Materials are provided for a two-semester digital and microprocessor technician postgraduate program. Prerequisites stated for the program include a background in DC and AC theory, solid state devices, basic circuit fundamentals, and basic math. A chronology of major topics and a listing of course objectives appear first. Theory outlines for each semester are followed by listings of experiments for the first and second semesters. Supplementary experiments are also provided. Major topics include a review of DC theory, AC theory, solid state devices, and basic circuit fundamentals; digital electronics; computer literacy; computer programming/flowcharting in high-level language; microprocessors; and microcomputers. Other contents include a list of digital and microprocessor systems compatible with the course (teaching systems, trainers, exercises, texts, manuals) and listings of references for each semester.

(YLB)
MICROPROCESSING COMPUTER TECHNICIAN

DIGITAL AND MICROPROCESSOR

TECHNICIAN PROGRAM

POST-GRADUATE 5th YEAR

DIVISION OF VOCATIONAL-TECHNICAL SCHOOLS

PREPARED FOR

CONNENTICUT STATE DEPARTMENT OF EDUCATION
DIVISION OF VOCATIONAL AND ADULT EDUCATION
BUREAU OF VOCATIONAL PROGRAM PLANNING AND DEVELOPMENT
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DIGITAL AND MICROPROCESSOR TECHNICIAN PROGRAM

Post-Graduate 5th Year

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DIGITAL AND MICROPROCESSOR TECHNICIAN
Post-Graduate Program

PREREQUISITE

Student must have a background in D.C. Theory, A.C. Theory, solid state devices, basic circuit fundamentals and basic math.

CHRONOLOGY OF MAJOR TOPICS

1. Review D.C. Theory, A.C. Theory, solid state devices and basic circuit fundamentals.
2. Digital Electronics.
3. Computer Literacy and programming/flow charting in high-level language.
4. Microprocessors and Microcomputers
COURSE OBJECTIVES

The student will be able to:

1. Convert between the binary and decimal number systems and recognize the most commonly used binary codes.
2. Name the major components used in implementing digital circuits and explain how they operate.
3. Explain the operation of Digital logic gates.
4. Use Boolean Algebra to express logic operations.
5. Explain the operation of Flip Flops.
6. Discuss the operation and application of binary and BCD counters, shift registers, and other sequential logic circuits.
7. Name the most frequently used combinational logic circuits and explain their operation.
8. Explain how a digital computer is organized and how it operates.
9. Explain the operation and interrelation of microprocessors and system elements.
10. Demonstrate troubleshooting techniques for logic circuits and microprocessors.
I. Introduction of Digital Electronics

A. Digital Techniques
   1. Where are Digital circuits used?
   2. Why use Digital circuits?

B. Binary Number System
   1. Counting in Decimal and Binary
   2. Place value
   3. Binary to Decimal conversion
   4. Decimal to Binary conversion

C. Binary Codes
   1. The 8421 code
   2. Excess 3 code
   3. Gray code
   4. ASCII code

D. Data Representation
   1. Electromechanical devices
   2. Logic levels
   3. Positive and negative logic
   4. Parallel vs. serial transmission

E. Logic Symbols
   1. MIL STD 806
   2. IEEE/IEE

II. Semiconductor Devices for Digital Circuits

A. Review of Semiconductors
II. A. 1. Bipolar transistor operations
       2. Unipolar transistor characteristics
       3. N channel and P channel Mosfets

III. Digital Logic Circuits
       A. Types of Logic Circuits
          1. And gate
          2. Or gate
          3. Inverter
          4. Nand/Nor gates
          5. Exclusive Or gate
          6. Exclusive Nor gate

IV. Digital Integrated Circuits
       A. Logic Circuit Characteristics
          1. Logic levels
          2. Propagation Delay
          3. Power Dissipation
          4. Fan in Fan out

       B. Integrated Circuits
          1. To 5
          2. Flat Pack
          3. Dip
          4. Transistor Logic
          5. Low power TTL
          6. High power TTL
          7. Schottgy TTL
          8. Tri-state Logic Circuits
          9. Emitter coupled Logic
         10. Positive vs Negative buses
V. **Boolean Algebra**
   A. Constructing Circuits from Boolean Expressions
      1. Boolean rules
      2. Truth Tables
      3. Karnaugh Maps

VI. **Flip-Flop and Registers**
   A. Memory Elements
      1. The Reset-Set Flip Flop
      2. The clocked Reset-Set Flip Flop
      3. The Data Flip Flop
      4. The J-K Flip Flops
      5. Edge and level Triggered Flip-Flops
      6. Comparison of Flip-Flops
      7. Inversion Circles
      8. Monostable Multivibrators

VII. **Sequential Logic Circuits**
    1. Counters
       1. The ripple counter
       2. Modulo - 10 ripple counter
       3. Synchronous Counters
       4. Up counters Down counters
       5. Frequency Dividers
       6. Self-stopping counters
       7. Digital waveforms for a Decade counter
B. Shift Registers
   1. Shift Register applications
   2. Shift Register Memory
   3. Dynamic Shift Registers
   4. Static Shift Registers
   5. Serial Load Shift Registers
   6. Parallel Load Shift Register
   7. Universal Shift Register

VIII. Combination Logic Circuits
   A. Decoders
      1. BCD to Decimal decoder
      2. Octal and Hex decoder
      3. BCD to 7 Segment decoder
   B. Encoders
      1. 10 line to 4 line encoders
   C. Multiplexers
      1. Multiplexer Applications
      2. Parallel to Serial Conversion
   D. Demultiplexers
   E. Random-Access Memories
      1. An IC RAM
      2. Using a RAM
      3. Magnetic Core Memory
      4. Bubble Memory
      5. Computer Bulk Storage Devices
F. Read-only Memory
   1. Using a ROM
   2. Prom
   3. EPROM, EEPROM, EAPROM

IX. Digital Design
   A. Design Criteria
      1. Maximum Performance
   B. Combinational Logic Circuit Design
      1. Truth Table Development
   C. Sequential Logic Circuit Design
      1. Design examples
      2. Design variations
      3. MOS handling procedures
      4. Multilayer PC Boards
      5. Wire wrapping
      6. Manufacturer's Catalog and Specifications

X. Digital Applications
   A. Digital Test Equipment
      1. The Frequency Counter
      2. Digital Voltmeters
      3. Dual-Trace Delayed sweep oscilloscopes
      4. Logic Probes, Logic Pulsers ad Logic Clips (Monitors)
      5. Logic Analyzers
      6. Signature Analyzers
   B. Digital Computers
      1. Minicomputers
      2. Microcomputers
      3. Microprocessors
C. Digital Computer Organization
   1. Memory
   2. Control Unit
   3. Arithmetic-logic unit
   4. Input-output unit

D. Digital Computer Operation
   1. Programming
   2. Writing programs
   3. Software

E. Microprocessors
   1. Types of Microprocessors
   2. Applications of Microprocessors
   3. Differences between Microprocessors (i.e., 6800, 68000, 6502, 8080, 8085, F80)
DIGITAL AND MICROPROCESSOR TECHNICIAN

Second Semester

THEORY OUTLINE

I. A. What is a Microprocessor? - Review
   B. What is a Microcomputer? - Review
   C. Comparing different Microprocessors. - Review

II. Number Systems and Codes
    A. Decimal Number System
    B. Binary Number System
    C. Binary to Decimal Conversions
    D. Octal Number System
    E. Binary to Octal Conversions
    F. Hexadecimal Number System
    G. Binary to Hexadecimal Conversions
    H. Binary Codes
       1. Binary Coded Decimals
       2. Special Binary Codes
       3. Alpha Numeric Codes

III. Microcomputer Basics
     A. Terms and Procedures
     B. Program Concept
     C. Word Length
     D. Hardware, Software, Firmware
     E. Microprocessor (MOU)
     F. Microprogramming - using microinstructions
     G. Simulation of microprocessors
H. Memory
I. Program - Fetch and Execute
J. Fetch, Execute, Halt Instructions
K. Addressing Modes
L. Programs in Addressing

IV. Computer Arithmetic
   Binary Arithmetic
   A. Addition
   B. Subtraction
   C. Multiplication
   D. Division
   E. Negative Numbers
   F. Two's Complement Arithmetic
   G. Ten's Complement Arithmetic
   H. Two's Supplement Subtraction
   I. Signed Numbers
   J. Boolean Math
   K. And
   L. Or
   M. Exclusive Or
   N. Inversion

V. Programming
   A. Flowcharts
   B. Branching
   C. Forward
   D. Backward
   E. Conditional Branching
V. F. Step by Step Procedure (Algorithms)

G. Multiplying

H. Dividing

I. BCD to Binary Conversion

J. Binary to BCD Conversion

K. Addition

L. Add with Carry (ADC)

M. Subtract with Carry (SBC)

N. Arithmetic Shift Accumulator Left (ASLA)

O. Decimal Adjust Accumulator (DAA)

VI. The Microprocessor

A. Computer Literacy - A Hands-On Approach

B. Operating Systems - MDOS, CP/M, MP/M, MPL, PL/M, RSTS, RT-11, UNIX

C. Flow Charting and High-Level Languages - BASIC or PASCAL

VII. The Microprocessor

A. Architecture of the 6800 MPU (6820, etc.)

B. Programming Microprocessor

C. Block Diagram

D. Addressing Modes

E. Arithmetic

F. Data Handling

G. Logic

H. Data Test

I. Index Register

J. Stack Pointer

K. Branch Instructions

L. Condition Code Register
M. New Addressing Modes
N. Stack Operations - Cascade and Memory
O. Subroutines
   1. Jump (JMP)
   2. Branch to SUB (BSR)
   3. Return from (RTS)
P. Input - Output Operations (I/O)
Q. Interrupts

VIII. A. Interfacing Fundamentals
      B. Interfacing with Random Access Memory (RAM)
      C. Interfacing with Display
      D. Interfacing Requirements - RS232, IEEE488, (GPIB), Modems Optoisolators
      E. Keyboard
      F. Peripheral Interface Adapter (PIA)
      G. I/O
      H. PIA Register
      I. Seven Segment Displays
      J. Decoding Keyboards
      K. Decoding a Switch Matrix
      L. Digital to - Analog Conversion
      M. Analog-to-Digital Conversion
      N. Sample and Hold
      O. Voltage to - Frequency and Frequency to Voltage converters
I. Binary Number System
   A. Counting in Decimal and Binary
   B. Binary to Decimal Conversion
   C. Octal and Hexadecimal Number Systems

II. Review of Semiconductors
   A. Bipolar transistor operations
   B. Unipolar transistor characteristics

III. Types of Logic Circuits

IV. Boolean Algebra

V. Memory Elements
   A. The Reset-Set Flip Flop
   B. The clocked Reset-Set Flip Flop
   C. The Data Flip Flop
   D. The J-K Flip Flops
   E. Monostable Multivibrators

VI. Counters
   A. The ripple counter
   B. Modulo - 10 ripple counter
   C. Up counter Down counters
   D. Self-stopping counters
   E. Ring counters

VII. Shift Registers
   A. Shift Register applications
   B. Serial Load Shift Registers
VIII. **Decoders**
   A. BCD to Decimal Decoder

IX. **Encoders**

X. **Random-Access Memories**

XI. **Read-only Memory**

XII. **Digital Test Equipment**
   A. The Frequency Counter
   B. Digital Voltmeters
   C. Dual-Trace Delayed-Sweep Oscilloscope
   D. Logic Probes, Logic Pulsers, and Logic Clips (Monitor)
   E. Logic Analyzers
   F. Signature Analyzers

XIII. **Digital Computer Operation**
   A. Programming

XIV. **Microprocessors**
   A. Types of Microprocessors
DIGITAL AND MICROPROCESSOR TECHNICIAN
Second Semester
EXPERIMENTS

I. Computer Literacy and Programming/Flow Charting
A. Computer Literacy - A Hands-On Approach
   1. Programming in BASIC
   2. Programming in LEVEL II
   3. Programming in PASCAL
   4. Programming in FORTRAN
   5. Programming in COBOL
B. Operating Systems - MDOS, CP/M, MP/M, MPL, PL/M, RSTS, RT-11, UNIX
C. Flow Charting and High-Level Languages or BASIC or PASCAL

II. Number Systems and Codes
A. Binary to Decimal Conversions
B. Hexadecimal Number System

III. Microcomputer Basics
A. Program Concept
B. Program - Fetch and Execute
C. Fetch, Execute, Halt Instructions
D. Addressing Modes
E. Programs in Addressing

IV. Computer Arithmetic
   Binary Arithmetic
   A. Two's Complement Arithmetic
   B. Two's Supplement Subtraction
   C. And
   D. Or
IV. Computer Arithmetic
   Binary Arithmetic
      E. Exclusive Or
      F. Inversion

V. Programming
   A. Branching
   B. Conditional Branching
   C. Add with Carry (ADC)
   D. Subtract with Carry (SBC)
   E. Arithmetic Shift Accumulator Left (ASLA)
   F. Decimal Adjust Accumulator (DAA)

VI. The Microprocessor
   A. Addressing Modes
   B. Index Register
   C. New Addressing Modes
   D. Stack Operations - Cascade and Memory
   E. Subroutines - Jump (JMP), Branch to SUB (BSR), Return from Sub. (RTS)
   F. Input - Ouput Operations (I/O)
   G. Interrupts

VII. Interfacing
   A. Interfacing with Random Access Memory (RAM)
   B. Interfacing with Display
   C. Peripheral Interface Adapter (PIA)
   D. I/O
   E. Seven Segment Displays
   F. Decoding Keyboards
   G. Decoding a Switch Matrix
DIGITAL AND MICROPROCESSOR TECHNICIAN
SUPPLEMENTARY EXPERIMENTS ONLY

I. Number Systems and Codes - Using Microprocessor Trainer - Binary and Decimal Experiments - Hexadecimal and Decimal Experiments

II. Straight Line Programs

III. Arithmetic and Logic Experiments

IV. Program Experiments

V. Additional Instructions for Program

VI. Interfacing Experiments
   A. Memory
   B. Clock
   C. Address Decoding
   D. Data Output
   E. Data Input
   F. Introduction to the Peripheral Interface Adapter (PIA)
   G. Audio Output
   H. Key Matrix and Parallel to Serial Conversion
   I. Digital to Analog and Analog to Digital Conversion

VII. Diagnostic and Fault Analysis/CORRECTION

VIII. PC Board Repair Procedures
DIGITAL AND MICROPROCESSOR SYSTEMS
COMPATIBLE WITH COURSE

COMMERCIAL TEACHING SYSTEMS

Heathkit - ET 3400 Trainer
Heathkit - Model EE-3401 Textbook and Experiments

HICKOK TEACHING SYSTEMS

K-6800 - Trainer
7-251 - Text - Digital Logic Fundamentals
7-290 - Text - Fundamentals of Memory Interface
7-288 - Text - A Study of MC6800 Based Systems
7-294 - Text - Introduction to Microprocessors/Microcomputer
7-289 - Text - Systems
7-289 - Text - Digital Logic and Computer Fundamentals

TETRA SYSTEMS CORPORATIONS

Tetra S-7400-System Digital Logic Trainer
Tetra 8010 - Microcomputer Trainer
Model 7400-2-Manuals - Digital Electronic Exercises
Model 8010 - Micro Trainer Exercises
Model 8092A - Microprocessing System Exercises

DIGIAC

CT-80 Microcomputer System - Text - Manuals
CT-80 Central Processing Unit - Text - Manuals
CT-81 Fault Insertion Terminal - Text - Manuals
CT-10 Computer Training System - Text - Manuals

DYNALOGIC

DES-921 Digital Electronic Trainer - Text - Manuals
MAS-900P Microprocessor Trainer - Text Manuals
# REFERENCES

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<thead>
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<th>TITLE</th>
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<th>PUBLISHER</th>
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<td>Tokheim</td>
<td>1979</td>
<td>McGraw-Hill</td>
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<td>Don Lancaster</td>
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**Second Semester**

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<td>George B. Rutkowski</td>
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**SOFTWARE CATALOG**

| Quality Educational Microcomputer Software          | Apple, Pet, TRS-80 | 1982-1983 | Charles Clark Company                     |
|                                                    |                   |           | 168 Express Drive, South                  |
|                                                    |                   |           | Brentwood, New York 1171                 |

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