# Appendix B-7: Orbital Engineering Syllabus

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# Orbital Engineering Syllabus

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|---|---|---|---|---|---|---|---|
| course title | Orbital engineering | | | | | Course number | 9033113021 |
| English name | Railroad Track Engineering | | | | | | |
| Applicable specialties | Civil Engineering (construction engineering direction ☐ road and bridge direction ☐ urban rail transit direction ☑) | | | | | | |
| 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 | 90 | credit | 3 | Contact hours | 48 | Self-study hours | 42 |
| Prerequisite courses | Theoretical mechanics, material mechanics, structural mechanics, principles of concrete structure design | | | | | | |
| Textbooks and teaching materials | Course materials: Highlighted. Track Engineering [M]. Beijing: China Railway Press, 2015.<br>Reference: Li Chenghui. Railway tracks [M]. Beijing: China Railway Press, 2014.<br>Railway Track Design Code (TB10082-2017) [S]. Beijing: China Railway Press, 2017.<br>Railway Seamless Line Design Code (TB10015-2012) [S]. Beijing: China Railway Press, 2013. | | | | | | |

## 1. Course Introduction

"Track Engineering" is a core professional course in the direction of urban rail transit engineering within the Civil Engineering discipline, and it is a required course for the major. The main content includes ballasted and non-ballasted track structures, geometric and positional aspects of track structures, mechanical analysis of track structures, structure and geometric dimensions of turnouts, basic principles of seamless lines, stability calculations, structural design methods, maintenance and management of track structures, and urban rail transit track structures. The learning objectives are to master the structures of ballasted and non-ballasted tracks, understand the geometric and positional aspects of track structures, apply principles of track structure mechanics and seamless line principles to design track structures, grasp the structure and dimensions of turnouts, possess the ability to calculate turnout designs, and be capable of maintaining and managing track structures.

## 1. The graduation requirements supported by this course and the path to achieve them

(1) The graduation requirements that this course can support

| Number | Graduation requirement indicators | Specific content of graduation requirement indicators |
|---|---|---|
| 1 | Graduation requirements 1.3 | Be able to use civil engineering professional knowledge and other knowledge to analyze, model and solve complex civil engineering problems, and have the ability to compare and synthesize solutions |
| 2 | Graduation requirement 5.2 | Be able to use modern tools to analyze, calculate and design complex civil engineering problems, and be able to analyze the effectiveness and limitations of the results |
| 3 | Graduation requirements 12.2 | Have the ability of independent learning, including the ability to understand technical problems, summarize and summarize, and ask questions, so as to adapt to the new development of civil engineering industry |

(2) The implementation path of graduation requirements in this course

1. Course objectives

Through the teaching of this course, students will master basic knowledge and have certain application ability. The specific objectives of this course are as follows:

Course Objective 1: master the professional knowledge of ballasted track structure, ballasted track structure, track geometry and position, turnout, seamless line, track maintenance, etc., understand the cutting-edge dynamic of track structure, be able to use the knowledge to analyze, model and solve complex engineering problems in track engineering, compare and synthesize solutions.

Course Objective 2: be able to use MATLAB, EXCEL and other modern tools to analyze, calculate and design complex engineering problems such as mechanical analysis and strength calculation of track structure in track engineering, size calculation and track distribution of single turnout, calculation and design of wireless line, etc., and analyze the effectiveness and limitations of the results.

Course Objective 3: In the study of track engineering knowledge and its application, I can cultivate my ability of independent learning, including the ability to understand technical problems, summarize and summarize, and put forward questions, so as to adapt to the new

development of civil engineering industry.

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

| Graduation requirement indicators | Course teaching objectives |
|---|---|
| Graduation requirements 1.3 | Course Objective 1 |
| Graduation requirement 5.2 | Course objective 2 |
| Graduation requirement 12.2 | Course objective 3 |

## 2. Expected learning results and details of teaching links

(1) Expected learning outcomes

The expected learning outcomes of this course are as follows

| blocks of knowledge | knowledge point | initial level | Degree of requirement | Expected learning outcomes | corresponding program objective |
|---|---|---|---|---|---|
| 1. Basic concepts of orbital structure | 1. The function, characteristics, types and requirements of the track | L1 | L 2 | 1. Correctly understand the role and characteristics of tracks; correctly distinguish different types of track structures; correctly distinguish the different requirements of high-speed railway, heavy-haul railway and urban rail transit for track structures; understand new technologies of track structures. | 1 |
| 2. Ballasted track structure | 2. Structure composition and components of ballasted track | L1 | L2 | 2. Correctly understand the structural composition of ballasted tracks and the functions of each part; distinguish between types of | 1 |

| blocks of knowledge | knowledge point | initial level | Degree of requirement | Expected learning outcomes | corresponding program objective |
|---|---|---|---|---|---|
| | | | | rails, correctly set the rail joints, and use rails; correctly differentiate the classification of sleepers and understand their advantages and disadvantages; correctly distinguish between joint connection components and intermediate connection components (couplers); correctly understand the ballast materials and technical standards of ballasted tracks, as well as the cross-sectional characteristics of the subgrade. | |
| 3. Ballastless track structure | 3. Types and structures of ballastless tracks | L1 | L2 | 3. Understand the types and parameters of common ballastless track connection parts; understand the structure composition and characteristics of various types of ballastless tracks. | 1 |
| 4. Track geometry and position | 4. Basic elements of orbital geometry | L1 | L2 | 4. Understand the structure of the running part of locomotives and rolling stock; correctly understand the | 1 |

| blocks of knowledge | knowledge point | initial level | Degree of requirement | Expected learning outcomes | corresponding program objective |
|---|---|---|---|---|---|
| | | | | basic requirements, meanings and standards of the geometric position of straight tracks. | |
| | 5. Curve track gauge widening, overhang and transition curve | L1 | L2 | 5. Correctly design the curve super height; correctly understand the basic principles and calculation methods of curve gauge widening; understand the function and setting method of the transition curve. | 1 |
| 5. Track structure mechanical analysis | 6. Quasi-static calculation and strength verification of track structure | L1 | L3 | 6. The continuous elastic foundation beam model is correctly applied to the static calculation of the track; the formula is correctly applied to the quasi-static calculation of the dynamic action of the track structure; the strength of each part of the track is correctly checked. | 2 |
| 6. Turnouts | 7. Type of turnout, structure and geometric dimensions of single turnout and overall layout diagram | L1 | L3 | 7. Understand the type of turnout; correctly understand the structure of a single turnout; correctly understand the geometric dimensions and significance of a single turnout. | 2 |

| blocks of knowledge | knowledge point | initial level | Degree of requirement | Expected learning outcomes | corresponding program objective |
|---|---|---|---|---|---|
| | 8. Crossing speed and measures to improve crossing speed | L1 | L2 | 8. Correctly understand the speed of crossing and measures to improve the speed of crossing. | 1 |
| 7. Seamless lines | 9. Stability principle and structural design method of seamless line | L1 | L3 | 9. Correctly distinguish the types of seamless lines and understand the basic principles, understand temperature force, longitudinal resistance of lines and temperature force; understand the concept of stability of seamless lines and influencing factors, apply unified theory of stability of seamless lines for calculation; correctly determine the design locking rail temperature and design structure of seamless lines. | 2 |
| 8. Repair and management of orbital structures | 10. Repair content of track structure, machinery and management | L1 | L2 | 10. Correctly understand the content of track structure inspection; correctly apply regulations to evaluate the quality of track structure; understand track structure repair machinery; understand seamless line | 3 |

| blocks of knowledge | knowledge point | initial level | Degree of requirement | Expected learning outcomes | corresponding program objective |
|---|---|---|---|---|---|
| | | | | maintenance technology; understand the characteristics of high-speed railway maintenance and repair. | |
| 9. Other urban rail transit tracks | 11. Introduction to other urban rail transit tracks | L1 | L2 | 11. Understand the track structure characteristics of ordinary subway rail transit, linear motor wheel rail traffic, monorail traffic, maglev rail transit and other urban rail transit. | 3 |

(2) Detailed rules for teaching links

| content of courses (knowledge point) | Class hours | Expected learning outcomes (ILO) | Implementation link (In class, projects, etc.) | instructional strategies |
|---|---|---|---|---|
| 1. The function, characteristics, types and requirements of the track | 2 | 1. Correctly understand the role and characteristics of tracks; correctly distinguish different types of track structures; correctly distinguish the different requirements of high-speed railway, heavy-haul railway and urban rail transit for track structures; understand new technologies of track structures. | In-class teaching class exercise | lecture deliberate picture presentation Problem-oriented |
| 2. Structure composition and components of ballasted track | 4 | 2. Correctly understand the structure of ballasted tracks and the functions of each part; distinguish between types of rails, correctly set the rail joints, and use rails; correctly differentiate the classification of sleepers and understand their advantages and disadvantages; correctly distinguish between joint connection components and intermediate connection components (couplers); | In-class instruction class exercise homework | lecture deliberate picture presentation Problem-oriented |

| content of courses (knowledge point) | Class hours | Expected learning outcomes (ILO) | Implementation link (In class, projects, etc.) | instructional strategies |
|---|---|---|---|---|
| | | correctly understand the ballast materials and technical standards for ballasted tracks, as well as the cross-sectional characteristics of the subgrade. | | |
| 3. Types and structures of ballastless tracks | 2 | 3. Understand the types and parameters of common ballastless track connection parts; understand the structure composition and characteristics of various ballastless tracks. | In-class instruction class exercise homework | lecture deliberate picture presentation Problem-oriented guidance |
| 4. Basic elements of orbital geometry and position | 2 | 4. Understand the structure of the running part of locomotives and rolling stock; correctly understand the basic requirements, meanings and standards of the geometric shape and position of straight track. | In-class instruction class exercise homework | lecture deliberate picture presentation Problem-oriented |
| 5. Curve track gauge widening, overhang and transition curve | 6 | 5. Correctly design the curve super height; correctly understand the basic principles and calculation methods of the curve gauge widening; understand the function and setting methods of the transition curve. | In-class instruction class exercise homework | lecture Problem-oriented Example analysis deliberate |
| 6. Quasi-static calculation and strength verification of track structure | 8 | 6. Correctly apply the continuous elastic base beam model to the static calculation of the track; correctly apply the formula to the quasi-static calculation of the dynamic action of the track structure; correctly check the strength of each component of the track. | In-class instruction class exercise Big assignment 1 | lecture Problem-oriented guidance Example analysis deliberate |
| 7. Type of turnout, structure, geometric dimensions and general layout diagram of single | 8 | 7. Understand the type of turnout; correctly understand the structure of a single turnout; correctly understand the geometric dimensions and significance of a single turnout. | In-class instruction class exercise Big assignment 2 | lecture Problem-oriented Example analysis deliberate |

| content of courses (knowledge point) | Class hours | Expected learning outcomes (ILO) | Implementation link (In class, projects, etc.) | instructional strategies |
|---|---|---|---|---|
| turnout | | | | |
| 8. Crossing speed and measures to improve crossing speed | 2 | 8. Correctly understand the speed of crossing and measures to improve the speed of crossing. | In-class instruction class exercise homework | lecture deliberate Problem-oriented |
| 9. Stability principle and structural design method of seamless line | 8 | 9. Correctly distinguish the types of seamless lines and understand the basic principles, understand temperature force, longitudinal resistance of lines and temperature force; understand the concept of stability of seamless lines and influencing factors, apply unified theory of stability of seamless lines for calculation; correctly determine the design locking rail temperature and design structure of seamless lines. | In-class instruction class exercise homework | lecture deliberate Problem-oriented guidance |
| 10. Repair content, machinery and management of the track structure | 4 | 10. Correctly understand the content of track structure inspection; correctly apply the regulations to evaluate the quality of track structure; understand the track structure repair machinery; understand the maintenance technology of seamless lines; understand the characteristics of high-speed railway maintenance and repair. | autonomic learning classroom testing homework | lecture deliberate picture presentation Problem-oriented guidance |
| 11. Urban rail transit track structure | 2 | 11. Understand the track structure characteristics of ordinary subway rail transit, linear motor wheel rail transit, monorail transit, maglev rail transit and other urban rail transit. | autonomic learning classroom testing homework | Problem-oriented deliberate |

## 4. Course assessment

(1) Course assessment structure

| Examination items | scale | ask |
|---|---|---|

| | | | |
|---|---|---|---|
| usual performance | Homework | 15% | Knowledge units (2, 3, 4, 6, 7) are arranged once each, and knowledge units 8 and 9 are combined once. There are a total of 6 regular assignments, which are completed independently by individuals |
| | In-class test | 15% | Each knowledge unit is assessed once, focusing on the students mastery of core knowledge points, with objective questions as the main part |
| | Big assignments | 10% | The internal force calculation of the track structure (knowledge unit 5) and the strength calculation of each part of the track structure are carried out independently by the students, focusing on the examination of students ability |
| final | | 6 0% | Assessment 1~7 knowledge units, focusing on the assessment of students mastery of professional knowledge and comprehensive analysis ability of specific engineering problems |
| amount to | | 100% | |

Note: When the final exam score is lower than (excluding) 5 0 points, the regular score is counted as no more than 6 0 points.

(2) Course assessment rules

| **Assessment items** | **primary coverage** | |
|---|---|---|
| | **Knowledge units/points** | **Ability items** |
| Homework | 2. Ballasted track structure<br>3. Ballastless track structure<br>4. Track geometry<br>6. Turnouts<br>7. Seamless lines<br>8. Repair, management and management of track structure 9. Other urban rail transit tracks | Written expression ability / analytical reasoning and solving complex engineering problems ability / industry standard reading and application ability / |
| In-class test | All knowledge units | Objective questions are all assessed in terms of knowledge |
| Big assignments | 5. Track structure mechanical analysis | Ability to effectively express complex civil engineering problems with drawings, charts and texts/ individual design of structures, components (nodes) to meet specific civil engineering requirements/ ability to |

| Assessment items | primary coverage | |
|---|---|---|
| | Knowledge units/points | Ability items |
| | | conduct multi-solution comparison and obtain effective conclusions/ ability to read and apply industry standards |
| final | Unit 1~7 Knowledge | |

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

Master the principles and methods of mechanical analysis and strength verification for track structures in railway engineering, dimensional calculation and track alignment for single turnout, wireless line calculation and design, etc. Be capable of using modern tools such as MATLAB and EXCEL to model and calculate complex engineering problems in related railway projects, effectively express the analysis process and conclusions, and analyze the validity and limitations of the results.

**6. Non-technical ability training and observation**

Cultivation: Guide students to study Unit 8 (Track Structure Repair and Management) and Unit 9 (Other Urban Rail Transit Tracks) independently. Through self-study, field research, and discussion outside of class, students will be encouraged to find solutions to complex engineering problems on their own and communicate effectively with classmates and teachers. This will foster their ability to learn independently and adapt to industry development needs.

Observation: The completion of regular assignments and classroom tests in units 8 and 9 is the main observation point.

**7. Course ideological and political design**

This course primarily teaches the basic requirements and standards for track engineering structure design and construction. In the process of imparting professional knowledge,

students should be made to understand that the design phase and construction phase are critical stages for quality control in engineering projects, determining the final quality of the physical structure. Students must always be educated to strictly adhere to design standards, construction norms, and acceptance criteria during both the design and construction phases. They should never blindly pursue economic benefits at the expense of quality, or substitute inferior materials for better ones, cutting corners. It is essential to fully recognize ones social responsibility. When you participate in a qualified construction project, on a smaller scale, you earn your salary and contribute to your family; on a larger scale, you contribute to national development.

## 8. Course evaluation and continuous improvement mechanism

(1) Course evaluation

The course evaluation cycle is set once per semester to evaluate the achievement of course objectives:

1. The achievement of course objective 1 is evaluated by in-class tests of knowledge points 1-5, 8, 10 and 11, regular assignments and final exams;

2. The achievement of course objective 2 is evaluated through in-class tests, major assignments and final exams of knowledge points 6, 7 and 9;

3. Achievement of Course Objective 3 Students will be evaluated by homework and tests after self-study with given self-study materials.

The course evaluation is carried out as follows:

| program objective | Corresponding graduation requirements | evaluation methodology | remarks |
|---|---|---|---|
| Course Objective 1 | 1.3 | The scoring method | Comprehensive evaluation through in-class test, regular homework and final exam |
| Course objective 2 | 5.2 | The scoring method | Comprehensive evaluation through in-class test, major assignment and final exam |
| Course | 12.2 | The scoring | Comprehensive evaluation |

| | | | |
|---|---|---|---|
| objective 3 | | method | through regular homework and classroom tests. |

(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 and supervising the continuous improvement process.

③ Develop continuous improvement measures.

2. Establish a course continuous improvement group

Team leader: person in charge of the course team. Team members: members of the course team

3. Continuous improvement of the course

① Regular grade assessment mechanism: According to the academic situation of each class, teachers of the course group must summarize and calculate the 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, and use the statistical results to analyze the course as a whole, so as to make improvements in the next class of students.

Formulator (signature):

Director of department (office) review (signature):

Professional person in charge of review (seal):