

# Theory of Computation

➤ Introduction to the Theory of Computation, Michael Sipser

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➤ Data Communications and Networking, Behrouz A. Forouzan

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# Distributed System

- Designing Distributed Systems: Patterns and Paradigms for Scalable, Reliable Services, Brendan Burns

Designing Distributed Systems: Patterns and Paradigms for Scalable, Reliable Services	
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# Parallel Computing

- Algorithms and Parallel Computing, Fayez Gebali

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Relating Parallel Algorithm and Parallel Architecture
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	Loop Spreading for Simple Dependent Loops
	Loop Unrolling Problem Partitioning
	Divide-and-Conquer (Recursive Partitioning) Strategies
	Pipelining
	<b>Non-serial-Parallel Algorithms</b>
	Introduction
	Comparing DAG and DCG Algorithms
	Parallelizing NSPA Algorithms Represented by a DAG
	Formal Technique for Analyzing NSPAs
	Detecting Cycles in the Algorithm
	Extracting Serial and Parallel Algorithm Performance Parameters
	Useful Theorems
	Performance of Serial and Parallel Algorithms on Parallel Computers
	<b>z-Transform Analysis</b>
	Introduction
	Definition of z-Transform
	The 1-D FIR Digital Filter Algorithm
	Software and Hardware Implementations of the z-Transform
	Design 1: Using Horner's Rule for Broadcast Input and Pipelined Output
	Design 2: Pipelined Input and Broadcast Output
	Design 3: Pipelined Input and Output
	<b>Dependence Graph Analysis</b>
	Introduction
	The 1-D FIR Digital Filter Algorithm
	The Dependence Graph of an Algorithm
	Deriving the Dependence Graph for an Algorithm
	The Scheduling Function for the 1-D FIR Filter
	Node Projection Operation
	Nonlinear Projection Operation
	Software and Hardware Implementations of the DAG Technique
	<b>Computational Geometry Analysis</b>
	Introduction
	Matrix Multiplication Algorithm
	The 3-D Dependence Graph and Computation Domain D
	The Facets and Vertices of D
	The Dependence Matrices of the Algorithm Variables
	Null-space of Dependence Matrix: The Broadcast Subdomain B
	Design Space Exploration: Choice of Broadcasting Versus Pipelining Variables
	Data Scheduling
	Projection Operation Using the Linear Projection operator
	Effect of Projection Operation on Data
	The Resulting Multithreaded/Multiprocessor Architecture
	Summary of Work Done in this Chapter

	<b>Case Study: One-Dimensional IIR Digital Filters</b>
	Introduction
	The 1-D IIR Digital Filter Algorithm
	The IIR Filter Dependence Graph
	z-Domain Analysis of 1-D IIR Digital Filter Algorithm
	<b>Case Study: Two and Three Dimensional Digital Filters</b>
	Introduction
	Line and Frame Wraparound Problems
	2-D Recursive Filters
	3-D Digital Filters
	<b>Case Study: Multi-rate Decimators and Interpolators</b>
	Introduction
	Decimator Structures
	Decimator Dependence Graph
	Decimator Scheduling
	Decimator DAG for $s_1 = [1 \ 0]$
	Decimator DAG for $s_2 = [1 \ -1]$
	Decimator DAG for $s_3 = [1 \ 1]$
	Poly-phase Decimator Implementations
	Interpolator Structures
	Interpolator Dependence Graph
	Interpolator Scheduling
	Interpolator DAG for $s_1 = [1 \ 0]$
	Interpolator DAG for $s_2 = [1 \ -1]$
	Interpolator DAG for $s_3 = [1 \ 1]$
	Poly-phase Interpolator Implementations
	<b>Case Study: Pattern Matching</b>
	Introduction
	Expressing the Algorithm as a Regular Iterative Algorithm (RIA)
	Obtaining the Algorithm Dependence Graph
	Data Scheduling
	DAG Node Projection
	DESIGN 1: Design Space Exploration When $s = [1 \ 1]$
	DESIGN 2: Design Space Exploration When $s = [1 \ -1]$
	DESIGN 3: Design Space Exploration When $s = [1 \ 0]$
	<b>Case Study: Motion Estimation for Video Compression</b>
	Introduction
	FBMA's
	Data Buffering Requirements
	Formulation of the FBMA
	Hierarchical Formulation of Motion Estimation
	Hardware Design of the Hierarchy Blocks
	<b>Case Study: Multiplication Over GF(2<sup>m</sup>)</b>
	Introduction
	The Multiplication Algorithm in GF(2 <sup>m</sup> )
	Expressing Field Multiplication as an RIA
	Field Multiplication Dependence Graph
	Data Scheduling
	DAG Node Projection
	Design 1: Using $d_1 = [1 \ 0]$
	Design 2: Using $d_2 = [1 \ 1]$

	Design 3: Using $d3 = [1 \ -1]$
	Applications of Finite Field Multipliers
	<b>Case Study: Polynomial Division Over GF(2)</b>
	Introduction
	The Polynomial Division Algorithm
	The LFSR Dependence Graph
	Data Scheduling
	DAG Node Projection
	Design 1: Design Space Exploration When $s1 = [1 \ -1]$
	Design 2: Design Space Exploration When $s2 = [1 \ 0]$
	Design 3: Design Space Exploration When $s3 = [1 \ -0.5]$
	Comparing the Three Designs
	<b>The Fast Fourier Transform</b>
	Introduction
	Decimation-in-Time FFT
	Pipeline Radix-2 Decimation-in-Time FFT Processor
	Decimation-in-Frequency FFT
	Pipeline Radix-2 Decimation-in-Frequency FFT Processor
	<b>Solving Systems of Linear Equations</b>
	Introduction
	Special Matrix Structures
	Forward Substitution (direct Technique)
	Back Substitution
	Matrix Triangularization Algorithm
	Successive Over Relaxation (SOR) (Iterative Technique)
	Problems
	<b>Solving Partial Differential Equations Using Finite Difference Method</b>
	Introduction
	FDM for 1-D Systems

# Discrete Mathematics

- Mathematical Structure for Computer Science: A Modern Approach to Discrete Mathematics, Judith L. Gersting

Mathematical Structure for Computer Science: A Modern Approach to Discrete Mathematics	
	<b>Formal Logic</b>
	Statements, Symbolic Representation, and Tautologies – Topics 4 and Exercises
	Propositional Logic – Topics 4 and Exercises
	Quantifiers, predicates, and Validity – Topics 3 and Exercises
	Predicate Logic – Topics 8 and Exercises
	Logic Programming – Topics 4 and Exercises
	Proof of Correctness – Topics 3 and Exercises
	Review on the Computer
	<b>Proofs, Recursion, and Analysis of Algorithms</b>
	Proof Techniques – Topics 8 and Exercises
	Induction – Topics 3 and Exercises
	More on Proof of Correctness – Topics 2 and Exercises
	Recursive Definitions – Topics 4 and Exercises
	Recurrence Relations – Topics 5 and Exercises
	Analysis of Algorithms – Topics 3 and Exercises
	<b>Sets, Combinatory, Probability and Number Theory</b>
	Sets – Topics 7 and Exercises
	Counting – Topics 4 and Exercises
	Principle of Inclusion and Exclusion; Pigeonhole Principle – Topics 2 and Exercises
	Permutations and Combinations – Topics 4 and Exercises
	Probability – Topics 5 and Exercises
	Binomial Theorem – Topics 3 and Exercises
	Number Theory – Topics 3 and Exercises
	Review on the Computer
	<b>Relations, Functions, and Matrices</b>
	Relations – Topics 5 and Exercises
	Topological Sorting – Exercises
	Relations and Databases – Topics 5 and Exercises
	Functions – Topics 12 and Exercises
	The Mighty Mod Function – Topics 8 and Exercises
	Matrices – Topics 3 and Exercises
	Review on the Computer
	<b>Graphs and Trees</b>
	Graphs and Their Representations – Topics 8 and Exercises
	Trees and Their Representations – Topics 5 and Exercises
	Decision Trees – Topics 4 and Exercises
	Huffman Codes – Topics 4 and Exercises
	Review on the Computer
	<b>Graph Algorithms</b>
	Directed Graphs and Binary Relations; Warshall's Algorithm – Topics 3 and Exercises
	Euler Path and Hamiltonian Circuit – Topics 2 and Exercises
	Shortest Path and Minimal Spanning Tree – Topics 2 and Exercises
	Traversal Algorithms – Topics 4 and Exercises
	Articulation Points and Computer Networks – Topics 3 and Exercises
	Review on the Computer

	<b>Boolean Algebra and Computer Logic</b>
	Boolean Algebra Structure – Topics 5 and Exercises
	Logic Networks – Topics 11 and Exercises
	Minimization – Topics 5 and Exercises
	Review on the Computer
	<b>Modeling Arithmetic, Computation, and Languages</b>
	Algebraic Structures – Topics 4 and Exercises
	Finite-State Machines – Topics 8 and Exercises
	Turing Machines – Topics 8 and Exercises
	<b>Formal Languages</b>
	Classes of Grammars
	Formal Languages and Computational Devices
	Context-Free Grammars
	Exercises
	Review on the Computer
	<b>Appendix A: Derivation Rules for Propositional and Predicate Logic</b>
	<b>Appendix B: Summation Notation</b>
	<b>Appendix C: The Logarithm Function</b>

## Schedule of Practice

	System and Communication		
01			
	<b>Total Lab Topics</b>		
02			
03			
04			
	<b>Total Theoretical Topics</b>		
05			
06			
	<b>Total Elective Topics</b>		
	<b>4 Months: (4 Weeks x 4 = 16 Weeks x 15 Hours) = 240 Hours</b>		
	<b>Per Day : (1000 Topics / 240 = 5 Topics x 3 Hours) = 15 Topics</b>		

Practice Hours Per Week	
<b>Theory</b>	5 Days x 3 Hours (Evening) = 15 Hours
<b>Lab Practice</b>	5 Days x 3 Hours (Morning) = 15 Hours
<b>Total Lesson Hours</b>	5 Days x 6 Hours (Full Day) = 30 Hours
<b>Review and Test</b>	1 Days x 6 Hours (Full Day) = 06 Hours
<b>Industrial Project</b>	1 Days x 6 Hours (Full Day) = 06 Hours
<b>Total Review Hours</b>	2 Days x 6 Hours (Full Day) = 12 Hours
<b>Week Hours</b>	<b>7 Days x 6 Hours (Full Day) = 42 Hours</b>

### Resources:-

1. Listed Books
2. GPT: Concept and Questions
3. YouTube: Professional and Industrial Practice Example
4. Websites: Additional Resources
5. Certification: MIT, Harvard, Oxford, Microsoft, Google, OpenAI, IBM, Etc

### Practice Recommendation:-

- Clear Each Concept Step by Step
- Apply to Get Output
- Manipulate
- Then Summarize the Lesson
- Make the Connected and Related List of Summarized Concept

### Review Recommendation:-

- Make Quiz, Interview Question (Google, Microsoft), Competitive Questions Using GPT
- Make Projects using GPT and Community According to Market and Client Needs