Competence field	Mathematics, Physics and Chemistry
Module designation	Unary Calculus (1)
Code, if applicable	219151
Subtitle, if applicable	
Semester(s) in which the module is taught	1st semester
Person responsible for the module	Professor WANG Guoqiang
Lecturer	Professor WANG Guoqiang Associate Professor FANG Tao Associate Professor ZHENG Zhongtuan Associate Professor WU Suichao Associate Professor LI Yiyang
Language	Chinese
Relation to curriculum	As an important introductory course designed for undergraduate students majoring in engineering in SUES, this course investigates differential calculus of one variable. The content of this course includes function, limit and continuity, derivative and differentiation, median theorem and application of derivatives. This course aims to provide students with an in-depth knowledge of related basic concepts/theories and basic calculation skills, providing a thorough grounding in mathematics and laying a foundation for further studies in mathematics. This course will help students to develop their skills required for logical reasoning, spatial imagination, calculation, abstraction and generalization, with an aim to help student to use their mathematical knowledge to solve problems in real contexts. It will also develop students' critical thinking skills for issue analyzing and problem solving, and improve their creativity and innovation.
Type of teaching, contact hours	Target students: students of Vehicle Engineering (Rail Transit Vehicle) Type of teaching: Using lecturing as a primary teaching method in combination with class discussion as a complementary manner Contact hours: 48 hours Of which Theoretical teaching: 48 hours Experiment/practice teaching: 0 hour Computer practice: 0 hour Size of class: 60-120 students
Workload	Workload = 90 hours Contact hours = 48 hours Self-study hours = 42 hours
Credit points	3.0
Requirements according to the	Only students with class attendance rate over 2/3 and

examination regulations	assignment completion rate over 2/3 are allowed to take the exam.
Recommended prerequisites	N/A
Module objectives/intended learning outcomes	Leaning outcomes: ● **Knowledge:** (1) Function, limit and continuity; (2) Derivative and differential; (3) Mean value theorem and derivative. ● **Skills:** (1) Make use of basic algorithms of unary function limit and differential calculus of univariate function to solve problems; (2) Apply basic operation and solution rules to solve limit and derivative problems; (3) Use derivatives to find the monotonicity of a function and determine extreme values. ● **Competence:** After successfully completing this course, students will be able to apply the concepts and techniques of scientific thinking to analyze and solve problems, and develop skills required for abstraction, generalization, and logical reasoning. They will be able to apply mathematical knowledge and methods to solve problems with application in sciences. This course will also help students to lay a foundation for further studies in subsequent courses with an aim to enable them to use their mathematical knowledge and skills to solve problems in real contexts (such as geometry and physics problems).
Contents	**Part A. Theoretical teaching (48 contact hours; 42 self-study hours)** **Chapter 1.** Functions and Limits (18 contact hours; 16 self-study hours) ● The concepts and properties of functions (parity, monotonicity, periodicity and boundedness); basic elementary functions.** ● The concepts of composite functions and inverse functions. The concepts of elementary functions.* ● Establish functional relations to solve simple practical problems.** ● Mixed operation laws for limits. Use variable substitutions to determine the limits of some simple composite functions.** ● The concept of a function which is continuous (1) only at a point and (2) on an interval.* **Chapter 2.** Derivatives and Differentials (16 contact hours;

	14 self-study hours) ● The concept of derivative and its geometric meaning (students are not required to use the derivative definition to study the derivability of an abstract function). The relationship between the derivability and continuity of a function.* ● Rational operation laws for derivatives and derivation rules for composite functions. Derivative formula for basic elementary functions.** ● The concept of higher order derivatives. Methods to find the first and second derivatives for elementary functions (students are not required to find the general expression of the nth derivative of a function).** ● The first derivative of a function implied by implicit functions and parametric equations and the simple second derivatives of these two types of functions. Rates of change in some simple practical problems.** ● The concept of differentiation;* ● Differential formula of basic elementary functions.** **Chapter 3.** Median Theorem and its Application (14 contact hours; 12 self-study hours) ● Rolle's Theorem and Lagrange's Mean Value Theorem. Cauchy's Theorem (students are not required to analyze and prove this theorem) * ● Determine the limits of an infinitive by using L'Hospital's Rules.** ● The concept of extreme values of a function;* ● Use the derivatives of a function to find its monotonicity and the method for finding extreme values. Solve simple maximum and minimum problems with application in sciences** ● Use the derivatives to determine the concavity and convexity of a function graph, find the inflection point and plot simple functions (including horizontal and vertical asymptotes).** **Part B. Experiment/practice teaching: 0 hours**
Study and examination requirements and forms of examination	● Attendance (no late arrivals, no early departures, and no unauthorized absences) 10% ● In-class performance (classroom participation, classroom discussion, etc.) 5%; ● Assignments (homework) 5% ● Periodic assessment (online test) 20% ● Final assessment (final exam) 60%
Media employed	PPT courseware, multimedia computers, projectors, laser pointers, blackboards, etc.
Reading list	1. Required books

	[1] ZHANG Xueshan, LI Lu. *Advanced Mathematics (Volume 1)*, Beijing: Tsinghua University Press, 2013. 2. Reference books [1] Department of Mathematics, Tongji University. *Advanced Mathematics (Volume 1)*, Beijing: Higher Education Press. 2014. [2] Department of Mathematics, Tongji University. *Sample Answers to Questions in Advanced Mathematics (Volume 1,·7th Edition)*, Beijing: Higher Education Press. 2014. [3] WU Ganchang. *Advanced Mathematics (Volume 1, Science and Engineering, 5th Edition)*, Beijing: China Renmin University Press, 2017. [4] WU Ganchang. *Study Aids and Sample Answers for Advanced Mathematics (Volume 1, Science and Engineering, 5th Edition)*, Beijing: China Renmin University Press, 2017. [5] Weir, Hass, Giordano. *Thomas Calculus (Volume 1, 11th Edition)*, Beijing: Higher Education Press. 2016. [6] MA Zhien. *Fundamentals of Advanced Mathematics (I)*, Beijing: Higher Education Press, 2008.

Competence field	Mathematics, Physics and Chemistry

Module designation	Unary Calculus (2)
Code, if applicable	219152
Subtitle, if applicable	
Semester(s) in which the module is taught	1st semester
Person responsible for the module	Professor WANG Guoqiang
Lecturer	Professor WANG Guoqiang Associate Professor FANG Tao Associate Professor ZHENG Zhongtuan Associate Professor WU Suichao Associate Professor LI Yiyang
Language	Chinese
Relation to curriculum	As an important introductory course designed for undergraduate students majoring in engineering in SUES and a successor to Unary Calculus (1), this course investigates integral calculus of one variable and ordinary differential equations. The content of this course includes indefinite integral, definite integral, application of definite integral, and ordinary differential equation. This course aims to provide students with an in-depth knowledge of related basic concepts/theories and basic calculation skills, providing a thorough grounding in mathematics and laying a foundation for further studies in mathematics. This course will help students to develop their skills required for logical reasoning, spatial imagination, calculation, abstraction and generalization, with an aim to help student to use their mathematical knowledge to solve problems in real contexts. It will also develop students' critical thinking skills for issue analyzing and problem solving, and improve their creativity and innovation.
Type of teaching, contact hours	Target students: students of Vehicle Engineering (Rail Transit Vehicle) Type of teaching: Using lecturing as a primary teaching method in combination with class discussion as a complementary manner Contact hours: 48 hours Of which Theoretical teaching: 48 hours Experiment/practice teaching: 0 hour Computer practice: 0 hour Size of class: 60-120 students
Workload	Total workload = 90 hours

	Contact hours = 48 hours Self-study hours = 42 hours
Credit points	3.0
Requirements according to the examination regulations	Only students with class attendance rate over 2/3 and assignment completion rate over 2/3 are allowed to take the exam.
Recommended prerequisites	Unary Calculus (1)
Module objectives/intended learning outcomes	Learning outcomes: **Knowledge:** This course aims to provide student with fundamental theoretical knowledge of unary integrals and ordinary differential equations, including: （1） Basic knowledge of indefinite integral and definite integral; （2） Definite integral and its application; （3） Ordinary differential equations. **Skills:** **（1）** Make use of basic algorithms to find definite and indefinite integrals; **（2）** Apply basic operation and solution rules to solve definite and indefinite integrals problems **（3）** Apply basic methods and techniques to solve ordinary differential equations. **Competence:** This course aims to provide students with the mathematical knowledge and skills for numerical calculation, symbolic calculation and other calculation, as well as skills required for plane observation, abstraction, generalization, and logical reasoning. After successfully completing this course, students will be able to develop critical thinking skills for issue analyzing and problem solving, and apply mathematical knowledge and methods to solve problems with application in sciences. This course will also improve students' creativity and innovation. This course will also help students to lay a foundation for further studies in subsequent courses with an aim to enable them to use their mathematical knowledge and skills to solve problems in real contexts (such as geometry and physics problems).
Contents	**Part A. Theoretical teaching (48 contact hours; 42 self-study hours)** **Chapter 4.**Indefinite Integral (16 contact hours; 14 self-study hours) ● The concept of primitive function and indefinite integral;* ● The properties of indefinite integral;**

	● Basic integral formula for indefinite integrals. Direct integration method, completing differention method, and substitution method to find indefinite integrals;** ● Partial integration for indefinite integrals.** **Chapter 5.** Definite Integral and its Application (18 contact hours; 16 self-study hours) ● The concept of definite integral and its geometric meaning (students are not required to use the definition of definite integral to find definite integrals and limits). The properties of definite integral and the mean value theorem of integral;* ● Use integral with variable upper limit as a function of its upper limit and its derivative theorem;* ● Newton-Leibniz Theorem;** ● Substitution method and partial integration method for definite integral;** ● Establishment of integral expressions for some simple geometric and physical quantities;** ● Calculation of the area of a plane figure and the volume of a rotating body. ** **Chapter 6.** Ordinary Differential Equations (14 contact hours; 12 self-study hours) ● Equations with separable variables and rules to solve first-order linear equations;** ● Rules to solve homogeneous equations;** ● Rules to solve the differential equations of the following form with the reduction method: $y^{(n)} = f(x),\ y'' = f(x, y'),\ y'' = f(y, y').$ ** ● The properties of the solutions to linear differential equations and the structural theorems of the solutions;* ● Rules to solve second-order homogeneous linear differential equation with constant coefficients;** ● Particular and general solutions to second-order non-homogeneous linear differential equations with constant coefficients whose free terms are polynomials or exponential functions;** **Part B. Experiment/practice teaching: 0 hour**
Study and examination requirements and forms of examination	● Attendance (no late arrivals, no early departures, and no unauthorized absences) 10% ● In-class performance (classroom participation, classroom discussion, etc.) 5%; ● Assignment (homework) 5%; ● Periodic assessment (online test) 20%; ● Final assessment (final exam) 60%.
Media employed	PPT courseware, multimedia computers, projectors, laser

	pointers, blackboards, etc.
Reading list	1. Required books [1] ZHANG Xueshan, LI Lu. *Advanced Mathematics (Volume 1)*, Beijing: Tsinghua University Press, 2013. 2. Reference books [1] Department of Mathematics, Tongji University. *Advanced Mathematics (Volume 1, 7th Edition)*, Beijing: Higher Education Press. 2014. [2] Department of Mathematics, Tongji University. *Sample Answers to Questions in Advanced Mathematics (Volume 1 ·7th Edition)*, Beijing: Higher Education Press. 2014. [3] WU Ganchang. *Advanced Mathematics (Volume 1, Science and Engineering, 5th Edition)*, Beijing: China Renmin University Press, 2017. [4] WU Ganchang. *Study Aids and Sample Answers for Advanced Mathematics (Volume 1, Science and Engineering, 5th Edition)*, Beijing: China Renmin University Press, 2017. [5] Weir, Hass, Giordano. *Thomas Calculus (Volume 1, 11th Edition)*, Beijing: Higher Education Press. 2016. [6] MA Zhien. *Fundamentals of Advanced Mathematics (I)*, Beijing: Higher Education Press, 2008.

Competence field	Mathematics, Physics and Chemistry

Module designation	Multivariate Calculus (1)
Code, if applicable	219155
Subtitle, if applicable	
Semester(s) in which the module is taught	2nd semester
Person responsible for the module	Associate Professor ZHENG Zhongtuan
Lecturer	Associate Professor LI Lu Associate Professor HU Xi Professor WANG Guoqiang Associate Professor WU Suichao Associate Professor LI Yiyang Associate Professor ZHENG Zhongtuan
Language	Chinese
Relation to curriculum	As an important introductory course designed for undergraduate students majoring in engineering in SUES, this course investigates differential and integral calculus of multivariable functions. The content of this course includes space analytic geometry and vector algebra, differential calculus of multivariable functions, and multiple integrals. This course aims to provide students with an in-depth knowledge of related basic concepts/theories and basic calculation skills, providing a thorough grounding in mathematics and laying a foundation for further studies in mathematics. This course will help students to develop their skills required for logical reasoning, spatial imagination, calculation, abstraction and generalization, with an aim to help student to use their mathematical knowledge to solve problems in real contexts. It will also develop students' critical thinking skills for issue analyzing and problem solving, and improve their creativity and innovation.
Type of teaching, contact hours	Target students: students of Vehicle Engineering (Rail Transit Vehicle) Type of teaching: Using lecturing as a primary teaching method in combination with class discussion as a complementary manner Contact hours: 48 hours Of which Theoretical teaching: 48 hours Experiment/practice teaching: 0 hour Computer practice: 0 hour Size of class: 60-120 students
Workload	Total workload = 90 hours Contact hours = 48 hours Self-study hours = 42 hours

Credit points	3.0
Requirements according to the examination regulations	Only students with class attendance rate over 2/3 and assignment completion rate over 2/3 are allowed to take the exam.
Recommended prerequisites	Unary Calculus (1) and Unary Calculus (2)
Module objectives/intended learning outcomes	Leaning outcomes: ● **Knowledge:** This course aims to provide student with fundamental theoretical knowledge of differential and integral calculus of multivariable functions, including: （1） Spatial analytic geometry and vector algebra; （2） Differential calculus of multivariable functions; （3） Multiple integrals. ● **Skills:** （1） Describe the equations and graphs of common quadric surfaces; （2） Apply the basic operation and solution rules to solve problems in vectors, derivatives of multivariable functions and integrals, etc.; （3） Use multiple integrals to calculate volume, mass, center of gravity, moment of inertia of a solid, etc. ● **Competence:** This course aims to provide students with the mathematical knowledge and skills for vector operations, numerical and symbolic calculation of limits and integrals for multivariable functions and other calculation, as well as skills required for spatial imagination, abstraction, generalization, and logical reasoning. After successfully completing this course, students will be able to develop critical thinking skills for issue analyzing and problem solving, and apply mathematical knowledge and methods to solve problems with application in sciences. This course will also improve students' creativity and innovation. This course will also help students to lay a foundation for further studies in subsequent courses with an aim to enable them to use their mathematical knowledge and skills to solve problems in real contexts (such as geometry and physics problems).
Contents	**Part A. Theoretical teaching (48 contact hours; 42 self-study hours)** **Chapter 7.** Spatial Analytic Geometry and Vector Algebra; (14 contact hours; 12 self-study hours) ● The concept and presentation of space rectangular coordinate system and vector.*

	● Vector operation (linear operation, dot product, and cross product), and conditions to determine if two vectors are perpendicular or parallel.** ● The coordinate expression of unit vector, direction cosine and vector. Use of coordinate expression in vector calculus.** ● The concept of formula for a curved surface. Equations of commonly used quadrics and their and graphics. The properties of surfaces of revolution created by rotating a curve around the coordinate axis and cylindrical surface equation with the generatrix parallel to the coordinate axis.* ● Plane equations and straight line equations and their solutions. Use the relationship between planes and straight lines to solve related problems.** **Chapter 8.** Concept of Multivariable Functions. (18 contact hours; 16 self-study hours) ● The concept of multivariable function.* ● The concept of limit and continuity of binary function.* ● The concept of partial derivative and total differential. The necessary and sufficient conditions for the existence of total differential.* ● How to find the first- and second-order partial derivatives of a composite function. How to find the partial derivatives of an implicit function.** ● The concept of a tangent to a curve and a tangent plane to a curved surface and their equations.** ● The concept of extreme values and conditional extreme values of a binary function;* ● Find the extreme values of a binary function. Determine the maximum and minimum values in some simple problems with application in sciences** **Chapter 9.** Multiple Integral (16 contact hours; 14 self-study hours) ● The concept of double integral and triple integral. The properties of multiple integrals;* ● Make use of basic algorithms to find double integrals (rectangular coordinates, polar coordinates). Calculate simple triple integrals (rectangular coordinates, cylindrical coordinates, spherical coordinates);** ● Simple application of multiple integrals. Use double integrals to calculate the volume, mass, center of gravity, and moment of inertia of a solid.** **Part B. Experiment/practice teaching: 0 hour**

Study and examination requirements and forms of examination	● Attendance (no late arrivals, no early departures, and no unauthorized absences) 10% ● In-class performance (classroom participation, classroom discussion, etc.) 5%; ● Assignment (homework) 5%; ● Periodic assessment (online test) 20%; ● Final assessment (final exam) 60%.
Media employed	PPT courseware, multimedia computers, projectors, laser pointers, blackboards, etc.
Reading list	1. Required books [1] ZHANG Xueshan, LI Lu. *Advanced Mathematics (Volume 1)*, Beijing: Tsinghua University Press, 2013. 2. Reference books [1] Department of Mathematics, Tongji University. *Advanced Mathematics (Volume 1, 7th Edition)*, Beijing: Higher Education Press. 2014. [2] Department of Mathematics, Tongji University. *Sample Answers to Questions in Advanced Mathematics (Volume 1 · 7th Edition)*, Beijing: Higher Education Press. 2014. [3] WU Ganchang. *Advanced Mathematics (Volume 1, Science and Engineering, 5th Edition)*, Beijing: China Renmin University Press, 2017. [4] WU Ganchang. *Study Aids and Sample Answers for Advanced Mathematics (Volume 1, Science and Engineering, 5th Edition)*, Beijing: China Renmin University Press, 2017. [5] Weir, Hass, Giordano. *Thomas Calculus (Volume 1, 11th Edition)*, Beijing: Higher Education Press. 2016. [6] MA Zhien. *Fundamentals of Advanced Mathematics (I)*, BeiJing: Higher Education Press, 2008.

Competence field	Mathematics, Physics and Chemistry
Module designation	Multivariate Calculus (2)
Code, if applicable	219156
Subtitle, if applicable	
Semester(s) in which the module is taught	2nd semester
Person responsible for the module	Associate Professor ZHENG Zhongtuan
Lecturer	Associate Professor LI Lu Associate Professor HU Xi Professor WANG Guoqiang Associate Professor WU Suichao Associate Professor LI Yiyang Associate Professor ZHENG Zhongtuan
Language	Chinese
Relation to curriculum	As an important introductory course designed for undergraduate students majored in engineering in SUES, this course investigates line integral, surface integral and infinite series. The content of this course includes curve integral, surface integral, series of constant terms, and series of function terms. This course aims to provide students with an in-depth knowledge of related basic concepts/theories and basic calculation skills, providing a thorough grounding in mathematics and laying a foundation for further studies in mathematics. This course will help students to develop their skills required for logical reasoning, spatial imagination, calculation, abstraction and generalization, with an aim to help student to use their mathematical knowledge to solve problems in real contexts. It will also develop students' critical thinking skills for issue analyzing and problem solving, and improve their creativity and innovation.
Type of teaching, contact hours	Target students: students of Vehicle Engineering (Rail Transit Vehicle) Type of teaching: Using lecturing as a primary teaching method in combination with class discussion as a complementary manner Contact hours: 48 hours Of which Theoretical teaching: 48 hours Experiment/practice teaching: 0 hour Computer practice: 0 hour Size of class: 60-120 students

Workload	Total workload = 90 hours Contact hours = 48 hours Self-study hours = 42 hours
Credit points	3.0
Requirements according to the examination regulations	Only students with class attendance rate over 2/3 and assignment completion rate over 2/3 are allowed to take the exam.
Recommended prerequisites	Multivariate Calculus (1)
Module objectives/intended learning outcomes	Learning outcomes: ● **Knowledge:** This course aims to provide student with fundamental theoretical knowledge of line integral, surface integral and infinite series, including: **（1）** Curve integral, surface integral; **（2）** Line integral, surface integral, flux, divergence, circulation, curl and other fundamental concepts of field theory; **（3）** Infinite series and power series expansion of commonly used functions. ● **Skills:** **（1）** This course aims to provide student with fundamental concepts and theoretical knowledge of line integral, surface integral and infinite series, including: **（2）** Make use of basic algorithms to find curve integrals and surface integrals; **（3）** Apply basic operation rules to solve problems in relation to series of constant terms and power series. ● **Competence:** This course aims to provide students with the mathematical knowledge and skills for numerical and symbolic calculation of line integrals, surface integrals and series convergence and divergence, as well as skills required for spatial imagination, abstraction, generalization, and logical reasoning. After successfully completing this course, students will be able to develop critical thinking skills for issue analyzing and problem solving, and apply mathematical knowledge and methods to solve problems with application in sciences. This course will also improve students' creativity and innovation. This course will also help students to lay a foundation for further studies in subsequent courses with an aim to enable them to use their mathematical knowledge and skills to solve problems in real contexts (such as geometry and physics problems).
Contents	**Part A. Theoretical teaching (48 contact hours; 42 self-study hours)**

	Chapter 10. Curve Integral and Curved Surface Integral (16 contact hours; 22 self-study hours) ● The concept of the two types of curve integrals. The properties of the two types of curve integrals and their relationship. Calculation of the two types of curve integrals (students are only required to be able to perform simple calculations on the integrals of space curves).** ● Green's Theorem. Conditions that determine whether a line integral is independent of path or not** ● The physical significance of path independence of line integrals of the second type. ● The concept, interrelation and computational method of the two types of curved surface integrals. ● Gauss' Theorem.** ● Use line integrals and surface integrals to calculate volume, mass, center of gravity, and moment of inertia of a curved component, etc.** ● The basic concepts of flux, divergence, curl and other fundamental concepts of field theory. Simple applications of line integrals and surface integrals in field theory. * **Chapter 11.** Infinite Series (24 contact hours; 20 self-study hours) ● The concepts of constant series convergence, divergence and the sum of convergent series;** ● The basic properties of series and the necessary conditions for convergence of series.* ● Convergence of geometric series and p-series. Examination of the convergent of a positive series by using direct comparison method and root value method;** ● Leibniz's Theorem of alternating series;** ● The concept of absolute convergence and conditional convergence of an infinite series. The relationship between absolute convergence and conditional convergence.** ● Find the convergence radius and convergence interval of a power series (to find the endpoint of interval of convergence).** ● The sum function of a power series in the convergence zone. Find the sum of certain series.** ● Use the power series expansion of the commonly used functions to indirectly expand some simple functions into power series.**

	● Expand the function defined on [-π, π] into a Fourier series. Know how to write the expression of the sum of a Fourier series;** **Part B. Experiment/practice teaching: 0 hour**
Study and examination requirements and forms of examination	● Attendance (no late arrivals, no early departures, and no unauthorized absences) 10% ● In-class performance (classroom participation, classroom discussion, etc.) 5%; ● Assignment (homework) 5%; ● Periodic assessment (online test) 20%; ● Final assessment (final exam) 60%.
Media employed	PPT courseware, multimedia computers, projectors, laser pointers, blackboards, etc.
Reading list	1. Required books [1] ZHANG Xueshan, LI Lu. *Advanced Mathematics (Volume 1)*, Beijing: Tsinghua University Press, 2013. 2. Reference books [1] Department of Mathematics, Tongji University. *Advanced Mathematics (Volume 1, 7th Edition)*, Beijing: Higher Education Press. 2014. [2] Department of Mathematics, Tongji University. *Sample Answers to Questions in Advanced Mathematics (Volume 1 · 7th Edition)*, Beijing: Higher Education Press. 2014. [3] WU Ganchang. *Advanced Mathematics (Volume 1, Science and Engineering, 5th Edition)*, Beijing: China Renmin University Press, 2017. [4] WU Ganchang. *Study Aids and Sample Answers for Advanced Mathematics (Volume 1, Science and Engineering, 5th Edition)*, Beijing: China Renmin University Press, 2017. [5] Weir, Hass, Giordano. *Thomas Calculus (Volume 1, 11th Edition)*, Beijing: Higher Education Press. 2016. [6] MA Zhien. *Fundamentals of Advanced Mathematics (I)*, Beijing: Higher Education Press, 2008.

Competence field	Mathematics, Physics and Chemistry
Module designation	Probability Theory and Mathematical Statistics
Code, if applicable	219163
Subtitle, if applicable	
Semester(s) in which the module is taught	3rd semester
Person responsible for the module	WU Suichao Associate Professor
Lecturer	Associate Professor LIU Ruijuan Associate Professor LIU Chunyan Associate Professor ZHOU Yu Associate Professor WU Suichao
Language	Chinese
Relation to curriculum	As a basic mathematics discipline that studies the statistical regularity of random phenomena from a quantitative perspective, Probability Theory and Mathematical Statistics is a science of reasoning by deduction and induction of the statistical regularity of random phenomena. Probability Theory and Mathematical Statistics can be divided into two interrelated branches, i.e., probability theory and mathematical statistics. Probability is a quantitative measure of the possibility that a random event occurs. Topics covered in the Probability Theory include, but not limited to, calculating probabilities by using the classical probability model, the distribution of random variables and numerical characteristics, and limit theorems. Mathematical Statistics is one of the mathematical sciences that have the most direct and extensive interactions with the real world. It investigates a number of fundamental knowledge and principles, including point estimation (estimation by method of moment, maximum likelihood estimation), parameter hypothesis testing, non-parametric hypothesis testing, variance analysis, multiple regression analysis, and reliability analysis, providing students with an in-depth knowledge of various statistical concepts and principles. After successfully completing this course, students will be able to describe and use the statistical concepts and principles of the Probability Theory and Mathematical Statistics, apply mathematical knowledge and methods to perform numerical or analytical calculation, and translate real-world problems in economics and management into probability and statistics models.

Type of teaching, contact hours	Target students: students of Vehicle Engineering (Rail Transit Vehicle) Type of teaching: Using lecturing as a primary teaching method in combination with class discussion as a complementary manner Contact hours: 48 hours Of which Theoretical teaching: 48 hours Experiment/practice teaching: 0 hour Computer practice: 0 hour Size of class: 60-90 students
Workload	Total workload = 90 hours Contact hours = 48 hours Self-study hours = 42 hours
Credit points	3.0
Requirements according to the examination regulations	Only students with class attendance rate over 2/3 and assignment completion rate over 2/3 are allowed to take the exam.
Recommended prerequisites	N/A
Module objectives/intended learning outcomes	Leaning outcomes: ● **Knowledge:** （1）Demonstrate understanding of the concepts of point estimation (estimation by method of moment, maximum likelihood estimation), parameter hypothesis testing, non-parametric hypothesis testing; （2）Demonstrate understanding of the concepts and principles of variance analysis, multiple regression analysis, and reliability analysis, among others; （3）Demonstrate understanding of fundamental knowledge of random mathematics. ● **Skills:** （1）Apply commonly used analysis and calculation rules and methods to solve problems, e.g., calculating probabilities by using the classical probability model; （2）Make use of probability formula and Bayes' Theorem to find the conditional probability of events, the mathematical expectation and variance of random variables; （3）Demonstrate understanding of how to find a confidence interval for the mean of a normal population. ● **Competence:**

	After successfully completing this course, students will be able to translate real-world problems in economics and management into probability and statistics models, and apply statistical concepts and principles to solve problems in real contexts.
Contents	**Part A. Theoretical teaching (48 contact hours; 42 self-study hours)** **Probability Theory and Mathematical Statistics** **Chapter 1.** Random Events and Their Probabilities (10 contact hours; 10 self-study hours) ● The concept of random events and sample space;* ● The relationship between events and basic operations;** ● The concept of event frequency; the statistical regularity of random phenomena;* ● The concept of classical probability;* ● The basic properties of probability (additive theorem in particular); use these properties to perform probability calculation;** ● The concept of conditional probability;* ● The Multiplication Theorem, Law of Total Probability and Bayes' Theorem. Apply these theorems to perform probability calculation. ** **Chapter 2.** Random Variables and Their Distribution (10 contact hours; 10 self-study hours) ● The concept and properties of the distribution function;* ● Discrete random variables and continuous random variable, and methods of describing them;** ● The concepts and properties of distribution law and distribution density;* ● Binomial distribution, Possion distribution, uniform distribution, exponential distribution and normal distribution. Make use of probability distribution to find the probability of related events;** ● The concepts of random variables and distribution functions;* ● Distribution function of a random variable (strictly monotonic) and methods of finding the probability distribution. ** **Chapter 3.** Multidimensional Random Vector and its Distribution (6 contact hours; 6 self-study hours) ● The concepts and properties of joint distribution

	function, joint distribution law, joint distribution density of bivariate random variables;* ● Methods of calculating the probability of an event;** ● The relationship between the marginal distribution and joint distribution of bivariate random variables;** ● The concept of independence of random variables;* ● Methods of calculating the probability of the independence of a random variable;** ● The distribution function of a bivariate random variable. * **Chapter 4.** Numerical Characteristics of Random Variables (6 contact hours; 6 self-study hours) ● The concepts, properties and calculation of mathematical expectation and variance;** ● Methods of calculating the mathematical expectation of the function of a random variable;** ● Mathematical expectation and variance of binomial distribution, Possion distribution, uniform distribution, exponential distribution and normal distribution;** ● The concept, properties and calculation of correlation coefficient;** ● Chebyshev's inequality. * **Chapter 5.** Law of Large Numbers and Central Limit Theorem(4 contact hours; 2 self-study hours) ● Law of Large Numbers by Jacob Bernoulli. ** **Chapter 6.** Key Concepts in Mathematical Statistics (4 contact hours; 4 self-study hours) ● The concepts of population, individual, sample and statistics;* ● Methods of finding the sample mean and sample variance;** ● The definitions of chi-square distribution, t-distribution, and F-distribution and methods of reading relevant tables;** ● The distribution of some commonly used statistics for a normal population. * **Chapter 7.** Parameter Estimation (4 contact hours; 2 self-study hours) ● Point estimation;** ● Estimation by method of moment (first-order,

	second-order) and maximum likelihood estimation. Estimator selection criteria;* ● The concept of interval estimation;* ● Methods of calculating the confidence interval for the mean and variance of the normal population. ** **Chapter 8.** Hypothesis Testing (4 contact hours; 2 self-study hours) ● The key concepts and steps in hypothesis testing;** ● Two types of errors that may occur in hypothesis testing;* ● Hypothesis testing of the mean and variance of one or two normal population(s).** **Part B. Experiment/practice teaching: 0 hour**
Study and examination requirements and forms of examination	After-class assignment shall be done independently by students after each class. Daily performance accounts for 40%, including attendance, in-class performance, assignments and stage assessments; Final exam (closed-book written exam): 60%.
Media employed	PPT courseware, multimedia computers, projectors, laser pointers, blackboards, etc.
Reading list	1. Required books [1] GE Yubo. *Probability Theory and Mathematical Statistics (2nd Edition)*. Beijing: Tsinghua University Press, 2017 2. Reference books [1] SHENG Xu, XIE Shiqian, PAN Chengyi. *Probability Theory and Mathematical Statistics*. Beijing: Higher Education Press, 2001.3. [2] XU Bosheng, ZHANG Ying. *Study Guide for Probability Theory and Mathematical Statistics*. Shanghai: Donghua University Press, 2013.6 [3] MAO Shisong, CHENG Yiming, PU Xiaolong. *A Textbook for Probability Theory and Mathematical Statistics.* Beijing: Higher Education Press. 2011.

Competence field	Mathematics, Physics and Chemistry
Module designation	Physics (Mechanics)
Code, if applicable	219251
Subtitle, if applicable	
Semester(s) in which the module is taught	2nd semester
Person responsible for the module	Associate Professor XU Hongxia
Lecturer	Associate Professor XU Hongxia Associate Professor CHEN Guanglong Associate Professor ZHAO Xinxin Lecturers: WANG Shunzhi, SHAO Huili, XIAO Yunhua, CHEN Li, REN Li, CAO Yunjiu, WANG Lili, SONG Pei, ZHANG Huiyan, WANG Huiping
Language	Chinese
Relation to curriculum	As a common fundamental course compulsory for students majoring in science and engineering in institutions of higher learning, Physics (Mechanics) is a discipline of physics that finds profound applications in science and engineering. This course investigates various knowledge and skills in classical mechanics. Topics covered in this course include particle mechanics, rigid body mechanics, fluid mechanics, simple harmonic oscillation, and other basic theories and fundamental laws. Topics on the particle mechanics and rigid body mechanics covered in this course include the applications of kinematics and dynamics analysis to find the characteristics of motion of particles and rigid bodies (such as law of momentum conservation, law of angular momentum conservation, and work-energy theorem and energy conservation). Topics on the fluid mechanics covered in this course include the properties of ideal fluids and Bernoulli equation. Topics on the simple harmonic oscillation covered in this course include the changes in motion and energy of the harmonic oscillator under ideal conditions, and synthesis of simple harmonic motions, among others. After successfully completing this course, students will be able to have an in-depth understanding of the fundamental theories, knowledge and skills to solve simple problems in real contexts.
Type of teaching, contact hours	Target students: students of Vehicle Engineering (Rail Transit Vehicle) Type of teaching: Using lecturing as a primary teaching method in combination with class discussion as a

	complementary manner Contact hours: 32 hours Of which Theoretical teaching: 32 hours Experiment/practice teaching: 0 hour Computer practice: 0 hour Size of class: 80-136 students
Workload	Total workload = 60 hours Contact hours = 32 hours Self-study hours = 28 hours
Credit points	2.0
Requirements according to the examination regulations	Only students with class attendance rate over 2/3 and assignment completion rate over 2/3 are allowed to take the exam.
Recommended prerequisites	Unary Calculus (1) and Unary Calculus (2)
Module objectives/intended learning outcomes	Leaning outcomes: ● **Knowledge:** **（1）** Demonstrate understanding of the methods of describing particle dynamics and kinematics, the physical laws they follow, and other fundamental knowledge. **（2）** Demonstrate understanding of the methods of describing the phenomenon of rigid body rotation on a fixed axis and the physical laws it follows; **（3）** Demonstrate understanding of the key concepts, fundamental theories and basic methods in simple harmonic oscillation; ● **Skills:** （1） Apply appropriate rules based on the characteristics, properties and actual situation of an ideal particle, to establish a rational mechanical model for the particle, and analyze its movement based on the force applied on it and its initial conditions; （2） Apply appropriate analysis to describe the physical quantities of a rigid body (such as rotational inertia, torque, and angular momentum). Make use of the law of conservation of angular momentum to solve related issues; （3） Demonstrate understanding of the periodic vibration of a simple harmonic oscillator and description methods to perform simple calculation on vibration synthesis.

	● **Competence:** After successfully completing this course, students will be able to apply physical concepts and principles to solve problems in engineering technologies and scientific research through scientific observation, analysis, synthesis, deduction, induction, scientific abstraction, analogy and association, and experiment. Students will also develop critical thinking skills for issue analyzing and problem solving.
Contents	**Part A. Theoretical teaching (32 contact hours; 28 self-study hours)** **Part I Particle Kinematics (6 contact hours; 4 self-study hours)** ● Position vector, displacement vector, velocity vector, acceleration vector, and other physical quantities used to describe the movement and change in the movement of the particle. ** ● Make use of the rectangular coordinate system to calculate the velocity and acceleration of a particle moving in a plane. ** ● Methods of calculating angular velocity, angular acceleration, tangential acceleration and normal acceleration of a particle when it moves in a circular motion. ** **Part II Newton's Laws of Motion (4 contact hours; 4 self-study hours)** ● Newton's law of motion and its applicable conditions;* ● Apply the concepts of calculus to solve simple particle dynamics problems under the work of a one-dimensional variable force;** ● The relativity principle of Newtonian mechanics;* ● Galileo coordinates and velocity transformation;* ● Methods of analyzing simple relative motion problems related to translation motion. ** **Part III Law of Conservation of Momentum and Energy (6 contact hours; 6 self-study hours)** ● The concept of momentum and impulse. Methods of calculating the impulse of a variable force in a linear motion. ** ● The concept of work and methods of calculating the

	work of a variable force in a linear motion;** ● The characteristics of conservative work and the concept of potential energy;** ● Methods of calculating the potential energy of gravity, elasticity and universal gravitation;** ● The kinetic energy theorem and momentum theorem of a particle. Methods of analyzing and solving simple mechanical problems of a mass point moving in a plane. ** ● The law of conservation of mechanical energy, the law of conservation of momentum and their applicable conditions;** ● Make use of the concepts and techniques from the law of conservation to analyze the mechanical problems of simple systems moving in a plane. ** **Part IV Rigid Bodies and Fluids (10 contact hours; 8 self-study hours)** ● The concept of moment of inertia. The law of rotation of a rigid body on a fixed axis.** ● The concept of moment of momentum (angular momentum) and the law of conservation of moment of momentum, as well as their applicable conditions;* ● Make use of the law of momentum conservation to analyze and calculate related problems.** ● The properties of ideal fluids and Bernoulli equation.* **Part V Mechanical Oscillation (6 contact hours; 6 self-study hours)** ● Describe the physical significance of physical quantities (especially phase) for simple harmonic oscillation and their relationship;** ● Rotation vector method, and its application in solving related problems;** ● The basic characteristics of simple harmonic oscillation, and methods of establishing the differential equations for simple harmonic oscillation of a spring oscillator or a pendulum;** ● Derive the equation of motion of a one-dimensional oscillation based on the given initial conditions and

	understand its physical significance.** ● The synthesis law of two harmonic oscillations of the same direction and the same frequency, and the conditions when the maximum or minimum amplitude can be achieved.* **Part B. Experiment/practice teaching: 0 hour.**
Study and examination requirements and forms of examination	After-class assignment shall be done independently by students after each class. Daily performance accounts for 30%, including assignments, in-class performance and attendance; Final assessment (closed-book written exam) accounts for 70%.
Media employed	PPT courseware, course website resources, Learning APP, multimedia computers, laser pointers, blackboards, etc.
Reading list	1. Required books [1] Editor-in-Chief MA Wenwei. *Physics (6th Edition) (2014.7)*, Beijing: Higher Education Press. 2. Reference books [1] Teaching Division of Physics, Shanghai University of Engineering Science. Study Guide for College Physics. Beijing: Tsinghua University Press, 2011. [2] Teaching Division of Physics, Shanghai University of Engineering Science. Assignments for College Physics. Beijing: Tsinghua University Press, 2011. [3] MAO Junjian, GU Mu. College Physics. Beijing: Higher Education Press. 2007. [4] Teaching and Research Section of Department of Physics, Shanghai Jiaotong University. College Physics. Shanghai: Shanghai Jiaotong University Press, 2006. [5] Teaching Division of Physics, Shanghai University of Engineering Science. College Physics. Beijing: Tsinghua University Press, 2013. [6] Halliday (USA), translated by TENG Xiaoying, ZHANG Sanhui, etc., and adapted by MA Tingjun. Fundamentals of Physics. Beijing: Machinery Industry Press, 2009.

Competence field	Mathematics, Physics and Chemistry
Module designation	Physics (Electromagnetics)
Code, if applicable	219252
Subtitle, if applicable	
Semester(s) in which the module is taught	2nd semester
Person responsible for the module	Associate Professor CHEN Guanglong, Associate Professor QIN Liguo;
Lecturer	Professor ZHANG Xiuli QIN Liguo, XU Hongxia, CHEN Guanglong, ZHAO Xinxin Associate Professor Lecturers: XIAO Yunhua, SHAO Huili, CHEN Li, WANG Lili, ZHANG Huiyan, WANG Huiping, CAO Yunjiu, SONG Pei, WANG Shunzhi
Language	Chinese
Relation to curriculum	As a compulsory introductory course designed for students majoring in science and engineering in institutions of higher learning, Physics (Electromagnetism) is an integral part in university physics education. This course aims to provide students with an in-depth knowledge of the key concepts and rules in static electricity and steady magnetic field, and the concepts and principles in electric field strength, electric potential, and the phenomenon of electrostatic equilibrium (the Gauss's law for magnetic field and Ampere's law in particular). Students will be able to apply the Gauss's law to calculate the electric field distribution of a charged body with a special symmetrical charge distribution. Emphasis will be given both to the concept of magnetic induction intensity and Biot-Savart law, and the Gauss's law for magnetic field and Ampere's law, with an aim to ensure that students can apply the Ampere's law to calculate the magnetic field distribution around an energized conductor with a special symmetrical charge distribution. Other topics covered in this course will include the concepts of Ampere's law, Lorentz force law, magnetic moment, polarization and magnetization of a medium, energy of an electromagnetic field, and some practical applications of electromagnetics. Emphasis will also be given to developing students' critical thinking skills and scientific and methodological rigor, as well as their abilities to analyze and solve problems with application in sciences.
Type of teaching, contact hours	Target students: students of Vehicle Engineering (Rail

	Transit Vehicle) Type of teaching: Using lecturing as a primary teaching method in combination with class discussion as a complementary manner Contact hours: 32 hours Of which Theoretical teaching: 32 hours Experiment/practice teaching: 0 hour Computer practice: 0 hour Size of class: 67-122 students
Workload	Total workload = 60 hours Contact hours = 32 hours Self-study hours = 28 hours
Credit points	2.0
Requirements according to the examination regulations	Only students with class attendance rate over 2/3 and assignment completion rate over 2/3 are allowed to take the exam.
Recommended prerequisites	Unary Calculus (1) and Unary Calculus (2)
Module objectives/intended learning outcomes	Leaning outcomes: ● **Knowledge:** （1） Demonstrate understanding of the concepts of electric field strength and electric potential in an electrostatic field and their superposition principle, as well as the Gauss's law for magnetic field and Ampere's law and other key concepts; （2） Demonstrate understanding of the electrostatic balance phenomenon of a conductor in an electrostatic field and its application, especially the capacitance of a capacitor; （3） Demonstrate understanding of the basic concepts and techniques to solve problems in a constant magnetic field, including the concept of magnetic induction intensity and Biot-Savart law; the Gauss's law for magnetic field and Ampere's law, Ampere's law, Lorentz force law, and magnetic moment. ● **Skills:** （1） Make use of the physical quantities of an electrostatic field to describe the distribution of the electrostatic field. And apply the Gauss's law for magnetic field to calculate the electric field and potential distribution of a charged body with a special symmetrical charge distribution;

	（2） Make use of the electrostatic equilibrium condition to analyze the laws of electrostatic balance, calculate the capacitance of a simple capacitor, etc.; （3） Apply the Biot-Savart law and the Ampere's law to calculate the magnetic field distribution around an energized conductor with a special symmetrical charge distribution. ● **Competence:** After successfully completing this course, students will be able to apply the fundamental concepts and techniques to simplify and abstract physical models for charged bodies and energized conductors in real engineering contexts, and analyze the distribution of electric and magnetic fields and the forces applied on them. They will be able to apply the electromagnetic knowledge learned in this course to solve practical issues. They will also understand the mechanisms behind electromagnetic phenomena and can apply them to solve practical problems. This course will also help students expand their knowledge and acquire new skills.
Contents	**Part A. Theoretical teaching (32 contact hours; 28 self-study hours)** **Part 1. Chapter 5. Electrostatic Field (14 contact hours; 13 self-study hours)** ● The concept of electric field strength of an electrostatic field;** ● The vector superposition principle for electrostatic fields. Methods of calculating the field strength of some simple charged objects by using the field strength superposition principle;** ● The concept of electric field lines;** ● Calculation of electric flux;** ● The Gauss's law for magnetic field;* ● The conditions and methods of using Gauss's law to calculate the field strength;** ● The characteristics and calculation of the work done by an electrostatic field;* ● The Ampere's law for electrostatic field;* ● The concept of electric potential of an electrostatic field, and the integral relationship between electric potential and field strength. Methods of calculating the electric potential in simple applicable scenarios;**

	Part 2: Chapter 6. Conductors and Dielectrics in Electrostatic Field(6 contact hours; 5 self-study hours) ● Electrostatic equilibrium phenomenon of conductors in electrostatic field and its application;* ● The characteristics of conductors in electrostatic field;** ● The capacitance of capacitor;* ● Methods of calculating the capacitance of 3 types of capacitors.*** ● The concept of electric energy density;* ● Methods of calculating the stored field energy in the electric field in some simple symmetrical cases.** **Part 3: Chapter 7. Constant Magnetic Field (12 contact hours; 10 self-study hours)** ● The concept of magnetic induction intensity and the principles of magnetic field superposition;** ● Biot-Savart law and its application in calculating the magnetic induction intensity in simple applicable scenarios;** ● The concept of magnetic induction line, and methods of calculating magnetic flux. The Gauss's law for magnetic field;** ● The Ampere's law and the conditions and methods of using Ampere's law to calculate the magnetic induction intensity;** ● The Lorentz force law. Analysis of the force and movement of a point charge in a uniform electromagnetic field (including pure electric fields and pure magnetic fields);* ● The Ampere's law and its application in calculating the force on current-carrying conductors with simple geometry in a magnetic field;* ● The concept of magnetic moment, and methods of calculating the magnetic moment of a planar current-carrying coil in a uniform magnetic field.* **Part B. Experiment/practice teaching: 0 hour**
Study and examination requirements and forms of examination	Attendance accounts for 10%, assignment accounts for 10%, in-class performance accounts for 10%, and final assessment (closed-book written exam) accounts for 70%.
Media employed	PPT courseware, multimedia computers, projectors, laser

	pointers, blackboards, etc.
Reading list	1. Required books [1] *Physics*, MA Wenwei et.al. Southeast University, BeiJing: Higher Education Press, sixth edition, 2014. 2. Reference books [1] Teaching Division of Physics, Shanghai University of Engineering Science. *Study Guide for College Physics*. Beijing: Tsinghua University Press, 2011. [2] Teaching Division of Physics, Shanghai University of Engineering Science. *Assignments for College Physics*. Beijing: Tsinghua University Press, 2011. [3] MAO Junjian, GU Mu. *College Physics*. Beijing: Higher Education Press. 2007. [4] Teaching and Research Section of Department of Physics, Shanghai Jiaotong University. *College Physics*. Shanghai: Shanghai Jiaotong University Press, 2006. [5] Teaching Division of Physics, Shanghai University of Engineering Science. *College Physics*. Beijing: Tsinghua University Press, 2013. [6] Halliday (USA), translated by TENG Xiaoying, ZHANG Sanhui et al., and adapted by MA Tingjun. Fundamentals of Physics. Beijing: Machinery Industry Press, 2009.

Competence field	Mathematics, Physics and Chemistry
Module designation	Wave and Optics
Code, if applicable	219253
Subtitle, if applicable	
Semester(s) in which the module is taught	3rd semester
Person responsible for the module	Professor ZHANG Xiuli
Lecturer	Professor ZHANG Xiuli Associate Professor XU Hongxia, Associate Professor CHEN Guanglong; Lecturers: REN Li, WANG Lili, SONG Pei, CAO Yunjiu, CHEN Li, XIAO Yunhua, etc.
Language	Chinese
Relation to curriculum	As a compulsory introductory course designed for students majoring in science and engineering in colleges and universities, Wave and Optics is an integral part in university physics education with the knowledge of the basic laws of physics at its core. This course aims to provide students with an in-depth knowledge of the Faraday's law and Lenz's law of electromagnetic induction, and the concepts of motional electromotive force and induced electromotive force. Students will be able to understand the physical significance of the production of mechanical waves and the equation of its speed of propagation, as well as the characteristics and basic concepts of optical interference and diffraction phenomena. Students will develop skills for analyzing Young's double slits, thin films, and interference fringes with equal thickness, as well as the impact of slit width and wavelength on the distribution of diffraction fringes. After successfully completing this course, students will be able to understand the fundamental principles of grating diffraction, light polarization, Brewster's Law and Malus' Law, and develop valuable skill of applying optical theory to solve practical problems. Emphasis will also be given to developing students' critical thinking skills and ability to analyze and solve problems in regard to electromagnetic waves, mechanical waves, and light waves, etc.
Type of teaching, contact hours	Target students: students of Vehicle Engineering (Rail Transit Vehicle) Type of teaching: Using lecturing as a primary teaching method in combination with class discussion as a complementary manner Contact hours: 32 hours Of which

	Theoretical teaching: 32 hours Experiment/practice teaching: 0 hour Computer practice: 0 hour Size of class: 100-136 students
Workload	Total workload = 60 hours Contact hours = 32 hours Self-study hours = 28 hours
Credit points	2.0
Requirements according to the examination regulations	Only students with class attendance rate over 2/3 and assignment completion rate over 2/3 are allowed to take the exam.
Recommended prerequisites	Multivariate Calculus (1) and (2), Physics (Mechanics), Physics (Electromagnetism)
Module objectives/intended learning outcomes	Leaning outcomes: ● **Knowledge:** **（1）** Demonstrate understanding of the Faraday's law and Lenz's law of electromagnetic induction, and the basic concepts, as well as the principles and physical significance of motional electromotive force, induced electromotive force, self-inductance coefficient, mutual-inductance coefficient and magnetic energy; **（2）** Demonstrate understanding of generation and classification of mechanical waves. Describe and analyze the characteristics of the fluctuation of plane harmonics. Understand the physical significance of the wave equation and its oscillogram and some simple calculations, wave interference and diffraction phenomena and generation conditions, etc.; **（3）** Demonstrate understanding of optical phenomena such as interference, diffraction and polarization in wave optics, including Young's double-slit interference, interference of thin films with equal thickness, single-slit Fraunhofer diffraction, grating diffraction, and light polarization, etc.; ● **Skills:** （1） Analyze and calculate motional electromotive force and induced electromotive force based on electromagnetic induction phenomena. Apply appropriate approaches to change the coefficients of self-inductance and mutual inductance, etc. （2） Establish the wave equation of the plane harmonic wave based on the harmonic vibration equation of the known mass point, and analyze the characteristics of the propagation of plane harmonic wave propagation

	in the medium; （3） Apply physical theories of interference, diffraction and polarization in wave optics to analyze various common interference and diffraction phenomena. Use Brewster's Law and Malus' Law to analyze and detect light polarization, reflection and refraction. ● **Competence:** After successfully completing this course, students will be able to understand the comprehensive theories of electromagnetic waves, mechanical waves and wave optics. They will apply the basic knowledge and basic laws learned in this course to analyze issues in real engineering contexts in regard to electromagnetic waves, mechanical waves, and light waves. They will develop skills to analyze and calculate the related factors in simple physical phenomena, and develop critical thinking skills for issue analyzing and problem solving from the perspectives of fluctuations. They will be able to apply the wave optics knowledge learned in this course to solve practical issues, thus improving engineering quality and technical level. This course will also help students expand their knowledge and acquire new skills.
Contents	**Part A. Theoretical teaching (32 contact hours; 28 self-study hours)** **Wave and Optics** **Part 1. Electromagnetic Induction and Electromagnetic Waves (10 contact hours; 8 self-study hours)** ● The concept of electromotive force;* ● Electromagnetic induction phenomenon and its application;** ● Faraday's law of electromagnetic induction and related calculation;** ● Lenz's law and its physical significance;** ● The concepts and behaviors of motional electromotive force and induced electromotive force;** ● The physical significance of induced electric field, the differences and similarities between an induced electric field and an electrostatic field;* ● Definition, physical significance and related calculation of self-inductance and mutual inductance coefficient. ● The concept of magnetic energy density. Know how to calculate the field energy stored in the magnetic field in some simple symmetrical situations. * **Part 2. Mechanical Waves (10 contact hours; 8 self-study hours)**

	● Method of establishing the wave function (wave equation) of plane harmonics based on the harmonic motion equation of the known mass point. The physical significance of wave function (wave equation), oscillogram; ** ● Energy characteristics of waves;** ● Huygens Principle, and the principle of superposition of waves;* ● Coherence conditions for waves;** ● Use the concept of phase difference or wave path difference to analyze and determine the conditions for amplitude strengthening and weakening of coherent waves after superposition.** **Part 3. Wave Optics (12 contact hours; 12 self-study hours)** ● Analyze and determine the position of interference fringes (including wedge and Newton's ring) of thin films with equal thickness;** ● Method of analyzing the distribution pattern of single-slit Fraunhofer diffraction fringes;** ● Analyze the impact of slit width and wavelength on the distribution of diffraction fringes;** ● Use grating diffraction formula to determine the position of grating diffraction patterns;* ● Analyze the impact of grating constant and wavelength on the distribution of grating diffraction lines;** ● Definition of natural light and linearly polarized light, and can differentiate these two lights;** ● Malus' Law and related analysis and calculations;** ● Generation and inspection method for polarized light;* ● Brewster's Law and related analysis and calculations;** **Part B. Experiment/practice teaching: 0 hour**
Study and examination requirements and forms of examination	After-class assignments shall be done independently by students after each class. Daily performance accounts for 30%, including assignments, mid-term examination and attendance; Final assessment (closed-book written exam) accounts for 70%.
Media employed	PPT courseware, multimedia computers, projectors, laser pointers, blackboards, etc.
Reading list	1. Required books [1] MA Wenwei. *Physics (6th Edition)*. Beijing: Higher Education Press. 2014

	2. Reference books [1] Teaching Division of Physics, Shanghai University of Engineering Science. Study Guide for College Physics. Beijing: Tsinghua University Press, 2011. [2] Teaching Division of Physics, Shanghai University of Engineering Science. Assignments for College Physics. Beijing: Tsinghua University Press, 2011. [3] MAO Junjian, GU Mu. College Physics. Beijing: Higher Education Press. 2016. [4] Teaching and Research Section of Department of Physics, Shanghai Jiaotong University. College Physics. Shanghai: Shanghai Jiaotong University Press, 2006. [5] Teaching Division of Physics, Shanghai University of Engineering Science. College Physics. Beijing: Tsinghua University Press, 2013. [6] Halliday (USA), translated by TENG Xiaoying, ZHANG Sanhui, et al., and adapted by MA Tingjun. Fundamentals of Physics. Beijing: Machinery Industry Press, 2009.

Competence field	Mathematics, Physics and Chemistry
Module designation	Heat and Modern Physics
Code, if applicable	219254
Subtitle, if applicable	
Semester(s) in which the module is taught	3rd semester
Person responsible for the module	Associate Professor QIN Liguo
Lecturer	Associate Professors: XU Hongxia, CHEN Guanglong, QIN Liguo; Lecturers: WANG Lili, SONG Pei, CAO Yunjiu, WANG Shunzhi, LI Xingjia, XIAO Yunhua, SHAO Huili, CHEN Li
Language	Chinese
Relation to curriculum	As a compulsory introductory course designed for students majoring in science and engineering in institutions of higher learning, Heat and Modern Physics is an integral part in university physics education with the knowledge of the basic laws of physics at its core. This course aims to provide students with an in-depth knowledge of related basic concepts, basic theories and basic approaches in kinetic theory of gases, thermodynamics, relativity and quantum physics. Topics on the kinetic theory of gases covered in this course include the ideal gas law, the theorem of equipartition of energy (stating that gas molecules in thermal equilibrium have the same average energy associated with each independent degree of freedom of their motion) and velocity distribution of gas molecules. Topics on the basic laws of thermodynamics include the use of the first law of thermodynamics to analyze the changes in work, heat and internal energy in different simple processes and the efficiency of the Carnot cycle, as well as the two statements of the second law of thermodynamics. Topics on the theory of relativity include the two fundamental assumptions of Einstein's special theory of relativity; the concepts of the relativity of simultaneity, length contraction and time expansion in the special theory of relativity; and the relationship between mass, speed, and energy. Topics on the quantum physics include Einstein’s photoelectric equation and its simple applications, the wave-particle duality of photons, De Broglie wave and its statistical interpretation, wave functions and their statistical

	interpretations, some simple quantum physical phenomena and experiments. After successfully completing this course, students will be able to have an in-depth knowledge of thermodynamics and physics theory, and scientific thinking skills in applying the basic laws of physics to explain common physical phenomena.
Type of teaching, contact hours	Target students: students of Vehicle Engineering (Rail Transit Vehicle) Type of teaching: Using lecturing as a primary teaching method in combination with class discussion as a complementary manner Contact hours: 32 hours Of which Theoretical teaching: 32 hours Experiment/practice teaching: 0 hour Computer practice: 0 hour Size of class: 100-136 students
Workload	Total workload = 60 hours Contact hours = 32 hours Self-study hours = 28 hours
Credit points	2.0
Requirements according to the examination regulations	Only students with class attendance rate over 2/3 and assignment completion rate over 2/3 are allowed to take the exam.
Recommended prerequisites	Unary Calculus A (1) and (2), Multivariate Calculus A (1) and (2), Physics (Mechanics), Physics (Electromagnetism)
Module objectives/intended learning outcomes	Leaning outcomes: ● **Knowledge:** **（1）** Understand the concepts of pressure, temperature, and internal energy, among others, the ideal gas law, the theorem of equipartition of energy (stating that gas molecules in thermal equilibrium have the same average energy associated with each independent degree of freedom of their motion) and velocity distribution of gas molecules, from the macroscopic and statistical significance perspective. **（2）** The concepts of work and heat and the two statements of the first and second law of thermodynamics; **（3）** Basic laws of Einstein's special theory of relativity, including two fundamental

	assumptions, the relativity of simultaneity, length contraction and time expansion, and the relationship between speed, mass, and energy; （4） Einstein's photoelectric equation and its simple applications, the wave-particle duality of photons, De Broglie wave and its statistical interpretation, wave functions and their statistical interpretations, some simple quantum physical phenomena and experiments. Fundamental knowledge and basic approaches in kinetic theory of gases, thermodynamics, relativity and quantum physics; ● **Skills:** （1） Analyze the behavior of an ideal gas under various condition of temperature, pressure, internal energy and velocity from the statistical thermodynamics perspective; （2） Analyze and calculate the changes in heat, work, internal energy and Carnot cycle efficiency of various gases based on the first law of thermodynamics; （3） Use the basic laws of Einstein's special theory of relativity to explain the relativity of simultaneity, length contraction and time expansion, and calculate the relationship between speed, mass and energy in high-speed motion; （4） Use the basic knowledge and basic laws of quantum physics to analyze and explain some simple phenomena. ● **Competence:** After successfully completing this course, students will be able to apply the basic concepts and techniques learned in this course to analyze thermal phenomena, effects of relativity and quantum issues in real engineering and scientific research contexts, and explain the physical phenomena and laws in it. They will develop critical thinking skills for issue analyzing and problem solving from the perspectives of thermodynamics, relativity and quantum theories. They will be able to analyze and solve problems from the perspective of mathematics and physics. By understanding various phenomena of heat and modern physics, students will be able to apply their knowledge to solve problems in real contexts. This course

	will also help students expand their knowledge and acquire new skills.
Contents	**Part A. Theoretical teaching (32 contact hours; 28 self-study hours)** **Heat and Modern Physics** **Part 1. Kinetic Theory of Gases (8 contact hours; 6 self-study hours)** ● The concepts of pressure, temperature, internal energy, etc. Understand the fact that the macroscopic nature of a system is the statistical manifestation of Brownian motion on the microscopic level;* ● The image of the thermal motion of gas molecules, the Ideal Gas Law and their physical significance;* ● The relationship between macroscopic and the microscopic quantities, the approach of analyzing macroscopic properties from microscopic models; ● The theorem of equipartition of energy (stating that gas molecules in thermal equilibrium have the same average energy associated with each independent degree of freedom of their motion). Calculate the constant pressure, constant volume heat capacity and internal energy of an ideal gas;* ● The physical significance and skillful application of Maxwell's rate distribution law and rate distribution function.** **Part 2. Fundamentals of Thermodynamics (8 contact hours; 8 self-study hours)** ● The concept of work and heat;* ● The quasi-static process;* ● Use the first law of thermodynamics to analyze and calculate the changes in work, heat and internal energy and the efficiency of the Carnot cycle in an equivalent process and an adiabatic process of an ideal gas;** ● Two statements of the second law of thermodynamics;* ● Statistical interpretation of reversible and irreversible processes by using the second law of thermodynamics; ● Practical applications of heat: dissipative structure theory and self-organization phenomena. **Part 3. Theory of Relativity (7 contact hours; 6 self-study hours)**

	● The two fundamental assumptions of Einstein's special theory of relativity;* ● The Lorentz coordinate transformation;* ● The concepts of the relativity of simultaneity, length contraction and time expansion in the special theory of relativity;** ● The space-time view in Newtonian mechanics and the space-time view in special relativity and their differences; ● The relationship between mass and speed, and between mass and energy in the special theory of relativity;* ● Nuclear fusion and nuclear fission, the development and utilization of nuclear energy. **Part 4. Quantum Physics (9 contact hours; 8 self-study hours)** ● Einstein's photoelectric equation and its simple application, the wave-particle duality of photons;* ● The experimental law of hydrogen atom spectrum and Bohr's hydrogen atom theory; ● The wave-particle duality of physical particles, De Broglie wave and its statistical interpretation;* ● Wave function and its statistical interpretation;* ● The application of Schrödinger equation, one-dimensional potential well and quantum theory in analyzing hydrogen atoms; ● Practical applications of quantum physics: electron tunneling microscope, laser technology. **Part B. Experiment/practice teaching: 0 hour**
Study and examination requirements and forms of examination	After-class assignments shall be done independently by students after each class. Daily performance accounts for 30%, including assignments, in-class performance and attendance; Final assessment (closed-book written exam) accounts for 70%.
Media employed	PPT courseware, multimedia computers, Learning APP, projectors, laser pointers, blackboards, etc.
Reading list	1. Required books [1] MA Wenwei. *Physics (6th Edition)*. Beijing: Higher Education Press. 2017 2. Reference books [1] Teaching Division of Department of Physics Teaching, Shanghai University of Engineering Science. *Study Guide for College Physics*. Beijing:

	Tsinghua University Press, 2011. [2] Teaching Division of Department of Physics Teaching, Shanghai University of Engineering Science. *Assignments for College Physics*. Beijing: Tsinghua University Press, 2011. [3] MAO Junjian, GU Mu. *College Physics*. Beijing: Higher Education Press, 2007. [4] Teaching and Research Section of Department of Physics, Shanghai Jiaotong University. *College Physics*. Shanghai: Shanghai Jiaotong University Press, 2006. [5] Teaching Division of Department of Physics Teaching, Shanghai University of Engineering Science. *College Physics*. Bejing: Tsinghua University Press, 2013. [6] Halliday (USA), translated by TENG Xiaoying, ZHANG Sanhui et al., and adapted by MA Tingjun. *Fundamentals of Physics*. Beijing: Machinery Industry Press, 2009.

Competence field	Mathematics, Physics and Chemistry
Module designation	Linear Algebra
Code, if applicable	219161
Subtitle, if applicable	
Semester(s) in which the module is taught	2nd semester
Person responsible for the module	Professor ZHAO Dejun
Lecturer	Professor ZHAO Dejun Associate Professors: WU Suichao, WANG Tianbo, LIU Ruijuan, PENG Liping, ZHOU Yu Lecturers: WU Zhongcheng, SHEN Yiyi, LIANG Yikong, BIAN Zhihao
Language	Chinese
Relation to curriculum	As a common introductory course designed for students majoring in science and engineering in institutions of higher learning, Linear Algebra is a discipline of mathematics that explains the classic theories in linear operations in algebra. Given the fact that linear problems have been observed extensively in various science and technology contexts and some nonlinear problems can be translated into linear problems, the Linear Algebra course is playing a bigger role with increasingly greater influence in the present world with the increasing popularity of computers. Therefore the theories and methods covered in this course will find profound applications in various science and technology contexts. This course will also provide a thorough grounding in mathematics and help students to lay a foundation for further studies in subsequent engineering courses.
Type of teaching, contact hours	Target students: students of Vehicle Engineering (Rail Transit Vehicle) Type of teaching: Using lecturing as a primary teaching method in combination with class discussion as a complementary manner Contact hours: 32 hours Of which Theoretical teaching: 32 hours Experiment/practice teaching: 0 hour Computer practice: 0 hour Size of class: 60-90 students
Workload	Total workload = 60 hours Contact hours = 32 hours Self-study hours = 28 hours
Credit points	2.0

Requirements according to the examination regulations	Only students with class attendance rate over 2/3 and assignment completion rate over 2/3 are allowed to take the exam.
Recommended prerequisites	N/A
Module objectives/intended learning outcomes	Leaning outcomes: ● **Knowledge:** （1） Demonstrate understanding of the fundamental knowledge in linear algebra, (with an emphasis on determinants, matrices and their operations); （2） Demonstrate understanding of the linear correlation of vector groups and linear equations; （3） Demonstrate understanding of the similar diagonalization of matrices and quadratic forms, among others. ● **Skills:** （1） Demonstrate understanding of the key concepts, basic operations and applications of determinants and matrices; （2） Demonstrate skills in solving linear equations and applying them in appropriate problems; （3） Demonstrate understanding of the concept of quadratic form and skills in transforming quadratic form into standard form. ● **Competence:** This course aims to lay down basic concepts, theories and techniques of linear algebra, providing a thorough grounding in linear algebra and laying a foundation for further studies in subsequent courses with an aim to enable them to use their linear algebra knowledge and skills to solve problems in real contexts.
Contents	**Part A. Theoretical teaching (32 contact hours; 28 self-study hours)** **Linear Algebra** **Chapter 1. Determinant** (5 contact hours; 5 self-study hours) ● The definition of the second- and third-order determinants;* ● The properties and calculations of the second- and third-order determinants;** ● The definition and properties of n-order determinant; ● Solutions to some simple n order determinants; ● Cramer's rule.** **Chapter 2. Matrix and Its Operation** (8 contact hours; 6 self-

	study hours) ● The concept of matrix, and the definitions and properties of some special matrices;* ● Linear operations on matrices, matrix multiplication and its algorithm;** ● The power of square matrix, matrix polynomial, and the determinant of the product of two square matrices;* ● The concept and properties of inverse matrix, the necessary and sufficient conditions for a matrix to be invertible, methods of finding the inverse of a matrix;** ● Partitioned matrix and its algorithm;* ● Elementary transformations of matrices; ** ● The properties of elementary matrices, the concept of matrix equivalence, and methods of finding the rank and inverse matrix of a matrix by using elementary transformations. ** **Chapter 3. Linear Correlation of Vector Groups** (4 contact hours; 4 self-study hours) ● *n*-Dimensional vectors and their linear operations;* ● The concepts of linear combination and linear representation of vector groups;* ● The definition and determination of linear dependence/independence of vector groups;** ● The maximal linearly independent array and the rank of vector groups; ** ● The rank of matrices and the rank of vector groups and methods of finding them. * **Chapter 4. Linear Equations** (5 contact hours; 5 self-study hours) ● The concept of linear equations and Gauss elimination;* ● Determination of the existence of a non-zero solution to homogeneous linear equations;** ● Determination of the existence of a solution to inhomogeneous linear equations;** ● The properties of solutions to two types of linear equations and the structure of the solutions;* ● The methods of finding the general solution to two types of linear equations by using elementary row transformations. ** **Chapter 5. Similar Diagonalization of Matrices** (8 contact hours; 6 self-study hours) ● The concepts and properties of the eigenvalues and

	eigenvectors of a matrix;** ● The methods of finding the eigenvalues and eigenvectors of a matrix;** ● The concept and properties of similar matrices, as well as the necessary and sufficient conditions for a matrix to be diagonalizable and the methods;** ● The inner product of vectors and standard orthogonalization methods for vector groups;* ● The concepts and properties of orthogonal matrices and orthogonal transformations;* ● The properties of real symmetric matrices and methods of orthogonal diagonalization.** **Chapter 6. Quadratics and Standard Form** (2 contact hours; 2 self-study hours) ● The concepts of quadratic form and standard form. Quadratics and symmetric matrices;* ● Make use of orthogonal transformation to convert a quadratic form into standard form; ** ● Methods of converting a quadratic form into standard form. * **Part B. Experiment/practice teaching: 0 hour**
Study and examination requirements and forms of examination	After-class assignments shall be done independently by students after each class. Daily performance accounts for 30%, including attendance, in-class performance and assignments; Final assessment (closed-book written exam) accounts for 70%.
Media employed	PPT courseware, multimedia computers, projectors, laser pointers, blackboards, etc.

Reading list	1. Required books [1] WU Suichao, SHEN Jun, YU Weiqin. *Linear Algebra (1st Edition)*, Beijing: Qinghua University of Science and Technology Press, 2014.4. [2] TIAN Yuan, SHEN Yiyi. *Linear Algebra (1st Edition)*, Shanghai: Donghua University Press, 2013.7. 2. Reference books [1] Department of Mathematics of Tongji University. *Linear Algebra (1st Edition)*, Shanghai: Tongji University of Science and Technology Press, 2011. [2] LI Jiongsheng, CHA Jianguo, WANG Xinmao. *Linear Algebra (2nd Edition),* AnHui: University of Science and Technology Press, 2010. [3] XU Zhixiao, LIANG Haiming, CHEN Fan. *Linear Algebra.* Beijing: Beijing Institute of Technology Press, 2016.

Competence field	Mathematics, Physics and Chemistry
Module designation	Computational Method
Code, if applicable	210111
Subtitle, if applicable	
Semester(s) in which the module is taught	4th semester
Person responsible for the module	Professor LI Mingming
Lecturer	Professor LI Mingming Associate Professor ZHAO Hongyan
Language	Chinese
Relation to curriculum	As a common elective course suitable for undergraduate students majoring in engineering, Computational Method is a course offered to undergraduate students after the successful introduction of Advanced Mathematics, Linear Algebra, and Language Programming. It aims to further improve students' skills in applying mathematical knowledge to solve practical problems.
Type of teaching, contact hours	Target students: students of Vehicle Engineering (Rail Transit Vehicle) Type of teaching: Using lecturing as a primary teaching method in combination with class discussion as a complementary manner Contact hours: 32 hours Of which Theoretical teaching: 32 hours Experiment/practice teaching: 0 hour Computer practice: 0 hour Size of class: 60-90 students
Workload	Total workload = 60 hours Contact hours = 32 hours Self-study hours = 28 hours
Credit points	2.0
Requirements according to the examination regulations	Only students with class attendance rate over 2/3 and assignment completion rate over 2/3 are allowed to take the exam.
Recommended prerequisites	*Multivariate Calculus (1)* and *(2)*, *Linear Algebra*, and *C Language Programming*
Module objectives/intended learning outcomes	Leaning outcomes: ● **Knowledge:** （1） Demonstrate understanding of the key concepts, fundamental methods and primitive types of numerical calculation; （2） Demonstrate understanding of the numerical

	methods for nonlinear and linear equations; （3） Demonstrate understanding of the concepts of numerical integration and numerical differentiation. ● **Skills:** （1） Apply the Gauss elimination method and principal component analysis to solve linear equations; （2） Apply the Trapezoidal Rule and Simpson's Rule to solve numerical integration; （3） Apply the numerical methods for calculation and apply the mathematical methods to solve practical problems. ● **Competence:** This course will help students to develop their skills required for abstraction, generalization, and logical reasoning, with an aim to help student to use their mathematical knowledge to solve problems in real contexts. It will also help students to lay a foundation for the subsequent use of computers to solve practical problems.
Contents	**Part A. Theoretical teaching (32 contact hours; 28 self-study hours)** **Computational Method** **Chapter 1.** Introduction (2 contact hours; 1 self-study hours) ● Error and error analysis, key concepts and basic calculation skills in significant figures;** ● Research purposes, characteristics and fundamental requirements of calculation methods; ● Critical issues in designing algorithms. * **Chapter 2.** Numerical Methods for Solving Nonlinear Equations (4 contact hours; 3 self-study hours) ● The fundamental concept of iterative method;** ● Iterative method and its convergence;** ● Convergence acceleration of iterative algorithms;* ● Newton method of iteration;** ● Numerical solution of nonlinear equations. **Chapter 3.** Numerical Methods for Solving Linear Equations (10 contact hours; 8 self-study hours) ● LU decomposition of a matrix; ** ● Apply the Gauss elimination method to solve linear equations;** ● Apply the principal component analysis to solve

	linear equations;** ● Square-root method (i.e., Cholesky method);* ● Calculation of norms of vectors and matrices;** ● Calculation of the spectral radius of a matrix and determination of the matrix sequence convergence;** ● Definition of ill-conditioned equations; ● Calculation of the condition number of a matrix;** ● The key concepts in iterative method;** ● Jacobi method and Gauss-Seidel method; ** ● The fundamental principles of the over-relaxation iterative method; ● Iterative method and its convergence. ** **Chapter 4.** Interpolation Method and Curve Fitting Method for Function Approximation (8 contact hours; 8 self-study hours) ● The key concepts in interpolation method, the basic construction method for Lagrange interpolation;** ● The basic construction method for Newton interpolation;** ● Hermite interpolation, piecewise low-order interpolation and spline interpolation; ● The fundamental principles for least square method;* ● The fundamental methods for linear least square method. ** **Chapter 5.** Numerical Integration and Differentiation (6 contact hours; 6 self-study hours) ● Trapezoid rule, Simpson's rule, complex trapezoid rule and complex Simpson's rule; ** ● Romberg's method; ** ● The midpoint formula for numerical differentiation. ** **Chapter 6.** Numerical Methods for Solving Ordinary Differential Equations (2 contact hours; 2 self-study hours) ● Euler's method; ** ● Runge-Kutta method;** ● Richardson extrapolation method;* ● Linear multi-step method; ● Numerical methods for solving first-order ordinary differential equations. **Part B. Experiment/practice teaching: 0 hour**
Study and examination requirements and forms of examination	After-class assignments shall be done independently by students after each class.

	Daily performance accounts for 30%, including assignments, mid-term examination and attendance; Final assessment (closed-book written exam) accounts for 70%.
Media employed	PPT courseware, multimedia computers, projectors, laser pointers, blackboards, etc.
Reading list	1. Required books [1] LIU Ling, WANG Zhengsheng. *Numerical Calculation Methods (2nd Edition).* Beijing: Science Press, 2010. 2. Reference books [1] WANG Shiru et al. *Calculation Methods (2nd Edition).* Xi'an: Xidian University Press, 2005. [2] SUN Zhizhong, YUAN Weiping, WEN Zhenchu. *Numerical Analysis.* Nanjing: Southeast University Press, 2002. [3] LI Mingming, JIANG Kaizhong et al. *Calculation Methods.* Shanghai: Donghua University Press, 2012.

Competence field	Mathematics, Physics and Chemistry
Module designation	College Chemistry
Module level, if applicable	
Code, if applicable	040117
Subtitle, if applicable	
Semester(s) in which the module is taught	1st semester
Person responsible for the module	Professor WU Yuandong
Lecturer	Professor WU Yuandong Associate Professor WANG Jinguo Associate Professor QU Yi Associate Professor MEI Dajiang Lecturer LI Lihong
Language	Chinese
Relation to curriculum	As a compulsory introductory course designed for undergraduate students majoring in science and engineering in institutions of higher learning, College Chemistry aims to provide students with an in-depth knowledge of the fundamental principles and skills required in chemistry. Emphasis is given both to the basic laws of aggregation state, dispersion system and chemical reaction, and the four main equilibriums of aqueous solutions and related analysis methods. Topics covered in this course also include material structure, element compound and instrumental analysis methods. By performing laboratory experiments in this course, students will be able to develop their critical thinking skills and other skills required for investigation, abstraction, and logical reasoning. By providing a better understanding of the fundamental principles and skills of chemistry, this course will help students to lay a solid foundation for further studies in subsequent professional courses.
Type of teaching, contact hours	Target students: students of Vehicle Engineering (Rail Transit Vehicle) Type of teaching: theoretical teaching Contact hours: 32 hours Of which Theoretical teaching: 32 hours Experiment/practice teaching: 0 hour Size of class: 60-90 students

Workload	Total workload = 60 hours Contact hours = 32 hours Self-study hours = 28 hours
Credit points	2.0
Requirements according to the examination regulations	Only students with class attendance rate over 2/3 and assignment completion rate over 2/3 are allowed to take the exam.
Recommended prerequisites	N/A
Module objectives/intended learning outcomes	**Learning outcomes:** ● **Knowledge:** **(1)** Demonstrate understanding of the fundamental principles of chemistry, with an emphasis on chemical thermodynamics, kinetics, chemical equilibrium, chemical bonds and electrochemistry; **(2)** Demonstrate understanding of the basics of material structure (such as atomic structure and periodicity of elements); **(3)** Inorganic compounds and applied chemistry. ● **Skills:** **(1)** Understand the fundamental principles of basic chemical reactions; **(2)** Understand the basic structures of commonly used substances and know how to analyze their fundamental properties; **(3)** Understand the methods of performing calculations on chemical reactions and the instrumental methods of chemical analysis. ● **Competence:** After successfully completing this course, students will be able to understand the scope of modern chemistry and its impact on society. They will be able to apply the laws of chemistry for quantitative calculation and analysis, and develop some basic skills to solve practical problems with application in chemistry.

Contents	Part A. Theoretical teaching (32 contact hours; 28 self-study hours) Chapter 1: Thermochemistry and Energy (4 contact hours; 4 self-study hours) ● The key concepts in thermochemistry; ● The first law of thermodynamics;** ● The concept of enthalpy;* ● Standard enthalpy of formation;* ● Evaluate enthalpy change and entropy change;* ● Utilization of fuel and energy. Chapter 2: Principles of Chemical Reactions (6 contact hours; 6 self-study hours) ● The concept of entropy;* ● Evaluate enthalpy change and entropy change;** ● The second law of thermodynamics; ** ● Standard Gibbs energy change;* ● Chemical equilibrium;** Chemical reaction rate;* ● Environmental chemistry and green chemistry. Chapter 3: Aqueous Solution Chemistry (6 contact hours; 6 self-study hours) ● Solution type and solution concentration;* ● Decrease of the freezing point of the solution, increase of the boiling point of the solution, and the osmotic pressure;* ● Theories of acids and bases;* ● Ionization equilibrium;* ● Buffer solution and pH control;** ● Precipitation-dissolution equilibrium;** Chapter 4: Electrochemistry (4 contact hours; 2 self-study hours) ● Primary battery;* ● EMF, ΔG°, and Keq; * ● Standard electrode potential; ** ● EMF as a function of concentration;* ● Battery: discharge through chemical reaction;* ● Electrolysis: causing non-spontaneous reactions to occur;* ● Corrosion and protection. * Chapter 5: Basics of Material Structure (6 contact hours; 6 self-study hours) ● Atomic structure; ** ● Periodic law and periodic table;** ● Periodicity of elements;**

	● Chemical bond;* ● Molecular orbital;* ● Crystalline solid. * Chapter 6: Inorganic Compounds (6 contact hours; 4 self-study hours) ● Properties of oxides and halides;* ● Coordination compound;* ● Inorganic materials: alloys and inorganic non-metallic materials. *
Study and examination requirements and forms of examination	1. Basic requirements for class (no late arrivals, no early departures, and no unauthorized absences) 10%. 2. In-class performance (classroom discussion, question answering) 10%; 3. After-class assignments 20%; 4. Final exam (closed-book written exam): 60%.
Media employed	PPT courseware, multimedia computers, projectors, laser pointers, blackboards, chalks
Reading list	1. Required books [1] XU Duanjun et al., *General Chemistry (6th Edition)*, Beijing: Higher Education Press, 2012 [2] ZHOU Shilin et al., *Experiments in General Chemistry*, Beijing: Science Press, 2013 2. Reference books [1] Ralfh H. Petrucci et al., *General Chemistry: Principles and Modern Applications (10th Edition)*, New Jersey: Prentice Hall, 2010 [2] HUA Tongwen et al., Principles of General Chemistry, Beijing: Peking University Press, 2013 [3] ZHOU Xuguang et al., *General Chemistry*, Beijing: Tsinghua University Press, 2011

Note: In Contents,** for key knowledge points, * for important knowledge points, and the rest for general information.