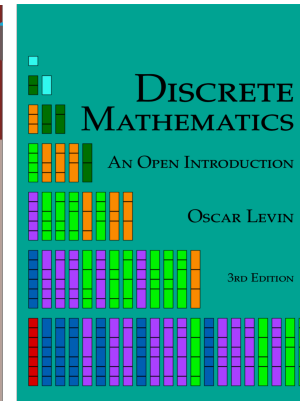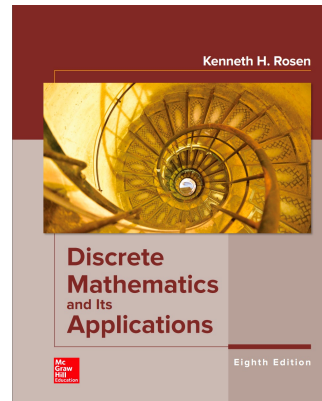# Vietnam National University of HCMC
International University
School of Computer Science and Engineering

DISCRETE MATHEMATICS (IT153IU)

Assoc. Prof. Dr. Nguyen Van Sinh

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Semester 1, 2022-2023

Providing all information...

- Check attendance
- Identify group
- Announce the rules of class
- Introduce to the Blackboard
- How to explore the text-book, reference books?
- How to submit assignment/homework?
- How to ask question or discuss problem on the forum?
- How to send an email for any problem?
- Your suggestion to the course?

Introduction

- The course for IT students
- Background of mathematics for IT:
  - Critical thinking
  - Logical thinking
  - Problems solving
  - Discrete problem
  - Optimization
  - Probabilistic, statistic, etc.
- Pre-request:
  - Calculus 1, 2
  - Linear algebra
  - Boolean algebra & logic
  - C/C++ programming

Introduction

- The main objective: to develop the ability to reason and think mathematically and logically; and apply this ability to analyze and solve discrete practical problems in Computer Science and IT

- Topics: this is an application-oriented course based upon the study of events that occur in small or discrete in computer science. Students will be introduced and studied the fields of logics, basic of counting, permutations and combinations, Boole algebra, induction and recursion, graph theory, etc; and its application in the field of computer science.

Lecturer

- Lecturer:
  - Assoc.Prof.Dr.Nguyen Van Sinh
    Dean, School of SCSE - HCMIU
  - Email: nvsinh@hcmiu.edu.vn
  - Office: Room A1.610
  - Website: https://it.hcmiu.edu.vn/faculty/
- Schedule:
  - G1: Tuesday afternoon (1:15 PM -> 4:00 PM)
  - G2: Wednesday morning (8:00 AM -> 11:00 AM)
  - G3: Friday morning (8:00 AM -> 11:00 AM)

Activities

- Lectures: 12 sessions (4 teaching hours for each)
- Assignments and Homework
- Grading:
  - Assignment: 25%
    - Attendance + classwork (quiz); Homework
  - Mid Exam: 30%
  - Final Exam: 45%

References

1) The textbook: Kenneth H. Rosen, Discrete Mathematics and its application, 8th edition, 2019.

2) References:

   ➢ Discrete mathematics An Open Introduction. 3rd edition. Oscar Levin, 2019.

   ➢ N.V.Sinh, T.M.Hà, N.T.T.Sang, N.M.Quân, "Nền tảng Toán học trong Công nghệ Thông tin", NXB - Đại học Quốc gia TPHCM, ISBN: 978-604-73-6518-0, 2018.

   ➢ The other sources on the internet.

Agenda

Week	Section (Handout)	Reading
1	Session 0 - Course Syllabus Session 1 - Logic and Propositions	Chapter 1
2	Session 1 - Logic and Propositions (continue)	Chapter 1
3	Session 2 - Propositional equivalences; Predicates and Quantifiers	Chapter 1
4	Session 2 - Nested Quantifiers and Methods of Proof	Chapter 1
5	Session 3 - Number theory (2.4; 3.1; 3.3; 3.4; 3.5; 3.6)	Chapter 4
6	Session 6 - Induction and Recursion	Chapter 5
7	Session 7 - Counting (6.1, 6.2 and 6.3)	Chapter 6
8	Session 8 - Counting (6.4; 6.5 and 6.6), review for midterm exam	Chapter 5

Agenda

Week	Section (Handout)	Reading
9	Session 9 - Advanced Counting Techniques	Chapter 8
10	Session 10 - Advanced Counting Techniques (continue)	Chapter 8
11	Session 11 - Boolean Algebra	Chapter 12
12	Session 12 - Graph Theory	Chapter 10
13	Session 13 - Optimal problem solving on graphs	Chapter 10
14	Session 14 - Optimal problem solving on graphs, examples	Chapter 10
15	Session 15 – Tree and Review for final exam	Chapter 11

Assignments

- Homework assignments will be given during the semester. They are typically simple questions and exercises from the textbook. The more exercises you do, the better you understand the topics.
- Submit your homework on the blackboard
- Classwork assignments will be given in the class.

Introduce to Blackboard space..!

Rules

- Assignments:
  - Copy program and report from others → failed the course

- Attendance:
  - Absence greater than 20% of the lectures → not allow attending the final exam
  - Attend less than 50% of lectures → fail the course

Introduction

What are "discrete structures" anyway?

- "***Discrete***" ($\neq$ "discreet"!): Composed of distinct, separable parts. (Opposite of *continuous*.)

  discrete:continuous :: digital:analog

- "***Structures***" - Objects built up from simpler objects according to some definite pattern.

- ***Discrete Mathematics:***

  - The study of discrete, mathematical objects and structures. (Or: A part of mathematics devoted to the study of discrete objects.)

Many kinds of problems can be solved by using Discrete mathematics

* How many ways are there to choose a valid password on a computer system?
* What is the probability of winning a lottery?
* Is there a link between two computers in a network?
* How can I identify spam e-mail messages?
* How can I encrypt a message so that no unintended recipient can read it?
* What is the shortest path between two cities using a transportation system?
* How can a list of integers be sorted so that the integers are in increasing order?
* How many steps are required to do such a sorting?
* How can it be proved that a sorting algorithm correctly sorts a list?
* How can a circuit that adds two integers be designed?
* How many valid Internet addresses are there

When we use discrete maths?

It is used:

➢ Whenever objects are counted,

➢ When relationships between finite (or countable) sets are studied,

➢ When processes involving a finite number of steps are analyzed.

Some Discrete Structures

- Propositional logic
- Predicates
- Proofs
- Number of theory
- Counting
- Advance counting
- Boolean algebra

- Sequences
- Strings
- Permutations
- Combinations
- Relations
- Graphs
- Trees

Examples:

- Logic is the study of the principles of valid reasoning and inference, as well as of consistency, soundness, and completeness.

- Combination studies the way in which discrete structures can be combined or arranged.

- Graph theory, the study of graphs and networks.

- Number theory is concerned with the properties of numbers in general, particularly integers.

- Discrete algebras includes: boolean algebra used in logic gates and programming; relational algebra used in databases.

- … etc.

Why Study Discrete Math?

- The basis of all of digital information processing is: *Discrete manipulations of discrete structures represented in memory.*

- It's the basic language and conceptual foundation for all of computer science.

- Discrete math concepts are also widely used throughout math, science, engineering, economics, biology, *etc.*, …

- A generally useful tool for rational thought!

Course Objectives

- Upon completion of this course, the student should be able to:
  - Count/enumerate objects in a systematic way.
  - Read, comprehend and construct mathematical arguments.
  - How to work with discrete structures
  - Algorithm thinking and modeling
  - All knowledge are applied in CS for solving problems.

Uses/applies of Discrete Math in/to Computer Science

- Advanced algorithms & data structures

- Programming language compilers & interpreters.

- Computer networks

- Operating systems

- Computer architecture

- Database management systems

- Cryptography

- Error correction codes

- Graphics & animation algorithms, game engines, *etc.*…

- *i.e.*, the whole field!

Significances of discrete mathematics in computer science

It is important to make us can think logically and mathematically in order to finished projects in Computer Science:

- First, through this course you can develop your mathematical maturity: that is, your ability to understand and create mathematical arguments.

- Second, discrete mathematics is the gateway to more advanced courses in all parts of the mathematical sciences.

Significances of discrete mathematics in computer science

- Discrete mathematics provides the mathematical foundations for many computer science courses including data structures and algorithms, database theory, automata theory, formal languages, compiler theory, computer security, and operating systems.

- It proof that this subject is important to Computer Science students to help them think logically when they develop their projects and it is useful in another subject as well.

How can you do?

- Think about the following five important points:
  - First, Mathematical Reasoning: understand mathematical reasoning in order to read, comprehend, and construct mathematical arguments.
  - Second, Combinatorial Analysis: An important problem-solving skill is the ability to count or enumerate objects.
  - Third, Discrete Structures: You must know, how to work with discrete structures, which are the abstract mathematical structures used to represent discrete objects and relationships between these objects.
  - Fourth, Algorithmic Thinking: Certain classes of problems are solved by the specification of an algorithm (algorithm has been described; a computer program can be constructed and implemented; the computer memory and time required to perform it have also been analyzed).
  - Fifth, Applications and Modeling: Discrete mathematics has applications to almost every conceivable area of study

Requirements to students

- Read, understand and memory some mathematical notations in "List of Symbol" of the textbook.

- Read again the part of "Goal of a Discrete Mathematics course" (page vii of the textbook).

- Study the part of "Optional Computer Science Sections" (page xiii in the textbook) as an additional reference.

- *Questions and answers to the course?*