash cast iron when stretching and compressing, determine the plastic characteristics of the material by using control indicators, and explain the phenomenon of stress concentration.	In-class teaching	lecture Problem-oriented give an example
Tensile strength verification	4	Understand the stress distribution of the cross-section of the tension and compression rod and the calculation formula. Combine the axial force diagram to calculate the maximum working positive stress, and establish the strength condition to analyze the safety of the rod.	In-class teaching In-class test after-class assignments	lecture Problem-oriented give an example
Draw the torque diagram	2	Remember the torque symbol (right hand spiral method); apply the section method to make a torque diagram;	In-class teaching homework	lecture Problem-oriented give an example
Calculation of the extreme moment of	2	Understand the concept and calculation of the extreme moment of inertia.	In-class teaching homework	lecture Problem-oriented

Teaching content (knowledge points)	Class hours	Expected learning outcomes	Implementation link	instructional strategies
inertia			k	give an example
Tensile stress strength condition	2	Understand the formula, distribution law and strength condition of torsional stress in circular shaft section.	In-class teaching In-class test after-class assignments	lecture Problem-oriented give an example
Shear diagram and bending moment diagram	6	Describe the concept of pure bending and transverse bending; use shear equation and moment equation to calculate bending internal forces and make diagrams.	In-class teaching In-class test after-class assignments	lecture Problem-oriented give an example
Calculation of static moment and inertial moment	2	Understand the common geometric characteristics of section such as centroid, moment of inertia, moment of inertia, polar moment of inertia and other concepts.	In-class teaching homework	lecture Problem-oriented guidance give an example
Normal stress strength condition	2	Describe the positive stress distribution law of the cross section when the beam is bent; determine the maximum working stress, and analyze the strength of the member.	In-class teaching In-class tests after-class assignments	lecture Problem-oriented guidance give an example
Shear stress strength condition	2	Describe the distribution law of shear stress in the cross section when the beam is bent; apply the strength condition for relevant calculation.	In-class teaching In-class test after-class	lecture Problem-oriented give an example

Teaching content (knowledge points)	Class hours	Expected learning outcomes	Implementation link	instructional strategies
			assignments	
Approximate differential equation of beam deflection curve and its integral	2	The displacement and rotation of the beam are obtained by applying the approximate differential equation of the flexural curve.	In-class teaching homework	lecture Problem guidance give an example
The deflection and rotation of the beam are calculated according to the superposition principle	2	The principle of superposition is applied to find the deflection and rotation.	In-class teaching homework	lecture Problem-oriented guidance give an example
Beam stiffness verification	2	Correctly calculate the stiffness condition of the beam.	In-class teaching homework after-class assignments	lecture Problem-oriented guidance give an example
Method of analysis of plane stress state	6	Understand the concept of stress state; apply the unit body to calculate the stress of any inclined section. Understand the physical meaning of Moire stress circle, and calculate the magnitude of principal stress and the position of principal plane based on Moire circle.	In-class teaching homework Big assignments	lecture Problem-oriented give an example
Analysis of principal stress in space stress state	2	Understand the stress and strain relationship of isotropic materials in space stress state.	In-class teaching homework	lecture Problem-oriented give an example
Theory of strength and its application	2	Understand the four strength theories and their application conditions, establish strength conditions based on considerable stress, and explain the reasons for material failure or failure.	In-class teaching homework	lecture Problem-oriented give an example

Teaching content (knowledge points)	Class hours	Expected learning outcomes	Implementation link	instructional strategies
Basic concept of combination deformation, processing principle and key points of solution	2	Understand the determination method of neutral axis in inclined curved member section, how to determine the position of danger point, stress superposition effect; concept and calculation method of section core.	In-class teaching homework Big assignments	lecture Problem-oriented give an example
Practical calculation method of connecting parts	2	Understand the practical calculation method of shear and compression engineering of connectors, and discuss the strength of joints.	In-class teaching homework	lecture Problem-oriented give an example
Derivation of the Euler formula for bar stability	2	Understand the concept of stable equilibrium and unstable equilibrium, and correctly choose the length coefficient of the bar.	In-class teaching homework	lecture Problem-oriented guidance give an example
The calculation method of critical force of slender bar with different end constraints	2	The critical force of stability of the bar is calculated by using Euler formula.	In-class teaching homework after-class assignments	lecture Problem-oriented give an example
Stability calculation of the pressure rod	2	Understand the concept of critical stress, stiffness and the application range of Eulers formula; use the stability factor related to stiffness for stability calculation.	In-class teaching homework Big assignments	lecture Problem-oriented guidance give an example

4. Course assessment

(1) Course assessment structure

Examination items	scale	ask

usual performance	Homework	20%	According to the course progress, after-school assignments are basically assigned for each knowledge unit to timely digest and understand the knowledge points.
	mid-term exam	20%	In the form of a combination of various types of questions, the knowledge points of axial tension and compression problems and bending problems are tested at different stages.
final		60%	The test is conducted with a combination of various types of questions to cover most of the knowledge points.
amount to		100%	

Note: When the final exam score is lower than 50 points (excluding 50 points), the regular score will be considered no higher than 60 points.

(2) Course assessment rules

Assessment items	Primary coverage	
	Knowledge units/points	**Ability items**
Homework	All knowledge units	Master the course knowledge points through after-class exercises
mid-term exam	Basic concepts, internal force calculation and strength calculation of axial tension and compression and bending problems.	Assess understanding and the degree of application of knowledge points
final	Most knowledge units	Assess understanding and the degree of application of knowledge points.

5. The tasks undertaken in the cultivation of the ability to solve complex engineering problems

It aims to cultivate students ability to calculate and analyze practical problems, master the calculation method of the basic deformation of the member in the engineering structure, and provide the calculation basis for the analysis of structural strength, stiffness and stability.

To cultivate students understanding and application ability of components, internal forces, stresses and deformations in structures, so as to lay a good foundation for professional courses.

6. Non-technical ability training and observation

Guide students to study independently, complete after-class assignments independently, and cultivate students to find their own ways to solve problems and solve complex engineering problems. Use after-class assignments as the main observation point, supplemented by questionnaire survey for observation.

7. Course ideological and political design

Materials mechanics is an ancient yet ever-renewing discipline, a required foundational course for students in mechanical, materials, civil, and aerospace engineering at higher technical institutions. It aims to cultivate students ability to derive and abstract mechanical models from practical engineering scenarios, combined with the safety analysis of these models, providing a theoretical foundation and computational methods for the design and material selection of engineering components. Therefore, in course instruction, it is essential not only to systematically impart knowledge of mechanics but also to foster innovative awareness and a rigorous scientific research attitude among students, integrating knowledge transmission, capability development, and value shaping organically. During lectures, topics such as the historical development of the course theory, stories of famous mechanicians, achievements in national key construction projects, and analyses of engineering disasters can be discussed to promote the close integration of ideological and political education with course content, embedding ideological and political education throughout the entire teaching process, thereby leveraging the educational role of the course.

8. Course evaluation and continuous improvement mechanism

(1) Course evaluation

The course evaluation cycle is set at once per semester. The evaluation is based on the achievement of the course objectives:

The achievement of course objective 1 is evaluated by the comprehensive evaluation of the midterm test and final exam;

The achievement of course objective 2 is comprehensively evaluated by the calculation

and analysis of regular assignments and final exam;

The course evaluation is carried out as follows:

program objective	Corresponding graduation requirements	evaluation methodology	remarks
Course Objective 1	2.2	The scoring method	Final exams, midterm tests
Course objective 2	12. 1	The scoring method	Regular assignments and final exams

(2) Continuous improvement mechanism

(1) Establish a continuous improvement system

① Establish a continuous improvement group for this course.

② The head of the course continuous improvement group is responsible for organizing, implementing and supervising the continuous improvement process.

③ Develop continuous improvement measures.

(2) Establish a course continuous improvement group

Team leader: course leader Team member: course team member

(3) Continuous improvement of courses

① Regular grade assessment mechanism: According to the learning situation of each class of students, teachers of the course group must summarize and collect various indicators of regular grade assessment every 4 weeks, adjust the status of students in time, and make corresponding records.

② Final examination assessment mechanism: analyze the final examination paper, count the score of each part of the test, use the statistical results to analyze the whole course, and make improvements in the next class of students.

(4) Continuous improvement measures of the course

① For the regular assessment of grades, measures such as symposium, discussion group, establishment of study groups and individual communication with students are adopted to improve the assessment.

② For the final examination assessment, unified guidance and other measures are taken

for students who take the make-up exam to improve according to the problems in students examination and the key content of this course.

Formulator (signature):
Director of department (office) review (signature):
Professional person in charge of review
(seal):