INTRODUCTION TO DISCRETE MATHEMATICS

MACM 101

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This course will provide the formal foundation for much of what you learn in computing science. This is a difficult course, but it is one of the most valuable subjects that you will undertake at SFU.

Topics of Introductory Discrete Mathematics

- Sets, Relations and Functions
- Mathematical Logic
- Number Theory
- Counting Theory
- Algorithms and Computational Complexity
- Probability (no longer in MACM 101)
- Mathematical Induction and Recurrence Relations
- Graph Theory and Trees
- Formal Languages (only if time permits)
- Boolean Algebra (only if time permits)

- MACM 101 is a course on **proof theory** within the setting of Discrete Mathematics.

Kinds of Problems Solved Using Discrete Mathematics

- How many ways can a password be chosen following specific rules?
- How many valid Internet addresses are there?
- What is the probability of winning a particular poker hand?
- Is there a link between two computers in a network?
- How can I identify spam email messages?
- How can I encrypt a message so that no unintended recipient can read it?
- How can we build a logic circuit that adds two integers?

Kinds of Problems Solved Using Discrete Mathematics

- What is the shortest path between two cities using a transportation system?
- How can we represent English sentences so that a computer can reason with them?
- How can we prove that there are infinitely many prime numbers?
- 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?
- Find the shortest tour that visits each of a group of cities only once and then ends in the starting city. https://www.youtube.com/watch?v=SC5CX8drAtU

Discrete Mathematics is a Gateway Course

- Topics in discrete mathematics will be important in many courses that you will take in the future:
  - **Computer Science**: Computer Architecture, Data Structures, Algorithms, Programming Languages, Compilers, Computer Security, Databases, Artificial Intelligence, Networking, Graphics, Game Design, Theory of Computation, …

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- Mathematic + CoMputing = MACM.

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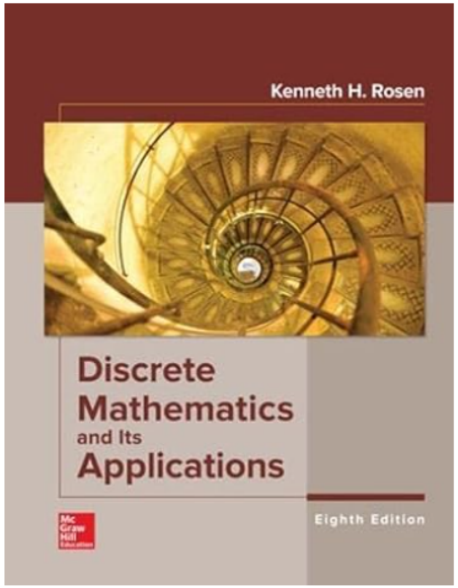
- **Other Disciplines**: You may find that concepts learned here are also useful in courses in philosophy, economics, linguistics, and other disciplines.

Textbook Topics



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Discrete Mathematics and Its Applications Hardcover – Jan. 1 2018

by Rosen (Author)

4.5 419 ratings

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Rosen's Discrete Mathematics and its Applications presents a precise, relevant, comprehensive approach to mathematical concepts. This world-renowned best-selling text was written to accommodate the needs across a variety of majors and departments, including mathematics, computer science, and engineering. As the market leader, the book is highly flexible, comprehensive and a proven pedagogical teaching tool for instructors. Digital is becoming increasingly important and gaining popularity, crowning Connect as the digital leader for this discipline.

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Tentative Syllabus (Rosen-based)

Weeks	Topic	Chapters	Assignments
1	**Introduction and background, elementary logic**	1 and 2	
2	**Elementary logic continued (1.1 – 1.8)**	2	
3	**Set theory, inclusion/exclusion (2.1 – 2.5, 8.5)**	2, 8.5	Assignment 1
4	**Algorithms and functions (3.1 – 3.3)**	3	
5	**Number theory (4.1, 4.3, 4.4)**	4	Assignment 2
6	**MIDTERM #1; Induction and recursion (5.1 – 5.3)**	5	
7	**Combinatorics**	6	Assignment 3
8	**Combinatorics continued (6.1 – 6.6)**	6	
9	**Relations (9.1 – 9.6)**	9	Assignment 4
10	**MIDTERM #2; Graphs and trees (10.1 – 10.2, 11.1 – 11.4)**	10	
11 and 12	**Trees continued and review**	11	

An Example of a MACM 101 Proof

PROPOSITION: If $(0 = 1)$, then $(1 = 1)$

True or False?

An Example of a MACM 101 Proof

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PROOF:

1. **State given premise, $(0 = 1)$.**

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PROOF:

1. **State given premise, $(0 = 1)$.**
2. **State given conclusion, $(1 = 1)$.**
3. **Now, thread a *valid argument* from 1 to 2 using the rules of algebra (*axioms*) and all requisite *definitions*.**

Step 3 in Detail

- $(0 = 1)$, given premise

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- $(1 = 0)$, commutative law

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- $(0 = 1)$, given premise
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- $(1 = 1)$, addition of previous two statements

Step 3 in Detail

- (0 = 1), given premise
- (1 = 0), commutative law
- (1 = 1), addition of previous two statements
- This is the conclusion that we sought

QED

The Complete Proof

PROPOSITION: If (0 = 1), then (1 = 1)

PROOF:

1. **State given premise, (0 = 1).**
2. **State given conclusion, (1 = 1).**
3. **Now, thread a *valid argument* from 1 to 2 using the rules of algebra (*axioms*) and all requisite *definitions*.**

   a) (0 = 1), given premise
   b) (1 = 0), commutative law
   c) (1 = 1), addition of previous two statements

QED

QED

Quod Erat Demonstrandum,

"What was to be demonstrated".

Key Issues

	Addition	*Multiplication*
Commutativity	$x + y = y + x$	$x * y = y * x$
Associativity	$(x+y)+z = x+(y+z)$	$(x*y)*z = x*(y*z)$
Identity	$x + 0 = x$	$1 * x = x$
Inverse	$x + -x = 0$	$x * 1/x = 1$
Distribution	$x*(y+z) = (x*y)+(x*z)$	

Know your **definitions** and **axioms** succinctly. Here is how you learned them in grade school algebra.

Presentation Terminated