Scarsdale High School
Mathematics Department

Digital Logic Design Course Curriculum
(Updated Summer 2022)
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I. Introduction to Electricity and Circuits

0. Digital vs. Analog Systems, Aristotelean Logic vs. Boolean Logic, Boole and Shannon
1. Newton's Laws of Motions
2. Coulomb's Force Law
3. Current, Voltage, Resistance, Ohm's Law
4. Practical Exercises
    a) Working with breadboard
    b) Measurements with multimeter
5. Energy and Power
6. Kirchhoff's Laws
7. Series Circuits
8. Parallel Circuits
9. Voltage Division
10. Solving Circuits
11. Augmented Matrices, Gaussian Elimination
12. Matrix Algebra (addition, scalar multiplication, matrix multiplication, transpose, trace)
13. Matrix Inverses
14. Determinants, Adjoints, Cramer's Rule
15. Network Theorems
    a) Superposition Theorem
    b) Thevenin's Theorem
    c) Norton's Theorem

II. Number Systems, Operations and Codes

1. Set Theory
    a) Review subsets, intersection, union
    b) Review DeMorgan's laws
2. Decimal and Binary Numbers
3. Binary Arithmetic
4. 1's and 2's Complement of Binary Numbers
5. Signed Numbers
6. Arithmetic Operations with Signed Numbers
7. Hexadecimal Numbers
8. Octal Numbers
9. Binary Coded Decimal (BCD)
10. Digital Codes (Gray, Hamming)
11. Error Detection and Correction Codes

III. Logic Gates

1. The Inverter (Theory and Practical)
2. The AND Gate (Theory and Practical)
3. The OR Gate (Theory and Practical)
4. The NAND Gate
5. The NOR Gate
6. The XOR AND XNOR Gate
7. Lab #1: Logic Gates
8. Lab #2: More Logic Gates

IV. Boolean Algebra and Logic Simplification

1. Boolean Operations and Expressions
2. Laws and Rules of Boolean Algebra
3. DeMorgan's Theorems
4. Boolean Analysis of Logic Circuits
5. Simplification Using Boolean Algebra
6. Standard Forms of Boolean Expressions
7. Boolean Expressions and Truth Tables
8. The Karnaugh Map
9. Karnaugh Map SOP Minimization
10. Karnaugh Map POS Minimization
11. Five-Variable Karnaugh Maps (Optional)
12. Lab #3: Boolean Laws and DeMorgan's Theorems
13. Lab #4: Logic Circuit Simplification
14. Lab #5: Design Practice

V. Combinational Logic Analysis

1. Basic Combinational Logic Circuits (AND-OR, etc).
2. Implementing Combinational Logic with Breadboard
3. Universal Property of NAND and NOR
4. Combinational Logic Using NAND and NOR Gates
5. Pulse Waveforms
6. Lab #6: Majority Logic
7. Lab #7: Perfect Pencil Machine
8. Lab #8: Molasses Tank

VI. Project A: 2 Bit Multiplier Circuit

VII. Functions of Combinational Logic I: Adders

1. Basic Adders
2. Parallel Binary Adders
3. Ripple Carry and Look-Ahead Carry Adders

VIII. Project B: 4-bit Adder/Subtractor Circuit

VIII. Functions of Combinational Logic

1. Comparators
2. Decoders and Encoders
3. Code Converters
4. Multiplexers and Demultiplexers
5. Lab #9: The Seven-Segment Display
6. Lab #10: Combinational Logic with Multiplexers
7. Lab #11: Design with Multiplexers

IX. Latches, Flip-Flops, Timers

1. Sequential Logic, State tables, State diagrams
2. S-R Latches, D-Latches
3. D Flip-flops, JK Flip-flops
4. Capacitors
5. 555 Timers
6. Lab #12: D Latch and D Flip-Flop
7. Lab #13: Baseball Scorecard

X. Counters and Shift Registers

1. Asynchronous Counters
2. Synchronous Counters
3. Designing Synchronous Counters
4. Shift Registers
5. Lab #14: Asynchronous Counters
6. Lab #15: Synchronous Counters

XI. Project C: Traffic Light Simulator

XII. Project D: Vending Machine Digital Simulator

XIII. Final Project