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Microprocessors: A Short Course

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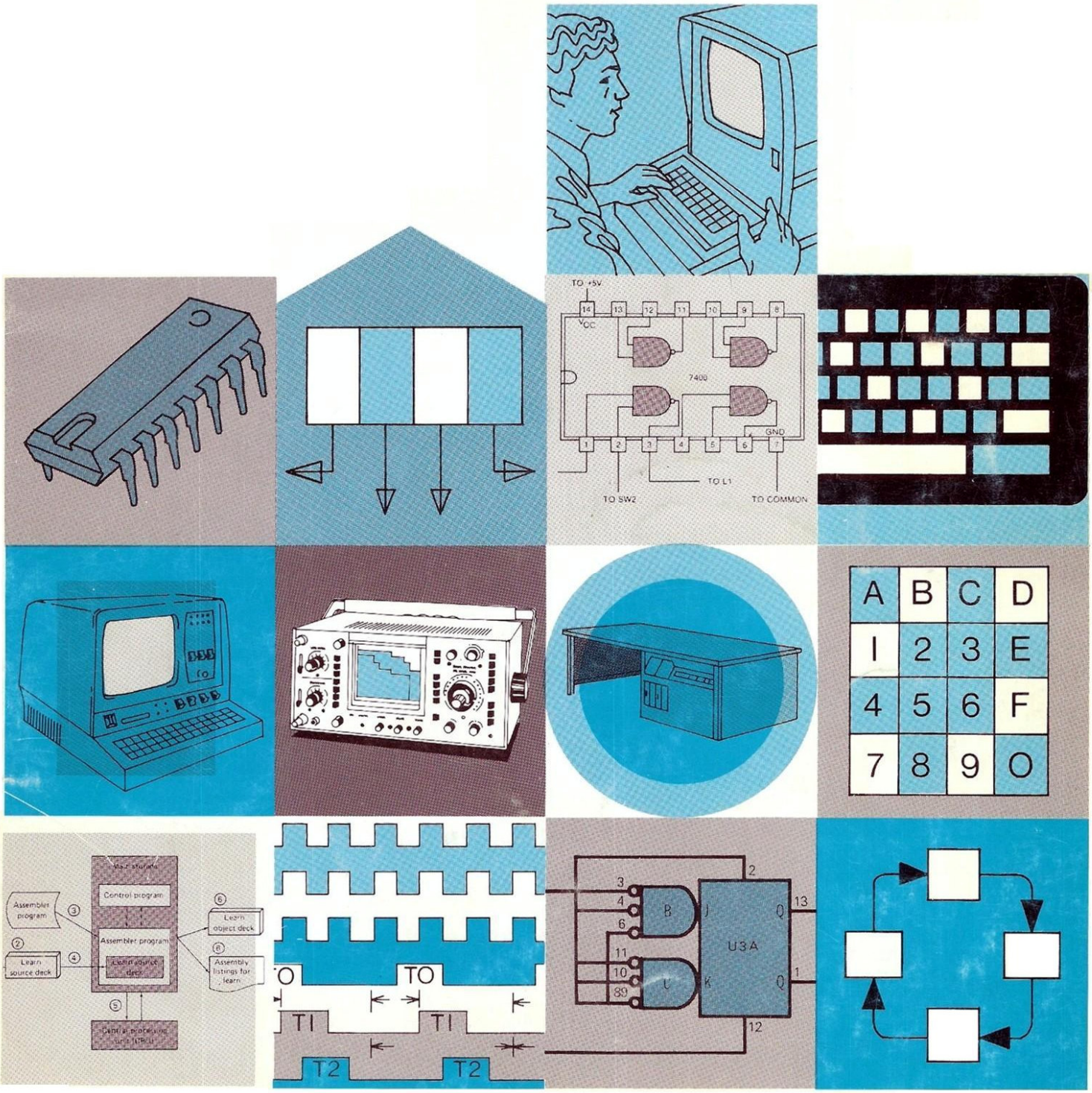

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MICROPROCESSORS: A SHORT COURSE

LEARNING GUIDE

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COURSE OVERVIEW

MICROPROCESSORS: A SHORT COURSE

This course is designed to give you a working knowledge of the concepts, terminology, and analysis of a basic microprocessor system. This course teaches you what a microprocessor is and how it functions. It explains basic programming techniques, introduces the languages of BASIC and Assembly, and describes fundamental techniques required to troubleshoot or verify circuit operations. The course is divided into twelve modules, which should be mastered sequentially. In each module, the learning material is presented through text readings, labs, and PLATO activities.

Module 1 provides you with the basic background information necessary for the study of microprocessors. It shows you how to add circuits to a microprocessor in order to construct a small computer system. It also answers some very basic questions about the makeup and function of computer systems. It helps you to define basic computer terms and systems, and to identify some basic computer languages.

Module 2 describes basic digital logic, symbols, functions, and operations. You will learn not only what digital logic is but also how digital logic functions.

In Module 3, terms directly related to microprocessors are defined. This module also describes how microprocessor chips are manufactured by examining both their external and internal structures. In addition, it describes microprocessor applications in the fields of instrumentation and control.

When you are familiar with the basic construction of microprocessors, you are ready to study fundamental microprocessor concepts. Module 4 emphasizes the format of basic machine language instructions, addressing techniques, and registers.

Modules 5 and 6 of this course describe machine language instructions and programming procedures. Specifically, module 5 studies the instruction set for an 8080 microprocessor and describes in detail the data transfer, arithmetic, and logical group instructions. Module 6 covers the data flow within a microprocessor for typical 1-, 2-, and 3-byte instructions. It provides you with a background in basic programming steps, which enables you to troubleshoot or verify microprocessing circuit operations.

In module 7, you will examine the basic circuits required to have a microprocessor look and function like a computer system. This section of the course describes the timing relationships and data flow for these circuits.

Module 8 describes general input/output interface circuits and covers the relationship between the time and data flow of these devices. The presentation of this material should enable you to understand how the microprocessor system is, or can become, a small computer system.

When you are familiar with the basic makeup of a microprocessor system, you are ready to examine two important conversion techniques used with microprocessors. Module 9 describes the theory, terms, functions, and applications of two important conversion techniques. The first technique, analog-to-digital/digital-to-analog, is used for process control and instrumentation applications. Module 10 describes the second technique, serial-to-parallel/parallel-to-serial, which is used for communications and other data processing applications.

Module 11 describes several types of microprocessors that are available in today's market. It informs you of some of the common faults/failures of these microprocessors and presents viable ways to deal with these problems.

Finally, module 12 introduces two high-level computer languages: BASIC and Assembly. These languages are used to program microprocessors as well as other computer systems. Because these languages permit faster entry of programs, their implementation offers many advantages.

Upon completion of this course, you should be able to understand the basic concepts of computers or microprocessors: what they are, what they do, and the advantages of using them.

MODULE 1: BASIC COMPUTER FUNDAMENTALS--INTRODUCTION

This module provides you with basic computer system fundamentals. It describes what the fundamental components are, shows how they interact with each other, and defines terms associated with computer systems. The module then describes basic number systems and codes, the words you can use to "talk" to the computer. Finally, the module looks at how the computer processes mathematical data.

Upon completion of this module, you should be able to--

- identify or describe fundamental computer components and define basic computer terms; and
- write various computer codes, convert number systems, and solve arithmetic problems.

MODULE 1: BASIC COMPUTER FUNDAMENTALS--INTRODUCTION

___1-A INTRODUCTION TO COMPUTERS

Any computer system, whether it is a "computer on a chip" or a large-scale scientific system, contains the same fundamental components. These components are memory, arithmetic logic unit, control, input, and output. This activity describes these components and their functions.

OBJECTIVE

Identify, define, or describe the fundamental components and the functions of the components in a typical computer system.

Resource

Reference Reading	Microprocessors and Microcomputers: Software and Hardware, "Introduction to Computers," pages 75 through 83, Tocci and Laskowski

___1-B HOW A COMPUTER WORKS

For a computer system to operate, the fundamental components of that system must interact with each other. This activity describes the interaction of these components by stepping through a simple "program." This activity is an alternative to activity 1-C.

OBJECTIVE

Identify, define, or describe the fundamental components and the functions of the components in a typical computer system.

Resource

PLATO Lesson	"How a Computer Works." This activity is accessed through the Control Data terminal from the study assignment display for this module. (PLATO course disk ct-micl, pub. no. 76773097)

___1-C HOW PARTS INTERACT

For a computer system to operate, the fundamental components of that system must interact with each other. This activity describes the interaction of these components. This activity is an alternative to activity 1-B.

OBJECTIVE

Identify, define, or describe the fundamental components and the functions of the components in a typical computer system.

Resource

Text "How Parts Interact." This activity is located in the course text.

___1-D COMPUTER TERMS

This activity defines various terms associated with computer systems. Terms such as storage, register, hardware, and software are common to every computer, and understanding these terms helps you to understand computer systems.

OBJECTIVE

Identify, define, or describe terms relating to computers and computer systems.

Resource

Text "Computer Terms." This activity is located in the course text.

___1-E COMPUTER WORDS

This activity describes how program statements are organized into instruction and data words. If you know how to interpret program statements, you will know what the computer is supposed to do and be able to make it perform specific functions. This becomes valuable when attempting to troubleshoot computer systems or even work with them.

OBJECTIVE

Write, code, or interpret simple base-10 "program statements" and/or computer programs.

Resource

Reference Reading — Microprocessors and Microcomputers: Software and Hardware, "Computer Words," pages 83 through 93, Tocci and Laskowski

___1-F COMPUTER NUMBERS

This activity describes the different number systems commonly used with computers. These number systems are binary, octal, and hexadecimal. The activity also explains techniques used to convert from one system to another. This activity is an alternative to 1-G.

OBJECTIVE

Convert numbers from one base number system into another number system. Identify or interpret BCD and alphanumeric codes.

Resource

PLATO Lesson — "Computer Numbers." This activity is accessed through the Control Data terminal from the study assignment display for this module. (PLATO course disk ct-micl, pub. no. 76773097)

___1-G DIGITAL NUMBER SYSTEMS

This activity describes the different number systems commonly used with computers. These number systems are binary, octal, and hexadecimal. The activity also explains techniques used to convert numbers from one system to another. This activity is an alternative to activity 1-F.

OBJECTIVE

Convert numbers from one base number system into another number system. Identify or interpret BCD and alphanumeric codes.

Resource

Reference Reading: Microprocessors and Microcomputers: Software and Hardware, "Digital Number Systems," pages 3 through 11, Tocci and Laskowski

___1-H CODES

In order to handle numbers and alphabetical characters, the computer must accept certain codes. Using these codes, you can "talk" to the computer and understand its reply. This activity describes two of the most popular codes in use, BCD and the alphanumeric code ASCII.

OBJECTIVE

Convert numbers from one base number system into another number system. Identify or interpret BCD and alphanumeric codes.

Resource

Reference Reading: Microprocessors and Microcomputers: Software and Hardware, "Codes," pages 12 through 16, Tocci and Laskowski

___1-I BINARY ARITHMETIC

This activity describes the processes required to solve addition and subtraction problems in the binary, octal, and hexadecimal base systems. The complement method is covered in detail. The complement method is required in order to subtract numbers in any of the above base systems. Signed numbers are also a part of this activity.

OBJECTIVE

Solve mathematical problems in the binary, octal, and hexadecimal base number systems.

Resource

Reference Reading — Microprocessors and Microcomputers: Software and Hardware, "Binary Arithmetic," pages 16 through 25, Tocci and Laskowski

___1-J NUMBER SYSTEMS AND MATH PROBLEMS

This activity provides practice in converting from one number system to another. It also allows you to solve addition and subtraction problems in these different number systems.

OBJECTIVE

Solve mathematical problems in the binary, octal, and hexadecimal base number systems.

Resource

Text — "Number Systems and Math Problems." This activity is located in the course text.

MODULE 2: BASIC COMPUTER FUNDAMENTALS-- LOGIC FUNDAMENTALS

This module describes the basic logic circuits used in all computer systems. The symbols representing these circuits are described, as well as their function or operation. The module also describes truth tables and explains how they illustrate output conditions for various input conditions. It is important for you to understand these truth tables so that you can determine how a particular circuit performs and recognize whether it is performing properly.

Finally, the module introduces and describes the basic microprocessor trainer that you will use throughout this course.

Upon completion of this module, you should be able to--

- identify logic symbols and describe their operation and truth tables; and
- identify important parts of a microprocessor trainer, and enter and execute simple programs.

MODULE 2: BASIC COMPUTER FUNDAMENTALS-- LOGIC FUNDAMENTALS

___2-A INTRODUCTION TO LOGIC

In order to show how a system is constructed and how it operates, certain symbols are drawn on a schematic diagram. Each of these symbols has a specific function and operation associated with it. This activity describes these symbols and their meaning, function, and operation.

OBJECTIVE

Identify various logic symbols, and define or describe the logic functions these symbols represent.

Resource

Reference Reading: Microprocessors and Microcomputers: Software and Hardware, "Digital Circuits," pages 26 through 57, Tocci and Laskowski

___2-B LOGICAL OPERATIONS--GATES

This activity describes truth tables and their functions. These truth tables are a valuable tool for understanding the operation of various logic circuits. This activity will show these tables for the simpler logic gates--AND, OR, NAND, NOR, and so forth.

OBJECTIVE

Generate or complete a logic truth table for a given logic symbol or function, and vice versa.

Resource

PLATO Lesson: "Logical Operations--Gates." This activity is accessed through the Control Data terminal from the study assignment display for this module.
(PLATO course disk ct-micl, pub. no. 76773097)

___2-C LOGICAL OPERATIONS--COMBINATIONAL CIRCUITS

This activity continues with truth tables and then describes flip-flops and counters. These circuits are called combinational logic circuits. This activity will also combine gates and circuits and describe/question their operation and results.

OBJECTIVE

Generate or complete a logic truth table for a given logic symbol or function, and vice versa.

Resource

PLATO Lesson	"Logical Operations--Combinational Circuits." This activity is accessed through the Control Data terminal from the study assignment display for this module. (PLATO course disk ct-micl, pub. no. 76773097)

___2-D INTRODUCTION TO THE TRAINER

This activity introduces the microprocessor trainer in the laboratory. It describes the basic functional areas of the trainer. It also allows you to enter and execute (run) several simple programs. This provides practice in using the trainer and its features.

OBJECTIVE

Identify, define, or describe the functions of various sections of a typical microprocessor training device, and enter/execute simple instructions/programs.

Resource

Lab Manual	"Introduction to the Trainer." The directions for this lab exercise are located in your lab manual.

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MODULE 3: FUNDAMENTAL MICROPROCESSOR CONCEPTS-- MICROPROCESSOR INTRODUCTION

This module begins your study of microprocessors by defining terms specific to microprocessors and microprocessor systems. It describes the construction of these devices, how the silicon chip is manufactured, and the types of material used. It also examines instrumentation and control application. Finally, the module presents the structure, architecture, read/write operation, and execution of instructions for a typical microprocessor.

Upon completion of this module, you should be able to--

- identify, define, or describe microprocessor terms, construction techniques, applications, and basic operation.

MODULE 3: FUNDAMENTAL MICROPROCESSOR CONCEPTS-- MICROPROCESSOR INTRODUCTION

___3-A MICROPROCESSOR TERMS

This activity defines common industrial terms or acronyms such as RAM, ROM, and bus, which are directly related to microprocessors, microcomputers, and systems.

OBJECTIVE

Identify, define, or describe terms relating to microprocessors and microprocessor systems.

Resource

Reference Reading: Microprocessors From Chips to Systems, "Microprocessor Terms," 1980, 3rd edition, pages 8 through 18 (1981, 1st edition, pages 1 through 15), Zaks

___3-B MICROPROCESSOR CONSTRUCTION

This activity describes the various manufacturing technologies of microprocessors. These include metal-oxide-semiconductor (MOS), PMOS, CMOS, and bipolar technologies. This activity also describes some of the advantages and disadvantages of these technologies. This activity is an alternative to activity 3-C.

OBJECTIVE

Identify, define, or describe the techniques, applications, circuit symbols, or terms associated with microprocessor manufacture.

Resource

Reference Reading: Microprocessors From Chips to Systems, "Large-Scale Integration," 1980, 3rd edition, pages 18 through 29 (1981, 1st edition, pages 15 through 27), Zaks

___3-C MICROELECTRONIC CIRCUIT ELEMENTS

This activity describes the various manufacturing technologies of microprocessors. These include metal-oxide-semiconductors (MOS), PMOS, CMOS, and bipolar technologies. This activity also describes some of the advantages and disadvantages of these technologies. This activity is an alternative to activity 3-B.

OBJECTIVE

Identify, define, or describe the techniques, applications, circuit symbols, or terms associated with microprocessor manufacture.

Resource

Reference Reading: Microelectronics, A Scientific American Book, (Freeman, ed.), "Microelectronic Circuit Elements," pages 12 through 23, Meindl

___3-D THE ROLE OF MICROELECTRONICS IN INSTRUMENTATION AND CONTROL

Microprocessors are used in a wide variety of fields. Some of these applications include commercial (point-of-sale terminals), consumer (educational systems), communications (switching systems), and data processing (office computers). This activity describes microprocessor applications in two additional fields: instrumentation and control.

OBJECTIVE

Identify, define, or describe the application of microprocessors in the fields of instrumentation and control.

Resource

Reference Reading: Microelectronics, A Scientific American Book, (Freeman, ed.), "The Role of Microelectronics in Instrumentation and Control," pages 90 through 97, Oliver

___3-E MICROPROCESSOR STRUCTURE AND OPERATION

This activity describes the external structure of a typical microprocessor circuit. Address bus, data bus, RAM, and ROM are shown in a typical block diagram. This activity also describes the function of each of these bus circuits.

OBJECTIVE

Identify, define, or describe the purpose or function of typical microprocessor "components."

Resource

Reference Reading: Microprocessors and Microcomputers: Software and Hardware, "Microcomputer Structure and Operation," pages 103 through 111, Tocci and Laskowski

___3-F MICROPROCESSOR ARCHITECTURE

This activity describes the internal structure of a typical microprocessor. This is shown in a block diagram format depicting the ALU, TMP Reg, register pairs, and so forth. This activity also describes the function of each of these circuits.

OBJECTIVE

Identify, define, or describe the purpose or function of typical microprocessor "components."

Resources

Text: "Microprocessor Architecture." This activity is located in the course text.

Reference Reading: Microprocessors and Microcomputers: Software and Hardware, "Digital Circuits," pages 58 through 72, Tocci and Laskowski

___3-G READ/WRITE OPERATION

This activity describes the steps or operations and their sequence during a read or write instruction. Timing or data flow is part of this sequence and is introduced in this activity.

OBJECTIVE

Identify, define, or describe the relationship and "data flow" of typical microprocessor "components."

Resource

Reference Reading: Microprocessors and Microcomputers: Software and Hardware, "Read/Write Operations," pages 111 through 115, Tocci and Laskowski

___3-H EXECUTION OF INSTRUCTIONS

This activity describes the internal data flow in the microprocessor during the execution of instruction. A simple instruction is executed, and the data is shown in the various registers. It also describes the timing of the data flow.

OBJECTIVE

Identify, define, or describe the relationship and "data flow" of typical microprocessor "components."

Resource

Reference Reading: Microprocessors From Chips to Systems, "Execution of Instructions Within the 8080," 1980, 3rd edition, pages 76 through 82 (1981, 1st edition, pages 83 through 92), Zaks

___3-I MICROPROCESSOR OPERATIONS

This activity describes the relationship between each of the functional units of the microprocessor in terms of control and data flow. This will be shown in a global, generic form without reference to any specific operation or mode of execution.

OBJECTIVE

Identify, define, or describe the relationship and "data flow" of typical microprocessor "components."

Resource

PLATO Lesson	"Introduction to Microprocessor Operations." This activity is accessed through the Control Data terminal from the study assignment display for this module. (PLATO course disk ct-micl, pub. no. 76773097)

MODULE 4: FUNDAMENTAL MICROPROCESSOR CONCEPTS-- MICROPROCESSOR FUNDAMENTALS

This module describes the basic format of machine language instructions. It also presents immediate, indirect, and direct addressing techniques. Then, the module identifies the functions and purposes of microprocessor registers. Finally, the module examines a typical 8-bit microprocessor in general and an 8080 microprocessor in specific.

Upon completion of this module, you should be able to--

- o identify, define, or describe the functions or formats of basic machine language instructions, addressing techniques, and internal circuit elements, and draw a block diagram of them.

MODULE 4: FUNDAMENTAL MICROPROCESSOR CONCEPTS-- MICROPROCESSOR FUNDAMENTALS

___4-A MACHINE LANGUAGE FORMAT

This activity introduces machine language instructions. The basic format and function are described. For example, 1-byte, 2-byte, and 3-byte instructions require different loading and execution sequences. The activity also describes how to interpret the code for programming and explains various symbols.

OBJECTIVE

Identify, define, or describe the function and format of basic machine language mnemonics or instructions.

Resource

Text — "Machine Language Format." This activity is located in the course text.

___4-B MACHINE LANGUAGE PROGRAMMING

This activity describes the format and functions of the 8080 microprocessor. This device is one of the standard microprocessors and is in wide use throughout the industry. You will be shown various instructions and their formats and functions.

OBJECTIVE

Identify, define, or describe the function and format of basic machine language mnemonics or instructions.

Resource

Text — "Machine Language Programming." This activity is located in the course text.

___4-C INTRODUCTION TO MACHINE LANGUAGE LAB

The code for any specific instruction is shown as 8 bits. The entry method for a particular system may be octal or hexadecimal, or you may have to recode from one system to another. This activity provides practice in writing or rewriting program codes in various base systems and interpreting the codes.

OBJECTIVE

Convert a simple program written in the octal base into the hexadecimal base, or vice versa.

Resource

Lab Manual	"Introduction to Machine Language Lab." The directions for this lab exercise are located in your lab manual.

___4-D ADDRESSING TECHNIQUES

This activity describes various addressing techniques such as direct, indirect, and immediate. Each of these techniques has different functions within a microprocessor or computer system. These functions are also described.

OBJECTIVE

Identify, define, or describe the function, purpose, or concept of various addressing techniques.

Resource

Reference Reading	Microprocessors From Chips to Systems, "Addressing Techniques," 1980, 3rd edition, pages 319 through 325 (1981, 1st edition, pages 439 through 447), Zaks

___4-E ADDRESSING TECHNIQUES LAB

This activity provides practice in programming by using the various addressing techniques.

OBJECTIVE

Identify, define, or describe the function, purpose, or concept of various addressing techniques.

Resource

Lab Manual	"Addressing Techniques, Lab." The directions for this lab exercise are located in your lab manual.

___4-F MICROPROCESSOR REGISTERS

This activity describes the functions of the various internal registers of the microprocessor. Some of these are the instruction register, memory address register, index register, and the general registers. This activity also describes control signal functions, such as MREQ and Ready.

OBJECTIVE

Identify, define, or describe the purpose or function of various internal microprocessor circuit elements and control signals.

Resource

Reference Reading	Microprocessors and Microcomputers: Software and Hardware, "The Microprocessor--Heart of the Microcomputer," pages 128 through 142, Tocci and Laskowski

___4-G REGISTERS LAB

This activity provides practice in moving data into and out of various registers. It describes how this data can be "viewed" as it moves from register to register. It also describes the various control signals.

OBJECTIVE

Identify, define, or describe the purpose or function of various internal microprocessor circuit elements and control signals.

Resource

Lab Manual	"Registers Lab." The directions for this lab exercise are located in your lab manual.

___4-H A TYPICAL 8-BIT MICROPROCESSOR

This activity describes a typical 8-bit microprocessor at the block diagram level. It also describes the relationship of each of the registers, control, and timing sections.

OBJECTIVE

Identify or draw, at the block diagram level, the architectural circuit elements of a typical 8-bit microprocessor.

Resource

Text	"A Typical 8-Bit Microprocessor." This activity is located in the course text.

___4-I THE 8080 MICROPROCESSOR

This activity describes the block diagram layout of the 8080 microprocessor. Control, registers, the ALU, and so forth are covered.

OBJECTIVE

Identify or draw, at the block diagram level, the architectural circuit elements of a typical 8-bit microprocessor.

Resource

PLATO Lesson	"The 8080 Microprocessor." This activity is accessed through the Control Data terminal from the study assignment display for this module. (PLATO course disk ct-micl, pub. no. 76773097)

___4-J PROGRESS TEST 1

At this point you should check your understanding by taking this progress test.

MODULE 5: MACHINE LANGUAGE INSTRUCTIONS--THE LANGUAGE

This module describes machine language instructions and programming. Each microprocessor family has its own distinct language set, and language sets are not compatible among microprocessor families or types. This module studies an instruction set for an 8080 microprocessor by describing data transfer, arithmetic, and logical group instructions.

Upon completion of this module, you should be able to--

- identify, define, or describe the mnemonics used in a microprocessor for data transfer operations, arithmetic operations, and logical operations.

MODULE 5: MACHINE LANGUAGE INSTRUCTIONS--THE LANGUAGE

___5-A DATA TRANSFER INSTRUCTIONS

This activity describes the typical data transfer group instructions for the 8080 microprocessor. These instructions include the move, load, store, and exchange commands. It covers both the format and the function of these instructions.

OBJECTIVE

Identify, define, or describe the format and function of typical data-transfer-group instruction mnemonics.

Resource

Reference Reading: The Bugbook VI, "Instruction Set," pages 18-18 through 18-30 and 18-64 through 18-67, Larsen, Rony, and Titus; or Introductory Experiments in Digital Electronics and 8080A Microcomputer Programming and Interfacing, vol. 2 (E and L Technibook Series), "The Instruction Set," pages 100 through 115 and 151 through 154, Larsen, Rony, and Titus

___5-B ARITHMETIC INSTRUCTIONS

This activity describes the typical arithmetic group instructions for the 8080 microprocessor. These instructions include add, subtract, increment, decrement, and compare commands. It covers both the format and the functions of these instructions.

OBJECTIVE

Identify, define, or describe the format and function of typical arithmetic-group instruction mnemonics.

Resource

Reference Reading: The Bugbook VI, "Arithmetic Group," pages 18-30 through 18-42, Larsen, Rony, and Titus; or Introductory Experiments in Digital Electronics and 8080A Microcomputer Programming and Interfacing, vol. 2 (E and L Technibook Series), "Arithmetic Group," pages 115 through 128, Larsen, Rony, and Titus

___5-C LOGICAL GROUP INSTRUCTIONS

This activity describes the typical logical group instructions for the 8080 microprocessor. These instructions include AND, OR, and X-OR commands. It also covers the remaining commands and instructions to rotate, branch, or jump. The activity then explains the format and function of these instructions.

OBJECTIVE

Identify, define, or describe the format and function of typical logical-group instruction mnemonics.

Resource

Reference Reading: The Bugbook VI, "Logical Group," pages 18-42 through 18-54, Larsen, Rony, and Titus; or Introductory Experiments in Digital Electronics and 8080A Microcomputer Programming and Interfacing, vol. 2 (E and L Technibook Series), "Logical Group," pages 128 through 145, Larsen, Rony, and Titus

___5-D MNEMONIC INSTRUCTIONS PRACTICE

This activity provides drill and practice in the use of mnemonics or instructions. The functional areas of the data transfer, arithmetic, and logical groups will be covered.

OBJECTIVE

Identify, define, or describe the purpose or function of a program containing data transfer, arithmetic, or logical group instructions, and/or calculate or determine the results.

Resource

PLATO Lesson — "Mnemonic Instructions Practice." This activity is accessed through the Control Data terminal from the study assignment display for this module.
(PLATO course disk ct-micl, pub. no. 76773097)

___5-E MNEMONIC INSTRUCTIONS SIMULATOR

This activity presents short program routines containing data transfer, arithmetic, and/or logical group instructions in which you predict the outcome of the operation. This activity also presents a simulator that will simulate these programs.

OBJECTIVE

Identify, define, or describe the purpose or function of a program containing data transfer, arithmetic, or logical group instructions, and/or calculate or determine the results.

Resource

PLATO Lesson — "Mnemonic Instructions Simulator." This activity is accessed through the Control Data terminal from the study assignment display for this module.
(PLATO course disk ct-micl, pub. no. 76773097)

___5-F MNEMONIC INSTRUCTIONS LAB

This activity presents several programs that may have portions missing or may be incorrectly written. You should be able to complete the program or correct it. Then, enter and execute the program to verify its operation.

OBJECTIVE

Complete, verify, or debug a program listing to solve a problem statement, and/or enter and execute the program on a microprocessor trainer.

Resource

Lab Manual	"Mnemonic Instructions Lab." The directions for this lab exercise are located in your lab manual.

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MODULE 6: INSTRUCTION FLOW

This module describes the data flow and sequence of operations involved in the execution of 1-byte, 2-byte, and 3-byte instructions in a typical 8-bit microprocessor. This module also introduces the concept of flow charting, function, and applications.

Upon completion of this module, you should be able to--

- describe the data flow of 1-byte, 2-byte, and 3-byte instructions in a typical 8-bit microprocessor; and
- analyze and construct simple flowcharts that describe programming routines.

MODULE 6: INSTRUCTION FLOW

___6-A Instruction Data Flow I

This activity will describe 1-byte, 2-byte, and 3-byte instructions. Examples of these are HLT, MVI M, data, and JMP addr. This activity also describes the sequence of operations and the data flow when these types of instructions are executed.

OBJECTIVE

Identify, define, or describe the data flow for a 1-byte, 2-byte, or 3-byte instruction.

Resource

Text — "Instruction Data Flow I." This activity is located in the student text.

(All mnemonics copyright Intel Corporation, 1977 and 1975.)

___6-B INSTRUCTION DATA FLOW II

This activity reinforces and expands the 1-byte, 2-byte, and 3-byte instruction and data flow.

OBJECTIVE

Identify, define, or describe the data flow for a 1-byte, 2-byte, or 3-byte instruction.

Resource

PLATO Lesson — "Instruction Data Flow." This activity is accessed through the Control Data terminal from the study assignment display for this module.
(PLATO course disk ct-micl, pub. no. 76773097)

___6-C INSTRUCTION DATA FLOW LAB

This activity provides practice in entering and executing 1-byte, 2-byte, and 3-byte instructions.

OBJECTIVE

Identify, define, or describe the data flow for a 1-byte, 2-byte, or 3-byte instruction.

Resource

Lab Manual	"Instruction Data Flow Lab." The directions for this exercise are located in your lab manual.

___6-D "ADD" DATA FLOW

This activity describes how data flows within the microprocessor by using a simple add program. It shows how the program will be stored in memory, how two numbers will be added, and how the results are stored back in memory.

OBJECTIVE

Identify, define, or describe the data flow for a program involving the arithmetic operation of two numbers.

Resource

Text	"Add Data Flow." This activity is located in the course text.

___6-E PROGRAM DATA FLOW

This activity simulates the internal data flow of a simple subtract program. Timing is not a consideration at this time. This simulation demonstrates an instruction-by-instruction data placement within a typical 8-bit microprocessor.

OBJECTIVE

Identify, define, or describe the data flow for a program involving the arithmetic operation of two numbers.

Resource

PLATO Lesson	"Program Data Flow." This activity is accessed through the Control Data terminal from the study assignment display for this module. (PLATO course disk ct-micl, pub. no. 76773097)

___6-F ARITHMETIC PROBLEM LAB

This activity provides practice in completing simple arithmetic programs. Both add and subtract problems will be demonstrated. After completing the program, you will verify it by entering and executing the program on the microprocessor trainer.

OBJECTIVE

Complete, verify, debug, or calculate the results of a simple arithmetic program, and/or enter and execute the program on a microprocessor trainer.

Resource

Lab Manual	"Arithmetic Problem Lab." The directions for this lab exercise are located in your lab manual.

___6-G FLOW CHARTING

Flowcharts are used to show both program flow and troubleshooting aids for computer systems. Before programmers write a program, they generate a flowchart to indicate the processing of data through the system; the same can be said for troubleshooting. This activity describes the symbols such as start, end, and decision. It also describes the procedures for using these symbols.

OBJECTIVE

Identify, define, or describe the functions and symbols associated with flowcharts.

Resource

Text	"Flow Charting." This activity is located in the course text.

___6-H FLOWCHART PROBLEMS

In the first part of the activity, you will design a flowchart. The text presents the problem, operations, and steps necessary to solve it. Then, you will sign on to the PLATO system, execute your design, and have the PLATO system verify its operation.

OBJECTIVE

Draw or verify a flowchart for a given problem statement.

Resource

Text/ PLATO Lesson	"Flowchart Problems." This activity is located in the course text. Upon completion of the text portion, you will be asked to verify your solutions with a PLATO activity. You can access the PLATO activity through the study assignment display for this module. (PLATO course disk ct-micl, pub. no. 76773097)

___6-I PROGRAMMING

This activity describes the steps/methods used to generate a simple program. It starts with a problem statement, draws a flowchart for the problem, and finally, uses machine mnemonics and codes to develop the program.

OBJECTIVE

Generate and code a program to solve a given problem statement, and/or enter, execute, and verify the program on a microprocessor trainer.

Resource

Text	"Programming." This activity is located in the course text.

___6-J PROGRAMMING LAB

This activity provides practice in generating a simple program. You will then enter and execute the program on a microprocessor trainer and verify its operation.

OBJECTIVE

Generate and code a program to solve a given problem statement, and/or enter, execute, and verify the program on a microprocessor trainer.

Resource

Lab Manual	"Programming Lab." The directions for this lab exercise are located in your lab manual.

MODULE 7: MICROPROCESSOR CIRCUITS--MEMORY

This module identifies the basic components/circuits required to have a microprocessor act as a microcomputer. It examines clock/oscillator circuits and the system controller to show their configuration with the microprocessor and memory. It also describes the data flow and timing relationships that exist among these devices.

Upon completion of this module, you should be able to--

- identify, define, or describe basic system support circuits, their configuration, their data flow, and their timing relationships.

MODULE 7: MICROPROCESSOR CIRCUITS--MEMORY

___7-A MEMORY DEVICES

This activity desribes the various semiconductor memory devices. These include RAM, ROM, PROM, EPROM, and PLA. It also presents the purpose and operation of these devices.

OBJECTIVE

Identify, define, or describe the architecture of semiconductor memory devices and the techniques required to read/write information.

Resource

Reference Reading: Microprocessors From Chips to Systems, "The Memory," 1980, 3rd edition, pages 107 through 120 (1981, 1st edition, pages 124 through 145), Zaks

___7-B SEMICONDUCTOR MEMORY

This activity reinforces your understanding of memory devices and their applications. You will select or determine if a particular memory is used properly.

OBJECTIVE

Identify, define, or describe the architecture of semiconductor memory devices and the techniques required to read/write information.

Resource

PLATO Lesson: "Semiconductor Memory." This activity is accessed through the Control Data terminal from the study assignment display for this module.
(PLATO course disk ct-mic2, pub. no. 76773098)

___7-C BASIC TIMING

This activity describes the timing sequence in a basic microprocessor circuit. The discussion of timing examines the fetch, process, and write procedures and also emphasizes the bidirectional bus scheme.

OBJECTIVE

Identify, define, describe, or draw a timing diagram for simple machine instructions.

Resource

Text	"Basic Timing." This activity is located in the course text.

___7-D TIMING SEQUENCE

This activity demonstrates the timing sequence during a simple program execution.

OBJECTIVE

Identify, define, describe, or draw a timing diagram for simple machine instructions.

Resource

PLATO Lesson	"Timing Sequence." This activity is accessed through the Control Data terminal from the study assignment display for this module. (PLATO course disk ct-mic2, pub. no. 76773098)

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MODULE 8: MICROPROCESSOR CIRCUITS--INTERFACE

This module identifies basic input/output interface components and their functions. These components include parallel-to-serial converters, multiplexers, and decoders. It demonstrates the configuration of these components to the microprocessor system. Finally, it describes the data flow and timing relationships that exist between these devices and the microprocessor system.

Upon completion of this module, you should be able to--

- identify, define or describe the basic interface support circuits, their configurations, their data flow, and their timing relationships.

MODULE 8: MICROPROCESSOR CIRCUITS--INTERFACE

___8-A ASSEMBLING THE CPU

This activity describes some of the basic CPU support circuits. The oscillator, controller, and memory are examples of these devices. The purpose of these devices is covered. Several types of microprocessors are also introduced, such as: the Z80, 8080, and 6800.

OBJECTIVE

Identify, define, or describe functions of a support circuit in the basic microprocessor system.

Resource

Reference Reading	Microprocessor Interfacing Techniques, 3rd edition, pages 26 through 55, "Assembling the Central Processing Unit" (2nd edition, pages 17 through 44), Lesea and Zaks

___8-B THE ASSEMBLED CPU

This activity provides practice in identifying the basic microprocessor system. You should be able to locate or identify these circuit ICs on the microprocessor trainer.

OBJECTIVE

Identify, define, or describe functions of a support circuit in the basic microprocessor system.

Resource

Lab Manual	"The Assembled CPU." The directions for this lab exercise are located in your lab manual.

___8-C BASIC INPUT-OUTPUT

This activity introduces and describes the basic interface circuits for a microprocessor system. Parallel and serial I/O, the UART, USART, and interrupt servicing are covered. Special attention should be given to the interrupt circuits.

OBJECTIVE

Identify, define, or describe the theory of operation of support circuits in the basic microprocessor system. Identify or draw a block diagram of a basic microprocessor system and its support circuits.

Resource

Reference Reading: Microprocessor Interfacing Techniques, 3rd edition, pages 56 through 99, "Basic Input-Output" (2nd edition, pages 45 through 86), Lesea and Zaks

___8-D PERIPHERAL INTERFACING

One of the most common I/O interface circuits is the keyboard and the LED. This activity describes the circuits to input data via the keyboard and to output data via the LED.

OBJECTIVE

Identify, define, or describe the theory of operation of support circuits in the basic microprocessor system. Identify or draw a block diagram of a basic microprocessor system and its support circuits.

Resource

Reference Reading: Microprocessor Interfacing Techniques, 3rd edition, pages 100 through 121, "Peripheral Interfacing" (2nd edition, pages 87 through 106), Lesea and Zaks

___8-E INTERFACE DATA FLOW AND TIMING

This activity describes the basic data flow and timing required when several basic interface circuits are connected to the microprocessor. For example, the keyboard interrupts the microprocessor, inputs the data, processes the data, stores it, and may or may not act upon it again during this cycle. Signals such as Enable, Interrupt, Wait, and Disable Interrupt may all come into play.

OBJECTIVE

Identify, describe, or draw the data flow and timing diagram of a basic microprocessor system and its support circuits.

Resource

Text — "Interface Data Flow and Timing." This activity is located in the course text.

___8-F DATA FLOW AND TIME RELATIONSHIPS

This activity demonstrates the data flow and timing relationships that exist in the microprocessor interfaced system.

OBJECTIVE

Identify, describe, or draw the data flow and timing diagram of a basic microprocessor system and its support circuits.

PLATO Lesson — "Data Flow and Time Relationships." This activity is accessed through the Control Data terminal from the study assignment display for this module.
(PLATO course disk ct-mic2, pub. no. 76773098)

___8-G PROGRESS TEST 2

At this point you should check your understanding by taking this progress test.

MODULE 9: MICROPROCESSOR INTERFACING--D/A AND A/D

This module describes analog-to-digital and digital-to-analog conversion techniques. It defines the conversion terms and describes the functions and applications of these devices. The module also presents the operational theory of these devices, which includes the programming and the required interfacing techniques. First each technique is presented individually, and then they are combined.

Upon completion of this module, you should be able to--

- identify, define, or describe terms, functions, theory of operation, and programming requirements for analog-to-digital and digital-to-analog conversion.

MODULE 9: MICROPROCESSOR INTERFACING--D/A AND A/D

___9-A D/A AND A/D TERMS

This activity defines terms associated with digital-to-analog conversion. These terms include slope, resolution, and analog signal. This activity provides the basic groundwork for understanding D/A and A/D principles and applications.

OBJECTIVE

Identify, define, or describe terms associated with digital-to-analog and analog-to-digital conversion.

Resource

Text — "D/A and A/D Terms." This activity is located in the course text.

___9-B D/A AND A/D FUNCTIONS

This activity describes some basic theories of operation and the applications of these devices. For example, D/A could be used for the raster on a video display, and A/D could monitor the temperature of an area.

OBJECTIVE

Identify, define, or describe functions and applications of digital-to-analog and analog-to-digital conversion.

Resource

Text — "D/A and A/D Functions." This activity is located in the course text.

___9-C D/A AND A/D CIRCUITS

This activity describes the theory of operation of both D/A and A/D conversion circuits as applied to microprocessor base systems. These circuits will be known as DAC for digital-to-analog and ADC for analog-to-digital. Several new terms will be introduced.

OBJECTIVE

Identify, define, or describe the theory of operation of digital-to-analog conversion circuits. Identify, define, or describe the theory of operation of analog-to-digital conversion circuits.

Resource

Reference Reading: Microprocessor Interfacing Techniques, 3rd edition, pages 261 through 321, "Analog to Digital and Digital to Analog Conversion" (2nd edition, pages 247 through 270), Lesea and Zaks

___9-D D/A CONVERSION

This activity describes the interfacing circuits using a D/A converter and discusses the theory of operation of this circuit. A typical DAC IC and its connections will be covered. The data flow in this circuit will be described also.

OBJECTIVE

Identify, define, or describe the theory of operation of digital-to-analog conversion circuits.

Resource

PLATO Lesson: "D/A Conversion." This activity is accessed through the Control Data terminal from the study assignment display for this module. (PLATO course disk ct-mic2, pub. no. 76773098)

___9-E D/A CONVERSION LAB

This activity provides practice in working with a DAC and a microprocessor. You will analyze a program listing to determine if it meets certain requirements, such as time and speed. You will then alter various loops to change these requirements.

OBJECTIVE

Identify, verify, or debug the operation of a program listing for digital-to-analog conversion, and/or enter and execute the program on a microprocessor trainer.

Resource

Lab Manual	"D/A Conversion Lab." The directions for this lab exercise are located in your lab manual.

___9-F A/D CONVERSION

This activity describes the interfacing circuits using an A/D converter. The theory of operation of this circuit is the topic. A typical ADC and its connections will be covered. The data flow in this circuit will be described also.

OBJECTIVE

Identify, define, or describe the theory of operation of analog-to-digital conversion.

Resource

PLATO Lesson	"A/D Conversion." This activity is accessed through the Control Data terminal from the study assignment display for this module. (PLATO course disk ct-mic2, pub. no. 76773098)

___9-G A/D CONVERSION LAB

This activity provides practice in working with an ADC and microprocessor. You will analyze a program listing to determine if it meets certain requirements, (for example, temperature range). You will then alter various loops to change these requirements.

OBJECTIVE

Identify, verify, or debug the operation of a program listing for analog-to-digital conversion, and/or enter and execute the program on a microprocessor trainer.

Resource

Lab Manual	"A/D Conversion Lab." The directions for this lab exercise are located in your lab manual.

___9-H DAC and ADC PROGRAMMING

This activity describes various techniques required to handle DAC and ADC programming. This activity will also cover any unique characteristics that may exist in these circuits. Thus, you will have the basic understanding of how to set up a conversion program.

OBJECTIVE

Complete, verify, or debug a program listing to solve a digital-to-analog and analog-to-digital problem statement, and/or enter and execute the program on a microprocessor trainer.

Resource

Text	"DAC and ADC Programming." This activity is located in the course text.

___9-I DAC and ADC PROGRAMS

This activity demonstrates a sample program flow for monitoring/executing a DAC and ADC circuit. For example, a thermistor and temperature control device will be activated and run under program control.

OBJECTIVE

Complete, verify, or debug a program listing to solve a digital-to-analog and analog-to-digital problem statement, and/or enter and execute the program on a microprocessor trainer.

Resource

PLATO Lesson	"DAC and ADC Programming." This activity is accessed through the Control Data terminal from the study assignment display for this module. (PLATO course disk ct-mic2, pub. no. 76773098)

___9-J DAC and ADC PROGRAMMING LAB

This activity provides practice in writing, verifying, or debugging programs for a DAC-ADC microprocessor base system. Limits, loops, timing, and interrupting will be involved.

OBJECTIVE

Complete, verify, or debug a program listing to solve a digital-to-analog and analog-to-digital problem statement and/or enter and execute the program on a microprocessor trainer.

Resource

Lab Manual	"DAC and ADC Programming Lab." Directions for this lab exercise are located in your lab manual.

MODULE 10: MICROPROCESSOR INTERFACING--SERIAL AND PARALLEL

This module describes parallel busing and serial busing technique protocols, such as the S100 and the RS232. It also explains parity and parity checking, and then describes circuits used for converting parallel and serial data.

Upon completion of this module, you should be able to--

- identify, define, or describe parallel busing and serial busing techniques and circuits.

MODULE 10: MICROPROCESSOR INTERFACING--SERIAL AND PARALLEL

___10-A PARALLEL AND SERIAL OUTPUT

This activity describes the various bus standards and techniques. There are two bus types: parallel and serial. Parallel buses include the S100 bus, 6800 bus, the IEEE-488, and IEEE-583 CAMAC interface. Serial buses include the EIA, RS232C, RS 422, and RS 423 communication buses.

OBJECTIVE

Identify, define, or describe terms and functions associated with serial-busing and parallel-busing techniques.

Resource

Reference Manual	Microprocessor Interfacing Techniques, 3rd edition, pages 322 through 376, "Bus Standards and Techniques" (2nd edition, pages 271 through 309), Lesea and Zaks

___10-B PARALLEL AND SERIAL CIRCUITS

This activity describes the basic theory of operation of devices known as universal asynchronous receive/transmit (UART) and universal synchronous/asynchronous receive/transmit (USART) communications devices. They are capable of receiving parallel data from the CPU and transmitting serial data to the output bus, and vice versa.

OBJECTIVE

Identify, define, or describe the theory of operation of serial-to-parallel and parallel-to-serial circuits.

Resource

Text	"Parallel and Serial Circuits." This activity is located in the course text.

MODULE 11: MICROPROCESSORS--TROUBLESHOOTING

This module contrasts common 4-bit, 8-bit, and 16-bit microprocessors. It also describes bit-chip slices and shows how they combine with other circuits to produce any size microprocessor/ microcomputer. The module also examines some of the common faults/failures and their symptoms such as shorts, opens, and bus problems.

Upon completion of this module, you should be able to--

- identify, define, or describe various types of microprocessors, their capabilities, and their basic failures.

MODULE 11: MICROPROCESSORS--TROUBLESHOOTING

___11-A TYPES OF MICROPROCESSORS

This activity describes the various bit-sized microprocessors. These include 4-, 8-, and 16-bit word sizes. It describes each type of microprocessor and the products that are available from different manufacturers. Several advantages and disadvantages are covered. This activity also describes bit/chip slice processors.

OBJECTIVE

Identify, define, or describe the various types of microprocessors and their capabilities.

Resource

Reference Reading: Microprocessors From Chips to Systems, "A Comparative Microprocessor Evaluation," 1980, 3rd edition, pages 164 through 197 (1981, 1st edition, pages 205 through 263), Zaks

___11-B MICROPROCESSOR FAULTS

This activity describes several of the basic microprocessor failures and their symptoms. Included are shorts, opens, bus problems, and circuit failures. The symptoms of these failures are included.

OBJECTIVE

Identify, define, or describe basic microprocessor failures and their symptoms.

Text: "Microprocessor Faults." This activity is located in the course text.

___11-C CIRCUIT FAILURES

This activity presents some common failures; you determine the possible cause and maintenance procedure. These failures are simulated.

OBJECTIVE

Identify, define, or describe basic microprocessor failures and their symptoms.

Resource

PLATO Lesson	"Circuit Failures." This activity is accessed through the Control Data terminal from the study assignment display for this module. (PLATO course disk ct-mic2, pub. no. 76773098)

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MODULE 12: MICROPROCESSORS--HIGHER LANGUAGES

This module introduces two basic high-level computer languages: BASIC and Assembly. The module presents the basic format, purpose, and statements of each language.

Upon completion of this module, you should be able to--

- identify, define, or describe the purpose, format, and statements for the program languages BASIC and Assembly.

MODULE 12: MICROPROCESSORS--HIGHER LANGUAGES

___12-A ASSEMBLY LANGUAGE

This activity describes a common program language, Assembly. This language enables easy and fast loading of the operating programs. This activity introduces the common basic statements and their meanings.

OBJECTIVE

Identify, define, or describe the basic purpose, format, and/or statements for the Assembly program language.

Resource

Reference Reading: Microprocessors From Chips to Systems, "Assembly Language Programming", 1980, 3rd edition, pages 325 through 351 (1981, 1st edition, pages 416 through 439 and pages 447 through 455), Zaks

___12-B HIGH-LEVEL COMPUTER LANGUAGES

This activity introduces higher languages; in particular, Assembly. Specific commands in Assembly may vary slightly between various types of computers and microcomputers. However, the basic format is similar to all.

OBJECTIVE

Identify, define, or describe the basic purpose, format, and/or statements for the Assembly program language.

Resource

PLATO Lesson: "High-Level Computer Languages." This activity is accessed through the Control Data terminal from the study assignment display for this module.
(PLATO course disk ct-mic2, pub. no. 76773098)

___12-C BASIC LANGUAGE

This activity describes the program language BASIC. Use of this language makes it easier to load the various operating programs by using statements that incorporate multiple machine language instructions. The basic statements are introduced in this activity.

OBJECTIVE

Identify, define, or describe the basic purpose, format, and/or statements for the BASIC program language.

Resource

Text "Basic Language." This activity is located in the course text.

___12-D PROGRESS TEST 3

At this point you should check your understanding by taking this progress test.

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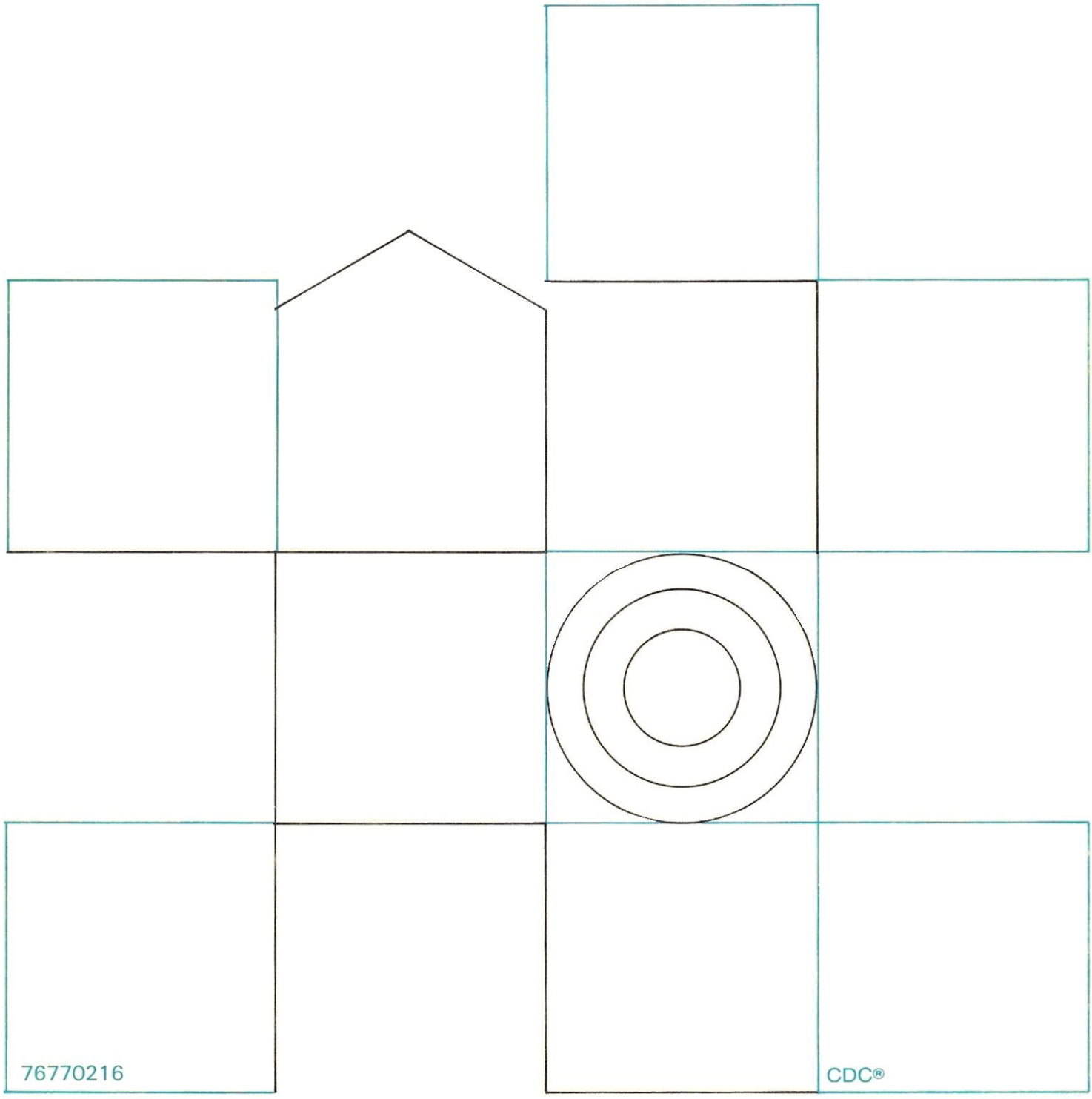
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