东北大学秦皇岛分校本科课程教学大纲

一、课程基本信息

<table>
<tr><td>开课单位</td><td colspan="3">悉尼智能科技学院</td><td>课程代码</td><td colspan="5">3100311002</td></tr>
<tr><td>中文名称</td><td colspan="8">数学分析与建模（二）</td></tr>
<tr><td>英文名称</td><td colspan="8">Mathematical Analysis and Modeling (II)</td></tr>
<tr><td>总学时</td><td>96</td><td rowspan="2">理论学时</td><td rowspan="2">96</td><td rowspan="2">实验学时</td><td rowspan="2">0</td><td rowspan="2">上机学时</td><td rowspan="2">0</td><td rowspan="2">设计学时</td><td rowspan="2">0</td><td rowspan="2">课外学时</td><td rowspan="2">0</td></tr>
<tr><td>学　分</td><td>6</td></tr>
<tr><td>课程类型</td><td colspan="11">☑理论课程　☐理论（含实验）课程　☐实践类课程</td></tr>
<tr><td>课程类别</td><td colspan="11">☐通识类　☑学科基础类　☐专业方向类　☐实践类</td></tr>
<tr><td>适用专业</td><td colspan="11">应用统计学</td></tr>
<tr><td>先修课程</td><td colspan="11">数学分析与建模（一）Mathematical Analysis and Modeling (I)</td></tr>
<tr><td>建议开课学期</td><td colspan="11">☐1-1 ☑1-2 ☐2-1 ☐2-2 ☐3-1 ☐3-2
☐4-1 ☐4-2 ☐5-1 ☐5-2 ☐*（代表每学期都开设）</td></tr>
<tr><td>考核方式</td><td colspan="3">☑考试 ☐考查</td><td>成绩分制</td><td colspan="6">☑百分制 ☐五级制 ☐二级制</td></tr>
<tr><td>使用教材</td><td colspan="11">1、 Mo Huixia, Li Xiaohua, Yuan Jianhua, Yuan Jianhua, Ai Wenbao, Zhu Ping, Advanced Mathematics (II), 2nd Edition, Beijing University of Posts and Telecommunications Press, 2018.</td></tr>
<tr><td>参考书及教学资源</td><td colspan="11">1、邓东皋，尹小玲，数学分析简明教程(第二版) 下册，高等教育出版社, 2006.
2、同济大学数学系，高等数学(第七版)下册，高等教育出版社, 2015.</td></tr>
<tr><td>其他说明</td><td colspan="11">无</td></tr>
</table>

二、课程简介

中文描述

本课程为数学学科中的一门核心基础课程，它为学生提供了深入理解数学分析理论和方法的坚实平台。课程旨在通过系统的理论学习与实践应用，使学生掌握数学分析的基本概念、原理和方法，培养其严密的逻辑推理能力、抽象思维能力和解决实际问题的能力。该课程是后续高级数学课程（如微分方程、最优化理论、高等微积分等）的重要基础，也是众多统计专业课（如回归分析与线性模型、概率论与随机变量、数理统计等）不可或缺的数学工具。

English Description

The course of Mathematical Analysis is a core foundational course in mathematics, providing students with a solid platform for a deep understanding of mathematical analysis theories and methods. The course aims to enable students to master the basic concepts, principles, and methods of mathematical analysis through systematic theoretical learning and practical application, and cultivate their rigorous logical reasoning ability, abstract thinking ability, and ability to solve practical problems. This course is an important foundation for subsequent advanced mathematics courses such as differential equations, optimization theory, advanced calculus, etc. It is also an indispensable mathematical tool for many statistical courses such as regression analysis, probability theory and random variables, mathematical statistics, etc.

三、课程目标

1、知识目标：

1-1：理解实数系的连续性，了解几个基础定理是等价的。

1-2：理解数项级数收敛和发散的定义，掌握数项级数敛散性的判定方法，掌握函数项级数一致收敛的定义以及和函数性质。

1-3：掌握向量与空间解析几何的概念和计算方法。

1-4：掌握多元函数微分法及其应用。

1-5：掌握重积分的计算方法。

1-6：掌握曲线、曲面积分的计算方法。

2、能力目标：

2-1：会写出实数连续性的等价定理。

2-2：会使用定义、判别法断定数项级数的敛散性，会判断函数项级数的一致收敛性，会求和函数。

2-3：会计算向量的数量级、向量积，并会求平面、空间直线、曲面以及空间曲线的方程。

2-4：能熟练计算多元函数的极限、偏导、全微分、方向导数以及极值和最值。

2-5：能熟练求二重、三重积分。

2-6：能熟练计算曲线、曲面积分，会使用格林公式、高斯公式、斯托克斯公式求积分。

3、德育/素养目标：

3-1：培养具有不畏困难、锲而不舍、敢于尝试、不惧失败、迎难而上的精神，并在学习过程中培养自己的细心和耐心的勇气和精神。

3-2：培养服务意识，具有 “以人为本” 的服务精神。

3-3：培养遵守法律、懂规则、讲规则的新时代公民。

表 1 课程目标与毕业要求的对应关系

毕业要求	指标点	课程目标	关联 (H/M/L)
1. 理学知识：具有扎实的数学基础，能够将数学、自然科学和专业知识用于解决复杂实际问题。	1.1 具有较强的演绎推理能力、准确计算能力、分析归纳能力、抽象思维能力，掌握数学、自然科学和相关专业知识，并使用其建立正确的数学、物理学等模型以解释复杂实际问题。	1-1 至 1-6、2-1 至 2-6、3-1 至 3-3	H
3.设计/开发解决方案：能够设计针对复杂实际问题的解决方案，设计满足特定需求的系统、单元或流程，并能够在设计环节中体现创新意识，考虑社会、健康、安全、法律、文化以及环境等因素。	3.1 能够设计针对本专业相关复杂实际问题的解决方案。	1-1 至 1-6、2-1 至 2-6、3-1 至 3-3	M

四、主要教学内容

（一）理论教学

第 1 章：Continuity of Real Numbers（支撑教学目标 1-1、2-1、3-1 至 3-3）

【1】知识点：

(1) Equivalent description of continuity of real numbers.

(2) Compactness of closed intervals of real numbers.

(3) Completeness of real numbers.

(4) Properties of continuous functions on closed intervals.

【2】学习目标：

理解：Concepts of supremum, infimum and cover of real number sets; The mutual equivalence of supremum and infimum principle, monotone bounded principle, finite covering theorem, nested interval theorem, compactness theorem and Cauchy convergence principle.

掌握：Ideas and methods for proving the equivalence of the above theorems; Ideas and methods for proving the properties of continuous functions on closed intervals.

【3】重点内容：

(1) The cover of real number sets.

(2) Methods for proving the equivalence of the above theorems.

【4】难点内容：

(1) Mutual equivalence of supremum and infimum principle, monotone bounded principle, finite covering theorem, nested interval theorem, compactness theorem and Cauchy convergence principle..

(2) Methods for proving the properties of continuous functions on closed intervals.

【5】思政案例：

Select classic cases related to the continuity of real numbers for analysis, such as the discovery process of irrational numbers, the development history of calculus, etc., so that students can experience the hardships and joys of scientific research from them. Select classic cases related to the continuity of real numbers for analysis, such as the discovery process of irrational numbers, the development history of calculus, etc., so that students can experience the hardships and joys of scientific research from them.

The discovery process of irrational numbers is a challenging and exploratory journey in the history of human mathematics, which profoundly changed people's understanding of numbers. In ancient times, people mainly used natural numbers (such as 1, 2, 3...) and fractions (such as rational numbers) for calculations and measurements. These numbers were sufficient to meet the needs of daily life and simple scientific calculations at that time. However, with the development of mathematics and geometry, people began to encounter quantities that could not be accurately represented by rational numbers. The discovery of irrational numbers is closely related to the ancient Greek mathematician Pythagoras and his school. The Pythagorean school firmly believes in "all things are numbers", which means that all phenomena in the universe can be explained by integers or ratios of integers (rational numbers). However, this belief has been severely challenged when faced with the issue of the diagonal length of a square. The discovery of irrational numbers not only challenged the mathematical concepts of the time, but also promoted the development of mathematics. Mathematicians began to accept and study numbers that cannot be represented by rational numbers, gradually forming the foundation of real number theory. The existence of irrational numbers proves the complexity and diversity of number systems, laying the foundation for the development of advanced mathematical branches such as calculus and real variable function theory.

无理数的发现过程是人类数学史上一个充满挑战与探索的历程，它深刻地改变了人们对数的认识。在古代，人们主要使用自然数（如 1, 2, 3...）和分数（如有理数）来进行计算和测量。这些数足以满足当时日常生活和简单科学计算的需要。然而，随着数学和几何学的发展，人们开始遇到一些无法用有理数精确表示的量。无理数的发现与古希腊数学家毕达哥拉斯及其学派密切相关。毕达哥拉斯学派坚信“万物皆数”，即认为宇宙间的一切现象都可以用整数或整数之比（有理数）来解释。然而，这一信念在面对正方形对角线长度的问题时受到了严峻挑战。无理数的发现不仅挑战了当时的数学观念，也促进了数学的发展。数学家们开始接受并研究这类无法用有理数表示的数，逐渐形成了实数理论的基础。无理数的存在证明了数系的复杂性和多样性，为后来的微积分学、实变函数论等高级数学分支的发展奠定了基础。

第 2 章：Series with Constant Terms（支撑教学目标 1-2、2-2、3-1 至 3-3）

【1】知识点：

(1) Convergence and divergence of a series with constant terms.

(2) Properties of series.

(3) A necessary condition for convergence of a series with constant terms.

(4) Convergence tests for series with positive terms.

(5) Cauchy convergence principle.

(6) General series and tests for convergence.

【2】学习目标：

理解：Concept of convergence, divergence of series and the sum of convergent series. Properties of series. Dirichlet test and Abel test. Similarities and differences between infinite series and generalized integral

掌握：Convergence tests for series with positive terms. Leibniz test.

【3】重点内容：

(1) Convergence tests for series with positive terms.

(2) Leibniz test.

【4】难点内容：

(1) Cauchy convergence principle

第 3 章：Functional Series（支撑教学目标 1-2、2-2、3-1 至 3-3）

【1】知识点：

(1) Convergence domain and sum function of functional series.

(2) Concept of uniform convergence of functional series.

(3) Properties of uniformly convergent functional series.

(4) Uniform convergence tests for functional series.

(5) Power series, radius of convergence、domain of convergence of power series.

(6) Necessary and sufficient conditions for the function to be expanded into Taylor series.

(7) Maclaurin expansion of some basic elementary functions.

(8) Fourier series.

【2】学习目标：

理解：Concepts of convergence domain and sum function of functional series. Concept of Fourier series and Dirichlet theorem. Concept of uniform convergence of functional series. Find the Fourier series of a function.

掌握：Uniform convergence tests for functional series. Analytical properties of the sum function of a uniformly convergent series with function terms. Methods for finding the convergence radius and convergence region of power series. Maclaurin expansion of basic elementary functions.

【3】重点内容：

(1) Uniform convergence tests for functional series.

(2) Analytical properties of the sum function of a uniformly convergent series with function terms.

【4】难点内容：

(1) Methods for finding the convergence radius and convergence region of power series.

(2) Maclaurin expansion of basic elementary functions.

第 4 章：Vectors and Solid Analytic Geometry（支撑教学目标 1-3、2-3、3-1 至 3-3）

【1】知识点：

(1) Vectors.

(2) Products of vectors.

(3) Equations for planes and lines in space.

(4) Surfaces and space curves.

【2】学习目标：

理解：Concepts of surfaces and space curves. Scalar product of two vectors. Vector product of two vectors.

掌握：Finding the equations of planes and lines in space. Common quadric surface.

【3】重点内容：

(1) Finding the equations of planes and lines in space.

(2) Common quadric surface.

【4】难点内容：

(1) Finding the equations of planes and lines in space.

(2) Common quadric surface.

第 5 章：Differential Calculus of Multi-variable Functions and its Application（支撑教学目标 1-4、2-4、3-1 至 3-3）

【1】知识点：

(1) Limit and continuity of multi-variable functions.

(2) Partial derivatives and total differentials.

(3) Derivation rules of multi-variable functions.

(4) Geometric application of differential calculus of multi-variable functions.

(5) Directional derivatives and the gradient.

(6) Extreme value、maxima and minima of multi-variable functions.

【2】学习目标：

理解：Concepts and properties of limit and continuity of multi-variable functions. Concepts of partial derivatives and total differentials of multi-variable functions. Invariance of the total differential form. Differentiation of implicit functions. Tangent line and normal plane to a space curve. Tangent planes and normal lines to a surface

掌握：Finding the partial derivative and total differential. Finding local extreme values and constrained extreme values of a function of two variables.

【3】重点内容：

(1) Finding the partial derivative and total differential.

(2) Finding local extreme values and constrained extreme values of a function of two variables.

【4】难点内容：

(1) Proof and solution of the limit of multi-variable functions.

(2) Higher-order partial derivatives of multi-variable functions.

第 6 章： Multiple Integrals（支撑教学目标 1-5、2-5、3-1 至 3-3）

【1】知识点：

(1) Concepts and properties of multiple integrals.

(2) Calculation of multiple integrals.

(3) Applications of multiple integrals.

(4) Integrals with parametric variables.

【2】学习目标：

理解：Concepts of multiple integrals. Properties of multiple integrals. Calculation of double integrals. Calculation of triple integrals.

掌握：Calculation of double integrals. Calculation of triple integrals..

【3】重点内容：

(1) Double integrals in rectangular and polar coordinates .

(2) Triple integrals in rectangular, cylindrical and spherical coordinates.

【4】难点内容：

(1) Calculation of triple integrals

第 7 章： Line Integrals and Surface Integrals（支撑教学目标 1-6、2-6、3-1 至 3-3）

【1】知识点：

(1) Line integrals with respect to arc length, Line integrals with respect to coordinates.

(2) Green's formula.

(3) Surface integrals with respect to surface area、surface integrals with respect to coordinates.

(4) Gauss formula and Stokes formula.

【2】学习目标：

理解：Concepts and properties of two kinds of line integral and two kinds of surface integral. Concept and calculation of divergence and rotation.

掌握：Calculation of two kinds of line integral and two kinds of surface integral. Green formula、Gauss formula and Stokes formula.

【3】重点内容：

(1) Calculation of two kinds of line integral and two kinds of surface integral.

【4】难点内容：

(1) Equivalent conditions of path independence of line integrals.

五、教学安排与学时分配

表 3 学时分配表

讲 课 内 容		学时				
		讲课	实验	上机	设计	课外
第 1 章	Continuity of real numbers	10	0	0	0	0
第 2 章	Series with Constant Terms	12	0	0	0	0
第 3 章	Functional Series	10	0	0	0	0
第 4 章	Vectors and Solid Analytic Geometry	10	0	0	0	0
第 5 章	Differential Calculus of Multi-variable Functions and its	20	0	0	0	0
第 6 章	Multiple Integrals	14	0	0	0	0
第 7 章	Line Integrals and Surface Integrals	20	0	0	0	0
小计		96	0	0	0	0
总计	96					

六、教学方法

1、Combination of blackboard writing and multimedia, mainly blackboard writing.

2、Combining theory with industrial practical problems.

3、Knowledge delivery with ethic education.

七、成绩评定

1、Behavior: According to instant answer to the teacher's questions, comprehensive report and question performance, the mark is evaluated, where question performance and instant answer accounts for 10%, assignments performance (pre-lecture and post-lecture) accounts for 90%.

2、Mid-term: Two threshold tests in the form of closed book, with 90 minutes each time. Each test score accounts for 50% of the total mid-term score.

3、Final：Closed book examination, 120 minutes.

八、评价及持续改进

1、课程负责人根据课程教学内容与人才培养目标组织课程团队讨论并修改教学大纲，报分管教学工作副院长审核后由执行院长批准。The subject coordinator shall be responsible for the syllabus discussion and improvement, and the revised version shall be submitted to deputy dean (teaching affairs) for reviewing then to executive dean for approvement.

2、课程负责人根据课程教学内容、课堂教学效果以及成绩分布，对课程教学方法和成绩评定环节进行改进，并同步优化评定办法。The subject coordinator shall revise the syllabus based on the teaching content, effect and result distribution while optimize the assessment measures.

….

撰写： 薛昌涛

审核： 韩鹏

批准： 史文博

日期： 2023.07.05