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">3100313045</td></tr>
<tr><td>中文名称</td><td colspan="8">离散数学</td></tr>
<tr><td>英文名称</td><td colspan="8">Discrete Mathematics</td></tr>
<tr><td>总学时</td><td>40</td><td rowspan="2">理论学时</td><td rowspan="2">40</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>2.5</td></tr>
<tr><td>课程类型</td><td colspan="8">☑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="8">□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="8">应用统计学</td></tr>
<tr><td>先修课程</td><td colspan="8">无</td></tr>
<tr><td>建议开课学期</td><td colspan="8">□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="4">☑百分制 □五级制 □二级制</td></tr>
<tr><td>使用教材</td><td colspan="8">1、 Susanna Epp, Discrete Mathematics with Applications (Fifth edition), 2018</td></tr>
<tr><td>参考书及教学资源</td><td colspan="8">1、耿素云，屈婉玲，张立昂，离散数学，清华大学出版社，2021 年</td></tr>
<tr><td>其他说明</td><td colspan="8">无</td></tr>
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二、课程简介

中文描述

本课程是为应用统计学专业本科生开设的专业方向课。内容包括集合论、代数系统、图论和数理逻辑等。通过学习，使学生掌握处理离散结构的描述工具和方法，为后续计算机相关课程的学习创造条件，同时可以提高学生的抽象思维和严密的逻辑推理能力，为将来参与创新性的研究和开发工作打下坚实的基础。

English Description

This course is a specialized elective designed for undergraduate students majoring in Applied Statistics. The content includes set theory, algebraic systems, graph theory, and mathematical logic. Through this course, students will master the tools and methods for describing discrete structures, laying the groundwork for subsequent computer-related courses. Additionally, it will enhance students' abstract thinking and rigorous logical reasoning abilities, providing a solid foundation for future participation in innovative research and development work.

三、课程目标

1、知识目标：

1-1：掌握命题和谓词符号化的方法，理解运用真值表及等值演算判断命题公式的类型、求命题公式的标准型，掌握数理逻辑的推理理论及其应用；掌握证明的三种方法，理解证明问题时的标准写法。

1-2：掌握集合运算的性质；掌握数学归纳法的原则，理解循环不变量，掌握应用 Euclidian 算法求两个整数的最大公约数。

1-3：掌握关系的定义、表示方法和性质，理解关系的运算，掌握等价关系和序关系的定义、性质及其在分类和排序中的应用。

1-4：掌握可数集的定义，理解实数集的不可数性，掌握算法时间复杂度的比较方法，掌握利用鸽笼原理证明问题的方法；掌握组合计数的加法和乘法原则及其应用。

1-5：理解模运算的基本性质及其应用；理解仿射密码加密和解密的原理；理解 RSA 的加密原理，掌握 RSA 算法的加密和解密方法。

1-6：掌握图的基本概念及表示方法，能够灵活应用握手定理解决实际问题，掌握图同构的判别方法；掌握平面图的判断方法。

2、能力目标：

2-1：具有理解常见离散结构的能力；具有将离散对象以及对象之间的关系抽象成离散结构的能力。

2-2：具有严密的逻辑推理能力；具有利用推理理论解决实际问题的能力。

2-3：具有利用图论建模解决实际问题的能力。

2-4：具有利用组合计数原理进行离散计数的能力。

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：培养遵守法律、懂规则、讲规则的意识，树立正确的人生观和价值观。

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 到 1-3、1-5、2-1、2-2、3-1、3-2	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	1-4、1-6、2-3、3-1	M

四、主要教学内容

（一）理论教学

第 1 章：Mathematical Logic（支撑教学目标 1-1、2-2、3-2）

【1】知识点：

(1) Logic form of Propositional Logic.

(2) Logical Equivalence.

(3) Valid and Invalid Arguments.

(4) Application of Propositional Logic in Digital Logic Circuits.

(5) Form of Predicates and Quantified Statements.

(6) Negations of Quantified Statements.

【2】学习目标：

理解：Application in Digital Logic Circuits; Negations of Quantified Statements.

掌握：Logic form of Propositional and Predicates and Quantified Statements; Logically equivalent statements; Method for validating arguments.

【3】重点内容：

(1) Logic form of Propositional and Predicates and Quantified Statements.

(2) The method of valid argument checking.

【4】难点内容：

(1) Method for validating arguments.

(2) Negations of Quantified Statements.

【5】思政案例：

Selecting sentences from literary works as cases for valid argument checking demonstrates that some statements may appear logical but are actually flawed. This approach integrates value guidance with knowledge impartation and skill development, helping students shape a correct worldview, outlook on life, and value system.

第 2 章：Proofs（支撑教学目标 1-2、2-2）

【1】知识点：

(1) Direct proof.

(2) Proving universal statements and existence statements.

(3) Proof by contrapositive.

(4) Proof by contradiction.

(5) Common mistakes in proofs.

【2】学习目标：

理解：Common mistakes in proofs.

掌握：Proving universal statements and existence statements; Proof by contrapositive; Proof by contradiction.

【3】重点内容：

(1) Direct proof.

(2) Proof by contrapositive.

(3) Proof by contradiction.

【4】难点内容：

(1) Direct proof.

(2) Proof by contrapositive.

(3) Proof by contradiction.

第 3 章：Sets and Mathematical Induction（支撑教学目标 1-2、2-1、3-1）

【1】知识点：

(1) The concepts and representations of sets and the properties of set operations.

(2) Principle of Mathematical Induction.

(3) Loop invariant.

(4) Euclidian Algorithm.

【2】学习目标：

理解：Concepts and representations of sets; Loop invariant.

掌握：Properties of set operations; Principle of Mathematical Induction; Euclidian Algorithm.

【3】重点内容：

(1) Properties of set operations.

(2) Loop invariant.

(3) Euclidian Algorithm.

【4】难点内容：

(1) Loop invariant.

第 4 章：Relations（支撑教学目标 1-3、2-1、3-1）

【1】知识点：

(1) The definition and properties of relations.

(2) Composite relations and inverse relations.

(3) The transitive closure of relations.

(4) Partition of sets, equivalence relations and equivalence classes.

(5) Partial order relations and topological sorting.

(6) The definition and properties of functions, composition of functions, and inverse functions.

【2】学习目标：

理解：Transitive closure of relations; Topological sorting; Definitions and properties of functions, composition of functions, and inverse functions.

掌握：Definition and properties of relations; Composite relations and inverse relations; Partition of sets, equivalence relations and equivalence classes; Partial order relations.

【3】重点内容：

(1) Properties of relations.

(2) Partition of sets and equivalence classes.

(3) Partial order relations.

【4】难点内容：

(1) Properties of relations.

(2) Partition of sets and equivalence classes.

(3) Partial order relations.

第 5 章：Countable Sets and Counting（支撑教学目标 1-4、2-1、2-4、3-1）

【1】知识点：

(1) Countable sets and Cantor’s diagonalisation argument.

(2) Comparing speeds of algorithms.

(3) Pigeonhole principle.

(4) Counting arguments: multiplication rule and addition rule.

(5) Inclusion-Exclusion Principle.

(6) Combinations and permutations (with and without repetition).

【2】学习目标：

理解：Definition of countable sets; Cantor’s diagonalisation argument; Pigeonhole principle; Proof of Inclusion-Exclusion Principle.

掌握：Dominance and Big O notation; Application of Pigeonhole principle; Counting based on multiple rules.

【3】重点内容：

(1) Application of Pigeonhole principle.

(2) Counting based on multiple rules.

【4】难点内容：

(1) Application of Pigeonhole principle.

(2) Counting based on multiple rules.

第 6 章：Modular Arithmetic（支撑教学目标 1-5、2-1、2-2、3-1）

【1】知识点：

(1) Number theory.

(2) Calculations involving large powers.

(3) Affine Cipher.

(4) Euler's theorem to calculate multiplicative inverses.

(5) Fermat's Little Theorem.

(6) RSA cryptography.

【2】学习目标：

理解：Number theory; Proof of Euler's theorem; Principles of RSA cryptography.

掌握：Calculations involving large powers; Calculation of Euler's Phi function; Encrypt and decrypt in Affine Cipher and RSA cryptography.

【3】重点内容：

(1) Calculations involving large powers.

(2) Calculation of Euler's Phi function.

(3) Encrypt and decrypt in Affine Cipher and RSA cryptography.

【4】难点内容：

(1) Calculation of Euler's Phi function.

(2) Encrypt and decrypt in Affine Cipher and RSA cryptography.

第 7 章：Graph Theory（支撑教学目标 1-6、2-3、3-1、3-2）

【1】知识点：

(1) Definitions in graph theory.

(2) Graph expressions.

(3) Handshaking Theory.

(4) Graph Isomorphisms.

(5) Planer graph.

(6) Graph modeling.

【2】学习目标：

理解：Definitions in graph theory.

掌握：Adjacency matrices expression; Application of Handshaking Theory; Graph Isomorphisms; Determination of Planer graphs; Modeling and solving a problem based on graph theory.

【3】重点内容：

(1) Application of Handshaking Theory.

(2) Graph Isomorphisms.

(3) Determination of Planer graph.

【4】难点内容：

(1) Graph Isomorphisms.

(2) Modeling and solving a problem based on graph theory.

五、教学安排与学时分配

This course is primarily based on classroom teaching, supplemented by discussions, case studies, and other forms. The classroom teaching focuses on the basic concepts, theories, and methods of the course. Centered on the fundamental task of fostering virtue through education, the course aims to cultivate well-rounded socialist builders and successors who excel in moral, intellectual, physical,

aesthetic, and labor development. The course takes the concepts and theories of discrete structures as its main thread and uses the modeling and application of discrete problems as its framework. It fully utilizes offline classroom, online teaching resources, and ideological and political education cases to conduct teaching activities. It aims to impart theoretical knowledge, guide values, deepen patriotism, and strengthen the concept of a strong nation. The course aims to solidify basic knowledge, enhance practical skills and innovative spirit, and establish correct views on life, the world, and values. The allocation of class hours for face-to-face instruction is shown in Table 2.

表 2 学时分配表

讲 课 内 容		学时				
		讲课	实验	上机	设计	课外
第 1 章	Mathematical Logic	6	0	0	0	0
第 2 章	Proofs	4	0	0	0	0
第 3 章	Sets and Mathematical Induction	4	0	0	0	0
第 4 章	Relations	6	0	0	0	0
第 5 章	Countable Sets and Counting	6	0	0	0	0
第 6 章	Modular Arithmetic	6	0	0	0	0
第 7 章	Graph Theory	8	0	0	0	0
小计		40	0	0	0	0
总计	40					

六、教学方法

1. Teach fundamental principles, link theory with practice, emphasize the basic logic and applications of discrete mathematics, and foster students' innovative abilities.

2. Utilize a combination of multimedia presentations and traditional teaching methods to enliven the classroom.

3. Combine theoretical instruction with discussions, and use the Rain Classroom online platform to test knowledge to motivate students' enthusiasm for learning and developing their self-study skills, teamwork abilities, and problem-solving capabilities.

七、成绩评定

This course follows the concept of continuous monitoring for assessment. The evaluation consists of three parts: attendance, assignments, classroom tests, and the final exam. The specific requirements and grading methods are as follows:

1. Attendance: Students are required to participate and sign in for all sessions of the course, and attendance accounts for 10% of the total grade. Students who miss 33% or more of the classes will lose the eligibility to take the final exam for this course.

2. Assignments: Assignments account for 40% of the total grade. It includes two parts: the in-class tests and the out-of-class assignment. Late submissions or assignments found to be plagiarized (identical) will receive a score of zero for that assignment.

3. Final Exam: The final exam accounts for 50% of the total grade.

八、评价及持续改进

1、教学大纲

考核周期：4 年，修订周期：4 年。

改进措施：课程负责人组织课程团队所有教师讨论后提出改进意见，经教研室主任审核后由教学院长批准。

1. Teaching Syllabus

Assessment Period: 4 years; Revision Period: 4 years

Improvement Measures: The course leader organizes a discussion with all course teachers to propose improvement suggestions, which are reviewed by the department head and approved by the dean of the faculty.

2、成绩评定考核

考核周期：1 学年，评价依据：学生最终成绩综合分析。

改进措施：根据学生最终成绩的分布，进行相应的内容调整和优化，并改进教学方法。

2. Performance Evaluation and Assessment

Assessment Period: 1 academic year

Evaluation Basis: Comprehensive analysis of students' final grades

Improvement Measures: Adjust and optimize the content and improve teaching methods based on the distribution of students' final grades.

撰写：　　郭静梅

审核：　　薛昌涛

批准：

日期：　　2023.07.05