

# Fundamentals of Computer Science Study Guide

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## Books

1. Rosen, K.H. *Discrete Mathematics and its Applications, Global Edition* [Direct Link](#)
2. Sipser, M. *Introduction to the theory of computation* PDF excerpts are provided on Coursera, however I suggest getting the book, because we only have access to chapter 1. The international edition can be found for cheap. [Link](#)
3. Hopcroft, J., R. Motwani and J.D. Ullman *Introduction to automata theory, languages and computation* PDF Excerpts are provided on Coursera.
4. Forbes, M. *A theoretical introduction to Turing Machine* [Direct Link](#) (This book is trash)
5. Kozen, D.C. *Automata and Computability*. PDF excerpts are provided on Coursera
6. Chang, S. (ed) *Data structures and algorithms* [Direct Link](#)

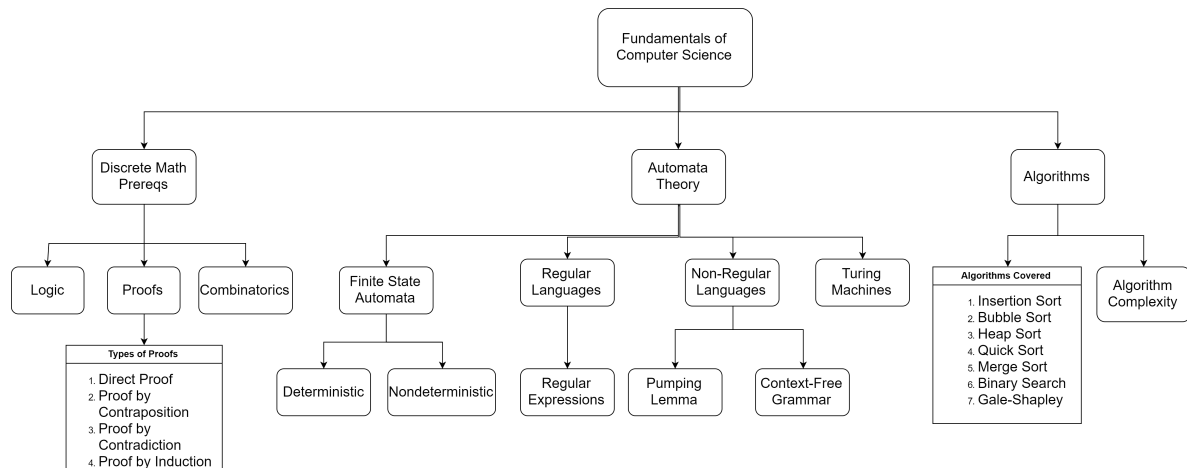
## Topics Covered

- Discrete Math Prerequisites
  - Logic
  - Proofs:
    - Direct Proof
    - Proof by Contraposition
    - Proof by Contradiction
    - Proof by Induction
  - Combinatorics
- Automata Theory
  - Finite State Automata
    - Deterministic
    - Nondeterministic
  - Regular Languages
    - Regular Expressions
  - Non-Regular Languages\*
    - Pumping Lemma
    - Context-Free Grammars
  - Turing Machines\*
- Algorithms
  - Algorithm Complexity
  - Algorithms Covered:
    - Insertion Sort
    - Bubble Sort
    - Heap Sort
    - Quick Sort
    - Merge Sort
    - Binary Search
    - Gale-Shapley

- Master Theorem

\*Consult external resources because these topics are not explained well in the lectures

## Topic Map



## Suggested Reading List

Week	Topic	Reading
1 & 2	Logic	<b>Rosen:</b> Chapter 1.1 - 1.4, 1.5 (optional)
3 & 4	Proofs	<b>Rosen:</b> Chapter 1.8, 1.9 (optional, to practice proof-writing) 5.1, 5.3 (optional, but highly recommended to get more comfortable with recursion)
5 & 6	Combinatorics	<b>Rosen:</b> Chapter 6.1 - 6.3
7 & 8	Automata Theory: DFA and NFA	<b>Sipser:</b> Chapter 1.1, 1.2
9 & 10	Automata Theory: Regular Languages	<b>Sipser:</b> Chapter 1.3, 1.4

Week	Topic	Reading
11 & 12	Automata Theory: Non-Regular Languages*	<b>Sipser:</b> Chapter 2.1 (More concise and easier to understand than Hopcroft reading) <b>Hopcroft:</b> Chapter 5 Chapter 7.1 (Covers Chomsky Normal Form)
13 & 14	Automata Theory: Turing Machines*	<b>Forbes:</b> Chapter 1 (I found this book to be unreadable. Read Sipser or Hopcroft instead) <b>Kozen:</b> Lecture 32 <b>Sipser:</b> Chapter 3.1 (Optional) <b>Hopcroft:</b> Chapter 8.1, 8.2 (Optional)
15 & 16	Algorithms I	<b>Rosen:</b> Chapter 3.1 <b>Chang:</b> Chapter 8, 9
17 & 18	Algorithms II	<b>Rosen:</b> 5.4
19 & 20	Algorithms: Complexity	<b>Rosen:</b> Chapter 3.2, 3.3 (both optional) <b>Chang:</b> Chapter 2, 3 (optional)

*\*The lectures in weeks 11 - 14 (covering non-regular languages and Turing machines) are exceptionally poor so I suggest consulting the resources below*

## Resources

[Lecture notes](#) by Felipe Balbi

### Writing Proofs

1. The exercises in chapters 1.8, 1.9, and 5.1 of the Rosen book give you the opportunity to practice proof-writing. Check your answers [here](#)
2. [A Guide to Proof-Writing](#)
3. [Techniques for Proof-Writing](#)
4. The Stanford CS103 [website](#) has many resources related to writing proofs

### Automata Theory

1. Practice designing automata, regular expressions, grammars, and Turing machines by solving homework problems in the Automata Theory MOOC (#5 below) or the Sipser book. Check your answers [here](#)
2. The Stanford CS103 [website](#) also has very well made and detailed slides covering Finite State Automata, Regular Expressions, Context-Free Grammars, and Turing Machines

3. [Theory of Computation lectures by UC Davis](#). Follows the Sipser book.
4. [NESO Academy Theory of Computation playlist](#)
5. [Stanford Automata Theory MOOC](#). Follows the Hopcroft book. Includes homework as well.

## Algorithms

There are many resources to learn algorithms online here is a few of them:

1. [Khanacademy](#).
2. [Visualgo](#)
3. [GeeksforGeeks](#)
4. [Interview Cake sorting algorithms reference](#), [Binary Search reference](#)
5. [Algorithms Youtube Playlist](#)
6. We also have access to CLRS, a popular algorithms textbook. [Direct Link](#)  
The chapters relevant to this course are: 2, 3, 4.5, 4.6, 6, 7