

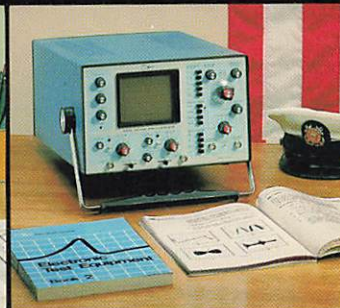
EDUCATIONAL SYSTEMS
RETAIL CATALOG 811/29 R
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Heathkit®/Zenith® Educational Systems & Instruments

Heathkit
ZENITH Educational
Systems



The most cost-efficient way to teach state-of-the-art electronics and computer programming



Total flexibility to fit any military/government – classroom or self-study learning environments

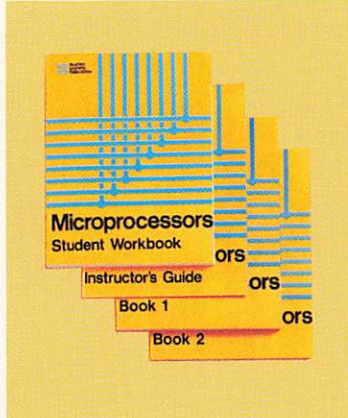


Heathkit/Zenith courses are structured for industrial training – in the field or in the plant



Classroom courses are also formatted for individualized self-learning

Two versatile formats for more effective teaching



Heathkit/ Zenith textbook series for classrooms, group instruction

Heathkit/Zenith Classroom Courses can form the core of your electronics, computer and automotive curriculum.

Each course is a

complete training package with texts; workbooks; a fully detailed Heathkit/Zenith instructor's guide with suggestions on making the course more effective; trainers and training materials for hands-on experiments; unit review examinations and a final examination for competency-based progress.

Our courses can be used in classes of varying lengths.

Student workbooks include interactive experiments, which provide actual experience with components and circuitry. Separate parts packs are available so each student can participate in these experiments.

Course-compatible trainers are used to perform experiments, and for later breadboarding and design work.

Heathkit/Zenith Courses are priced to fit your budget. Contact your local representative (see back cover) to get complete information and price schedules.

Tried and tested in classrooms around the nation, these courses will be a welcome addition to your curriculum.



Need self-study courses? Heathkit/ Zenith has the effective answer

Do you need to provide effective training on-the-job, or in-the-field, because important people can't be taken off the job and into the classroom?

Heathkit/Zenith can provide the answer!

Heathkit/Zenith Classroom Courses are also available in a convenient and effective format for individualized study.

Programmed self-study texts allow the student to progress at his or her own pace. Program materials are designed to guide the student, step-by-step, until important concepts are mastered.

Audio-visual aids, included with many courses, help teach those difficult concepts.

Self-test reviews insure that the student thoroughly understands what has been presented before moving on to the next section.

Heathkit/Zenith Self-Instruction Courses feature hands-on experiments to give students the actual experience so vital to understanding state-of-the-art electronics, computer programming and other subjects.

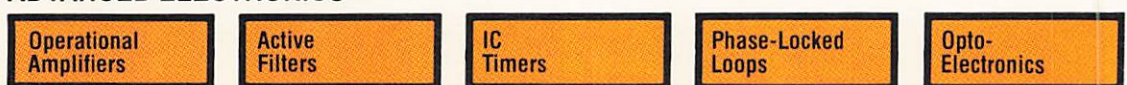
As in our classroom courses, these self-instruction courses include specially-written final examinations.

Full Line of Heathkit/Zenith Courses Covers Most Important Subjects

FUNDAMENTALS OF ELECTRICITY/ELECTRONICS



ADVANCED ELECTRONICS



EXPLORATORY ELECTRICITY/ELECTRONICS



DIGITAL/MICROPROCESSOR/MICROCOMPUTER TECHNOLOGY



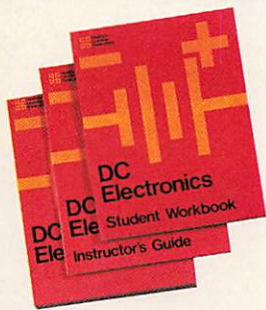
COMPUTER PROGRAMMING



COMPUTER APPLICATIONS IN BUSINESS



Heathkit/Zenith Educational Systems Curriculum



Fundamental Electronics pages 4-10

Complete core curriculum. Includes DC Electronics, AC Electronics, Semiconductor Devices, Electronic Circuits, Electronic Communications and Test Instruments Courses.



Computer Systems pages 21-24

Students can gain valuable programming experience by using a Heathkit/Zenith system – based on the Z-89 Computer. Teachers and administrators can realize many benefits from our computer systems, too.



Advanced Electronics pages 11-13

The next step in an electronics education. Five courses cover state-of-the-art subjects (Op-Amps, Active Filters, IC Timers, Phase-locked Loops, Optoelectronics).



Computer Programming pages 25-29

Courses which cover business applications. Programming courses teach today's most popular computer languages – BASIC, Microsoft BASIC, Pascal, FORTRAN and COBOL.



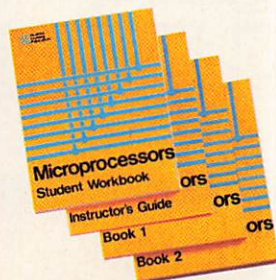
Digital Techniques pages 14-15

Includes theory and practical applications. Covers logic circuits, Boolean algebra, flip-flops and registers, digital design and more. Special hands-on digital techniques trainer also available.



Professional Software pages 25-29

Operating systems/languages for courses above. Word processing. Business applications software for student use – can also solve problems of teachers and administrators.



Microprocessor Technology pages 16-17

One of the lowest-priced courses of its type. Covers microprocessors, microcomputers, interfacing and programming. Students put theory into practical use.



Exploratory Courses pages 30-32

Stimulate students' appetites with these professionally-written courses. We offer Introductions to Electricity, Electronics, Microprocessors, PC Boards and Weather in this course line.



Test Instruments pages 18-20

Our instruments help students get more from the interactive experiments in our courses. Oscilloscopes, frequency counter, multimeters, function generator, audio generator and power supply.



Automotive Courses pages 33-35

With these application-oriented courses, students can learn about Automotive Ignition and Electrical Systems. Many professional auto servicing aids are also available from Heathkit/Zenith.

Fundamental Electronics Series...

A solid foundation for all electronics studies

Six courses – designed to form the core of any modern electronics curriculum

Give your students a thorough understanding of electronics with this comprehensive series of core courses. Courses start at the entry level of electronics and move into state of the art technology...or branch into instruments and the use of electronics in communications.

The **Fundamental Electronics Series** from Heathkit/Zenith has been developed to provide instructors and training directors with a complete package of courses that start at the entry level in electronics and progress logically through DC and AC electronics, semiconductor devices, and into the study of electronic circuits and beyond. All courses in this series are written in a logical learning sequence that first explains concepts and then builds upon these concepts for a thorough understanding of each topic.

The **DC Electronics Course** introduces electricity and magnetism: voltage, current and resistance relationships. It continues with studies of electrical measurements, circuits, resistors, capacitors, inductors and more.

The **AC Electronics Course** covers AC fundamentals and theory. Included are discussions and experiments in resonance and reactance; RC, RL and RLC circuits; and how to work with formulas to analyze the operations of AC circuitry.

The **Semiconductor Devices Course** is next, with advanced study in semiconductor fundamentals, diodes, zeners, bipolar transistor operation and characteristics, FETs, thyristors, ICs and optoelectronics. **The fourth course is Electronic Circuits.** It covers all of the most popular electronic circuits, with emphasis on integrated circuits.

Electronic Communications presents amplitude modulation, AM and FM transmitters, pulse modulation and antennas – with discussions of applications. **Test Equipment** covers analog and digital meters, oscilloscopes, frequency generation and measurement, and special measuring instruments.



The latest in learning enhancement techniques are employed in the courses in this series. Course material is presented in concise, fast paced units of study, with major topic areas highlighted in modular subsections. Illustrations are used throughout to teach important points. Programmed reviews, at the end of each section, reinforce learning and increase comprehension.

"Hands-on" experiments provide positive reinforcement of the material. Experiments are directly related to the material the student has just learned.

The **DC, AC, Semiconductor, Electronic Circuits and Test Instruments Courses** have student textbooks, workbooks, instructor guides, and course-compatible trainers. Handy parts packs relieve you of the strain of locating individual parts. The Communications Course and the full Fundamental Series are also available in self-instruction formats for individualized learning requirements.

Spanish language versions are available for self-instruction of the DC, AC and Semiconductor Courses. The translated manuals are supported with Spanish-language records. The ET-3100-S Kit Trainer described below also is available with Spanish manual.

Series Flow Chart

FUNDAMENTALS OF ELECTRICITY/ELECTRONICS



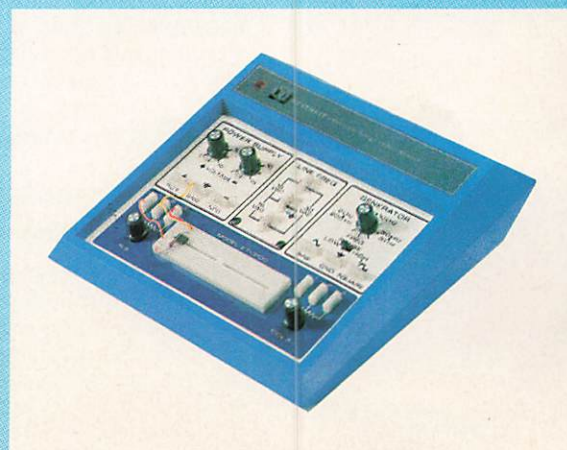
Add hands-on experience for learning success

Provide students with a greater understanding of electronics. Use the ETW-3100 Experimenter/Trainer for hands-on reinforcement of points made in the Fundamental Electronics Courses.

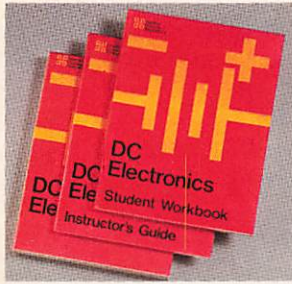
The **ETW-3100 Experimenter/Trainer** is required for all the Fundamental Electronics Courses. It has solderless breadboarding sockets for easy component substitution, a 2-range variable sine and square wave (200-20,000 Hz) signal source, dual-variable power supplies for positive and negative voltages (1.2-16 V, 120 mA). A center-tapped transformer provides 30 V. rms, 60 Hz for line experiments.

ETW-3100, Assembled and tested, Shpg. wt. 6 lbs.

ET-3100-S, Kit with Spanish manual, Shpg. wt. 6 lbs.



Entry-Level DC Electronics Course



Teach the essential electronic principles your students need

Here's a course that enables you to teach students with no prior electronics knowledge the necessary electrical principles that are imperative to their understanding of electronics.

When your students complete this Heathkit/Zenith Course, they will be able to:

- Explain the relationship of current, voltage, resistance and power, and solve problems with Ohm's Law.
- Explain the relationship between electricity and magnetism.
- Construct DC circuits with components such as resistors, relays, switches, lamps, batteries and capacitors using a schematic diagram as a guide.
- Given a wiring diagram of a circuit, draw a schematic.
- Use a multimeter to measure current, voltage & resistance.
- Convert metrics prefixes and work with powers of ten.

- Explain the construction, operation and purpose of resistors, potentiometers, switches, fuses, relays, capacitors, inductors and batteries.
- Demonstrate safety procedures for test equipment & user.
- Build and experiment with DC circuits of their own design.

Required Course Trainer: ETW-3100, Shpg. wt. 6 lbs.

For Spanish Version: ET-3100S, Shpg. wt. 6 lbs.

Classroom Texts, Workbook, Guides, and Accessories:

EB-6101, Student Textbook, Shpg. wt. 2 lbs.

EB-6101-40, Student Workbook, Shpg. wt. 2 lbs.

EB-6101-50, Instructor's Guide, Shpg. wt. 1 lb.

EB-6101-30, Parts for projects, Shpg. wt. 1 lb.

Self-instructional:

EE-3101, 1 Binder, Shpg. wt. 7 lbs.

EEA-3101, Cassette Tapes, Shpg. wt. 1 lb.

EE-3101-S, Spanish Version, Shpg. wt. 7 lbs.

Recommended Test Equipment

The ETW-3100 Experimenter/Trainer (p. 4) is required for completing experiments in the DC Course, as well as other courses in the series. A SM-5225 FET (p. 19) Multimeter or equivalent is also needed.

COURSE OUTLINE

UNIT I: CURRENT

Composition of Matter:

Elements and Compounds
Atoms
Electrons, Protons and Neutrons
Bohr Model of Atom
The Balanced Atom

Electrostatics:

The Electrical Charge
Law of Electrical Changes
The Ion
Action of Electrostatic Changes

Current Flow:

Freeing Electrons
Conductors and Insulators
The Battery
Random Drift
Directed Drift
The Electric Circuit

Measuring Current:

The Coulomb
The Ampere
The Ammeter

Series-Opposing
Parallel Connection
Series-Parallel Connection

Voltage Rises and Drops:

Voltage Rise
Voltage Drop
Voltage Drops Equal
Voltage Rises

Concept of Ground
Measuring Voltage

Experiments:

Measuring Voltage
Voltage Rises
Voltage Drops
Shorts, Opens

Determining Current
Finding Voltage
Finding Resistance

Power:

Work and Power
Power, Current and Voltage
Power Dissipation in Resistors
Deriving More Equations

Experiments:

Measuring Current
Verifying Ohm's Law
Power

Appendix:

Finding the Square Root of a Number

Loudspeaker
Magnetic Tape
DC Motor
Meter
Computer Memories
Magnetic Deflection of Electron Beams

Parallel Circuit
Series-Parallel
Voltage Dividers

Bridge Circuits:

Balanced
Unbalanced
Wheatstone
Self-Balancing
Temperature Sensing

Kirchoff's Law:

Voltage Law
Current Law
Superposition Theorem
Thevenin's Theorem
Norton's Theorem

Experiments:

Bridge Circuits
Network Theorems
Maximum Power Transfer

UNIT III: RESISTANCE

Basic Concepts:

The Ohm
Resistivity
Conductance
Factors Determining Resistance

Resistors:

Wire-Wound
Carbon-Composition
Deposited-Film

Resistor Ratings:

Resistance
Tolerance
Wattage
Variable Resistors

Connecting Resistors:

In Series
In Parallel
Equal Resistors in Parallel
Series-Parallel

Experiments:

Color Code
Measuring Resistance

UNIT V: MAGNETISM

The Magnetic Field:

Magnets
Lines of Force
Theory of Magnetism

Electricity and Magnetism:

Current Flow and Magnetism
The Electromagnet

Magnetic Quantities:

Flux
Flux Density
Magnetomotive Force
Field Intensity
Permeability
Reluctance
Ohm's Law for Magnetic Quantities
Comparison of Units

Induction:

Magnetic Induction
Electromagnetic Induction
Generators

Magnetic and Electro-magnetic Applications:

Relay
Reed Switch
Record Pickup

UNIT VI: ELECTRICAL MEASUREMENTS

The Meter Movement:

Construction
Operation
Taut-Band Movement

The Ammeter:

Measuring Current
Increasing Range
Computing Shunt
Resistance
Ammeter Accuracy

The Voltmeter:

Extending Range
Calculating the Multiplier
Multiple-Range Voltmeters
Sensitivity
Loading Effect

The Ohmmeter:

Basic Circuit
Calibration
Creating Higher and Lower Ranges
Shunt Ohmmeter

Multimeters:

Basic Circuit
Electronic Multimeter
Inaccuracies

Experiments:

Determining the Sensitivity of a Voltmeter
Loading Effects of the Voltmeter

UNIT VII: DC CIRCUITS

Simple Circuits:

Series Circuit

UNIT VIII: INDUCTION AND CAPACITANCE

Inductance:

Self-Induction
Inductance
Inductors
Time Constant

Capacitance:

Capacitors
Charging the Capacitor
Discharging the Capacitor

Capacitors:

Units of Capacitance
Factors Determining Capacitance
RC Time Constants

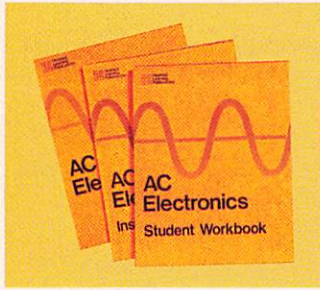
Capacitors in Combination:

Capacitors in Series
Capacitors in Parallel

Experiments:

RC Time Constants
Series and Parallel Capacitors
Using Capacitors

Comprehensive AC Electronics Course



Enhance your students' understanding of electronics with this thorough course

This course takes over where DC Electronics leaves off. It enables you to teach your students the principles of Alternating Current, and its special application in electronic circuits and equipment.

Like our other courses in the Heathkit/Zenith Fundamental Electronic series, the AC Electronics Course features textbooks, workbook and instructor's guide. The text uses the proven programmed-instruction format to present and reinforce course concepts. These concepts come to life for your students in the hands-on experiments listed in the student workbook. The instructor's guide lets you coordinate your lab sessions with the course material covered in each unit of the text. In addition, a parts package is available for the experiments.

Upon completing this course, your students will be able to:

- Explain the difference between AC and DC.
- Describe the operation of a simple AC generator.
- Determine the average or effective value of an AC sine wave when its peak or peak-to-peak value is known.
- Determine the frequency of an AC waveform when its period is known or vice-versa.
- Use AC meters to measure current, voltage, and power.
- Analyze simple AC circuits which contain only resistance.
- Describe the electrical property of capacitance & inductance and explain how capacitors & inductors are constructed.

COURSE OUTLINE

<p>UNIT I: ALTERNATING CURRENT</p> <p>The Importance of AC: What is AC Why and Where is AC used?</p> <p>Generating AC: Electromagnetic Induction A Simple AC Generator</p> <p>The Sinusoidal Waveform</p> <p>AC Values: Peak Values Peak-to-Peak Values Average Values Effective Values Period Frequency</p> <p>Nonsinusoidal Waveforms: The Square Wave The Triangular Wave The Sawtooth Wave Fluctuating DC Waves</p>	<p>Oscilloscopes: Oscilloscope Operation Using the Oscilloscope</p> <p>Resistance in AC Circuits: Basic AC Circuit</p> <p>Calculations: Series AC Circuit Calculations Parallel AC Circuit Calibrations Power in AC Circuits</p> <p>Experiment: Measuring AC Voltages</p>	<p>RC Circuits: Series RC Circuits Vector Diagrams Impedance Phase Shift Power in AC Circuits Parallel RC Circuits</p> <p>Applications of Capacitive Circuits: Capacitive Voltage Dividers RC Filters Phase Shift Networks</p> <p>Experiments: RC Circuits Capacitor Applications</p>	<p>Mutual Induction Inductors in Series and Parallel</p> <p>RL Circuits: Series RL Circuits Vector Diagram Impedance Phase Shift Power in Inductive Circuits Parallel RL Circuits</p> <p>Experiment: RL Circuits</p>	<p>Electronic Applications Autotransformer</p> <p>Experiment: Transformer Characteristics</p>
<p>UNIT II: AC MEASUREMENTS</p> <p>AC Meters: Rectifier-Type, Moving-Coil Meters Moving-Vane Meters Electrical Characteristics Thermocouple Meters Clamp-On Meters Using AC Meters</p>	<p>UNIT III: CAPACITIVE CIRCUITS</p> <p>Review of Capacitors and Capacitance: Units of Capacitance Factors Affecting Capacitance Types of Capacitors Capacitor Ratings Capacitor Defects Capacitors in Series and Parallel Capacitors in DC Circuits</p> <p>Capacitors in AC Circuits: Current-Voltage Relationships in Capacitive AC Circuits Capacitive Reactance Ohm's Law in Capacitive Circuits</p>	<p>UNIT IV: INDUCTIVE CIRCUITS</p> <p>Review of Inductors and Inductance: Self-Induction Inductors and Inductance Units of Inductance Factors Affecting Inductance Types of Inductors Inductors in DC Circuits Inductive Time Constant</p> <p>Inductors in AC Circuits: Current-Voltage Relationship Inductive Reactance Ohm's Law in Inductive Circuits</p>	<p>UNIT V: TRANSFORMERS</p> <p>Transformer Action: Transformer with No Load Transformer with Load</p> <p>Transformer Ratios: Voltage Ratio Current Ratio Impedance Ratio Power Ratio Solving Transformer Problems</p> <p>Transformer Losses: Core Losses Copper Losses External Induction Losses Transformer Efficiency</p> <p>Transformer Applications: Power Distribution</p>	<p>UNIT VI: TUNED CIRCUITS</p> <p>RLC Circuit: Series RLC Circuits Parallel RLC Circuits</p> <p>Resonance</p> <p>Series Resonance Q and Bandwidth in Series</p> <p>Parallel Resonance: Ideal Circuit Flywheel Effect Practical Tank Circuits Q in Parallel Resonant Circuits Distributed Capacitance and Self-Resonance of Coils</p> <p>LC Filters: Band-Pass Filter Band-Stop Filter Low-Pass Filter High-Pass Filter</p> <p>Experiments: Series Resonance Parallel Resonance LC Filters</p>

- Analyze AC circuits which contain only inductance or a combination of inductance and resistance.
- Analyze AC circuits which contain capacitance or a combination of capacitance and resistance.
- Explain the basic transformer action.
- Determine the current, voltage and power relationships at the inputs and outputs of ideal and practical transformer circuits.
- Analyze electronic circuits with resistance, capacitance and inductance.
- Explain series and parallel resonant circuit operation.

An individual, self-instruction version of the complete Heathkit/ Zenith AC Electronics Course is available for self-study training situations in government and industry. The self-instruction version includes a binder with text material and experiments, plus a parts package at no extra charge.

Required Course Trainer: ETW-3100, Shpg. wt. 6 lbs.

For Spanish Version: ET-3100S, Shpg. wt. 6 lbs.

Classroom Texts, Workbooks, Guides, and Accessories:

EB-6102, Student Text, Shpg. wt. 2 lbs.

EB-6102-40, Student Workbook, Shpg. wt. 2 lbs.

EB-6102-50, Instructor's Guide, Shpg. wt. 1 lb.

EB-6102-30, Parts Package, Shpg. wt. 1 lb.

Self-Instruction Format:

EE-3102, 1 Binder Text, Shpg. wt. 7 lbs.

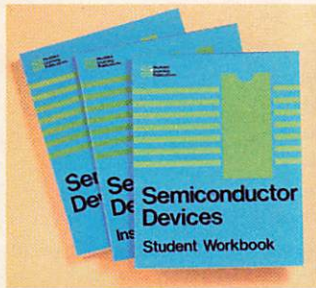
EAA-3102, Cassette Tapes, Shpg. wt. 1 lb.

EE-3102-S, Spanish Version, Shpg. wt. 7 lbs.

Recommended Test Equipment

To complete the experiments listed in the student workbook of the AC Electronics Course above, your labs will require the Heathkit/ Zenith ETW-3100 Experimenter/ Trainer that's described on page 4. In addition, your students will need a quality VOM or multimeter such as our SM-5225 Multimeter detailed on page 19.

Semiconductor Devices Course



Teach your students the latest semiconductor technology with the Heathkit/Zenith Course

This course continues to build your students' electronics knowledge by covering the modern solid-state technology of semiconductors.

Each concept is presented in a clearly written text, and instantly reinforced with programmed review. The concepts are further reinforced with 11 hands-on experiments contained in a separate student workbook.

A course instructor's guide comes complete with text unit objectives, unit review questions, unit exams, and a final exam. A course outline is also included in the guide to help you appropriately schedule the workbook experiments with the concepts presented in the text.

Upon completing this course, your students will be able to:

- Describe the electrical characteristics of materials which are classified as semiconductors.
- Explain the operation and characteristics of popular semiconductor devices.
- Describe the construction of semiconductor devices.

- Experiment with semiconductor components without exceeding their maximum ratings or damaging them.
- Recognize commonly used semiconductor packages and identify their schematic symbols.
- Test various semiconductor devices to determine if they are functioning properly.

A self-instructional version of the Semiconductor Course is available for self-study training situations.

Prerequisite: The DC & AC Electronics Courses or equivalent knowledge.

Required Course Trainer: ETW-3100, Shpg. wt. 6 lbs.

For Spanish Version: ET-3100S, Shpg. wt. 6 lbs.

Classroom Textbooks, Workbooks, Guides, and Accessories:

EB-6103, Student Text, Shpg. wt. 2 lbs.

EB-6103-40, Student Workbook, Shpg. wt. 2 lbs.

EB-6103-50, Instructor's Guide, Shpg. wt. 1 lb.

EB-6103-30, Parts Package, Shpg. wt. 1 lb.

Self-instruction Format:

EE-3103, 1 Binder Text, Shpg. wt. 6 lbs.

EAA-3103, Cassette Tapes, Shpg. wt. 1 lb.

EE-3103-S, Spanish Version, (less parts), Shpg. wt. 6 lbs.

Recommended Test Equipment

The ETW-3100 Experimenter/Trainer (p.4) is required to perform the experiments for this course. Also needed for the experiments, are a VOM or multimeter like our SM-225 FET Multimeter (p. 19).

COURSE OUTLINE

UNIT I: SEMICONDUCTOR FUNDAMENTALS

Importance of Semiconductors:
Advantages
Disadvantages

Semiconductor Materials
Germanium and Silicon
Atoms and Crystals:
Semiconductor Atoms
Semiconductor Crystals

Conduction in Intrinsic Material
Germanium and Silicon:
Low Temperature Characteristics
High Temperature Characteristics
Holes
Current Flow

Conduction in Doped Germanium and Silicon:
N-Type Semiconductors
P-Type Semiconductors

Considerations
Diode Symbols
Diode Construction:
Grown Junctions
Alloyed Junctions
Diffused Junctions
Diode Packaging

Diode Applications
Experiments:
Semiconductor Diode Characteristics
Testing Semiconductor Diodes

The Tunnel Diode:
Voltage-Current Characteristics
Construction
Applications

The Varactor Diode:
Electrical Characteristics
Operating Efficiency
Construction
Applications

High-Frequency Diodes:
PIN Diodes
IMPATT Diodes
Hot Carrier Diodes
Gunn-Effect Diodes

Current Gain
Alpha Cutoff Frequency
Collector-to-Base Leakage Current
Characteristics of Common-Collector Circuits
Maximum Transistor Rating
Experiment:
Common-Emitter Transistor Characteristics

Bidirectional Triode Thyristors:
Basic Construction and Operation
V-I Characteristics
Practical Applications

Unijunction Transistors:
Basic Construction
Operation
V-I Characteristics
Applications of the UJT
Programmable UJTs

Experiments:
SCR Characteristics
UJT Characteristics

UNIT III: THE ZENER DIODE
Zener Diode Characteristics
Power Dissipation in Zener Diodes
Current Limitations in Zener Diodes
Effects of Temperature on Zener Voltage
Temperature-Compensated Zener Diodes
Zener Diode Impedance
Zener Diode Packages
Voltage Regulation with Zener Diodes:
The Basic Zener Diode Regulator

Experiments:
Zener Diodes

UNIT V: BIPOLAR TRANSISTOR OPERATION
PNP and NPN Configurations
Transistor Construction:
Construction Techniques
Packaging

Basic Transistor Action
Transistor Amplification
Transistor Circuit Arrangements
Testing Bipolar Transistors:
Test Procedures

Experiment:
Testing Bipolar Transistors

UNIT VII: FIELD-EFFECT TRANSISTORS
The Junction FET:
Construction of a JFET
Operation of a JFET
Gate-to-Source Cutoff Voltage
Pinch-Off Voltage
Drain Characteristic Curve

The Insulated-Gate FET:
Depletion-Mode Devices
Enhancement-Mode Devices
Safety Precautions

FET Circuit Arrangements
Experiments:
Junction FET Characteristics
Insulated-Gate FET Characteristics

UNIT IX: INTEGRATED CIRCUITS
The Importance of ICs
Basic IC Construction:
Monolithic ICs
Applications of ICs

UNIT II: SEMICONDUCTOR DIODES

The PN Junction
Diode Characteristics:
Germanium Diode
Silicon Diode:
Forward Characteristics
Reverse Characteristics
Diode Ratings
Temperature

UNIT IV: SPECIAL APPLICATIONS

UNIT VI: BIPOLAR TRANSISTOR CHARACTERISTICS
Characteristics of Common-Base Circuits

UNIT VIII: THYRISTORS
Silicon-Controlled Rectifiers:
Basic Construction and Operation
V-I Characteristics
Practical Applications

UNIT X: OPTOELECTRONIC DEVICES
Basic Principles of Light:
Characteristics
Unit of Measurement

Light-Sensitive Devices
Light-Emitting Devices
Experiments:
Phototransistor Characteristics
LED Characteristics

Electronic Circuits Course - theory to practice



Students learn how electronic theories work together in commonly-found electronic circuits with this course

In this course, the student applies theoretical electronic knowledge to understand electronic circuitry. A student textbook, with seven carefully designed units, covers electronic circuits from basic amplifiers through modulation and demodulation.

Upon completion, the student will be able to:

- Identify basic transistor amplifier circuits, describe their operation and list the characteristics of each.
- Discuss DC, audio, video, IF and RF amplifiers, including their applications in practical electronic systems.
- Explain differential amplifiers, comparators, summing and difference amplifiers, and active filter circuits.
- Analyze and design simple inverting and non-inverting amplifiers that use operational amplifiers.
- Identify and explain the operation of power supply rectifiers, filters and regulation circuits.
- Discuss the principles of oscillation; identify and describe how commonly used LC, RC and crystal oscillators operate.
- Demonstrate a knowledge of pulse shapers, multivibrators, the Schmitt trigger and ramp generators.
- Explain amplitude and frequency modulation, the

heterodyne principle, modulation and detection circuits.

- Construct transistor and integrated circuit amplifiers, oscillators, active filters and pulse-shaping circuits; power supplies and power supply regulation circuits; a basic amplitude modulation and demodulation system.
- Use a voltmeter and an oscilloscope to analyze the operation of various electronic circuits.

The text, and a workbook with 15 practical experiments, drive home important concepts. The ETW-3100 Trainer (below) is required for the experiments. An optional final exam is included in the instructor's guide for your convenience.

The DC Electronics, AC Electronics and Semiconductor Devices Courses (or equivalent knowledge) are prerequisites.

Required Course Trainer: ETW-3100, Shpg. wt. 6 lbs.

Classroom Texts, Workbooks, Guides and Accessories:

EB-6104, Student Text, Shpg. wt. 2 lbs.

EB-6104-40, Student Workbook, Shpg. wt. 2 lbs.

EB-6104-50, Instructor's Guide, Shpg. wt. 1 lb.

EB-6104-30, Parts Pack, Shpg. wt. 1 lb.

Self-Instruction Format:

EE-3104, Binder and Records, Shpg. wt. 7 lbs.

EEA-3104, Optional Cassettes (duplicate records), 1 lb.

COURSE OUTLINE

UNIT I: BASIC AMPLIFIERS

Importance of Amplifiers
Amplifier Configurations:
 Common-Emitter Circuits:
 Circuit Operation
 Current Gain
 Voltage Gain
 Power Gain
 Input/Output Resistance
 Common-Base Circuits:
 Circuit Operation
 Gain
 Input/Output Resistance
 Common-Collector Circuits:
 Circuit Operation
 Gain
 Input/Output Resistance
Amplifier Biasing:
 Base-Biased Circuits
 Feedback Bias
 Voltage Divider Biasing
 Class of Operation
Amplifier Coupling:
 RC Coupling
 Impedance Coupling
 Direct Coupling
 Transformer Coupling
Experiments:
 Thermal Stability
 Common-Emitter Amplifier Characteristics

UNIT II: TYPICAL AMPLIFIERS
 Direct Current Amplifiers

Audio Amplifiers:
 Voltage Amplifiers
 Power Amplifiers
 Single-Ended Power Amps
Push-Pull Power Amplifiers:
 Phase Splitters
 Complementary Amplifier
 Quasi-Complementary Amplifiers
Video Amplifiers:
 Frequency Response
 Frequency Compensation
 Typical Video Amplifiers
RF and IF Amplifiers:
 Tuned Amplifiers
 Typical RF Amplifiers
 IF Amplifiers
Experiments:
 DC Amplifiers
 Complimentary Power Amps

UNIT III: OPERATIONAL AMPLIFIERS

Differential Amplifiers:
 Basic Differential Amplifier Circuits
 Current Sources and Voltage Sources
 Common-Mode Input
 Differential-Input
 Common-Mode Rejection
 IC Differential Amplifiers
Op-Amp Characteristics:
 Electrical Characteristics
 IC Op-Amp Families
Closed-Loop Operation:
 Inverting Configuration
 Noninverting Configuration
 Bandwidth Limitations

Applications of Op-Amps:
 Summing Amplifier (Adder)
 Difference Amplifier
 Other Applications
Experiments:
 Differential Amplifiers
 Operational Amplifiers
 Inverting and Noninverting Amplifiers

UNIT IV: POWER SUPPLIES

Rectifier Circuits
 Half-Wave Rectifier
 Full-Wave Rectifier
 Bridge Rectifier
 Comparison of Rectifiers
Power Supply Filters:
 The Capacitor as a Filter
 Percent Ripple
 RC Filters
 LC Filters
Voltage Multipliers:
 Doublers and Triplers
Voltage Regulation:
 Load Regulation
 The Zener Regulator
Series Voltage Regulation:
 The Emitter Follower Regulator
 The Feedback Regulator
 Short-Circuit Protection
Power Supply Circuits:
 Overload Protection
 Shunt and IC Regulators
 Typical Circuits

Experiments:
 Unregulated Power Supplies
 Voltage Regulation

UNIT V: OSCILLATORS

Oscillator Fundamentals
LC Oscillators:
 Hartley Oscillators
 Colpitts Oscillators
 Clapp Oscillators
Crystal Oscillators:
 Crystal Characteristics
 Crystal Oscillators
RC Oscillators:
 The Phase-Shift Oscillator
 The Wien-Bridge Oscillator
Nonsinusoidal Oscillators:
 The Blocking Oscillator
 Sawtooth Oscillator
 High-Frequency Oscillators
Experiments:
 Practical Tank Circuit
 LC and Crystal Oscillators
 The Wien-Bridge Oscillator

UNIT VI: PULSE CIRCUITS

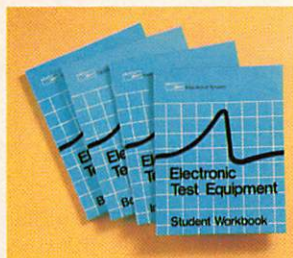
Nonsinusoidal Waveforms:
 Frequency Domain Analysis
 Waveform Spectrum
 Waveshaping
Diode Clipping Circuits:
 The Series Clipper
 Shunt Clippers
 Slicer Circuits
 Transistor Clipper

Clampers
 Multivibrators
 Schmitt Trigger
 The 555 Timer
Ramp Generators:
 Forming the Ramp, Op-Amp Integrator, Sawtooth Generator
Experiments:
 Waveshaping
 Rectangular - Wave and Ramp Generators

UNIT VII: MODULATION

Amplitude Modulation:
 The Radio Wave
 The Diode Modulator
 The AM Transmitter
 Modulator Circuits
 The AM Detector
 Tuned RF Receiver
 Superhetrodyne Receiver
 Mixers and Frequency Converters
 Other AM Systems
Frequency Modulation:
 The FM Waveform
 Frequency Modulation
 The FM Transmitter
 The FM Receiver
FM Detectors:
 Slope Detector
 Double-Tuned Detector
 Foster-Seeley Detector
 Ratio Detector
Experiment:
 Amplitude Modulation

Electronic Test Equipment Course



Uses proven teaching methods, hands-on exercises to cover instrument applications and operation

Specially formatted for instructor-led classroom learning, this course provides an insight into the operation and practical application of popular test instruments.

The course is divided into six units, which cover the theory and application of analog and digital meters, oscilloscopes, frequency generation, frequency measurements and special measuring instruments. The first four Fundamental Electronics Courses and the Digital Techniques course (page 15) are prerequisites.

Upon completion, the student will be able to:

- Make measurements with digital and analog meters.
- Explain the operation of both integrating and non-integrating meters.
- Explain the operation of oscilloscopes.
- Use an oscilloscope in electronic testing and servicing.
- Describe the operation and use of the three most popular types of passive frequency meters.
- Describe the operation of, and be able to use the four most popular types of active frequency meters.
- Calculate value of an unknown inductor with a dip meter.

- Explain the operation and use of electronic counters.
- Use appropriate bridge circuits to measure resistance, capacitance, inductance and impedance.
- Use a transistor tester to determine beta and leakage values of transistors, and transconductance and leakage values of Field-Effect Transistors (FETs).
- Demonstrate an understanding of curve tracers, spectrum analyzers and logic probes.

Fifteen interactive experiments give the student actual hands-on experience, using many types of test equipment.

This course is also available in an effective self-instruction format, for situations where self-study is required.

Required Course Trainer: ETW-3100, Shpg. wt. 6 lbs.

Classroom Text, Workbook, Guide and Accessories:

EB-6105, Student Text, Shpg. wt. 4 lbs.

EB-6105-40, Student Workbook, Shpg. wt. 2 lbs.

EB-6105-50, Instructor's Guide, Shpg. wt. 1 lb.

EB-6105-30, Parts Kit, Shpg. wt. 1 lb.

Self-Instruction Format:

EE-3105, Binder, Records and Parts, Shpg. wt. 18 lbs.

Recommended Test Equipment

The ETW-3100 Experimenter/Trainer (page 4) is necessary for performing course experiments. A digital meter, analog meter, oscilloscope, frequency generator and frequency counter are also required to complete the hands-on experiments. Heathkit/Zenith test equipment is displayed on pages 18-20.

CONDENSED COURSE OUTLINE

UNIT I: ANALOG METERS

The Meter Movement:

d'Arsonval Movement
Taut-Band Movement
Electrodynamometer
Iron Vane
Thermocouple
Electrostatic

The Ammeter:

Increasing the Range of the Ammeter
Scales
Clamp-On Meters

The Voltmeter:

Extending the Range
Sensitivity (Ohms/Volt)
Loading Effect of Voltmeters
Accuracy

The Ohmmeter:

Basic Circuit
Creating Higher Ranges
Creating Lower Ranges
Shunt Ohmmeter
Volt-Ohm-Milliammeter
Electronic Meters

Experiment:

Meter Resistance

Experiments:

Loading Effect, Capacitor Checks, Linear Ramp A/D Converter

UNIT III: OSCILLOSCOPES

Cathode-Ray Tube
Deflection Circuits

Oscilloscope Circuits:

Sweep Generator
Triggering
Amplifiers
Power Supply

Special Features:

Delayed Sweep
Two Traces
Storage Scope
Controls

Experiment:

Oscilloscope Control Operation

Oscilloscope Measurements:

Voltage
Time Duration
Pulse Measurement
X-Y Measurements
Dual-Trace Measurements

Experiments:

Lissajous Measurements, Digital Measurement

UNIT IV: FREQUENCY MEASUREMENT

Basic Concepts:

Time and Frequency
Frequency Standards
Types of Instruments

Passive Frequency Meters:

Resonance
Vibrating Reed Meters
Wavemeters

Dip Meters:

Principles of Operation
Operating Procedures

Experiment:

Determining Inductance with a Dip Meter

Heterodyne Frequency Meters:

Principles of Operation

Transfer Oscillators:

Principles of Operation
Operation Techniques

Electronic Counters, General Principles:

Operational Overview
Signal Conditioner
Main Gate
Time Base
Gate Control
Decade Counter and Display
Counter Time Base Section
Counter Gate Control Section
Counter Signal Conditioner
Signal Conditioner Input Considerations
Main Gate, Counter and Display Section

Experiments:

Main Gate and Decade Counter Circuit; Memory Latch, Decoder and Display Circuit

Counter Measurement Modes:

Totalizing
Period Measurement
Period Average Measurement

Time Interval Measurement

Time Interval Averaging
Extending the Counter's Limits
Calibrating the Counter

UNIT V: FREQUENCY GENERATION

Basic Signal Generator Concepts:

Frequency Ranges
Modulation
Characteristics
Frequency Domain Analysis
Waveforms

Audio Frequency Generators:

Oscillator Circuits
Buffer/Output
Amplifier Circuits
Output Attenuators
Squaring Circuits
Audio Generator Applications:
Amplifier Gain
Input, Output Impedance
Input Sensitivity
Frequency Response

Radio Frequency Generators:

General Characteristics
Overall Operation

RF Generator Applications:

Impedance Matching
General Coupling Techniques
AM Receiver Alignment
Testing Wideband Amps

Function Generators:

General Operation

Overall Operation

Experiments:

Signal Generator Calibration Check, Performance Check of Oscilloscope Vertical Input Circuits, Performance Check of Oscilloscope Sweep Calibration

UNIT VI: SPECIAL MEASURING INSTRUMENTS

Bridge Circuits:

Resistance Bridges
Capacitance Bridges
Inductance Bridges
RLC Bridges

Transistor Tester:

Beta
Leakage
FET Tests
Diode Tests
Other Components

Curve Tracer:

Block Diagram
Presentation
Applications

Spectrum Analyzer:

Types
Requirements
Applications

Experiment:

Spectrum Analyzer

Logic Testers:

Principles
Logic Probe
Logic Pulser

Experiment:

Digital Logic Probe

Heathkit/Zenith Electronic Communications



Uses proven training methods to cover state-of-the-art forms of communication

The Electronic Communications Course introduces students to the fundamentals of electronic communications.

Instructor-guided, the course takes the student through amplitude, frequency, phase and angle modulation; through a study of transmitters and antennas; to an understanding of state-of-the-art broadcasting and data communications.

Seven experiments are included to provide valuable hands-on experience with actual communications circuits. Unit tests allow students to check their progress in understanding and retaining previous text material.

Upon completion of the course, the student will be able to:

- Discuss and explain the characteristics, advantages and disadvantages of amplitude, frequency and phase modulation systems.
- Analyze the composition of complex waveforms.

COURSE OUTLINE

UNIT I: COMMUNICATION FUNDAMENTALS

Introduction
Unit Objectives
Unit Activity Guide
What is Communication?
Information Transfer
Modulation
Types of Modulation
Review of Complex Waves:
Sine Wave
Square Wave
Sawtooth Wave
Amplitude Modulation:
The AM Waveform
Percent of Modulation
Sidebands
Bandwidth
Angle Modulation:
Frequency Modulation
Phase Modulation
Modulation Index
Sidebands
Bandwidth
The Communications System:
Input/Output Devices
Transmitter
Channel
Noise
Receiver

UNIT II: AMPLITUDE MODULATION

Introduction
Unit Objectives
Unit Activity Guide
AM Circuits:
The Diode Modulator
The Absorption Modulator
The Collector Modulator
The Series Modulator

The Progressive Series Modulator
Suppressed Carrier AM:
Standard AM Disadvantages:
Carrier Power
Bandwidth
Propagation Problems
Balanced Modulators:
Twin FET
Diode-Ring
IC
Suppressed Carrier AM Disadvantages
Single Sideband:
Filter Method SSB
Transmitter:
Sideband Filters
Frequency Conversion
Sideband Selection
Phasing Method of SSB
Linear Amplifiers
SSB Power Ratings
Experiments:
AM Transmitter, Balanced Modulator

UNIT III: AM RECEIVERS

Introduction
Unit Objectives
Unit Activity Guide
AM Detectors:
The Diode Detector
The Transistor Detector
The Synchronous Detector
The Product Detector
Tuned RF Receiver
Superhetrodyne Receivers:
Block Diagram
Frequency Conversion Circuits
Intermediate Frequency Selection
IF Amplifiers

Automatic Gain Control
Double Conversion Receivers
Receiver Specifications:
Sensitivity
Selectivity
Image Rejection
IF Rejection
Dynamic Range
Analysis of a Communications Receiver:
Specifications
Circuit Analysis
AGC Circuit
Experiment:
Diode Detector

UNIT IV: ANGLE MODULATION

Introduction
Unit Objectives
Unit Activity Guide
Angle Modulation Transmitters:
Reactance Modulator
Varactor Modulator
Phase Modulator
The Complete Transmitter
Demodulators:
Slope Detector
Double-tuned Detector
Foster-Seeley Discriminator
Ratio Detector
Phase-Locked Loop Demodulator
Receivers:
Block Diagram
Limiter
Automatic Frequency Control
AM/FM Broadcast Tuner
An FM Transceiver:
Schematic Analysis
Experiment:
Frequency Modulation

UNIT V: PULSE MODULATION

Introduction
Unit Objectives
Unit Activity Guide
Analog Pulse Modulation:
Sampling
Pulse Amplitude Modulation
Pulse Time Modulation:
Pulse Duration/Pulse Position Modulation
Digital Pulse Modulation:
Pulse Code Modulation
Other DPM Systems
Multiplexing:
Time Division Multiplex
Frequency Division Multiplex
Experiments:
Pulse Amplitude Modulation
Time Division Multiplex

UNIT VI: ANTENNAS

Introduction
Unit Objectives
Unit Activity Guide
Transmission Lines:
Balance Transmission Line
Standing Waves
Standing Wave Ratio
Transmission Line Resonant Circuits
SWR Measurement
Coaxial Transmission Lines Comparisons
Antennas:
Antenna Principles
Antenna Radiation
Antenna Polarization
The Dipole Antenna
The Vertical Antenna
Antenna Arrays:
Parasitic Arrays
Driven Arrays

Radio Propagation:
Ground Waves
Space Waves
Sky Waves
The Ionosphere
Sky Wave Propagation:
Multiple-Hop Transmission
Fading
Ionospheric Variations
VHF-UHF Propagation
Extending VHF-UHF Communications:
Tropospheric Scatter Propagation
Satellite Communications:

UNIT VII: COMMUNICATIONS SYSTEMS

Introduction
Unit Objectives
Unit Activity Guide
FM Stereo Broadcasting:
Stereo Multiplex System
Stereo Transmitter
Stereo Receiver
SCA
Pre-emphasis/De-emphasis
Television Broadcasting:
Television Transmission
The Video Signal
The TV Transmitter
The TV Receiver
Data Communications:
Requirements
System Types
Modes of Operation
Modems
Data Communications Codes
Experiment:
FSK Modem

- Describe how AM and FM transmitters and receivers operate.
- Construct basic communications circuits.
- Explain differences between frequency and phase modulation.
- Discuss both frequency and time division multiplexing as methods of increasing communications channel capacity.
- State the characteristics and uses of transmission lines.
- Explain electromagnetic radiation and propagation, and list the various types of propagation.
- Discuss the basic types of antennas – including dipoles, verticals and directional arrays.

Required Course Trainer: ETW-3100, Shpg. wt. 6 lbs.

Self-Instruction Format:

EE-3106, Text, Records and Parts, Shpg. wt. 7 lbs.

Recommended Test Equipment

To perform the experiments in this course, the ETW-3100 Experimenter/Trainer is needed. A VOM and oscilloscope are also required. See pages 18 and 19 in this catalog for more details on the recommended SO-4550 Dual-Trace Oscilloscope and SM-5225 FET Multimeter. All other parts for the experiments are supplied with the course.

Expand students' electronics knowledge

Give your students the competitive edge by enhancing their electronics knowledge with one or more of these independent advanced courses

The Heathkit/Zenith Advanced Electronic Courses listed on the following pages do more than just build upon your students' basic knowledge of electronics – they provide that extra learning experience students need to secure a career in electronics.

Individual courses include Operational Amplifiers, Active Filters, IC Timers, Phase-Locked Loops, and Optoelectronics. All of the courses were developed because there was a recognized need for technicians and engineers to know how to design and work with these specialized electronic devices.

Every course in our Advanced Series is comprehensive and complete in its coverage, yet self-contained. The courses can be taught individually, or in any collective combination to fit your particular curriculum needs.

In addition, each course features textbooks, student workbook, and instructor's guide. The text presents the course material in easy-to-understand terms, and uses a programmed-instruction format to immediately reinforce course concepts. Likewise, the hands-on experiments in the student workbook also strengthen and reinforce the concepts for improved comprehension and retention.

The instructor's guide has a unit-by-unit outline of the course, allowing you to coordinate the workbook experiments with the concepts covered in the text. It also contains unit review questions, unit exams, and a final examination.

Besides the text, workbook, and instructor's guide, a parts package is offered with each course. The package comes complete with all the parts needed to perform the experiments in the student workbook.

On the following two pages, you'll find valuable and detailed



descriptions about each course in our Advanced Electronics Series. These descriptions will help you select which series or courses are necessary to enhance your electronics curriculum. Whichever course or courses you choose, you can be assured that they will give your students the most comprehensive, up-to-date information they need to become more proficient technicians and engineers in their chosen electronics specialty.

Recommended Test Equipment

To complete the experiments for the courses in our Advanced Electronics Series, your labs should be equipped with the required ETW-3300 Lab Breadboard described underneath the course chart below. In addition to the ETW-3300 Trainer, your labs should also have a quality dual-trace oscilloscope such as our SM-4550 Oscilloscope on page 18, and multimeter like our low-cost SM-5225 Multimeter on page 19.

Series Chart

ADVANCED ELECTRONICS

Operational
Amplifiers

Active
Filters

IC
Timers

Phase-Locked
Loops

Opto-
Electronics

Versatile, Lab Circuit Breadboard makes experimenting easier

This **multipurpose Lab Breadboard** is specifically designed to be used with the hands-on experiments listed in the student workbooks of our Advanced Electronic Courses described on pages 12 and 13.

Made from quality materials, the Lab Breadboard features solderless breadboards for quick and easy circuit setups. Also, the breadboards can accommodate any size dual in line integrated circuit package. Convenient, built-in power supplies save on set-up time and eliminate tangling wires. The power supplies provide +5 VDC ($\pm 4\%$), +12 VDC or -12 VDC ($\pm 2\%$) power to the breadboard, with fixed current limiting of each supply, at rated current, for short circuit protection. Power Requirements, 120/240 VAC, 50/60 Hz. Measures 3.5" H x 12" W x 12" D. (8.89 cm x 30.48 cm x 30.48 cm).

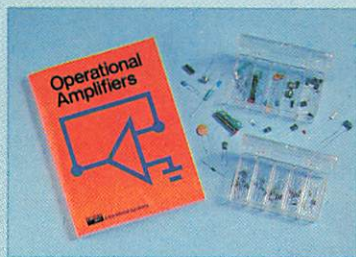
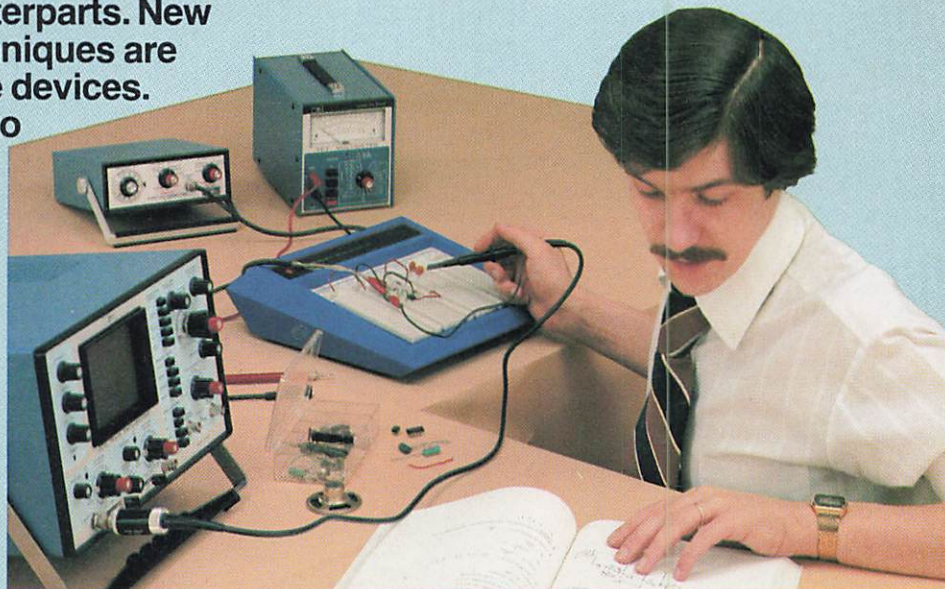
ETW-3300, Assembled, Shpg. wt. 6 lbs.



Intensive, specialized courses in these five

Integrated circuits are rapidly replacing their discrete component counterparts. New knowledge, skills and techniques are required to deal with these devices. These courses, designed to fit any state-of-the-art electronic curriculum, provide those skills.

We believe that students learn best by doing. That's why our courses include hands-on experiments that reinforce important concepts. Students actually observe, measure and experience the dynamics of circuit operation. Experiments allow the student to interact with the circuit. By designing, building, and then modifying the circuit, the student becomes intimately familiar with its behavior, limitations and abilities.



Operational Amplifiers Course gives students working knowledge of these useful devices

A universal and "idealized" amplifier, op-amps are the basic building block for a wide range of circuits – including amplifiers, oscillators, comparators and active filters. Op-amps make the design of complex circuits easier than ever before, once you understand how to use them. This popular course makes it easy for the student to gain an in-depth understanding of op-amps.

An effective text with hands-on experiments teaches the student how to measure and compute op-amp parameters, how to design basic op-amp circuits, how to design integrator and differential circuits, and how to design and predict the performance of op-amp constant current sources, current-voltage and voltage-current converters – and much more. Even the popular Norton and BiFET op-amps are covered in-depth.

Experiments require ETW-3300 Breadboard. An oscilloscope like the SO-4205 (p. 18), a multimeter and a frequency generator are also useful in the experiments. The student should first complete the Basic Electronics Series (EB-6101 through 6104, pages 4-8) – or have equivalent knowledge.

A self-instruction format of this course is available for industrial training, government and individual learning situations where a self-study application is required. Components for experiments are included with this version.

Required Course Trainer: ETW-3300, Shpg. wt. 6 lbs.

Classroom Text, Guides, Accessories:

EB-601, Student Text (includes experiments), Shpg. wt. 2 lbs.

EB-601-50, Instructor's Guide, Shpg. wt. 1 lb.

EB-601-30, Parts Pack, Shpg. wt. 1 lb.

Self-Instruction Format:

EE-101, Operational Amplifiers, Shpg. wt. 5 lbs.



Active Filters Course provides in-depth understanding of smaller, high-performance components

Filters are an integral part of many electronic devices. But the days of the bulky, expensive LC filters are gone forever. Active filters allow unusually sharp and responsive filter networks using small, inexpensive, readily available parts. A complete understanding of this very critical element in circuit design is provided by this course.

The course uses a specially-written text and hands-on experiments to help you teach students how to design active filters with op-amps, plot and predict frequency responses, design and breadboard first-order low-pass and high-pass filters. Later units cover second-order and high-order filters, as well as bandpass and state-variable filters. The student should first complete EB-601 Op-Amps, or have equivalent knowledge.

Separate Parts Kits contain all electronic components necessary to complete the experiments. The Heathkit/Zenith ETW-3300 Breadboard is needed to complete the experiments, as well as an oscilloscope like the SO-4205 (p. 18), a multimeter and frequency generator.

A self-instruction format of this course is also available for industrial training, government and individual learning situations where a self-study application is required. Components for experiments are included in this version.

Required Course Trainer: ETW-3300, Shpg. wt. 6 lbs.

Classroom Text, Guide and Accessories:

EB-602, Student Text (includes experiments), Shpg. wt. 2 lbs.

EB-602-50, Instructor's Guide, Shpg. wt. 1 lb.

EB-602-30, Parts Pack, Shpg. wt. 1 lb.

Self-Instruction Format:

EE-102, Active Filters, Shpg. wt. 5 lbs.

important areas of modern electronics



IC Timers Course gives students knowledge about this important control device

IC Timers provide controlling signals for many modern electronic circuits. Our IC Timers Course introduces the student to IC timers, how they work, what they do and where they're used. The course, which explains timing devices and their usefulness in all types of everyday devices, is especially valuable to students in technical or engineering curricula.

A comprehensive 348-page text covers the 555 and 556 general-purpose timers, 322 and 3905 wide-range precision, monostable timers and programmable timer/counters (including 2240 binary, 2250 BCD and 8260 seconds/minutes/hours BCD programmable timer/counters).

Interactive experiments demonstrate the many uses of IC timers – in logic functions, output drive circuits, time-delay relay circuits, wide-range pulse generators, voltage/frequency converters, oscillators, precise clock sources and more.

The Parts Pack (below) contains all components necessary for experiments. Also required are the ETW-3300 Breadboard, an oscilloscope like the SO-4205 (page 18) and a multimeter.

A self-instruction format is also available for industrial training, government and individual learning situations where a self-study application is required. All components necessary for experiments are included in this format.

Required Course Trainer: ETW-3300, Shpg. wt. 6 lbs.

Classroom Text, Guide, Accessories:

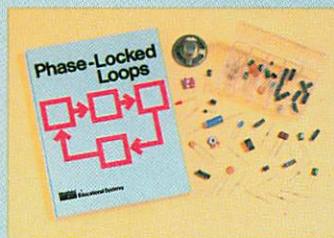
EB-603, Student Text (includes experiments), Shpg. wt. 2 lbs.

EB-603-50, Instructor's Guide, Shpg. wt. 1 lb.

EB-603-30, Parts Pack, Shpg. wt. 1 lb.

Self-Instruction Format:

EE-103, IC Timers, Shpg. wt. 5 lbs.



Phase-Locked Loops gives knowledge of this accurate circuit

As technological growth requires more versatility and accuracy from electronic devices, phase-locked loops become more popular. PLLs are widely used in television receivers, FM receivers, 40-channel CB and 2-meter FM transceivers.

This Phase-Locked Loops Course shows the student how these state-of-the-art devices work. The student should have completed the Basic Electronics Series (EB-6101 through 6104, pgs. 4-8) and the Digital Techniques Course (EB-6201, p. 15), or have equivalent knowledge, before starting this course.

A comprehensive 268-page student text illustrates the principles of PLLs and their building blocks – the phase detector, loop filter and voltage-controlled oscillator. After each unit, the student performs hands-on experiments to reinforce these concepts. Components for the experiments are in the Parts Pack (below).

Experiments require the ETW-3300 Breadboard and a DC voltmeter. We recommend, in addition, a dual-channel oscilloscope like the SO-4205 (page 18) and an audio signal generator like the SG-5218 (page 20).

A self-instruction format is also available for industrial training, government and individual learning situations where a self-study application is required. This version includes the parts necessary to perform the experiments.

Required Course Trainer: ETW-3300, Shpg. wt. 6 lbs.

Classroom Text, Guide, Accessories:

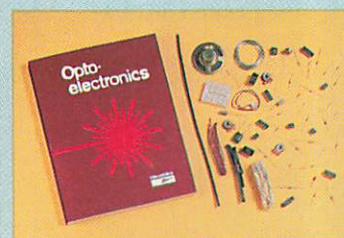
EB-604, Student Text (includes experiments), Shpg. wt. 2 lbs.

EB-604-50, Instructor's Guide, Shpg. wt. 1 lb.

EB-604-30, Parts Pack, Shpg. wt. 1 lb.

Self-Instruction Format:

EE-104, Phase-Locked Loops, Shpg. wt. 5 lbs.



Optoelectronics Course covers the latest in electronic displays and fiber optics – effectively

The latest developments in this rapidly-changing field are explained in this fascinating course. The Heathkit/Zenith Optoelectronics Course teaches basic optical terms and concepts. It covers the types of available light sources, and provides an understanding of optoelectronic displays – including driving and multiplexing.

This course provides in-depth coverage of light-sensitive components such as photodiodes, photo-transistors, LCDs, solar cells and optocouplers – including design and applications. Fiber optics theory and operation are also covered.

Students perform a series of interactive experiments to gain practical, hands-on experience with the many optoelectronic circuits discussed in this course.

All parts necessary for the experiments are included in the Parts Pack listed below. Experiments require the ETW-3300 Breadboard; we also recommend a milliammeter and voltmeter – or a VTVM, and an oscilloscope like the SO-4205 (page 18).

Prerequisites for the Heathkit/Zenith Optoelectronics Course are the Heathkit/Zenith DC and AC Electronics Courses (EB-6101 and EB-6102, pages 5 and 6) or equivalent knowledge; some experience in electronics or optics.

A self-instruction format of the Optoelectronics Course is also available for industrial training, government and individual learning situations where a self-study application is required. This version includes all electronic components necessary to perform the experiments.

Required Course Trainer: ETW-3300, Shpg. wt. 6 lbs.

Classroom Text, Workbook, Guide, Accessories:

EB-605, Student Text, Shpg. wt. 2 lbs.

EB-605-40, Student Workbook, Shpg. wt. 1 lb.

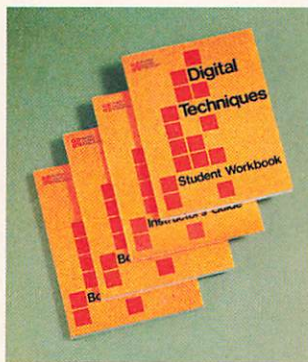
EB-605-50, Instructor's Guide, Shpg. wt. 1 lb.

EB-605-30, Parts Pack, Shpg. wt. 1 lb.

Self-Instruction Format:

EE-105, Optoelectronics, Shpg. wt. 5 lbs.

Digital Techniques – the course that



A must for students entering the growing field of electronics!

Here's a comprehensive course your students will need to secure their future in modern electronics. It covers the important concepts they need to understand today's microprocessors and tomorrow's electronic devices.

This course is designed for the student with a basic electronics background. It begins with the fundamentals of Digital Techniques and moves on to explain logic circuits, Boolean Algebra, flip-flops, registers, combinational logic circuitry, and digital design.

Like all Heathkit/Zenith Educational Courses, Digital Techniques uses a step-by-step approach in presenting the subject material. In addition, the course features an easy-to-read textbook, student workbook with over 20 hands-on experiments and an instructor's guide that includes course outline, unit learning objectives, answers to unit quizzes, and a final exam.

Upon completing the course, a student will be able to:

- State the advantages and benefits of using digital techniques in electronic equipment.
- Convert between the binary and decimal number systems and recognize the most commonly used binary codes.
- Explain the operation of digital logic gates & flip-flops
- Identify the most common integrated circuit families used in digital equipment, and discuss their operation, characteristics, and features.
- Use Boolean Algebra to express logic operations and minimize logic circuits in design.
- Describe the operation and application of binary and BCD counters, shift registers and other sequential logic circuits.

COURSE OUTLINE

UNIT 1: INTRODUCTION TO DIGITAL TECHNIQUES

Digital Techniques
Contrasting Analog and Digital Devices and Techniques

Where are Digital Techniques Used?

Communications
Telemetry Systems
Industrial Controls
Consumer Electronic Equipment

Why Use Digital Techniques?

Greater Accuracy
Greater Dynamic Range
Greater Stability
Convenience
Automation
Design Simplicity
New Approaches

The Binary Number System:
Positioning Number System
Fractional Numbers

Converting Between the Binary and Decimal Number System:
Binary to Decimal
Decimal to Binary
Binary Number Sizes
Number Identification

Binary Codes

Binary Coded Decimal

Special Binary Codes:
Excess 3 Code
Gray Code
ASCII Code

Data Representation
Electromechanical Devices
Transistors
Magnetic Cores
Logic Levels
Positive and Negative Logic
Parallel vs. Serial Data Representation
Logic Circuits

UNIT 2: SEMICONDUCTOR DEVICES FOR DIGITAL CIRCUITS

A Programmed Review of Transistor Operations

The Bipolar Transistor Switch

Modes of Operation:
Cut-off
Linear
Saturation

Saturation Switching Circuits

Switching Speed

Non-saturating Switching Circuits

Designing a Saturated Switch-Logic Inverter:
Procedure

Example Application 1
Example Application 2

MOS Field Effect Transistors

The N-Channel MOSFET

The P-Channel MOSFET

Bipolars vs. MOSFETs

MOSFET Circuits
Experiment: Bipolar Transistor Switch

UNIT 3: DIGITAL LOGIC CIRCUITS

Types of Logic Circuits

The Inverter:

The AND Gate
The OR Gate
The Dual Nature of Logic-Gates

NAND/NOR GATES:
NAND Gates
NOR Gates
How NAND/NOR Gates Are Used

Practical Logic Circuits:
Relays and Switches
Discrete Component Logic-Circuits
Integrated Circuits

Experiments: Transistor Logic-Gate, Logic Inverter, Decision-Making Logic Elements, Diode Logic Gates

UNIT 4: DIGITAL INTEGRATED CIRCUITS

Logic Circuit Characteristics

Logic Level

Propagation Delay

Power Dissipation

The Speed-Power Trade Off
Noise Immunity

Fan Out:
Current Source Logic
Current Sink Logic

Integrated Circuits

Manufacturing Methods:
Monolithic
Thin and Thick Film Techniques
Hybrid Circuits

Application
Function

Integrated Circuit Package:
TO5
Flat-Pack
DIP

Temperature Ranges

Transistor Logic

Circuit Operation

TTL Characteristics

Special TTL Variations:

Low Power TTL
High Power TTL
Schottky TTL
Three State TTL

Emitter Coupled Logic:

Circuit Operation
ECL Characteristics

Metal Oxide Semiconductor-

Integrated Circuits:
PMOS and NMOS Circuits
Complementary MOS
CMOS Characteristics

Selecting a Digital Integrated Circuit for a Special Application:

Trends
Complex Functions
Trade-Offs

Experiments: CMOS Logic Gate, TTL Logic Gates

UNIT 5: BOOLEAN ALGEBRA

Relating Digital Logic Circuits and Boolean Equations

Truth Tables

Boolean Rules

Minimizing Logic Expressions

Using NAND/NOR Gates

Experiments: Applying NAND and NOR Gates, The Wired OR Connection

UNIT 6: FLIP-FLOPS AND REGISTERS

Flip-Flops

D Type Flip-Flops and Registers

JK Flip-Flops

Experiments: JK Flip-Flops, Set-Reset-Flip-Flops, D-Type Flip-Flops and Registers

UNIT 7: SEQUENTIAL LOGIC CIRCUITS: COUNTERS, SHIFT REGISTERS, AND CLOCKS

Counters

opens the way to modern electronics

- Name the most frequently used combinational logic circuits and explain their operation.
- Design both combinational and sequential logic circuits for a given application from definition and concept to the selection of the integrated circuits.
- Describe the operation and the application of digital counter in time and frequency measurements.
- Explain how a digital computer is organized and how it operates.
- Describe microprocessors, explain their operation and give examples of their applications.

Prerequisites: DC, AC, & Semiconductors Courses or equivalent knowledge.

An individual self-instruction format of the Digital Techniques Course is available for self-study situations.

Required Course Trainer: ETW-3200, Shpg. wt. 6 lbs.

Classroom Texts, Workbooks, Guides, and Accessories:

EB-6201, Student Text, Shpg. wt. 3 lbs.

EB-6201-40, Student Workbook, Shpg. wt. 2 lbs.

EB-6201-50, Instructor's Guide, Shpg. wt. 1 lb.

EB-6201-30, Parts Kit, Shpg. wt. 1 lb.

Self-Instruction Format:

EE-3201, 2 Binders with parts, Shpg. wt. 9 lbs.

EEA-3201, Optional Cassettes, Shpg. wt. 1 lb.

Recommended Test Equipment

To perform the workbook experiments, you'll need the ETW-3200 Trainer below, plus an oscilloscope like our SO-4550 on p. 18 and a multimeter like our SM-1210 on p. 19.

Required ETW-3200 Digital Techniques Trainer

Your students will gain more confidence and get more out of your labs with this simple-to-setup ETW-3200 Trainer.

It's especially made for experiments in the student workbook. It features solderless breadboards for experimenting and circuit design; four binary data switches; two no-bounce switches, 3-frequency pulse clock generator, and four LED dis-

plays for monitoring the experiments.

In addition, the Trainer has 3 built-in power supplies with outputs of +12 VDC @ 100 mA, -12 VDC @ 100 mA and +5 VDC @ 500 mA. Overload protected.

All breadboards, switches, displays, and power outputs are located in front for easy access. 120/240 VAC.

ETW-3200, Assembled, Shpg. wt. 6 lbs.



Binary Counters:
Frequency Dividers
Maximum Count
Down Counters
Up-Down Counters
Synchronous Counters
Counter Functions

Typical Integrated Circuit Counters

BCD Counters:
Cascading BCD Counters
The BCD Counter as a Frequency Divider
Typical Integrated Circuit BCD Counter

Special Counters:
Modulo 3 Counter
Modulo 5 Counter

Shift Register:
Shift Register Operation
Bipolar Logic Shift Registers

Shift Register Applications:
Scaling Operations
Shift Register Memory
Sequencer/Ring Counter Counters

MOS Shift Registers:
Dynamic MOS Shift Registers

Static MOS Shift Registers

Clock and One Shots

Clock Oscillator Circuits:
Discrete Component Circuits
IC Clock Circuits
One shot Multivibrators
One shot Applications

Experiments: Clock and One Shots, Binary Counters, The BCD Counter, Counter Applications, Shift Registers, Shift Register Applications

UNIT 8: COMBINATIONAL LOGIC CIRCUITS

Decoders:
BCD to Decimal Decoder
Octal and Hex Decoders
BCD to 7-Segment Decoder

Encoders

Multiplexer Operation

Multiplexer Applications:
Parallel to Serial Conversion
Serial Binary Word Generator

Boolean Function Generators

Demultiplexers

Exclusive OR:
Applications of the Exclusive OR
Binary Adder
Parity Generator/Checker
Binary Comparators

Read Only Memories

ROM Operation

ROM Construction:
Bipolar ROM
MOS ROMs
Access Time

ROM Applications:
Random Logic
Code Conversion
Arithmetic Operations

Microprogramming Programmable Logic Arrays

Experiments: Exclusive OR Code Converters, Exclusive OR Applications, Decoders, 7-Segment Decoder-Driver and Display Multiplexers, Multiplexers

UNIT 9: DIGITAL DESIGN

Design Criteria
Maximum Performance
Lowest Cost

Trade-Offs

Combination Logic Circuit-Design

Problem Definition:
Example Problem

Truth Table Development

Develop the Logic Equations

Circuit Minimization

Karnaugh Maps

Implementing the Logic Equations:

SSI Implementation
MSI Implementation
ROM Implementation
PLA Implementation

Multiple Output Combinational Circuits

Design Example #1

Design Example #2

Sequential Logic Circuit Design

Design Procedure:

Defining the Problem
Developing a State or Flow Table
Developing a Karnaugh Map for the Counter
Drawing the Logic Diagram

Design Examples:
Two-Bit Gray Code Counter
XS3 Code BCD Counter

Design Variations

Experiments: Designing Sequential Logic Circuits, Designing Combinational Circuits

UNIT 10: DIGITAL APPLICATIONS

Digital Test Equipment:
The Frequency Counter

Input Circuits

Time Base

Decimal Counter and Display

Modes of Operation:
Totalize Mode
Frequency Measurement
Period Measurement
Time Interval Measurements

Counter Specifications:

A Typical Digital Counter:
General Circuit Description
Input Circuit and Schmitt-Trigger
10 MHz Clock and Scaler
Decade Counter and Display
Control Circuitry
Over-Range Detection

Digital Computers What is a Digital Computer? How Computers Are Classified

Digital Computer Organization:

Memory
Control Unit
Arithmetic-Logic Unit
Input-Output Unit

Digital Computer Operation

Programming:
Programming Procedure

Writing Programs:

Computer Instructions
A Hypothetical Instruction-Set
Example Programs

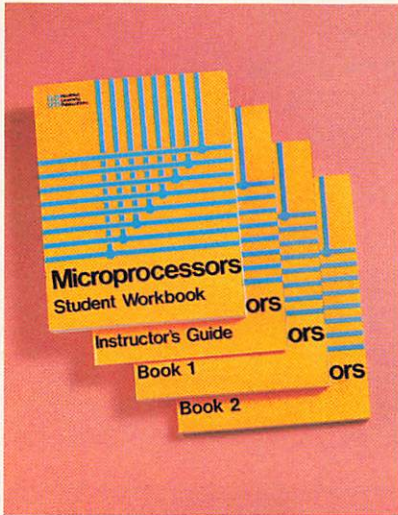
Software:

Subroutines
Utility Programs
Assembler
Compiler
Cross Assemblers and Compilers

Microprocessors:

Types of Microprocessors
Applications of Microprocessors
Where are Microprocessors Used?
Designing With Microprocessors

Heathkit/Zenith Microprocessor Course teaches



Microprocessors are being used more and more in electronic equipment. Our course gives students the thorough training they need to work with these complex devices

No electronics curriculum today can be called up-to-date or complete without a microprocessor course. And the Heathkit/Zenith Microprocessor Course is the most comprehensive, fun-to-teach and cost effective course available to you.

The course is competency-based, and uses the unique Heathkit/Zenith segmented, step-by-step learning approach. This proven approach not only keeps the student motivated and interested in the subject material, but it also enables you to provide your students with the thorough training that industry demands.

The course covers microprocessor theory and operation, computer arithmetic, programming, and interfacing. Each concept

is carefully integrated into the textbook, student workbook, and the instructor's guide.

The text is written with you and the student in mind. Microprocessor concepts are presented in plain, easy-to-understand language, and reinforced with simple-to-follow illustrations. Each unit is structured so it can easily be broken into 50 minute study sessions. The text also contains programmed-instructional reviews and self-test review exams to improve the students' comprehension of the subject.

The Student Workbook gives students a chance to try their newly acquired knowledge in real-world situations. The workbook is loaded with "hands-on" hardware and programming experiments to reinforce the concepts presented in the text.

The instructor's guide reduces your class preparation time. Every part of the course is outlined and briefly described in the guide. The guide includes course outline, unit by unit learning objectives, answers to unit examinations, plus a comprehensive final examination – everything you need to plan daily classroom and lab sessions.

COURSE OUTLINE

UNIT 1: NUMBER SYSTEMS AND CODES

Decimal Number System
Binary Number System:
 Positional Notation
 Converting Between the Binary and Decimal Number Systems
Hexadecimal Number System:
 Converting from Decimal to Hex
 Converting between the Hex and Binary Number Systems
Binary Codes:
 Binary Coded Decimal
 Special Binary Codes
 Alpha Numeric Codes
 Experiments 1 & 2 (Unit 9)

UNIT 2: MICRO-COMPUTER BASICS

Terms and Conventions:
 Stored Program Concept
 Computer Words
 Word Length

An Elementary Micro-computer:
 The Microprocessor Unit (MPU)
 Memory
 Fetch-Execute Sequence
 A Sample Program
 The Fetch Phase
 The Execute Phase
 Fetching the Add Instruction
 Executing the Add Instruction
 Fetching and Executing the HLT Instruction
Addressing Modes:
 Inherent or Implied Addressing
 Immediate Addressing
 Direct Addressing
 Sample Program Using Direct Addressing
 Executing the Sample Program
 Combining Addressing Modes
 Experiment 3 (Unit 9)

UNIT 3: COMPUTER ARITHMETIC

Binary Arithmetic:
 Binary Addition
 Binary Subtraction
 Binary Multiplication
 Binary Division
 Representing Negative Numbers
 Two's Complement Arithmetic
 Ten's Complement Arithmetic
 Two's Complement Subtraction
 Arithmetic With Signed Numbers
 Boolean Operations
 AND Operation
 OR Operation
 Exclusive OR Operation
 Invert Operation
 Experiment 4 (Unit 9)

UNIT 4: INTRODUCTION TO PROGRAMMING

Branching:
 Relative Addressing
 Executing Branch Instructions
 Branching Forward
 Branching Backward
Conditional Branching:
 Conditional Codes
 Conditional Branch Instruction
Algorithms:
 Multiplying by Repeated Addition
 Dividing by Repeated Subtraction
 Converting BCD to Binary
 Converting Binary to BCD
Additional Instructions:
 Add with Carry (ADC) Instruction
 Subtract with Carry (SBC) Instruction
 Arithmetic Shift Accumulator Left (ASLA) Instruction

Decimal Adjust Accumulator (DAA) Instruction
 Experiments 5 & 6 (Unit 9)

UNIT 5: THE 6800 MICROPROCESSOR – PART 1

Architecture of the 6800 MPU:
 Programming Model of the 6800 MPU
 Block Diagram of the 6800 MPU
Instruction Set of the 6800 MPU:
 Arithmetic Instructions
 Data Handling Instructions
 Logic Instructions
 Data Test Instructions
 Index Register and Stack Pointer Instructions
 Branch Instructions
 Condition Code Register Instructions
 Summary of Instruction Set

your students the latest technology

This course, along with your teaching expertise, will give your students the knowledge and the experience they'll need to succeed in modern electronics. By the time your students complete our course, they'll be able to meet the following objectives:

- Convert between the various number systems and codes used by microprocessors.
- Explain the instruction set, addressing modes and architecture of a representative microprocessor.
- Program a representative microprocessor.
- Interface the microprocessor with its own family of support circuit.
- Interface the microprocessor with external components such as keyboards, displays, speakers, analog-to-digital converters, TTL and MOS Circuits.
- Create microprocessor-based circuits of his or her own design.
- Compare and contrast the various types of microprocessors available and decide which is more suitable for a particular application.

A complete individual self-instruction version of the Microprocessor Course is available for industrial or government training purposes. This self-study version of the Microprocessor Course is complete, and features a 2-binder text with the course experiments. Also, this version includes a parts package for the experiments at no extra cost.

Prerequisite: Heathkit/Zenith Digital Techniques Course or equivalent knowledge.

Required Course Trainer, ETW-3400, Shpg. wt. 6 lbs.

Classroom Texts, Workbooks, Guides, and Accessories:

EB-6401, Student Text, Shpg. wt. 4 lbs.

EB-6401-40, Student Workbook, Shpg. wt. 1 lbs.

EB-6401-50, Instructor's Guide, Shpg. wt. 1 lb.

EB-6401-30, Parts Kit, Shpg. wt. 1 lb.

EB-6401-60, Cassettes, Shpg. wt. 1 lb.

EE-3401-1, Optional 35mm slides duplicate audio-visual flip charts in EE-3401, Shpg. wt. 2 lbs.

EE-3401-2, Optional 35mm filmstrip, Shpg. wt. 1 lb.

Self Instruction Format:

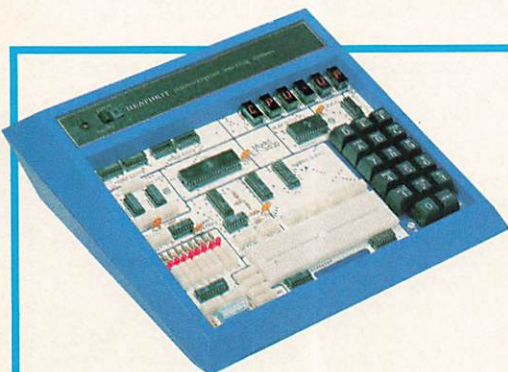
EE-3401, 2 Binders plus parts, Shpg. wt. 12 lbs.

EE-3401-1, Optional 35mm slides which duplicate audio-visual flip charts in EE-3401, Shpg. wt. 2 lbs.

EE-3401-2, Optional 35mm filmstrip, Shpg. wt. 1 lb.

Recommended Test Instruments

To perform the experiments listed in this course, you'll need the ETW-3400 Experimenter/Trainer (see description below), and a high-quality multimeter, and oscilloscope. For this course, we recommend our SM-1210 Multimeter (page 19) and our SO-4550 Oscilloscope (page 18).



Required Experimenter/Trainer for lab sessions

This ETW-3400 Trainer is actually a digital computer with 256 bytes of built-in RAM. The keyboard lets you enter program data, examine MPU registers, examine memory, single step through a program, & enter breakpoints for easy debugging.

Features a built-in 1K ROM monitor program for controlling unit operation.

The 6 digit LED display shows keyboard entry in binary or hexadecimal form. Has step forward/backward for examining sequential memory address.

Features +5, +12, and -12 VDC power supplies. Dimensions: 3½" H x 12½" W x 11¾" D. 120/240 VAC.

ETW-3400, Assembled, wt. 6 lbs.

New Addressing Modes:
Extended Addressing
Indexed Addressing
Instruction Set Summary
Experiments 7 & 8 (Unit 9)

UNIT 6: THE 6800 MICROPROCESSOR - PART 2

Stack Operations:
Cascade Stack
Memory Stack

Subroutines:
Jump (JMP) Instruction
JSR and RTS Instruction
Nested Subroutines
Branch to Subroutines (BSR) Instruction
Summary of Subroutine Instruction

Input-Output (I/O) Operations:
Output Operations
Input Operations
Input-Output Programming

Program Control of I/O Operations
Interrupt Control of I/O Operations

Interrupts:
Reset
Non-Maskable Interrupts
Return From Interrupt (RTI) Instruction
Interrupt Request (IRQ)
Interrupt Mask Instructions
Software Interrupt (SWI) Instruction
Wait for Interrupt (WAI) Instruction

Experiments 9 & 10 (Unit 9)

UNIT 7: INTERFACING PART 1

Interfacing Fundamentals:
Buses
3-State Logic
The 6800 MPU Interface Lines
Instruction Timing
Timing of Program Segment
The 6800 Data Sheet

Interfacing With Random Access Memory:

The Static Ram Storage Cell
A 128-Word by 8-bit RAM
A 256-Word by 4-bit RAM
Connecting RAM to the MPU
Address Decoding

Interfacing With Displays:
The 7-Segment Display
Driving the 7-Segment Display
Using an Addressable Latch
Multiplexing Displays
Experiments 1-4 (Unit 10)

UNIT 8: INTERFACING PART 2

Interfacing With Switches:
Interfacing Requirements
A Typical Keyboard Arrangement

The Peripheral Interface Adapter (PIA):
I/O Diagram
PIA Registers
Addressing the Register in the PIA
Initializing the PIA
Addressing the PIA

Using the PIA:
Driving 7-Segment Displays
Decoding Keyboards
Decoding a Switch Matrix
Experiments 5-9 (Unit 10)

UNIT 9: PROGRAMMING EXPERIMENTS

Experiment 1: Binary/Decimal Training Program
Experiment 2: Hexidecimal/Decimal Training Program
Experiment 3: Straight Line Programs
Experiment 4: Arithmetic and Logic
Experiment 5: Program Branches
Experiment 6: Additional Instructions
Experiment 7: New Addressing Modes
Experiment 8: Arithmetic Operations

Experiment 9: Stack Operations
Experiment 10: Subroutines

UNIT 10: INTERFACING EXPERIMENTS

Experiment 1: Memory Circuits
Experiment 2: Clock
Experiment 3: Address Decoding
Experiment 4: Data Output
Experiment 5: Data Input
Experiment 6: Introduction to the Peripheral Interface Adapter (PIA)
Experiment 7: Audio Output
Experiment 8: Key Matrix and Parallel-to-Serial Conversion
Experiment 9: Digital-to-Analog and Analog-to-Digital Conversion

Quality test equipment... superior learning tools



- Two vertical input channels
- Bright easy-to-read trace
- Shielded against interference
- 19 calibrated time base steps

The SO-4550 is a dual-trace lab-grade scope. It features a digitally controlled time base with automatic triggering, an extra-bright trace, and fast vertical rise time (35 nS) and writing speed.

Two vertical input channels have sensitivities adjustable from 10 mV/cm to 20 V/cm with a 1-2-5 sequenced attenuator.

Accurate, versatile lab-grade Dual-Trace Oscilloscope

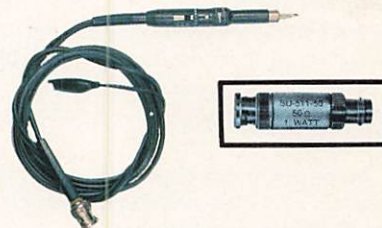
Select from 19 digitally controlled calibrated time base steps ranging from 0.2 μ S/cm to 0.2 S/cm in 1-2-5 sequence.

Recommended for use with these Heathkit/Zenith courses: AC Electronics, Circuits, Test Equipment, Communications, Advanced Electronics Series.

SO-4550, Assembled and calibrated, Shpg. wt. 25 lbs.

SO-4550 SPECIFICATIONS: Vertical: Deflection Factor: Sensitivity: 10 mV/cm to 20 V/cm. Variable: Continuous between steps to 60 V/cm (approx.). Accuracy: 3%. Vertical Response: DC Coupling: DC to 10 MHz. AC Coupling: 2 Hz to 10 MHz. Rise time: 35 nS. Vertical Input: Impedance: 1 M Ω shunted by 38 pF. Horizontal: Time Base: Ramp: 0.2 S/cm to 0.2 μ S/cm. Variable: Continuous between ranges to 0.6 S/cm (approx.). Accuracy: 3%. Magnifier: X5 (adds 2% to sweep accuracy). External: Sensitivity: 0.1 V/cm

(approx.). Impedance: 100 k Ω (approx.). Trigger: Internal: Automatic and Normal: Adjustable over 10 divisions. Slope Selection: + or -. External: Automatic & Normal: Adjustable over 0.8 V. Impedance: 1 M Ω shunted by 40 pF. Power Requirement: 120/240 VAC, 50/60 Hz, 70 W. Dimensions: 6.9" H x 12.9" W x 19.3" D (17.53 x 32.77 x 49.02 cm).



X1/X10 Scope Probe Combination. DC-15 MHz/DC-60 MHz bandwidths.

PKW-105, Assembled, Shpg. wt. . . . 1 lb.
SU-511-50 50 Ω Termination 1 lb.



- Full complement of modes, trigger sources and couplings
- Monitor simple sine-wave signals or complex electronic waveforms
- Delayed-sweep magnifies user-selected part of normal waveform

The SO-4235 is one of the most versatile scopes ever offered. Some of its

Professional Dual-Trace Delayed-Sweep Scope

outstanding features include a dual-trace capability, algebraic add, single-sweep function and a unique TV coupling which triggers on alternate fields.

Extra-value features include fully regulated power supplies, a front-panel 1 V square wave output and a variable hold-off control.

Display is bright enough to pick up fast, narrow signals.

SO-4235, Assembled and calibrated, Shpg. wt. 38 lbs.

SO-4235 SPECIFICATIONS: Vertical: Sensitivity: 2 mV/cm-10 V/cm, 12 steps in 1-2-5 sequence. Variable: Continuous between steps to 30 V/cm (approx.). Accuracy: Within 3% (20-30°C), 5% (10-50°C), referred to 1 V/cm. Vertical Response: DC Coupling: DC-35 MHz (-3 dB). AC Coupling: 1 Hz-

35 MHz. Rise Time: 10 nS. Overshoot: Less than 3%. Delay Line: Allows display of at least 20 nS of pre-triggered waveform. Vertical Input: Impedance: 1 M Ω shunted by 30 pF. Vertical Modes: Y1, Y2, Y1/Y2 chopped, Y1/Y2 alternate, algebraic add (\pm Y1, \pm Y2). Horizontal: Time Bases: Ranges: 0.2 S/cm - to 50 nS/cm. Positions: 21 steps in 1-2-5 sequence. Variable: Continuous between ranges to 0.6 S/cm (approx.). Accuracy: Within 3% (20-30°C), 5% (10-40°C) referred to 1 mS/cm. Trigger: Source: \pm Y1, \pm Y2, \pm Line, \pm EXT. Coupling: AC, AC Fast, DC, TV (flip-flop). Modes: Automatic baseline, normal, single-sweep. Hold-Off: Variable, including an "A ends B" position. External Trigger: Sensitivity: 100 mV at 50 MHz. Phase Shift: Less than 8° at 100 kHz. Power Requirement: 120/240 VAC, 85 W. Dimensions: 7.75" H x 13.75" W x 19.75" D (19.7 x 34.9 x 50.2 cm).

Dual-trace capabilities at a single-trace price

- Convenient controls and features
- Excellent vertical input sensitivity
- Superior price/performance value

The SO-4205 Oscilloscope compares two signals simultaneously and allows you to check phase relationships.

A stable triggering circuit is used for solid waveform displays. Trigger controls include normal or automatic modes, switch-controlled AC or DC coupling, and front panel input of external triggering signals.

Select from seven calibrated time bases. A variable control provides precise settings between steps.

The vertical input sensitivity is 10

mV/cm. Eleven calibrated attenuator positions will accommodate a wide range of input signals.

A fully regulated low-voltage power supply provides accurate voltage and current under varying line and load.

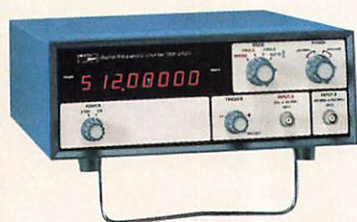
SO-4205, Assembled and calibrated, Shpg. wt. 20 lbs.

SO-4205 SPECIFICATIONS: Vertical: Bandwidth: DC to 5 MHz, -3 dB. Sensitivity: 10 mV/cm. Attenuator: 1-2-5 sequence, calibrated and variable. Rise Time: 70 nS. Overshoot: 5% at 1 kHz. Impedance: 1 M Ω shunted by 38 pF. Horizontal: Bandwidth: DC to 1 MHz. Sensitivity: 0.1 V/cm. Impedance: 1 M Ω , shunted by 50 pF. External Horizontal Input: X1 and X10 attenuator and variable.



Sweep: Type: Triggered. Range: 200 mS to 0.2 μ S in 7 steps, plus variable. Trigger Source: Y1/Y2 External/Line. Trigger Modes: AC/DC/TV/+/ - / Slope/ Auto/Normal. CRT: 5DEP31F, 8 x 10 cm viewing area, blue-green medium persistence phosphor, 5-inch round flat-face tube. Accelerating Potential: Approximately 1.6 kV. Graticule: Screened, 8 x 10 cm. Power Requirements: 120/240 VAC, 50/60 Hz, 50 watts. Dimensions: 8" H x 13" W x 17" D (20.32 x 33.02 x 48.18 cm).

..excellent price/performance values



- Extra-wide frequency range
- 8 digits for high resolution
- Crystal-controlled time base; long-term stability and accuracy

The SM-2420 Digital Frequency Counter gives you UHF capability up to 512 MHz; low-frequency capacity down to 5 Hz. More than just measuring frequencies of input signals, it also measures cycle time in seconds and the ratio between two input frequencies.

Big Value! Low-cost Digital Frequency Counter

Make more accurate measurements.

A standby power switch keeps the crystal oven warm for maximum accuracy without warmup. The proportionally controlled oven keeps the internal time base accurate over a wide temperature range. The crystal-controlled time base keeps drift to less than 1 ppm per year.

Four gate times and a large 8-digit LED display provide resolution needed for UHF signals.

Count weak signals with the excellent 4 to 15 mV typical sensitivity over the entire range. The trigger level control assures stable counting and more accurate measurement of complicated waveforms. Improved shielding from radio frequency interference.

SM-2420, Assembled, Wt. 9 lbs.

SM-2420 SPECIFICATIONS: Inputs: Frequency Ranges: 5 Hz to 50 MHz; 40 MHz to 512 MHz. Sensitivity: 25 mV rms guaranteed, 4-15 mV rms typical. Impedance: 5 Hz to 50 MHz range, 1 M Ω shunted by <25 pF; 40 MHz to 512 MHz range, 50 Ω nominal. Period Measurement Mode: Input: 5 Hz to 50 MHz only. Range: 5 Hz to 10 MHz. Sensitivity: 25 mV rms guaranteed, 4-15 mV rms typical. Ratio B/A Measurement Mode: Input. Frequency Limits: 5 Hz to 25 MHz, and 40 MHz to 512 MHz. Effective Measurement Range: From 1.6 to 1.024 x 10⁸ guaranteed; Sensitivity: 25 mV rms guaranteed; 4-15 mV rms typical. Power Requirement: 120/240 VAC, 50/60 Hz, 40 watts maximum. Dimensions: 4 $\frac{1}{4}$ " H x 10" W x 12 $\frac{1}{2}$ " D (10.8 x 25.4 x 31.8 cm).



- Accurate testing on a budget
- Full-function capability
- Overload protection on all ranges
- Universal banana jack inputs

For high-performance testing at a low cost, consider this Digital Multimeter. Its full-function capability includes AC voltage measurements up to 700 volts. It has

Low-cost, high-performance Digital Multimeter

four overlapping AC and DC voltage and current ranges, and five resistance ranges. Built-in calibration standards make initial and periodic adjustments easy and quick.

Features include overload protection on all ranges, 120 or 240 volt operation, isolated floating ground, a heavy-duty case to withstand rugged use, and universal banana jack inputs for easy testing of electronic equipment.

SM-1210, Assembled and calibrated, Shpg. wt. 5 lbs.

SM-1210 SPECIFICATIONS: Voltmeter

Ranges: DC: 0-2, 20, 200, 1000 V. AC: 0-2, 20, 200, 700 V rms (50 Hz to 10 kHz). Current Ranges: DC: 0-2, 20, 200, 2000 mA. AC: 0-2, 20, 200, 2000 mA rms (60 Hz to 10 kHz). AC & DC Resistance Ranges: 0-200, 2 k, 20 k, 200 k, 2 M Ω . Overrange: 25% on all functions, within maximum input limits. Low Range Resolution: Volts: 10 mV. Current: 10 μ A. Ohms: 1 Ω . Accuracy (Full Scale, ± 1 Digit). DC Volts: $\pm 1\%$. AC Volts: $\pm 1.5\%$. DC Current: $\pm 1.5\%$. AC Current: $\pm 2\%$. Ohms: $\pm 1.5\%$. Input Impedance: 1 M Ω on all voltage ranges. Power Requirement: 100-135 VAC, 200-270 VAC, 50/60 Hz, 8 watts. Dimensions: 3" H x 8 $\frac{1}{16}$ " W x 10 $\frac{9}{16}$ " D (7.6 x 22.1 x 26.8 cm).

NOTE: Specifications based on 30-minute warmup.



- Measures AC/DC volts, current and resistance
- Features anti-polarity for extra convenience

The SM-5225 accurately measures AC and DC voltages from 0.1 to 1000 volts, DC and AC currents from 0.1 to 1000 mA, and resistance from 1 ohm to 1 megohm.

Top-of-the-line bench model FET Multimeter

High and low voltage/ohms ranges allow in-circuit or out-of-circuit checking of semi-conductor junctions without causing semiconductor conduction. Recommended for use with the following Heathkit/Zenith Courses:

- DC Electronics
- AC Electronics
- Semiconductor Devices
- Electronic Circuits
- Electronic Test Equipment
- Electronic Communications
- Advanced Electronics

SM-5225, Assembled and calibrated, Shpg. wt. 8 lbs.

SM-5225 SPECIFICATIONS: DC Voltmeter: Ranges (9): from 0.1 to 1000 V full-scale. Input resistance: 10 M Ω . Accuracy: $\pm 2\%$ of full scale. AC Voltmeter: Ranges (9): from 0.1 to 1000 V full-scale. DC Milliammeter: Ranges (6): from 0.1 to 1000 mA full-scale. Accuracy: $\pm 2\%$ on 0.01 to 100 ranges; $\pm 3\%$ on 1000 range. AC Milliammeter: Ranges (6): from 0.1 to 1000 mA full-scale. Accuracy: $\pm 3\%$ on 0.01 to 100 ranges; $\pm 4\%$ on 1000 range. Ohmmeter: Ranges (7): Ω X1 (10 Ω center scale) to Ω X1M. Accuracy: $\pm 3^\circ$ of arc on Ω X1 range (above 2 Ω); $\pm 2^\circ$ of arc on Ω X10 to Ω X1M ranges. Decibels: Ranges (9): -40 to +62 (0 dB = 1 mW into 600 Ω). Accuracy: +3 dB at -20 dB to +0.3 dB at +2 dB. Dimensions: 6 $\frac{7}{8}$ " H x 5 $\frac{3}{4}$ " W x 11 $\frac{1}{4}$ " D.

Quality equipment aids education process

Heathkit/Zenith SG-1271 Function Generator produces sine and square waves for testing purposes

A valuable aid in the study of electronics: The Heathkit/Zenith SG-1271 Assembled Function Generator is a high-quality test instrument that produces highly accurate sine, square or triangle waveforms over a frequency range of 1 Hertz to 1 Megahertz.

The frequency multiplier and front panel tuning control set any frequency fast and easy. The output amplifier supplies a 10 Volt (peak-to-peak) signal into a 50-ohm load.

A calibrated step attenuator adjusts from 0 to 50 dB (10 Volts peak-to-peak) in 10 dB steps. A continually variable attenuator control provides up to 20 dB of additional attenuation.

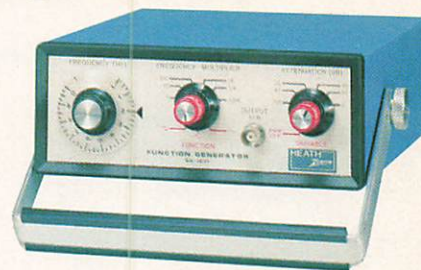
Most of the SG-1271's components

have been assembled on one circuit board, making the unit easy to service. Its compact size and lightweight design allow the Function Generator to be easily moved and allows it to be set anywhere.

For 120/240 VAC, 50/60 Hz power. Overall Dimensions of the SG-1271 are 3.00" H x 7.25" W x 8.88" D (7.62 x 18.42 x 22.54 cm). Recommended for use with EE-101 and -102 courses (p. 12).

SG-1271, Factory tested and calibrated, Shpg. wt. 7 lbs.

SG-1271 SPECIFICATIONS: **Frequency Range:** 1 Hz to 1 MHz. **Functions:** Triangle **Waveform:** Nonlinearity, 5% maximum. Symmetry within 10% of 50% duty cycle. **Square Waveform:** 100 nanosecond maximum rise or fall time. Symmetry within 10% of 50% duty



cycle. **Sine Waveform:** Harmonic distortion, 3% maximum from 5 Hz to 100 kHz. **Attenuator:** 0 to 50 dB in 10 dB steps. 0 to 20 dB minimum variable, ± 1 dB accuracy. **Output:** 10 Volts*peak-to-peak into 50 ohms. ± 1.5 dB flatness from 0.1 Hz to 100 MHz. 50 ohms impedance, $\pm 5\%$. **Operating Temperature Range:** 32 degrees F to 104 degrees F (0 degrees C to 40 degrees C). **Power Requirement:** 120/240 VAC, 50/60 Hz, 12 Watts maximum. **Overall Dimensions:** 3.00" H x 7.25" W x 8.88" D (7.62 x 18.42 x 22.54 cm), with handle removed. **Net Weight:** 4.2 lbs.

Sine-Square Wave Generator is ideal for measuring gain, frequency response in audio amplifiers

- Ideal signal source for measuring gain/frequency response, harmonic distortion
- A low-cost way to upgrade your service bench

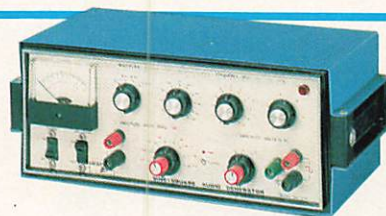
The SG-5218 Sine-Square Wave Audio Generator provides sine wave signals from 1 Hz to 100 kHz. Distortion is less than 0.1% from 10 Hz to 20 kHz. Eight switch-selected output ranges from 3 mV to 10 V. are available when operating into a high-impedance (10 k Ω minimum) external load.

A front-panel meter monitors the sine wave output. The meter is calibrated in both volts and decibels.

Square wave output is available from 5 Hz to 100 kHz with peak-to-peak output levels of 0.1 and 10 V. into a minimum load of 2 k Ω . Rise time is 50 nS. The 0-100 and 0-10 ranges are switch selectable, as are the multipliers.

SG-5218, Factory tested and calibrated, Shpg. wt. 10 lbs.

SG-5218 SPECIFICATIONS: **Sine Wave Output:** **Frequency Range:** 1 Hz to 100 kHz. **Output Voltage Ranges:** 8 ranges, 0.003 to 10 V. rms (full-scale with 10 k Ω or higher external load. 6 ranges, 0.003 to 1 V (full-scale) with 600 Ω internal or external load. **dB Ranges:** -62 to +22 dB. -12 to +2 dB in eight 10 dB switch positions. +2 dB maximum into 600 Ω load. Output Variation: +1 dB from



10 Hz to 100 kHz. **Output Impedance:** 10 V. range: 0-1000 Ω ; 3 V. range: 800-1000 Ω ; 1 V. range and lower: 600 Ω . **Square Wave Output:** **Frequency Ranges:** 5 Hz to 100 kHz. **Output Voltage Ranges:** 0-0.1 V., 0-1 V., and 0-10 V. zero-to-peak into 2000 Ω or higher load. **Output Impedance:** 52 Ω on 0.1 and 1 V. ranges; up to 220 Ω on 10 V. range. **Rise Time:** Less than 50 nS. **Frequency Error:** Within $\pm 5\%$ of first and second digit. **Power Requirement:** 105-125 VAC or 210-250 VAC, 50/60 Hz, 6 watts. **Dimensions:** 5 $\frac{1}{8}$ " H x 13 $\frac{1}{4}$ " W x 7" D (13 x 34 x 18 cm).



- Unique versatility at such a low cost
- Provides fixed and adjustable outputs
- Outputs are short-circuit protected

The Heathkit/Zenith SP-2718 combines a fixed 5 VDC output with two continuously adjustable 0 to 20 VDC outputs for circuit designs requiring more than one voltage supply. It's one of the most versatile, lowest cost power supplies available.

Interconnect the two variable outputs and the fixed output in any combination to provide both positive and negative volt-

Enhance design experiments with this accurate, professional-quality Tri-Power Supply

ages with a fixed reference. They can also be allowed to "float" at no reference level.

A clutch-coupled control allows the two VDC supplies to "track" each other at any specific voltage differences. This makes the Tri-Power Supply ideal for working with analog circuits requiring both a positive and a negative voltage. The fixed 5 VDC supply at 1.5 A is useful for digital circuit design.

All three outputs are short-circuit proof, with automatic current limiting. For independent operation, each supply may be floated at a level of up to 200 V from the ground, or from each other. Independent ground-referenced operation is also available with any of the output terminals, + or -, or grounded in any combination.

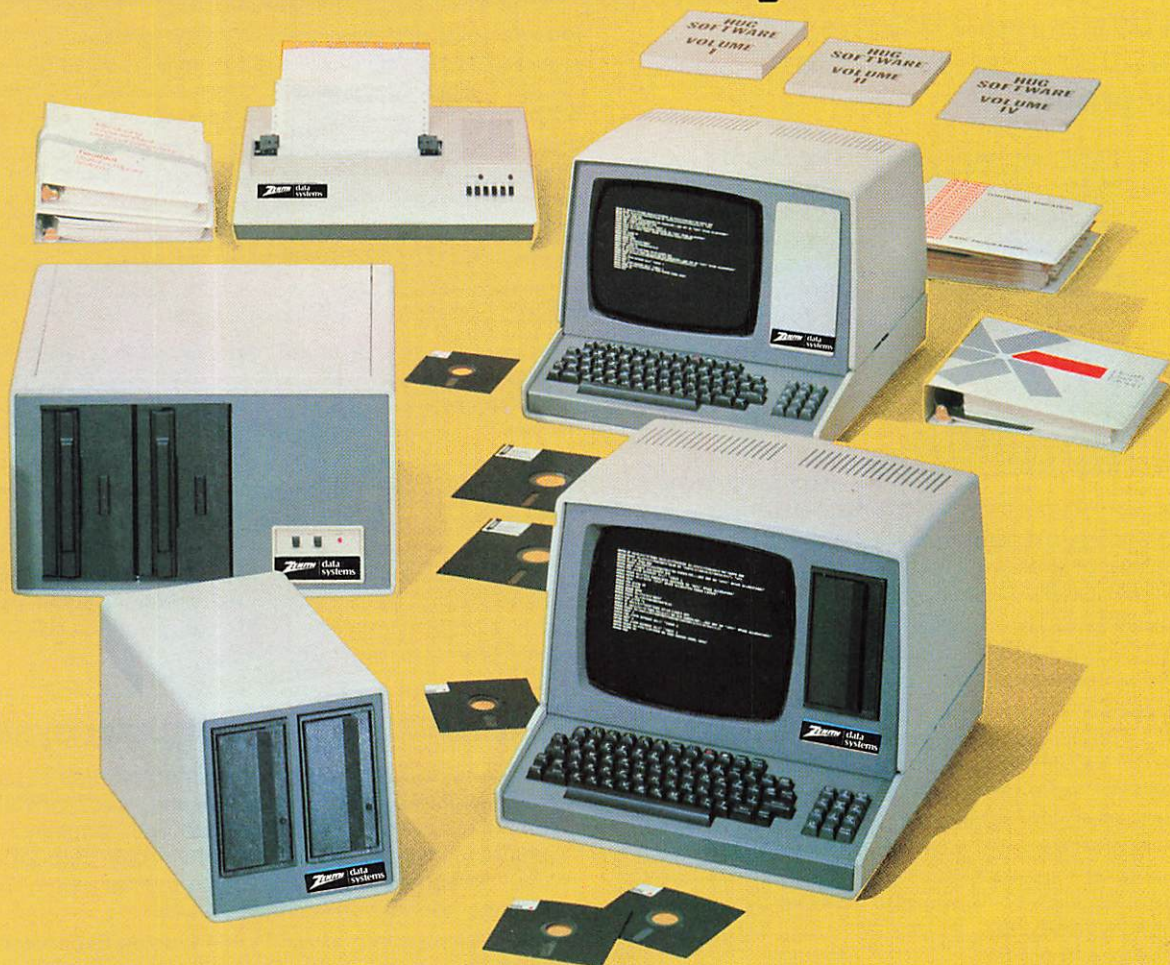
The two variable supplies can be connected in parallel for higher current

through the load. The SP-2718 may also be used for a variety of tracking and floating circuits.

SP-2718, Factory tested and calibrated, Shpg. wt. 12 lbs.

SP-2718 SPECIFICATIONS: **Outputs:** **5-Volt Supply:** 5 VDC $\pm 5\%$ at 1.5 amperes. **'A'-Supply:** 0 to 20 VDC at 0.5 ampere. **'B'-Supply:** 0 to 20 VDC at 0.5 ampere. **Regulation:** **Load:** Less than 0.1% (20 mV) variation from no-load to full-load on 20 VDC supply. Less than 2% (100 mV) variation from no-load to full-load on 5 VDC supply. **Line:** **20-Volt Supplies:** Less than 0.2% (40 mV) for a line voltage change of 10 volts. **5-Volt Supply:** Less than 0.2% (10 mV) for a line voltage change of 10 volts. **Ripple and Noise:** Less than 5 mV rms. **Power Requirement:** 100-130 VAC or 200-270 VAC, 50/60 Hz, 100 watts at full load. **Dimensions:** 4 $\frac{1}{2}$ " H x 10 $\frac{3}{4}$ " W x 9" D (11.4 x 27.3 x 22.9 cm).

Teach computer programming with our effective "total concept"



Heathkit/Zenith has it all. We've put together a unique "total concept" in computer education. Not only do we offer computer concept and programming courses: Heathkit/Zenith has the professional software and hardware necessary to make each course a totally effective learning experience!

Programming courses cover today's widely-used languages – Assembly, BASIC, Microsoft BASIC, FORTRAN and COBOL. Each course has the features which make all Heathkit/Zenith courses more effective: They're complete, clearly-written, have frequent breakpoints to fit any class schedule, and feature competency-based instruction with hands-on experiments.

Two courses are available for business classes: One helps students get acquainted with computers (Personal Computing). The other helps assess the benefits of a computer in a business (Computer Concepts for Small Business).

Powerful software packages can be used with our programming courses – and to add versatility to our computers. Operating systems include the Heath Disk Operating System (HDOS) with BASIC, industry standard CP/M and the UCSD P-System with Pascal. Microsoft BASIC, Microsoft FORTRAN and Microsoft COBOL Programming Software is also available.

Business applications software can help students master word processing (Zenith Electronic Typing) and business accounting (general ledger, inventory). Teachers can speed grading with Heathkit/Zenith software. Administrators can use our software in a school's day-to-day operations.

Professional-quality Heathkit/Zenith computer hardware gives students actual programming experience. Using the Z-89 and available peripherals, our hardware can pull double duty – teach and make teaching and administration easier!

Heathkit/Zenith Computer Programming Curriculum

COMPUTER PROGRAMMING

Assembly
Language

BASIC
Language

Microsoft BASIC
Language

Pascal
Language

FORTRAN
Language

COBOL
Language

COMPUTER APPLICATIONS IN BUSINESS

Personal
Computing

Computer Concepts
for Small Business

Word
Processing

Business Applications Software:
General Ledger, Inventory

Our courseware, hardware and software provide

Heathkit/Zenith Computer-Related Courses offer a more practical education, using state-of-the-art computer products



Our courses teach students how to save time and labor by using a computer – not just how to push a few buttons.

Heathkit/Zenith offers courses on computer-related decision-making and the most widely-used programming

languages. Our courses build a solid foundation of usable skills.

Heathkit/Zenith computer programming courses cover some of the most popular programming languages – BASIC, Microsoft BASIC, FORTRAN, COBOL and UCSD Pascal.

Your students can gain even more from these courses with Heathkit/Zenith's professional-quality computer hardware, peripherals and software programs.

Software includes the versatile HDOS, CP/M and UCSD P-System with Pascal operating systems. BASIC, Microsoft BASIC, Microsoft FORTRAN, Microsoft COBOL and UCSD Pascal language software is also available from Heathkit/Zenith.

The Z-89 is the first microcomputer system to combine computer, video terminal, floppy disk drive and interfacing – all in one unit. It has TWO Z-80 microprocessors, 48K bytes of RAM (expandable to 64K), professional video terminal, keyboard with 12-key calculator-format numeric pad, 5.25" disk drive capable of storing 100K bytes of data, and a 3-port RS-232C Interface.

More data storage is available – 200K additional bytes with the 5.25" Z-87 Floppy Disk System. Or you can expand to over 2 megabytes with the dual-drive 8" Z-47 Floppy Disk System.

Two printers: You can pick the low-priced, high-performance WH-14 for general-purpose applications – or, for word processing uses, order the letter-quality WH-54/Diablo 630 RO.

Both an acoustic modem and a direct-connect modem are available to permit communication over standard phone lines.

Many programming languages available

Today's computer programmer needs to know more than one language. While BASIC is the standard language of most micro-computer users, Pascal is gaining new acceptance because of its modular construction and clear readability.

Many scientists and mathematicians prefer to program in FORTRAN language. And businesses around the world use COBOL language, because of its adaptability to many different business-oriented data processing applications.

Heathkit/Zenith offers courses in ALL of these programming languages – BASIC, Microsoft BASIC, Pascal, FORTRAN and COBOL – for group or individual learning situations.

Each course uses teaching methods with proven effectiveness to provide complete coverage of the subject. Comprehensive textbooks include frequent reviews to check progress. Interactive programming experiments provide hands-on experience with the language. And to complete the learning process, complete final examinations are provided with our courses.

Our courses are fully supported: Computer hardware and software products are available, for use with the above courses. This simplifies purchasing – all of your computer-related educational needs can be placed on ONE purchase order, instead of several. Competitive prices and superior service support make Heathkit/Zenith an even smarter buy.

Z-89 an All-In-One computer system

This desktop microcomputer system features separate Z-80 microprocessors for computer and video terminal – so computer never has to share power with terminal. Functions as video terminal, with all features of Z-19 (p. 24). Full ASCII keyboard with 33 graphics symbols and 12-key calculator-format numeric pad.

48K RAM supplied; expand to 64K, using Expansion Set below. Built-in 5.25" disk system holds up to 100K bytes on-line. You can add up to 2.2 megabytes of storage with the Z-47 8" Floppy Disk System. Built-in 3-port RS-232C Interface allows communication with peripherals. Requires HDOS, CP/M or similar operating software for normal operation. For 120/240 VAC.

Z-89, Assembled Computer, Shpg. wt. 54 lbs.

WH-88-16, Assembled 64K Expansion Set, Shpg. wt. 1 lb.

Select a Z-89 All-In-One Computer System to meet your needs

First, select the software you'll need. Then, configure the Z-89 to handle the maximum requirements of your software.

The Z-89 has 48K of RAM and 3 ports of serial I/O. Expand to 64K RAM. Add over 2 megabytes of on-line storage, a printer and/or one of our two modems.

Memory

64K (CP/M), 56K (HDOS) Expansion Set H-88-16 (p. 22)

Mass Storage

Floppy Disk Z-47 (two 8-inch dual-density, double-sided disk drives – p. 24) Z-87 (two 5.25" single-density, single-sided disk drives – p. 23)

Peripherals

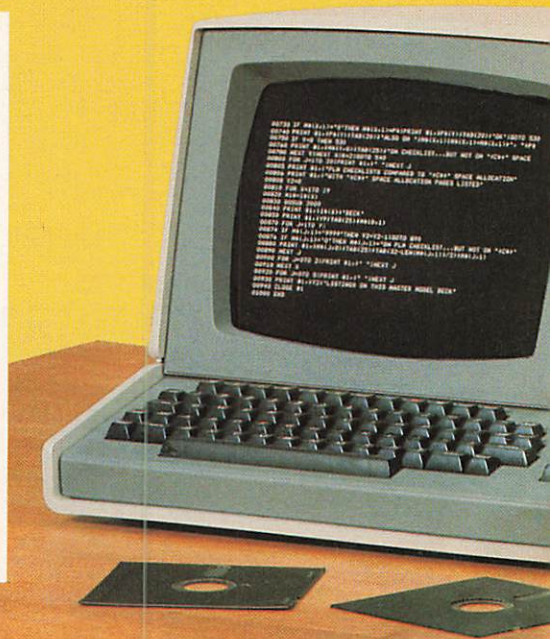
Printer (p. 24) WH-14 (dot matrix), WH-54 (letter-quality) Modems (p. 24) WH-23 (acoustic), WH-33 (direct-connect)

Operating Systems

Heath Disk Operating System (HDOS 2.0 – 5.25 or 8"; runs with Z-47 and Z-87 – p. 26) Heath CP/M 2.2 (5.25 or 8"; runs with Z-47 and Z-87 – p. 26) UCSD P-System with Pascal (5.25"; runs with Z-87 – p. 27)

Programming Languages

BASIC Course – p. 29 Software – part of HDOS Microsoft BASIC Programming Course, Interpreter Software and Compiler Software – all on page 27 Microsoft FORTRAN Course, Software – p. 28 Microsoft COBOL Course, Software – p. 28 UCSD Pascal Course – p. 27 Software – part of UCSD P-System



a complete computer education package

We have business-oriented programming courses

Computer-related courses from Heathkit/Zenith Educational Systems teach computer concepts, programming and word processing skills that can be used in the business world.

In each Heathkit/Zenith course, comprehensive textbooks combine with practical experience – gained through hands-on programming experiments – for the most complete teaching possible. Specially-written instructor's guides, available with some courses, give additional ideas on how to use the course in a group learning environment.

Students can practice what they learn on the same software used on many personal, scientific and business computer systems. Heathkit/Zenith offers a full complement of programming languages, utilities and applications programs.

Is the subject business computer programming? Make the experience more realistic by using our COBOL Language Programming System (p. 28). If the focus is on word processing, we have improved Zenith Electronic Typing (see page 26).

Our software helps students master programming, word processing and other applications. In Zenith Electronic Typing, a special self-instruction course teaches the system in as little as 2 hours. And in all software packages, manuals are written in easy-to-understand, everyday English.

Useful in administrative applications

Because the Heathkit/Zenith computer education line is designed for practical application, teachers and administrators can use our courseware, hardware and software to make teaching and running a school less time-consuming.

The Heathkit/Zenith way offers dual benefits to you:

The full line of Heathkit/Zenith computer-related courses, for use in instructor-led group education, will help teach your students about microprocessors, microcomputers, computer hardware, software and programming.

And professional-quality Heathkit/Zenith computer hardware and software – which teaches hardware, software and programming fundamentals to your students – can also be used in administrative and teaching tasks. Schools use our products every day – to maintain a general ledger, to track cash flow and inventory, and for word processing applications. More helpful software tools are currently under development.

Heathkit/Zenith builds its hardware and software line on the powerful, versatile Z-89 All-In-One Computer. With 48K bytes of RAM (expandable to 64K) and a 5.25" disk drive built-in, the Z-89 can handle many high-volume files.

A video terminal, 5.25" and 8" disk systems which can provide over 2 megabytes of on-line storage, a dot matrix printer, a letter-quality printer, and two modems are also available.

Z-87 for additional disk storage

Designed for the Z-89, the assembled Z-87 Floppy Disk System gives you all the storage capacity you need for many programming applications. Mount operating system and program disks at the same time, for fast operation.

Disk drives install vertically, so the Z-87 takes up less space. Attractive design matches the Z-89.

The Z-89 is fully compatible with all other Heath and Zenith floppy disk systems (except H/WH-27). This means that you can use the Z-87 in the same system with a Z-89 and Z-47. Which means you can have up to 2.3 megabytes of on-line data storage.

Expand your Z-89's capabilities today – with the Z-87. 120/240 VAC. Dimensions. 8.625" H x 8.875" W x 15" D (21.91 x 22.54 x 38.10 cm).

Z-87, Assembled, Shpg. wt. 28 lbs.

WH-14 prints permanent copies

This microprocessor-based line printer prints standard 96-character ASCII set (upper/lower case) via 5 x 7 dot matrix print head. Uses readily available 0.5-inch wide nylon inked ribbon on 2-inch spools.

Maximum throughput is 75 cps, with selectable 80, 96 or 132 character line length. 6 lines/inch spacing; 8 lines/inch software selectable. 110-4800 baud rates. Adjustable width sprocket feed handles edge-punched fan-fold paper from 2.5 to 9.5" wide.

Connects to Z-89 with RS-232C Interface. Handshaking provided by busy control signal. Includes 25-pin male EIA connector, matching paper catch. 120/240 VAC. Dimensions, 4.80" H x 18.33" W x 14.33" D.

Requires HDOS, CP/M or similar O/S to use with Z-89.

WH-14, Assembled, Shpg. wt. 27 lbs.



Train with professional peripherals



Z-19 Professional Video Terminal with full capabilities

- Z-80 microprocessor-based for efficient data handling
- Typewriter-style keyboard, 12-key calculator-format numeric pad

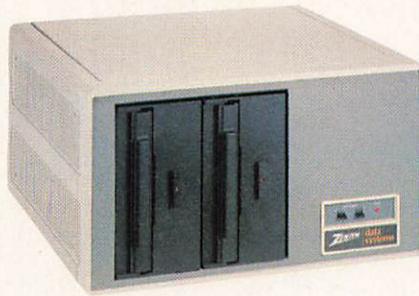
Design-compatible with the Z-89 and most other RS-232C devices – and DEC VT-52 software-compatible – the desktop Z-19's Z-80 microprocessor makes it ideal for high-speed data handling. Its typewriter-format keyboard allows user to begin entering data right away.

Thirty-two functions can be controlled from keyboard or computer. A 12-key numeric keypad, in calculator format, makes entering math programs or numeric data faster and easier. Keyboard-selectable 110-9600 baud rates allow for fast changes. Eight user-function keys give extra flexibility.

The Z-19 displays the entire ASCII set, upper and lower case. 33 graphics characters can be arranged for a variety of effects. Use reverse video to add emphasis. Prints twenty-four 80-character lines (with a special software-controlled 25th line).

Using direct or relative addressing, a blocking, non-destructive underlining or block cursor lets you edit anywhere on the video screen. 120/240 VAC.

Z-19, Assembled, Shpg. wt. 43 lbs.



Z-47 Disk System provides over 2 megabytes of on-line storage

- Two disk drives provide over 2 million bytes of on-line data storage
- Stores over a million bytes on each 8" floppy disk

Over 2 megabytes of on-line storage – Each 8" disk can hold over 1 million bytes of data. Because the Z-47 has two drives, this means you can have over 2,000,000 bytes of data on-line at any one time – enough to handle most administrative tasks (scheduling, inventory, et. al.).

Compatible with Heath 5.25" systems – You can use up to three 5.25" drives (example, the Z-89 and Z-87) with the two 8" drives in the Z-47 for maximum storage – over 2.3 million bytes!

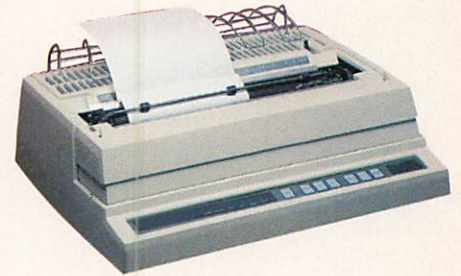
Less than half the access time – 191 milliseconds – compared to the 490 millisecond time of 5.25" disk systems available for use with the Z-89.

Enhanced software capabilities – With the Z-47, you can run HDOS and CP/M. These systems open the door to thousands of useful programs. And you can transfer data between 8" and 5.25" disks.

Includes 40-conductor flat cable for connection to Z-89. Requires Z-89-47 Interface to operate with Z-89.

Z-47-BA, Assembled, Shpg. wt. 66 lbs.

Z-89-47, Interface for Z-89, 1 lb.



Letter-quality Diablo printer for word processing use

- Diablo 630 RO is factory assembled and tested
- Features famous letter-quality daisy-wheel printing method

A value-packed breakthrough in letter-quality printers, the reliable WH-54/Diablo 630 RO Daisy Wheel Printer is ideal for word processing uses in secretarial science and business occupations classes.

The 630 RO prints the standard 96-character ASCII set, both upper and lower case – at speeds up to a maximum of 35-40 characters per second.

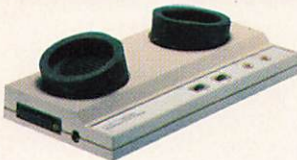
Software-compatible with the Diablo 1640/1650 series, the WH-54 uses both metal and plastic print wheels – so you can take advantage of the added durability of metal in high-production word processing, as well as other functions.

Bi-directional printing provides maximum output. RS-232C Interface with 256-byte buffer runs at 110-1200 baud, compatible with most modems.

With friction platen, power supply, operator control panel, HCS-22 Print Wheel (Elite 12 with un-slashed zero) and HCS-51 Film Ribbon. For 120/240 VAC. Dimensions, 9.25" H x 23.5" W x 15.75" D (23.50 x 59.69 x 40.01 cm).

WH-54, Assembled, Mtr. Frt. 65 lbs.

Accessories add utility to Z-89 Computer Systems



Acoustic Modem for any phone

The Lexicon Lex-11 Modem lets your computer talk with other computers over standard phone lines. Also communicates with any Bell 103 compatible modem. Selectable originate/answer modes. 300 bps. RS-232C interfacing. For 120 VAC, 60 Hz.

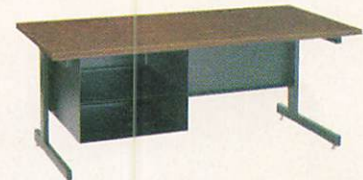
WH-23, Assembled, Shpg. wt. 3 lbs.



Step up to direct-connect quality

Full-duplex communication, originate/answer modes. 300 bps. RS-232C interfacing. Powered by phone line. Has 2 modular phone jacks. Requires single-line phone with modular connectors. Includes phone-modem cable. For 120 VAC, 60 Hz.

WH-33, Assembled, Shpg. wt. 2 lbs.



Organize your computer system

Computer system desk features 60" x 30" simulated wood-grain Formica desk top. Two shelves for computer, peripherals (except Z-87, Z-47). Upper shelf measures 8.5" H x 20" W x 19.75" D; lower shelf, 7" H x 20" W x 19.75" D.

PD-11, Partially assembled, 95 lbs., Mtr. Frt. FOB El Segundo, CA.

Our Programming Courses and Software teach the professional way to program



Professionally-designed Heathkit/Zenith Computer Programming Courses teach today's most widely-used computer programming languages

With courses from Heathkit/Zenith Educational Systems, students can now learn the most popular microcomputer programming languages:

BASIC Programming (see page 29) covers the fundamentals of programming in this straightforward, general-purpose programming language.

Microsoft BASIC Programming (page 27) shows your students how to best program with this enhanced language on the Z-89, TRS-80, Apple or any other computer which uses Microsoft BASIC. This course includes many features of our Microsoft BASIC Interpreter Programming Software.

Pascal Programming teaches modular programming in this popular language—using readable yet powerful types of data. Turn to page 27 for more details.

FORTRAN Language is suited to complicated math and science uses. Turn to page 28 and find out more.

COBOL Programming teaches the best programming techniques in this language—which is used by thousands of businesses, large and small, because it's well-suited to large accounting operations. See page 28 for the full story.

Audio-tutorial course material, interactive programming experiments and your expert teaching skills work together to produce more effective learning—and higher rates of retention.

Heathkit/Zenith's unique course design also lends itself to individual learning environments.

Much of Heathkit/Zenith's effectiveness is due to the experiments in most courses, which give hands-on programming experience. These experiments become even more effective when professional Heathkit/Zenith software is used (see right).



Professional software puts concepts of courses into practical everyday applications

Heathkit/Zenith Programming Software Packages work together with our Computer Programming Courses to create a total teaching experience. Together, they make one of the most effective computer education lines available anywhere.

Each programming software package is a complete, professional configuration—the same one thousands use to solve their problems every day. The full line of Heathkit/Zenith Programming Software Packages includes these languages:

BASIC—a conversational, general-purpose language for use with the Heathkit/Zenith BASIC Language Programming Course on page 29. Part of the Heath Disk Operating System (HDOS—see page 26).

Microsoft BASIC—fast becoming the new standard of general microcomputer programming. Both an interpreter and compiler are available for use with the Microsoft BASIC Programming Course. See page 27.

UCSD P-System with Pascal—a general-purpose language that is rapidly gaining popularity. Its modular construction, clear readability and powerful data types make it more flexible than similar languages. Use the P-System, including UCSD Pascal, with our Pascal Programming Course. See both on page 27.

FORTRAN—ideal for mathematical and scientific work. The Microsoft FORTRAN Programming System can be paired with the Heathkit/Zenith FORTRAN Programming Course. Turn to page 28 for more information.

COBOL is one of the top business data processing languages. Microsoft's COBOL Programming System helps students learn more from the Heathkit/Zenith COBOL Programming Course. See page 28.

Operating Systems help teach programming



HDOS, Version 2.0 – especially designed for the All-In-One

- Available on both 5.25" and 8" disks
- Updates supplied free for one year

HDOS, Version 2.0, is a versatile, useful operating system. Programming can begin right away – in BASIC, optional Micro-

soft BASIC and optional FORTRAN languages – with this easy-to-learn system. HDOS includes these modules and more:

Extended Benton Harbor BASIC, Version 6 – an easy-to-use conversational computer language with strings and files. It includes additional convenience commands, math functions, Boolean values for logical operations and more.

ASM Assembly Language, a 2-pass absolute 8080 assembler which includes a cross-reference feature. Create source programs by generating efficient machine code.

EDIT Text Editor converts your computer and terminal into a typewriter for generating and editing text. It prepares source code for Assembly Language and can help prepare reports, write letters and edit manuscripts;

DEBUG Console Debugger, to debug machine language programs via an external terminal (user program required);

TEST, a utility program which assists in checking out and maintaining your Heath floppy disk system.

HDOS' device drivers for directory devices (such as floppy disks) are disk-resident, instead of internal (Example: SY.DVD). Fully dynamic non-contiguous allocation and de-allocation allows more efficient use of disk space.

HDOS includes 713-page manual, diskette. Supports Z-89; Z-47, Z-87. All versions identical (except for media).

Requires 32K bytes of RAM and 1 disk drive, although two disk drives are highly recommended – and may be required to use some other software products with HDOS.

HOS-817-1, on 5.25" diskette, Shpg. wt. 5 lbs.

HOS-847-1, on 8" diskette, Shpg. wt. 5 lbs.



Digital Research's CP/M – the industry standard disk operating system

- Choose from hundreds of software programs
- Includes all features of Standard CP/M

Teach programming with the industry standard disk oper-

ating system. CP/M is used by over 100,000 computer users and many software vendors.

Standard Zero-Origin CP/M, Version 2.2, includes full source code for hardware drivers to facilitate customization. IOBYTE permits switching between hard copy and CRT terminals – or between several printers – without rebooting.

Additional features, such as the implementation of BIOS as a disk-resident relocatable file, make this one of the best available implementations of CP/M.

CP/M includes three modules: BIOS, supplied in source code and object code, contains all hardware-level I/O code. BDOS is the resident nucleus, with all file level and logical I/O code. CCP is the transient monitor, facilitating command-level communications.

Utilities include a 2-pass absolute 8080 assembler, a text editor, an 8080 debugger and others. You can also convert Intel HEX files into memory images.

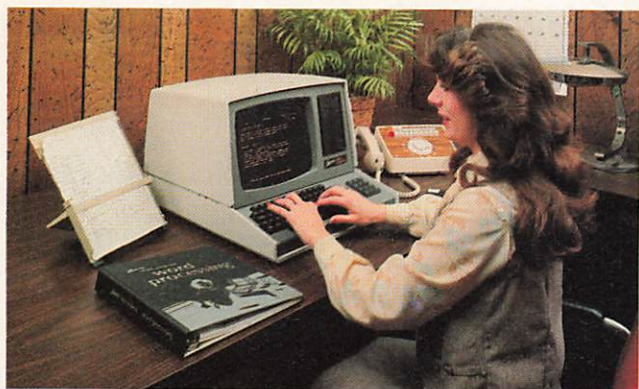
Other software available, from Heathkit/Zenith and others, includes BASIC, FORTRAN, COBOL, Pascal, "C," ALGOL, PL/1, FORTH and APL computer languages. There are also hundreds of utility, applications, game and other software programs.

Includes 300-page manual, diskette. Supports Z-89, all Heath and Zenith Floppy Disk Systems (allows concurrent operation, automatic density selection), printers, hard copy terminals.

CP/M requires 32K RAM and one disk drive (2 drives recommended). Includes support and updates for one year.

HOS-817-2 (Requires Sublicense Grant – ask representative), on 5.25" diskette, Shpg. wt. 5 lbs.

HOS-847-2 (Requires Sublicense Grant – ask representative), diskette, Shpg. wt. 5 lbs.



Zenith Electronic Typing teaches word processing, reduces paperwork

- Word processing is easy to learn – we include a special two-hour self-instruction course
- Supports three-drive floppy disk systems

Here's an excellent way to teach word processing in secretarial science classes, or to train clerical employees to upgrade skills. Anyone who can turn on a TV and type can increase his/her output by 50 percent or more. A special self-instruction course, with training disk, shows you how – in as little as two hours.

Two Search Modes quickly locate areas which need editing. Insert/delete any word, sentence or paragraph. Automatically replace any word, name or phrase. Automatic Realignment and Page Numbering saves hours of retyping. Automatic Centering and Justification, on command, means no counting or guessing.

Once the document is letter-perfect, the touch of another key automatically prints a clean copy on a printer (not included) – at up to 450 words per minute.

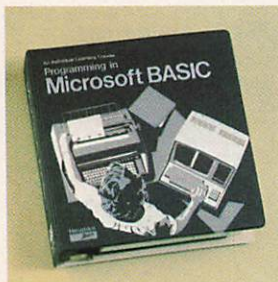
Zenith Electronic Typing includes set-up and operating manual, easy-to-use training disk and master disk.

Requires Z-89 with 48K RAM, one or more 5.25" disk drives and printer. Any Heath-offered printer works; we recommend the WH-54 Letter-Quality Printer (page 24).

H-8-40, on 5.25" disk, Shpg. wt. 6 lbs.

Teach practical computer programming

Microsoft BASIC Course



- Students learn to write and modify powerful programs, using this popular version of BASIC
- Ideal for individualized learning situations
- Features hands-on programming experiments to give students actual experience

Now your students can learn Microsoft BASIC, one of the most powerful and popular computer languages.

The audio-tutorial learning technique guides the student through specific directed functions for maximum learning and retention. The 800-page text and 3 cassettes cover MBASIC programming fundamentals in 12 units:

Unit 1 is an Introduction to Computers and Programming. **Immediate Mode** is discussed in the **second unit**. **Program Structures** are covered in **Unit 3**, while **Unit 4** has **More about Decisions and Loops**. **Data Structures** are taught in **Unit 5**. **Subprograms** are covered in **Unit 6**, with **Unit 7** discussing **Complex Structures**.

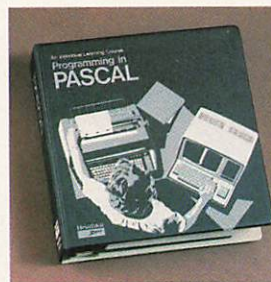
The last 5 units cover disk operations and extensions. **Unit 8** discusses **Major Language Extensions** and **Unit 9** covers **Sequential Disk Operation**. **Unit 10** teaches **Random Access Disk Operation**. **Error Trapping and Memory Conservation** are **Unit 11's** topics, with **Optimization and Machine Interfacing** being covered in **Unit 12**.

This course is ideal for individualized learning situations in the classroom and learning lab, with special emphasis on hands-on MBASIC programming experiments. Has all features of MBASIC software below, except for TRON/TROFF debugging feature. Upon completion, students will be able to write MBASIC programs that instruct a computer to sort, plot and organize data, and more. Access to a computer will help provide full benefit.

This course includes a pre-written final examination.

EC-1110, Shpg. wt. 7 lbs.

Pascal Programming Course



- An ideal language for new programmers and more experienced computer users.
- Cost-effective training designed for use on computer station, in learning lab
- Students perform interactive programming experiments

Pascal is the new, structured and very adaptable language that has quickly swept into popularity. This readable, reliable and simple language implements the best ideas that have been developed by computer programmers over the last twenty years.

Pascal incorporates Top-Down Detail, where overall structure can be established before adding details; and Modular Organization, which makes fixing programming errors easier than with other languages. Any module can be fixed independently of the rest of the program.

Heathkit/Zenith has placed the Pascal language into a structured learning course for individualized learning with instruction overview. A 500-page text and 5 cassettes guide students through the learning process:

The introduction shows how to write simple Pascal programs. It also covers constants, variables, expressions, input and output. In **Modular Programming, Unit 2**, students learn to identify and write correct self-contained procedures. **Unit 3** covers **Making Decisions**, while **Unit 4** covers **REPEAT... UNTIL, WHILE... DO** and **FOR** loops. **Unit 5** discusses **data types**.

Unit 6 shows how to use **Arrays and Character Strings**, and **Unit 7** has **More About Procedures**. Students learn about **Records and Sets** in **Unit 8**. **Unit 9** explains **Pointers**, and the **final unit** covers **Disk Files**.

Experiments give students hands-on programming experience.

A pre-written final examination comes with the course.

EC-1111, Shpg. wt. 7 lbs.

MBASIC Interpreter Software

Direct access to CPU ports/memory locations, more highly-structured programming capabilities, double precision math. Edit and file management, string processing, other extended capabilities not found in most other BASICs. Requires Z-89 with 32K RAM and HDOS or CP/M (p. 26).

H-8-21 (Ver. 4.7), Manual and 5.25" diskette, for HDOS. **Requires Sublicense Grant – ask representative.** 3 lbs.

HMS-817-1 (Ver. 5.1), Manual and 5.25" diskette, for CP/M. **Requires Sublicense Grant – ask representative.** 5 lbs.

HMS-847-1 (Ver. 5.1), Manual and 8" diskette, for CP/M. **Requires Sublicense Grant – ask representative.** 5 lbs.

BASIC Compiler speeds programming

Pre-compiled (into machine code) programs run faster than similar program run through an interpreter. MACRO-80 Assembler, LINK-80 Editor, LIB-80 Library Manager. Requires Z-89 with 40K RAM, 2 disk drives, CP/M (p. 26).

HMS-817-4, Manual and 5.25" disk. **Requires Sublicense Grant – ask representative.** Shpg. wt. 5 lbs.

HMS-847-4, Manual and 8" disk. **Requires Sublicense Grant – ask representative.** Shpg. wt. 5 lbs.

Use UCSD P-System with above course

This programming software system is more versatile because programs are compiled into universal P-code, which can be run on any microcomputer with a resident interpreter.

Includes Operating System, an interactive system with disk file handling capabilities, run-time support routines and block I/O service routines; Pascal Compiler, a fast one-pass compiler which produces universal P-code; Interpreter, an efficient and compact program which runs universal P-code.

Has two editors – a powerful screen-oriented editor that runs in both programming and text editing modes and a character-oriented editor with a wide variety of commands for context editing with hard-copy terminals; Filer, a utility program to manipulate and keep track of disk files; Conditional Macro Assembler for your computer's microprocessor, which produces code that can be linked with your Pascal program.

Also includes Linker, which allows link-editing of Pascal object code and assembly code modules; and the System Library, a collection of frequently used utility programs.

Requires Z-89 with 48K RAM, 2 disk drives. Supported by Softech Microsystems. Updates supplied for a nominal charge.

HOS-817-3, Manual and 5.25" diskettes, Shpg. wt. 8 lbs.

Heathkit/Zenith has the courses and software for



FORTRAN Programming Course teaches how to use this powerful language

- Here's an effective way to teach FORTRAN Language
- Features audio-tutorial teaching with hands-on programming experiments

FORTRAN Language can take on complicated scientific tasks with ease. And this Heathkit/Zenith Programming Course teaches FORTRAN programming fundamentals with similar ease. The 500-page text and 6 cassettes concentrate on programming – not on computers – for a more complete learning experience.

The text includes a special Introduction to Computers. Eleven units show all the fundamentals:

Getting Started, Unit 1, shows how to analyze a FORTRAN program, introduces statement types, statement elements and the character set. **Unit 2** covers **Arithmetic Operations**, and **Elementary I/O** is taught in **Unit 3**.

Unit 4 covers **Library Functions**, with **Other Control Statements** being taught in **Unit 5**. **Unit 6** introduces **Arrays**, and **Programming Practices** are covered in **Unit 7**.

Other Variables are covered in **Unit 8**, and **Advanced I/O** is taught in the **ninth unit**. **Unit 10** covers **Subprograms**, and the Course concludes with **Unit 11** discussing **Special I/O**.

Students perform interactive experiments to gain FORTRAN programming experience. All the necessary coding forms are included. The text also offers practice in writing FORTRAN programs and using the character set.

Upon completion, students will be able to write FORTRAN programs that instruct a computer to perform specific tasks – such as keeping track of student records, sorting, solving geometry problems and many more.

A final examination package is provided with the Course.

A Z-89 Computer with two disk drives, HDOS or CP/M (p. 26) and Microsoft FORTRAN (below) are highly recommended.

EC-1101, Shpg. wt. 7 lbs.

Microsoft FORTRAN Programming System Software for course above

With more power to help teach more highly-structured programming procedures like those in the above course, Microsoft's FORTRAN Programming System features:

The unique Microsoft FORTRAN-80 Compiler, which uses the powerful ANSI-66 FORTRAN IV Computer Language – so you can draw from a large base of programs; **the MACRO-80 Relocating Assembler**, an enhanced language which assembles programs into runnable machine code; **the CREF Cross-Reference Generator**, for sorted cross-reference listings; **the LINK-80 Editor**, which generates runnable load modules.

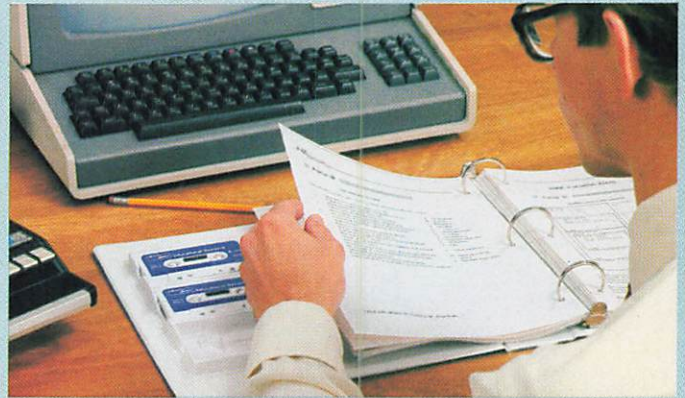
The Microsoft FORTRAN Library, filled with floating point math routines – plus all FORTRAN I/O and utility routines; the versatile **LIB-80 Library Manager** (on CP/M versions only).

This programming system requires a Z-89 Computer with 48K RAM, two floppy disk drives and HDOS or CP/M (see page 26).

H-8-20, Manual and 5.25" disk for HDOS systems, 4 lbs.

HMS-817-2, Manual and 5.25" disk for CP/M systems. **Requires Sublicense Grant – ask representative.** Shpg. wt. 5 lbs.

HMS-847-2, Manual and 8" disk for CP/M systems. **Requires Sublicense Grant – ask representative.** Shpg. wt. 5 lbs.



COBOL Course introduces students to this business language

Most commercial data processing systems use COBOL. COBOL is useful in accounting applications and other functions which involve manipulating large, highly structured files.

Designed for individualized learning, the Heathkit/Zenith COBOL Course covers the basics of encoding, input characteristics, program hierarchy, identification, environment, data and procedure divisions, in both ANS-74 and ANS-68 COBOL.

The audio-tutorial format combines a clearly written self-instruction textbook and nine cassettes for effective learning.

The student text covers program variations, structure and syntax, arithmetic statements, comments and diagnostics, advanced control statements, additional data concepts, magnetic tape and disk storage and an applied COBOL program.

Six practice COBOL programs are at the end of the workbook. Students can work on them at specified points in the course – or at the end of the text. A master COBOL coding sheet is also included to aid students in writing programs.

A final examination is packaged with the Course.

To get more from this course in classroom or learning lab situations, we recommend a Z-89 with floppy disk storage, CP/M (page 26) and Microsoft COBOL (below).

EC-1105, Shpg. wt. 7 lbs.

Use this software with the course above to effectively teach COBOL

Microsoft COBOL-80, Ver. 4.0, makes this powerful, versatile language practical for microcomputer users. It far exceeds the minimum specifications of ANSI-74 COBOL, and has so many Level-II features and optional modules that COBOL programs written for large computer systems can be easily used.

MACRO-80 Assembler generates object code for the **LINK-80 Linkage Editor**. LINK-80 converts relocatable libraries or modules into runnable load modules for direct execution or disk storage. **COBOL Library** contains most COBOL functions. **LIB-80 Library Manager** allows building of libraries of relocatable modules. **Run-time software** adds versatility.

Extended debugging facilities make debugging convenient. **Advanced screen handling facilities** permit easy forms handling on CRT terminals with cursor control (Z-19, p. 24).

Requires Z-89 with 48K RAM (64K recommended), 2 disk drives (Z-47, p. 24, recommended for large files), and CP/M (p. 26).

HMS-817-3, Manual and 5.25" disk. **Requires Sublicense Grant – ask representative.** Shpg. wt. 5 lbs.

HMS-847-3, Manual and 8" disk. **Requires Sublicense Grant – ask representative.** Shpg. wt. 5 lbs.

ALL of today's popular computer languages



BASIC Course teaches problem-solving programming

- Teach BASIC effectively with this field-proven educational Heathkit/Zenith course
- Use with any BASIC-programmable computer

More programs are written in BASIC than in any other computer language. Your students can learn how to program in popular BASIC, with this effective Heathkit/Zenith Course.

Fourteen programmed-instruction units teach students BASIC—including numbers, statements, syntax, functions, loops, lists, arrays and strings. The course also includes special problem-solving tips students can use when writing programs.

Students learn to define and plan a program, format and write their own programs, and how to adapt others' programs. Interactive experiments, which can be performed on the Z-89 Computer (or any other computer system using BASIC), give you experience in writing and running BASIC programs.

A self-instruction version is also available for situations where a self-study course is required.

Classroom Text, Workbook, Guide:

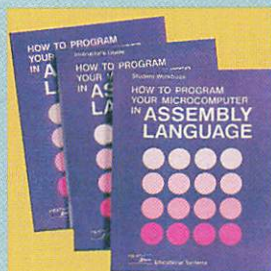
EB-6100, Student Text, Shpg. wt. 4 lbs.

EB-6100-40, Student Workbook, Shpg. wt. 2 lbs.

EB-6100-50, Instructor's Guide, Shpg. wt. 1 lb.

Self-Instruction Format:

EC-1100, Text/Workbook with Experiments/Reference Cards, Shpg. wt. 7 lbs.



Assembly Language Course teaches how to write faster-running programs

- Teaches how to store more information in less memory space
- Hands-on exercises for effective learning and retention

With Assembly Language, no run time is wasted interpreting. Programs are written in the language your computer understands best. So programs run much faster. There's less wasted memory, because more data is stored in less space. And changes can be made easily.

This Heathkit/Zenith Classroom Course teaches Assembly Language programming at your pace, using a special 400-page classroom text. A workbook provides interactive hands-on training—students actually write programs on a computer (required—not included). The text also adapts to individual learning situations.

The course includes a placard with ASCII code chart and all 244 Assembly Language instructions. It's designed for 8080, 8085 and Z-80 microcomputers—including the Z-89.

A self-instruction version is also available.

Classroom Text, Workbook, Guide:

EB-6108, Student Text, Shpg. wt. 4 lbs.

EB-6108-40, Student Workbook, Shpg. wt. 2 lbs.

EB-6108-50, Instructor's Guide, Shpg. wt. 1 lb.

Self-Instruction Format:

EC-1108, Text/Workbook/Instruction Placard, Shpg. wt. 7 lbs.



Personal Computing Course teaches microcomputing principles

- Explains computers in easy-to-understand, non-technical language
- Text/cassette format

The Heathkit/Zenith Personal Computing Course shows your students how to determine if a particular problem can be solved by a computer. When they complete this course, they'll also be able to cut through the technical fog and understand what a computer can do—in everyday terms.

No extensive math, electronics or computer background is needed. The text and two cassettes, effective in classroom and individualized study situations, present each concept logically.

Five easy-to-understand units explain different parts of the microcomputer system:

In **Computers and Data**, students find how to apply the capabilities of a computer to specific problems. They'll see how computers "understand" electronic data—and how written words are converted into electronic data.

The **Hardware** unit shows students how to compare computers. **Systems and Interfacing** teaches how to evaluate microcomputer systems. Students will discover how the computer communicates with other components, and how to distinguish between analog and digital data. **Software** shows how to choose programs that help solve specific problems. In the last unit, students actually write short programs using BASIC.

EC-1000, Text and Cassettes, Shpg. wt. 5 lbs.



Computer Concepts for Small Business Course aids in decision-making

- Students learn how to assess business data processing requirements
- Uses text, cassettes

When business owners consider making a computer investment that can run into thousands of dollars, they need to know as much about computers as possible.

Now you can show your students how to make that decision. Ideal in business and adult education curriculums, the Computer Concepts for Small Business Course provides the information and understanding students need to evaluate the usefulness of a computer in business.

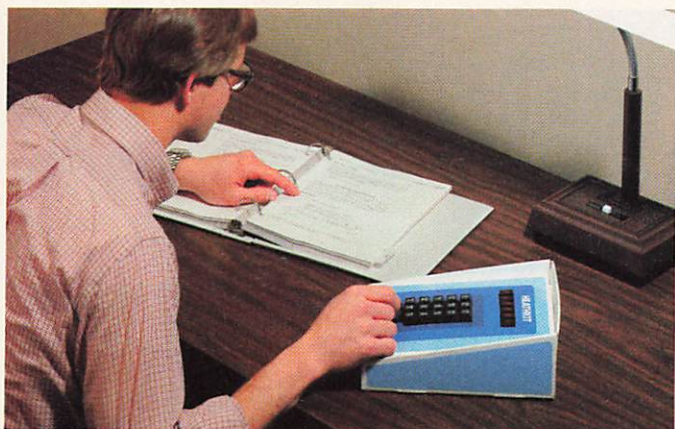
Proven education methods are used. A text and three audio cassettes give students everything needed to intelligently decide how a computer can benefit a business. **The Computer and How It Works** covers types of memory, input/output devices, capabilities of different types of storage media and applications software. It explains the typical tasks a computer can perform.

The **Data Processing Department and Personnel** teaches how to organize a DP department, and explains the roles of DP personnel. **Alternatives In Computer Services** compares the advantages of owning a computer versus time sharing or a computer service bureau.

Use this Heathkit/Zenith Course in classroom or individualized learning environments.

EC-1103, Text and Cassettes, Shpg. wt. 5 lbs.

Heathkit/Zenith exploratory courses



Six easy-to-teach courses that meet your needs for subject overview, specialty focus or entry level learning

Heathkit/Zenith understands the need for exploratory courses in today's modern science and electronics curriculums. Special courses which can round out the curriculum by providing an overview of a subject area like electronics or a focus on specific areas such as the design of PC boards. This section outlines six new courses which can broaden and provide new dimensions to your classroom.

The EE-3100 Concepts of Electricity Course gives the novice an overview of the concepts of direct current, circuit theory, electromechanical systems, alternating current, current generation, motors, and the measurement of electrical properties.

The EB-6134 Printed Circuits Course is an information-packed, enjoyable hands-on learning experience. The student uses both the direct pattern and photographic methods to make PC boards, learning about circuit board materials, layout, preparing artwork, image transfer and assembly.

In the EB-6140 Concepts of Electronics Course, the student with no prior knowledge of electronics will learn the basics of electronics, what electrons are and how they work, direct current principles, alternating current principles, an overview of active devices, electronic circuits, digital electronics, and digital computers. No prerequisite is required.

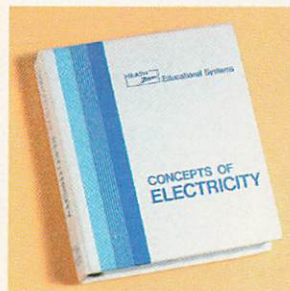
The EE-6800 Introduction to Microprocessors Course leads the student totally inexperienced in programming into the exciting world of microprocessors – an increasingly important part of modern life. The course is an invaluable learning experience for technical and non-technical students alike.

As part of science and electronics, we offer a course in the weather. The EW-4100 Weather Course covers such timely subjects as how to predict upcoming weather conditions, how clouds form, how weather instruments operate and how to read them, how to forecast weather by using instrument readings and surface maps, and how to start your own weather station.

Soldering made easy – with the EE-3133 Soldering Course. Designed for beginning students, to teach the proper techniques for high-reliability soldering in electronic applications. Step-by-step instruction begins with mechanical connection and progresses through tinning, temperature control, different types of solder, the advantages and disadvantages of various irons, guns and tips – even includes a section on desoldering. A great prerequisite course for anyone interested in electronics!

Heathkit/Zenith Introductory Courses are designed for classroom instruction. Each course is packaged in a convenient teaching module complete with exams and lab experiments. Many of the courses incorporate separate parts packs to give each student hands-on learning experience.

Basic Electricity made easy for the non-technical student



The Heathkit/Zenith **Concepts of Electricity Course** is designed to provide a working knowledge of the basics of electricity to the student having no prior knowledge or experience in this area of science. The Course's easy-to-follow programmed instruction text is reinforced by a beautifully illustrated audio-

visual presentation. It is designed to build upon the student's knowledge, a step at a time, until a thorough understanding of the subject is achieved. The format incorporates removable unit exams, as well as a final exam, that test the progress of the student while reinforcing learning.

In classroom applications where time is limited, the instructor can make use of the Concepts of Electricity Course to teach an overview of the subject matter in one semester. The exploratory nature of the course presents the interested student with the opportunity to examine the subject with an eye toward selecting a career field.

The student begins by learning the fundamental concepts of direct current. This background is then expanded into the areas of circuit theory and associated electromechanical systems. These concepts are used to explain alternating current, current generation, and motors.

Using an audio-visual presentation reinforced by programmed instruction, this course charts a logical course through the fundamentals of electricity. It leads the student a step at a time through units that teach the understanding of direct current; circuit theory, electromechanical systems, alternating current theory, generators and motors, and finally, meters.

In the "Understanding Direct Current" unit, the student learns such basic concepts as current, voltage and resistance; Ohms Law, and the principles of batteries.

The "Circuit Theory" unit covers such fundamentals as simple series and parallel circuits, as well as the series-parallel circuit.

"Electromechanical Systems" are covered in another unit, giving the student a thorough understanding of the theory and operation of basic electromechanical systems.

The unit on "Alternating Current Theory" explains the principles and characteristics of alternating current and the application of Ohms Law to alternating current.

"Generators and Motors" are the subjects of a unit exposing the student to magnetism, current, AC and DC generators, AC to DC conversion, and AC motors.

A final unit on "Meters" teaches fundamentals and characteristics of meters and meter systems, including meter movement, ammeters, DC voltmeters, Ohmmeters, AC voltmeters and VOMs.

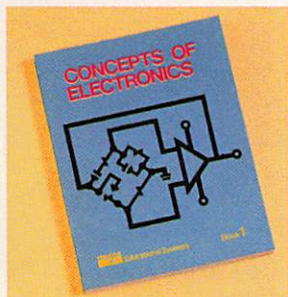
The programmed instruction format of the Concepts of Electricity Course also lends itself well to industrial training, government and individual learning situations in which time, distance and schedule considerations make a self-study application necessary or desirable.

Self-Instruction Format:

EE-3100, Basic Electricity, Shpg. wt. 5 lbs.

for science and technology

An overview of the exciting world of electronics – designed for the novice



The Concepts of Electronics Course from Heathkit/Zenith Educational Systems brings the whole exciting world of electronics into focus for the beginning student. No prior knowledge or experience of the subject is required. The course is structured in a logical progression from "Direct Current" fundamentals

to "Digital Computers." Each new unit builds upon the foundation set up in the preceding unit. Numerous illustrations are included to enhance the presentation. A "Student Workbook," complete with experiments and examinations, an "Instructor's Guide," and a parts package to augment the material in the text.

Unit 1, "Direct Current," begins with a discussion of atomic theory and the electron. The student is introduced to series and parallel circuits. DC theory, including Ohm's Law and Coulombs Law, is presented in detail. Resistance, conductance, and magnetism, as well as other basic electronic concepts, are thoroughly covered.

The next unit, "Alternating Current," covers alternating current and basic RL, RC, and RLC circuits. Students are introduced to the concepts of frequency, inductance, reactance, capacitance, and resonance.

The third unit, "Active Devices," starts with a discussion of semiconductor materials. Transistor theory and operation, including common base, common emitter, and common collector circuits are presented. Integrated circuits, optoelectronic devices, and transistors are reviewed in detail.

"Electronic Circuits" are the subject of the next unit. It examines the application of electronic devices and components in power supplies, audio and radio frequency amplifiers and oscillators.

The unit on "Digital Electronics" gives the student a broad overview of digital electronics by teaching the basic digital logic functions, elementary Boolean Algebra, and the application of these techniques in experiments.

A final unit on "Digital Computers" introduces the beginning student to the exciting world of the digital computer and its related hardware.

Ideally suited for classroom teaching, the Heathkit/Zenith EB-6140 Concepts of Electronics Course is packaged in a convenient teaching module, with student text and workbook complete with exams and lab experiments, plus an instructor's guide. Separate parts kits are available for each student.

A self-instruction format of the course also is available for industrial training, government and individual learning situations where a self-study application is required.

Classroom Texts, Guides, Accessories

EB-6140, Student Text, Shpg. wt. 3 lbs.

EB-6140-30, Parts Kit, Shpg. wt. 1 lb.

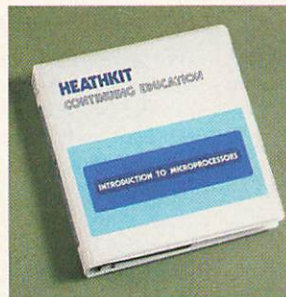
EB-6140-40, Student Workbook, Shpg. wt. 1 lb.

EB-6140-50, Instructor's Guide, Shpg. wt. 1 lb.

Self-Instruction Format

EE-3140, Course Binders, Shpg. wt. 11 lbs.

Microprocessing tailored for beginning students



"Introduction to Microprocessors" is tailored to the beginning student who will learn how to program microprocessors and gain a working knowledge of the technology without being inundated with superfluous information. The course is divided into six easy-to-follow, progressive units:

The first unit, "Number Systems and Codes," provides a firm foundation in the basic language of all microprocessors – binary numbers and codes including decimal number and binary, octal and hexadecimal systems. Unit 2, Microcomputer Basics, teaches how microprocessors operate.

Computer Arithmetic, the third unit, completes the study of the binary number system. This unit helps the student understand the fundamentals of binary mathematics – addition, subtraction, multiplication and division.

Unit 4, "Introduction to Programming," helps the student understand how the microprocessor handles complex tasks by presenting programs that illustrate many important programming concepts.

The final two units, devoted to the 6808 Microprocessor, teach the student how to program this versatile member of the 6800 microprocessor family.

Designed for easy classroom teaching, the Heathkit/Zenith EC-6800 Introduction to Microprocessors Course is packaged in a convenient instruction module complete with exams, and lab experiments performed on the ET-6800 Trainer below.

Required Course Trainer: Kit ET-6800 or ETW-3400.

Self-Instruction Format:

EC-6800, Introduction to Microprocessors, 9 lbs.

Microprocessor Trainer for hands-on learning



- Miniature digital computer
- Facilitates learning of operation, programming

The ET-6800 Microprocessor Trainer functions as a miniature computer with 1K ROM monitor program. Address and data readout on six-digit hexadecimal keyboard gives access to memory locations. Employs an 8-bit parallel NMOS, bus-oriented CPU with 256 bytes of NMOS RAM. Built-in +5 volt DC power supply. Rugged, attractive cardboard cabinet holds the price to an absolute minimum. For 120 VAC, 60 Hz. Measures 3 3/4" H x 8" W x 10" D.

Kit ET-6800, Shpg. wt. 17 lbs.

Introduce students to fascinating fields

The Heathkit/Zenith Printed Circuits Course teaches your students to make PC boards



- Students learn to design custom printed circuit boards
- Hands-on design experiments

Do you have students who are interested in designing and etching custom printed circuit boards for special electronic projects, or modifying existing designs to suit specific needs? Would you like to expand your employees' or students' electronics knowledge? The Heathkit/Zenith EB-6134 Printed Circuits Course explains all facets of making PC boards. It teaches by example – students design and build PC boards for two electronic projects.

Designed for the classroom learning

environment, the Heathkit/Zenith Printed Circuits Course teaches students how to make their own printed circuit boards – using both the direct pattern method and the photographic method. The projects, integrated in a student workbook, provide many hands-on learning exercises in the design, layout and production of a PC board.

Printed Circuits is an ideal exploratory course – no previous training is needed. And the self-teaching textbook presents new information a little bit at a time.

By taking our **Printed Circuits Course**, students will be able to:

- Identify the properties of different types of PC board materials.
- Explain the processes used in manufacturing printed circuit boards.
- Design a circuit board layout, fulfilling all circuit requirements.
- Prepare direct pattern artwork, positive and negative photographic artwork.
- Explain the processes used in producing automated artwork.
- Transfer circuit patterns from artwork to the circuit board.
- Assemble their own printed circuit boards, using the manual assembly method, manual soldering and conformal coating.
- Understand how printed circuit boards are assembled by automatic methods, using automatic insertion machines and wave soldering.

In the projects for this course, the student designs and builds circuit boards for two electronic devices – the Heathkit GD-600 Automatic Lamp Switch and the GD-1287 Touch Control Switch. All materials necessary to complete the projects are available from Heathkit/Zenith. This course is not available outside the Continental U.S.

Classroom Text, Workbook, Guide and Accessories:

EB-6134, Student Text, Shpg. wt. 1 lb.

EB-6134-40, Student Workbook, Shpg. wt. 1 lb.

EB-6134-50, Instructor's Guide, Shpg. wt. 1 lb.

EB-6134-30, Parts Pack, Shpg. wt. 2 lbs.

Self-Instruction Format:

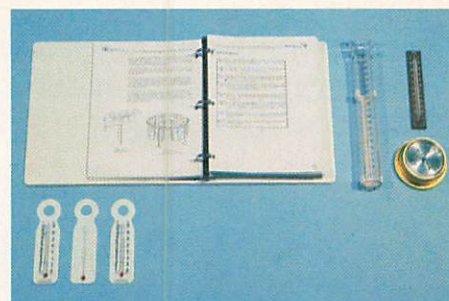
EI-3134, Manual and materials for projects. Specially designed for individualized learning environments. Includes all necessary parts for completing two Heathkit products – the GD-600 Automatic Lamp Switch and the GD-1287 Touch Control Switch. Shpg. wt. 7 lbs.



Soldering Course teaches techniques

Teaches high-reliability soldering. With instruction manual, 2-transistor light oscillator students build during course. Requires a soldering iron and small hand tools.

EI-3133, 2 lbs.



Weather Course is ideal for science classes

- Teaches how to predict coming weather conditions
- Includes weather instruments

The EW-4100 Weather Course takes the mystery out of weather. It explains nature's invisible forces and how they affect the weather in your area.

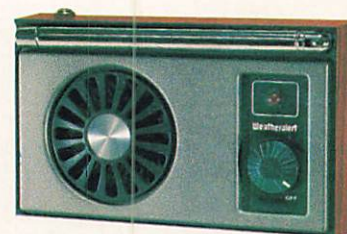
With this course, your students will understand weather – and learn how to predict it! It covers most every weather condition the student will encounter.

The course comes with a barometer, rain gauge and 3 thermometers to help students learn how to use weather instruments. Also includes workbook with map reading/forecasting exercises, a book to log daily weather conditions, and a textbook that is effective in any training situation.

Students will be able to:

- Explain how the sun and earth's atmosphere affect weather.
- Identify different clouds by shape.
- Determine what type of weather is coming by reading the clouds.
- Read weather instruments.
- Identify air masses by temperature and pressure characteristics.
- Describe how frontal systems develop, and the weather they bring.
- Forecast weather by using instrument readings and surface weather maps.

EW-4100, Manual and instruments, 10 lbs.



StormAlarm by WeatherAlert sounds weather warnings!

Receives severe weather alarms from local NOAA Weather Radio Station. Also get current forecasts. 120 VAC or 9 VDC battery. 1.25" H x 5" W x 3" D.

EWA-4100, Assembled, 2 lbs.

Automotive Courses and Equipment

Award Winning Courses

Now you can take students with no prior knowledge of automotive electronics, and thoroughly train them to tune any ignition or fix any electrical system problem, as well as prepare them for the NIASE Exams.

Here are two award-winning courses that are helping instructors, like yourself, teach automotive ignition tuning and electrical systems troubleshooting more efficiently and successfully.

Both courses feature audio-visual presentations that make learning the subject material more enjoyable for student and instructor alike. The presentations use colorful filmstrips and audio cassettes to clarify those electrical concepts which trouble beginning students.

In addition, the texts for these courses feature a programmed-instruction format that expands and reinforces the concepts presented in the filmstrips. What's more, the textbooks are loaded with clear, detailed illustrations and are written in plain, comprehensible English.

The student workbooks are specifically designed to give your students the hands-on training they need to be successful automotive technicians. The projects do more than just demonstrate how components work or how test instruments operate – they give your students real-life automotive repair experience.

All the filmstrips, text material and workbook projects are listed in the instructor's guide for each course. The guide not only helps you coordinate class and shop sessions, it also contains answers to review questions, a sample final exam, plus a practice certification exam to prepare your students for the types of questions asked on the NIASE exam.

Both our Automotive Electrical Systems Courses and Automotive Ignition and Tune-up Course are described in detail on the following pages.

Tested Ignition Analyzer



Our WO-2700 Ignition Analyzer features the latest circuitry for rock-steady trace patterns.

The 12" CRT is scaled for easy reading and displays primary and secondary ignition waveforms in superimposed, parade, or stacked array patterns. In addition, the waveforms can be scaled at two different amplitudes for closer look of ignition operations.

Front panel cylinder selection buttons allow the user to short out banks of cylinders for carburetor balance, or for precise inspection of one or more cylinders.

Besides the scope operation, the WO-2700 also has an 8" meter for measuring dwell, RPM, and voltage.

The WO-2700 Analyzer tests four-cycle 4, 6, and 8 cylinder engines (or 2 rotor Wankel engines) equipped with standard, transistorized, or capacitive-discharge ignitions. Has adaptor for HEI systems. Measures: 12 $\frac{7}{8}$ " H x 25 $\frac{1}{4}$ " W x 14 $\frac{1}{8}$ " D.

WO-2700, Ignition Analyzer, Shpg. wt. 63 lbs.

For convenience and savings – get the WOS-2700 Deluxe Ignition Analyzer System! This system includes the WO-2700 Ignition Analyzer, plus the COA-2600-3 Cart, the WOA-2700-4 Timing Light/Advance Meter, and a COA-2700-2 Alternator Test Adaptor (not shown).

WOS-2700, Ignition Analyzer System, Shpg. wt. 92 lbs.

Portable cart for WO-2700



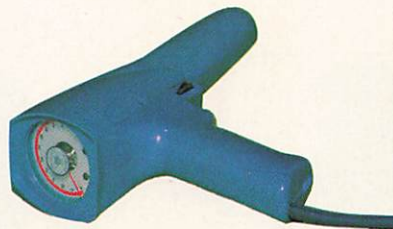
- Features easy-rolling casters for maneuverability
- Special tilted top slants analyzer for easy reading

Here's a specially-made cart that makes wheeling your WO-2700 Ignition Analyzer around shop stations easy.

The wood top slants a full 15 deg. for easy analyzer viewing. Features steel tube frame construction and oil-resistant casters for long life. This useful cart measures: 36" H x 25" W x 20" D.

COA-2600-3, Shpg. wt. 25 lbs.

Quality Timing Light with Advance Meter



Plugs into WO-2700 for simple operation. Features super-bright flash that is strong enough to be seen even in broad daylight.

Also has built-in meter for measuring distributor advance to 60 deg. from 1500-4500 RPM. Constructed with rugged molded housing. All cables included.

Comes assembled and tested.

WOA-2700-4, Shpg. wt. 3 lbs.

Professional-grade Engine Analyzer

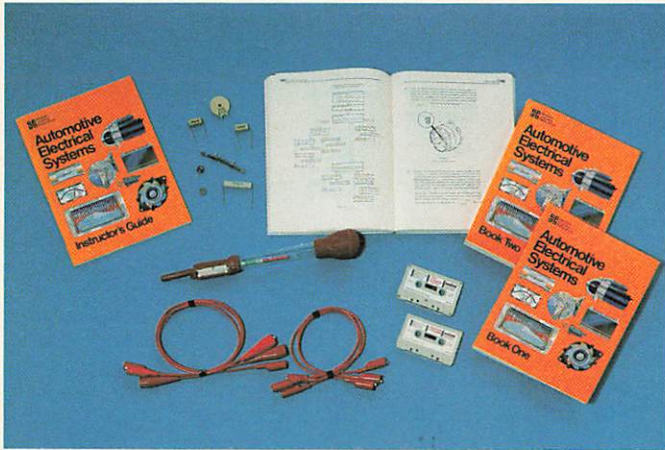


This budget-priced analog engine analyzer features color-coded 6" meter for easy reading.

Tests almost any type of ignition system – pos./neg. grnd., any voltage – on 3, 4, 6 or 8 cyl. engines. Test other auto electrical components, too. Operates on 3 "C" batteries (not supplied). Dimensions: 7.5" H x 10.5" W x 8.75" D. In kit form.

Kit CM-1050, Shpg. wt. 8 lbs.

Comprehensive Auto Electrical Systems Course



Now you can teach any student to troubleshoot and repair automotive electrical systems with this course

“control circuit bypass test,” as an aid to localizing starting system malfunction.

- Identify the three basic charging systems and explain the operation of each.
- Recognize the symptoms of charging system failure and implement a troubleshooting plan to pinpoint the defect.
- Use electrical test instruments to make specific charging system checks, such as “determining charging voltages” and “no-load test” as an aid to localizing charging system malfunctions.
- Explain the operation of the turn signals, the hazard warning flashers, and other lighting systems and diagnose problems in these circuits.
- Identify the different automotive gauge and indicating systems, and explain the operation of each.
- Troubleshoot automotive indicating systems.
- Use a logical troubleshooting plan to diagnose failures in power accessory circuits.
- Use automotive wiring diagrams as an aid when troubleshooting malfunctions in automotive electrical systems.

An individual, self-instruction format of the Automotive Electrical Systems is available for self-study situations.

Classroom Texts, Workbooks, Guides, and Accessories:

- EB-10, Student Textbook, Shpg. wt. 3 lbs.
- EB-10-40, Student Workbook, Shpg. wt. 2 lbs.
- EB-10-50, Instructor's Guide, Shpg. wt. 1 lb.
- EB-10-60, Cassette Tapes, Shpg. wt. 1 lb.
- EB-10-70, Filmstrips, Shpg. wt. 1 lb.
- EB-10-30, Parts Pack, Shpg. wt. 2 lbs.

Self-Instruction Format:

- EAC-1, 4 Binders, Shpg. wt. 23 lbs.
- EA-11, Electrical Principles with Binder, Shpg. wt. 5 lbs.
- EA-12, Starting Systems with Binder, Shpg. wt. 5 lbs.
- EA-13, Charging Systems with Binder, Shpg. wt. 5 lbs.
- EA-14, Accessories & Body Electrical Systems with Binder, Shpg. wt. 5 lbs.

Here's a comprehensive course that allows you to take students with absolutely no background in electricity, and transform them into skillful electrical system specialists.

This course features colorful filmstrips and audio cassettes to present difficult electrical concepts. These concepts are further reinforced in the programmed-instruction text, and in the student workbook with hands-on projects. An instructor's guide coordinates the text and workbook material with your lecture schedule. The material is divided into four major headings: Electrical Principles of Automobiles, the Starting System, the Charging System, and Accessory and Body Electrical Circuits.

After completing this course, your students will be able to perform the following:

- Demonstrate an understanding of the fundamentals of electricity and be able to apply this knowledge in the diagnosis of automotive electrical problems.
- Use electrical test instruments to measure voltage, current, and resistance in automotive electrical systems.
- Identify the three basic starting systems and explain how each one operates.
- Implement a logical troubleshooting plan to aid in the diagnosis of an electrical malfunction.
- Use electrical test instruments and a troubleshooting plan to locate starting system failures.
- Perform specific starting system checks, such as the “starter drive test,” “headlight-cranking test,” and the

COURSE OUTLINE

<p>UNIT I: ELECTRICAL FUNDAMENTALS AND BATTERIES</p> <p>Current Voltage and Resistance Ohm's Law Automotive Battery Shop Project 1: Battery Maintenance</p>	<p>UNIT III: STARTING SYSTEM FUNDAMENTALS</p> <p>Starting System Components Starter Motors Starter Systems Shop Project 3: Measuring Starter System Voltage Drops</p>	<p>UNIT V: CHARGING SYSTEM FUNDAMENTALS</p> <p>Alternator Basics AC-DC Current Regulation Transistorized Regulation and Standard Charging Systems Shop Project 5: Getting to Know Your Charging System</p>	<p>UNIT VI: SERVICING THE CHARGING SYSTEM</p> <p>Symptoms and General Testing Load Testing Component Testing Shop Project 6: Servicing the Charging System</p>	<p>UNIT VIII: SERVICING ACCESSORY AND BODY ELECTRICAL CIRCUITS</p> <p>The Multiple-Page Wiring Diagram Shop Project 8: Using the Multiple-Page Wiring Diagram The Fold-out Wiring Diagram Shop Project 9: Using the Fold-out Wiring Diagram Body Wiring Troubleshooting Tips Shop Project 10: Turn and Hazard Warning Signal</p>
<p>UNIT II: CIRCUIT TROUBLESHOOTING</p> <p>Series Circuits Parallel Circuits Series-Parallel Circuits Troubleshooting Opens and Shorts Fuses and Circuit Breakers Troubleshooting Automotive Circuits Shop Project 2: Electrical Circuit Checks</p>	<p>UNIT IV: SERVICING THE STARTING SYSTEM</p> <p>Logical Troubleshooting Starting System Troubleshooting Starting System Isolation Tests Shop Project 3: Starting System Cranking Checks</p>		<p>UNIT VII: ACCESSORY AND BODY ELECTRICAL FUNDAMENTALS</p> <p>The Lighting System Instrumentation Accessories Shop Project 7: Checking Instrumentation</p>	

Ignition Systems & Tune-up Course



Helps you teach students to tune up both standard and electronic automotive ignition systems

Here's a cost-effective course that enables you to take students with no prior knowledge of automotive ignition systems, and turn them into proficient automotive ignition technicians—technicians who can troubleshoot and tune any standard or electronic GM, Ford, Chrysler ignition system.

This course is a comprehensive one. The textbook, student workbook and shop projects work together to give your students the knowledge and actual experience they need to troubleshoot and tune-up ignitions—and pass their NIASE exam. The instructor's guide allows you to coordinate the informative filmstrips and audio cassettes with the material covered in the textbook and workbook.

The course escorts your students through an 8 unit journey into automotive ignition systems. In Units 1 through 4, they learn about ignition fundamentals, the construction and operation of ignition system components, plus tune-up and power balancing standard systems.

Units 5 through 8 explain how GM, Ford, and Chrysler electronic ignitions work, and describe the exact procedures for tuning them. Units 5 and 6 cover the various types of GM electronic ignition systems, while Units 7 and 8 spell out the step-by-step procedures to tune Ford and Chrysler electronic ignition systems.

When your students finish this course, they will be able to:

- Describe the ignition components and systems, their operation, and how to use this knowledge to diagnose auto ignition problems.
- Perform a complete ignition tune-up on automobiles equipped with either standard or electronic systems.

- Troubleshoot ignition system problems using test instruments.
- Analyze both primary and secondary ignition circuits using the automotive oscilloscope.
- Perform scheduled maintenance of carburetion, engine emission, and ignition systems on General Motors, Ford, or Chrysler engines.
- Describe the principles and operation of computer-controlled ignition systems.
- Pass the NIASE Certification Examination on Engine Tune-up

An individual, self-instructional format of the complete Automotive Ignition Tune-up Course is offered for self-study training. Ask your representative for complete details.

Classroom Text, Workbooks, Guides, and Accessories:

EB-20, Student Textbook, Shpg. wt. 4 lbs.

EB-20-40, Student Workbook, Wt. 2 lbs.

EB-20-50, Instructor's Guide, Wt. 1 lb.

EB-20-70, Filmstrips, Wt. 1 lb.

EB-20-30, Parts Pack, Wt. 2 lbs.

Self-Instruction Format:

EA-2000, 2 Binders & parts, Wt. 12 lbs.

EA-21, 1 Binder, Units 1-4 & parts, 7 lbs.

EA-22, 1 Binder, Units 5-8 & parts, 7 lbs.

This Heathkit/Zenith Automotive Course features color filmstrips to present and emphasize major tune-up concepts covered in the course. Along with the filmstrips, audio cassettes narrate and explain the concepts, making it easier for the student to grasp and remember the course material.

Accessory Instruments



Needed for shop projects. Includes compression tester, vacuum pressure gauge, & vacuum "T" fitting.

EAC-2-1, 1 lb.

COURSE OUTLINE

UNIT I: IGNITION FUNDAMENTALS

The Need for Ignition
The Spark
Building an Ignition System
Timing the Spark

UNIT II: IGNITION SYSTEM COMPONENTS

Spark Plugs
Plug Wires
The Distributor
The Ignition Coil
Standard Systems
Dual Breaker Points
Shop Project 1: Testing Ignition Components

UNIT III: INSTRUMENTS

Basic Test Instruments
The Ignition Scope
Abnormal Scope Patterns
Shop Project 2: Using the Instruments

UNIT IV: TUNE-UP AND TROUBLESHOOTING

Distributor/Coil Service
Plug Replacement
Ignition Calibration
Troubleshooting a No-Start Condition
Shop Project 3: Tune-Up

UNIT V: GENERAL MOTORS ELECTRONIC IGNITION FUNDAMENTALS

High Energy Ignition Components

G.M. Electronic Ignition Systems
High Energy Ignition Operation
Shop Project 4: HEI Component Inspection and Testing

UNIT VI: HEI TUNE-UP AND TROUBLESHOOTING

Emission Control Maintenance
Service Inspection
Engine Area Test
Scope Diagnosis
Abnormal Scope Patterns
Ignition Timing
HEI Troubleshooting
Shop Project 5: HEI Tune-up and Troubleshooting

UNIT VII: CHRYSLER AND FORD ELECTRONIC IGNITIONS

Ignition Pickups
Ford Solid-State Ignition Systems:
Solid-State Ignition
Duraspark II
Duraspark I
Ford Electronic Engine Control Systems:
Electronic Engine Control I
Electronic Engine Control II
Electronic Engine Control III
Chrysler Electronic Ignition

Chrysler's Electronic Lean Burn
Shop Project 6: Identifying and Testing Ford and Chrysler Electronic Ignition Components

UNIT VIII: FORD-CHRYSLER ELECTRONIC IGNITION TUNE-UP AND TROUBLESHOOTING

Ignition Waveforms
Abnormal Scope Patterns
Troubleshooting (No Run)
Troubleshooting (Poor Performance)
Shop Project 7: Ford-Chrysler Tune-Up and Troubleshooting

Heathkit Electronic Centers Nationwide

Visit your nearby Heathkit Electronic Center (unit of Veritechnology Electronics Corporation) for products in this catalog. Parts and service are available.

ARIZONA - Phoenix, 85017
2727 W. Indian School Rd., 602-279-6247

CALIFORNIA - Anaheim, 92805
330 E. Ball Rd., 714-776-9420

El Cerrito, 94530
600 Potrero Ave., 415-236-8870
Los Angeles, 90007
2309 S. Flower St., 213-749-0261
Pomona, 91767
1555 N. Orange Grove Ave., 714-623-3543

Redwood City, 94063
2001 Middlefield Rd., 415-365-8155

Sacramento, 95825
1860 Fulton Ave., 916-486-1575

San Diego (La Mesa), 92041
8363 Center Dr., 714-461-0110

San Jose (Campbell), 95008
2350 S. Bascom Ave., 408-377-8920

Woodland Hills, 91364
22504 Ventura Blvd., 213-883-0531

COLORADO - Denver, 80212
5940 W. 38th Ave., 303-422-3408

CONNECTICUT - Hartford (Avon), 06001
395 W. Main St. (Rt. 44), 203-678-0323

FLORIDA - Fort Lauderdale (Plantation), 33317
7173 W. Broward Blvd., 305-791-7300

Miami (Hialeah), 33012
4705 W. 16th Ave., 305-823-2280

Tampa, 33614
4019 W. Hillsborough Ave., 813-886-2541

GEORGIA - Atlanta, 30342
5285 Roswell Rd., 404-252-4341

ILLINOIS - Chicago, 60645
3462-66 W. Devon Ave., 312-583-3920

Chicago (Downers Grove), 60515
224 Ogden Ave., 312-852-1304

INDIANA - Indianapolis, 46220
2112 E. 62nd St., 317-257-4321

KANSAS - Kansas City (Mission), 66202
5960 Lamar Ave., 913-362-4486

KENTUCKY - Louisville, 40243
12401 Shelbyville Rd., 502-245-7811

LOUISIANA - New Orleans (Kenner), 70062
1900 Veterans Memorial Hwy., 504-467-6321

MARYLAND - Baltimore, 21234
1713 E. Joppa Rd., 301-661-4446

Rockville, 20852
5542 Nicholson Lane, 301-881-5420

MASSACHUSETTS - Boston (Peabody), 01960
242 Andover St., 617-531-9330

Boston (Wellesley), 02181
165 Worcester Ave. (Rt. 9 just west of Rt. 128), 617-237-1510

MICHIGAN - Detroit, 48219
18645 W. 8 Mile Rd., 313-535-6480

East Detroit, 48021
18149 E. 8 Mile Rd., 313-772-0416

MINNESOTA - Minneapolis (Hopkins), 55343
101 Shady Oak Rd., 612-938-6371

St. Paul, 55106
1645 White Bear Ave., 612-778-1211

MISSOURI - St. Louis (Bridgeton), 63044
3794 McKelvey Rd., 314-291-1850

NEBRASKA - Omaha, 68134
9207 Maple St., 402-391-2071

NEW JERSEY - Fair Lawn, 07410
35-07 Broadway (Rt. 4), 201-791-6935

Ocean (Ashbury Park), 07712
1013 State Hwy. 35, 201-775-1231

NEW YORK - Buffalo (Amherst), 14226
3476 Sheridan Dr., 716-835-3090

Jericho, Long Island, 11753
15 Jericho Turnpike, 516-334-8181

Rochester, 14623
937 Jefferson Rd., 716-424-2560

White Plains (North White Plains), 10603
7 Reservoir Rd., 914-761-7690

OHIO - Cincinnati (Woodlawn), 45215
10133 Springfield Pike, 513-771-8850

Cleveland, 44122
28100 Chagrin Blvd., 216-292-7553

Columbus, 43229
2500 Morse Rd., 614-475-7200

Toledo, 43615
48 S. Byrne Rd., 419-537-1887

OKLAHOMA - Oklahoma City, 73112
2727 NW Expressway, 405-848-7593

PENNSYLVANIA - Frazer (Chester Co.), 19355
630 Lancaster Pike (Rt. 30), 215-647-5555

Philadelphia 19149
6318 Roosevelt Blvd., 215-288-0180

Pittsburgh, 15235
3482 William Penn Hwy., 412-824-3564

RHODE ISLAND - Providence (Warwick), 02886
558 Greenwich Ave., 401-738-5150

TEXAS - Dallas, 75201
2715 Ross Ave., 214-826-4053

Houston, 77008
1704 West Loop North, 713-869-5263

San Antonio, 78216
7111 Blanco Rd., 512-341-8876

UTAH - Salt Lake City (Midvale), 84047
58 East 7200 South, 801-566-4626

VIRGINIA - Alexandria, 22303
6201 Richmond Hwy., 703-765-5515

Norfolk (Virginia Beach), 23455
1055 Independence Blvd., 804-460-0997

WASHINGTON - Seattle, 98109
505 8th Ave. N., 206-682-2172

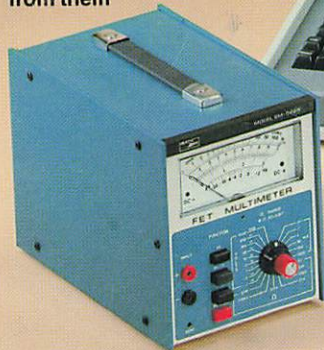
Seattle (Tukwila), 98188
15439 53rd Ave. S., 206-246-5358

WISCONSIN - Milwaukee, 53216
5215 W. Fond du Lac, 414-873-8250

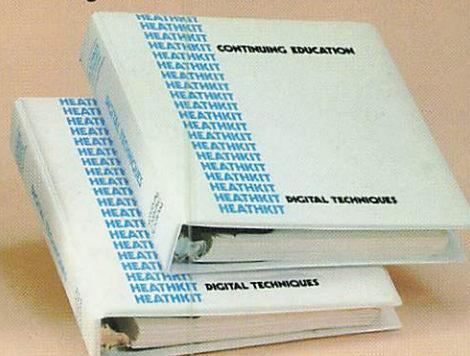
We have the hardware and software to back up our courses on micro-processors, computers and programming

Complete line of test instruments and the educational courses needed to get the most from them

Whatever your educational needs, Heathkit/Zenith is your problem solver



Texts are specially designed for effective learning in classroom or individualized learning environments



Veritechnology Electronics Corporation
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St. Joseph, MI 49085

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2800 W. 10th St. (Rt. 24)
Midvale, Pa. 15066
(412) 847-8888