南方科技大学
SOUTHERN UNIVERSITY OF SCIENCE AND TECHNOLOGY

课程详述
COURSE SPECIFICATION

以下课程信息可能根据实际授课需要或在课程检讨之后产生变动。如对课程有任何疑问，请联系授课教师。

The course information as follows may be subject to change, either during the session because of unforeseen circumstances, or following review of the course at the end of the session. Queries about the course should be directed to the course instructor.

1.	**课程名称 Course Title**	**离散数学及其应用 Discrete Mathematics and Its Applications**
2.	**授课院系 Originating Department**	统计与数据科学系
3.	**课程编号 Course Code**	STA202
4.	**课程学分 Credit Value**	3
5.	**课程类别 Course Type**	专业基础课 Major Foundational Courses
6.	**授课学期 Semester**	春季 Spring
7.	**授课语言 Teaching Language**	中英双语 English & Chinese
8.	**授课教师、所属学系、联系方式（如属团队授课，请列明其他授课教师） Instructor(s), Affiliation& Contact （For team teaching, please list all instructors）**	胡延庆，副教授，统计与数据科学系 Yanqing HU，Associate Professor, Department of Statistics and Data Science Email: huyq@sustech.edu.cn
9.	**实验员/助教、所属学系、联系方式 Tutor/TA(s), Contact**	待公布 To be announced
10.	**选课人数限额(可不填) Maximum Enrolment （Optional）**	

11.	授课方式 Delivery Method	讲授 Lectures	习题/辅导/讨论 Tutorials	实验/实习 Lab/Practical	其它(请具体注明) Other（Please specify）	总学时 Total
	学时数 Credit Hours	48				

12.	先修课程、其它学习要求 Pre-requisites or Other Academic Requirements	MA102B 高等数学(下)A Calculus II A （MA127 高等数学（下）） 或者 MA102a 数学分析 II Mathematical Analysis II MA107A 线性代数 A LinearAlgebral-A （MA113 线性代数 LinearAlgebral ）
13.	后续课程、其它学习规划 Courses for which this course is a pre-requisite	无 NO
14.	其它要求修读本课程的学系 Cross-listing Dept.	无 NO

教学大纲及教学日历 SYLLABUS

15. 教学目标 Course Objectives

本课程旨在理解和应用在计算机科学中广泛存在的一系列抽象的离散结构。具体地说，本课程将介绍逻辑、集合与函数、数学证明、计算复杂度、数论及其应用、数学归纳法、计数、递归、关系、图论等内容，特别是这些内容在计算机中的实际应用。

The objective of this course is to understand and use (abstract) discrete structures that are backbones of data science and computer science. In particular, this course is meant to introduce logic, sets and functions, mathematical proofs, complexity, number theory, induction, counting, recurrences, relations, graph theory, with an emphasis on applications in computer science.

16. 预达学习成果 Learning Outcomes

本课程预期达到以下学习效果:
- 能够阅读、理解、完成数学证明
- 理解离散数学中各个部分问题的形式化表述，包括计数、图论、数论、逻辑和证明、递归、概率论等
- 学习一系列的离散数学工具并学会应用这些工具解决计算机科学中的一些实际问题

On completion of this course, the students are expected to:

- be able to read, understand, and construct mathematical arguments and proofs
- understand the formulation of common problems in several areas of discrete mathematics, including counting, graphs, number theory, logic and proof, recursions, probability theory, etc.
- learn a number of discrete mathematical tools and apply discrete mathematical tools to solve certain problems in computer science

17. 课程内容及教学日历 （如授课语言以英文为主，则课程内容介绍可以用英文；如团队教学或模块教学，教学日历须注明主讲人）

Course Contents (in Parts/Chapters/Sections/Weeks. Please notify name of instructor for course section(s), if this is a team teaching or module course.)

第一课，离散数学概论与数理逻辑：离散数学介绍、典型问题、命题逻辑、逻辑连接符、真值表
第二课，数理逻辑：逻辑等价性、谓语逻辑、命题逻辑的应用、逻辑等价性及证明、命题逻辑的限制、谓语逻辑及量词
第三课：数理逻辑：逻辑推导、证明思路 逻辑推导规则及应用、五种证明思路及举例证明
第四课:集合与函数：集合及运算、逻辑表示、定义函数、单射、满射函数
第五课:复合函数：序列、可数集、复合函数、函数逆定义、序列、序列求和、公式推导 可数集定义、证明及举例
第六课:计算复杂度 I：大 O 符号、复杂度计算举例、NP 理论介绍、决定和优化问题
第七课:计算复杂度 II：初等数论 I、NP 完全问题、整除、模运算、b 进制表示及相关算法
第八课:初等数论 II：素数、最大公约数、欧几里得算法、Bezout 等式 线性同余方程、模 n 逆及求解
第九课:初等数论应用： 中国剩余定理、向后置换法 线性同余法生成伪随机数 费马小定理、欧拉定理、本原根定义
第十课：数学归纳法：数学归纳法介绍及证明、数学归纳法弱准则、强准则
第十一课:递归 I 汉诺塔举例、递归式求解
第十二课:递归 II 递归式求解、主定理
第十三课:计数 I： 排列组合计数、加法乘法规则 容斥原理及证明、鸽巢原理、一一对应原理
第十四课:计数 II：二项式系数及性质、Pascal 恒等式、组合证明
第十五课:高级计数方法：欧几里得算法复杂度分析、求解线性递归式、生成函数
第十六课:关系 I： 二元关系、关系的性质及计数、关系复合
第十七课:关系 II： 传递关系性质及证明、关系闭包、关系数据库
第十八课:关系 III： 连通关系与传递闭包的关系、Roy-Warshall 算法、等价关系、等价类、偏序、Hasse 图
第十九课:图论 I：图论基本概念、无向图、有向图、二分图等、匹配、Hall 定理及证明
第二十课:图论 II：图表示、邻接矩阵、关联矩阵、图同构、路径、连通性、欧拉图
第二十一课:图论 III： Hamilton 图、最短路径问题、Dijkstra 算法、平面图、欧拉公式、图染色问题
第二十二课:树 I： 树基本概念、平衡树
第二十三课:树 II：先序、中序、后序遍历 最小生成树及算法 深度、广度优先搜索、
第二十四课:图论的应用：搜索引擎，复习课

1.Overview of Discrete Math and Propositional Logic Introduction to Discrete Math: typical problems Propositional logic, logical connectives, truth tables

2.Logical Equivalence: Predicate Logic Application of propositional logic Logical equivalence and proof Limitations of propositional logic Predicate logic, quantifiers

3.Logical Inference: Proof Methods, Rules of logical inferences and applications Five methods of proof, proof exercises

4.Set and Functions: Set, set operations, and representations using logic Definition of functions, one-to-one functions, onto functions

5.Composite Functions: Sequences, Countable Sets Composite function, inverse function,Sequences, sum of sequences, closed-form formula Countable sets, proofs and examples

6.Computational Complexity I: Big-O notation, examples of complexity NP theory,Decision problem, optimization problem

7.Computational Complexity II: Number Theory I,NP-Completeness,Divisibility, modular operation, base-b representation, related algorithms

8.Number Theory II:Primes, greatest common divisor,Euclidean algorithm, Bezout identity,Linear congruential equation, inverse modulo n

9.Applications of Number Theory:Chinese remainder theory, back substitution Pseudorandom numbers using linear congruential method Fermat's little theorem, Euler's theorem,Primitive root

10.Mathematical Induction:Introduction to induction, typical proofs,Weak principle, strong principle of mathematical induction

11.Recurrence I:Hanoi tower and recurrence,Solving recurrences with initial conditions

12.Recurrence II: Solving recurrences, more examples The master theorem

13.Counting I:Permutations, combinatorial numbers, the sum/product rule Inclusion-Exclusion principle and its proof, Pigeonhole principle

14.Counting II:Binomial coefficient and properties Pascal identity,Combinatorial proofs

15.Advanced Counting Techniques:Complexity of Euclidean algorithm,Solving linear recurrence relations with initial conditions Generating functions

16.Relation I:Binary relation,Properties of relation, and counting Composite relations

17.Relation II: Transitive relations, properties and proofs Transitive closure,Relational database

18.Relation III: Connectivity relation and transitive closure Roy-Warshall algorithm,Equivalence relations, equivalence class Partial ordering, Hasse diagram

19.Graph Theory I: Basic concepts of graph theory,Undirected graphs, directed graphs, Bipartite graphs Matching, Hall's marriage theorem, proof

20.Graph Theory II: Representations of graphs, adjacency matrix, incidence matrix Isomorphism of graphs,Path, connectivity, Euler graph

21.Graph Theory III: Hamilton graph,Shortest path, Dijkstra algorithm Planar graphs, Euler formula,Graph coloring

22.Tree I: Basic concepts of tree Balanced tree and counting

23.Tree II: Preorder, inorder, postorder traversal Minimum spanning tree and algorithms Depth-first search and breadth-first search

24. Application of graph theory: search engine, review.

18. **教材及其它参考资料 Textbook and Supplementary Readings**

Kenneth Rosen, Discrete Mathematics and Its Applications, 7th Edition, Mc Graw Hill Eduction, 2012

课程评估 ASSESSMENT

19.

评估形式 Type of Assessment	评估时间 Time	占考试总成绩百分比 % of final score	违纪处罚 Penalty	备注 Notes
出勤 Attendance		10%		
课堂表现 Class Performance				
小测验 Quiz				
课程项目 Projects				
平时作业 Assignments		30%		
期中考试 Mid-Term Test				无期中考试
期末考试 Final Exam		60%		

期末报告 **Final Presentation**				
其它（可根据需要改写以上评估方式） **Others (The above may be modified as necessary)**				

20. 记分方式 **GRADING SYSTEM**

A. 十三级等级制 **Letter Grading**

课程审批 REVIEW AND APPROVAL

21. 本课程设置已经过以下责任人/委员会审议通过
This Course has been approved by the following person or committee of authority
