This section describes the first of a three part curriculum in trade electricity-electronics (each part is described in a separate volume). It presents a unit of 6 to 10 weeks duration which develops only those competencies necessary to all electricity or electronics employment. A flow chart indicates how an individual student's program can be arranged within, or across, the three curriculum areas. This section is divided into eight units: Orientation, Electrons as Charge Carriers, Circuit Component Identification, Basic Laws; Circuit Concepts, Magnetism, Batteries, Introduction to AC Principles, Use of Test Equipment, Fundamental Skills, Hand and Power Tools, Circuit Drawings, and Recordkeeping.

The units are organized in a three-column format: Content, objectives, and teaching suggestions, with a resource list and suggested equipment list appended. The first column, Content, consists of items of instruction; the second column, Objectives, states in performance terms the student achievement which must result from the item of instruction; the third column, Teaching Suggestions, presents a variety of methods by which the content may be taught. Following the eight units is a listing of only the tools and equipment considered essential to properly instruct a class-group of 20 students in basic electricity. A sample course of study for this section of basic electricity is also provided, intended as an aid to creating the syllabus-based course of study, and tailored to local conditions. Content outlines for Section II and III of the curriculum are included. (HD)
SYLLABUS IN TRADE ELECTRICITY-ELECTRONICS

SECTION I

BASIC ELECTRICITY

The University of The State of New York/The State Education Department
Bureau of Occupational and Career Curriculum/Albany, New York 12234
1976
<table>
<thead>
<tr>
<th>Year</th>
<th>Name</th>
<th>Title</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>1978</td>
<td>Alexander J. Allan, Jr., LL.D., Litt.D.</td>
<td></td>
<td>Troy</td>
</tr>
<tr>
<td>1980</td>
<td>Joseph T. King, LL.B.</td>
<td></td>
<td>Shelter Island</td>
</tr>
<tr>
<td>1981</td>
<td>Joseph C. Indelicato, M.D., L.H.D.</td>
<td></td>
<td>Brooklyn</td>
</tr>
<tr>
<td>1979</td>
<td>Francis W. McGinley, B.S., J.D., LL.D.</td>
<td></td>
<td>Glens Falls</td>
</tr>
<tr>
<td>1983</td>
<td>Harold E. Newcomb, B.A.</td>
<td></td>
<td>Owego</td>
</tr>
<tr>
<td>1988</td>
<td>Willard A. Genrich, LL.B., L.H.D., LL.D.</td>
<td></td>
<td>Buffalo</td>
</tr>
<tr>
<td>1982</td>
<td>Emlyn I. Griffith, A.B., J.D.</td>
<td></td>
<td>Rome</td>
</tr>
<tr>
<td>1977</td>
<td>Genevieve S. Klein, B.S., M.A.</td>
<td></td>
<td>Bayside</td>
</tr>
<tr>
<td>1976</td>
<td>Mary Alice Kendall, B.S.</td>
<td></td>
<td>Irondequoit</td>
</tr>
<tr>
<td>1984</td>
<td>Jorge L. Batista, B.A., J.D.</td>
<td></td>
<td>Bronx</td>
</tr>
<tr>
<td>1982</td>
<td>Louis E. Yavner, LL.B.</td>
<td></td>
<td>New York</td>
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</tbody>
</table>

President of the University and Commissioner of Education
Ewald B. Nyquist

Executive Deputy Commissioner of Education
Gordon M. Ambach

Deputy Commissioner for Elementary, Secondary, and Continuing Education
Thomas D. Sheldon

Associate Commissioner for Instructional Services
William L. Bitner III

Assistant Commissioner for General Education and Curricular Services
Vivienne N. Anderson

Director, Division of Curriculum Development
Gordon E. Van Hooft

Chief, Bureau of Occupational and Career Curriculum
G. Earl Hay

Assistant Commissioner for Occupational Education
Robert S. Seckendorf

Director, Division of Occupational Education Instruction
Douglas T. Adamson

Chief, Bureau of Trade and Technical Education
Carl G. Benenati
In 1972 an experimental syllabus for a core course in trade electricity-electronics was distributed to the field. Feedback from teachers and administrators, individually and through workshops, provided desired recommendations for revision. In August 1974, a committee consisting of teachers of the subject, Blake Bayly of Albany-Schenectady-Schoharie BOCES, Roy Bloom of Nassau BOCES, and Edward Chauvin of Dutchess BOCES, met with Joseph J. Messier, Associate in Vocational Curriculum, and Charles A. Stebbins, Associate in Industrial Education, to effect changes in the curriculum. A three-section, eleven-module content outline was produced.

At a subsequent meeting of the Directors, Divisions of Curriculum Development, Occupational Education Instruction, and Occupational Education Supervision, the Chief of the Bureau of Trade and Technical Education, and the Supervisor of the then Vocational Curriculum Unit, it was decided to develop the content outline through grants to selected local education agencies. A proposal submitted by Orange County BOCES, acting as agent for Orange, Rockland, and Ulster BOCES, to develop a syllabus and sample course of study for the basic electricity section of the content outline, was accepted.

In January 1975, Harold Dworetzky, Curriculum Coordinator, Orange BOCES, assembled a development team consisting of trade electricity-electronics teachers Irving Fox and Frank Perez of Orange BOCES, and Parker Black and Leó Rozman of Ulster BOCES. Under Mr. Dworetzky's supervision, and general guidance of Mr. Messier, the project manager, a first draft of the curriculum was prepared. The draft was reviewed by Mr. Messier and Mr. Stebbins, and revision effected through Mr. Dworetzky. A final draft became this Section I — Basic Electricity of the Syllabus in Trade Electricity-Electronics.

Grants to local agencies to develop modules of the remaining two sections have been, and will be, made. Distribution of Section II — Trade Electricity, and Section III — Trade Electronics, will be initiated as each section is completed.

G. Earl Hay, Chief
Bureau of Occupational and Career Curriculum

Gordon E. Van Hooft, Director
Division of Curriculum Development
TO THE TEACHER

The Syllabus in Trade Electricity-Electronics is a new, highly flexible curriculum organized in three parts: Section I — Basic Electricity, Section II — Trade Electricity, and Section III — Trade Electronics.

Section I — Basic Electricity is a unit of 6 to 10 weeks duration which develops only those competencies necessary to all electricity or electronics employment. Each student must possess those competencies before choosing the specialty areas of electricity or electronics for continued study. Section II — Trade Electricity, and Section III — Trade Electronics consist of several modules each of specialized study. The chart on page iii indicates how an individual student's program can be arranged within these areas or, in certain cases, across them.

To obtain course credit the student must attain the objectives of Basic Electricity and one or more of the specialty modules. No credit should be granted for Basic Electricity alone, since by itself it does not provide entry-level skills. A maximum of two credits may be granted for one year of 160 teaching days of 2½ hours each. Two such academic years of study of trade electricity-electronics will satisfy the requirements for a Group II sequence as outlined in The Secondary School Curriculum of New York State — A Handbook for Administrators.

When a local program of instruction conforms to this syllabus, approval to grant State credit is presumed. Only where there is reason to adopt a nonconforming course of study must copy of the course be submitted to the Bureau of Occupational and Career Curriculum toward specific approval.

Carl G. Benenati, Chief
Bureau of Trade and Technical Education

Douglas T. Adamson, Director
Division of Occupational Education Instruction
## CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foreword</td>
<td>iii</td>
</tr>
<tr>
<td>To The Teacher</td>
<td>iv</td>
</tr>
<tr>
<td>Flow Chart</td>
<td>v</td>
</tr>
<tr>
<td>Contents Page</td>
<td>vi</td>
</tr>
<tr>
<td>Using The Syllabus</td>
<td>1</td>
</tr>
<tr>
<td>Unit I: Orientation</td>
<td>2</td>
</tr>
<tr>
<td>Unit II: Electrons As Charge Carriers</td>
<td>7</td>
</tr>
<tr>
<td>Unit III: Circuit Component Identification</td>
<td>9</td>
</tr>
<tr>
<td>Unit IV: Basic Laws</td>
<td>11</td>
</tr>
<tr>
<td>Unit V: Circuit Concepts</td>
<td>13</td>
</tr>
<tr>
<td>Unit VI: Magnetism</td>
<td>15</td>
</tr>
<tr>
<td>Unit VII: Batteries</td>
<td>17</td>
</tr>
<tr>
<td>Unit VIII: Introduction to AC Principles</td>
<td>20</td>
</tr>
<tr>
<td>Unit IX: Use of Test Equipment</td>
<td>22</td>
</tr>
<tr>
<td>Unit X: Fundamental Skills</td>
<td>24</td>
</tr>
<tr>
<td>Unit XI: Hand and Power Tools</td>
<td>26</td>
</tr>
<tr>
<td>Unit XII: Circuit Drawings</td>
<td>28</td>
</tr>
<tr>
<td>Unit XIII: Recordkeeping</td>
<td>29</td>
</tr>
<tr>
<td>Resource List</td>
<td>30</td>
</tr>
<tr>
<td>Tools, Equipment, Materials</td>
<td>36</td>
</tr>
<tr>
<td>Sample Course of Study</td>
<td>42</td>
</tr>
<tr>
<td>Content Outline, Section II — Trade Electricity</td>
<td>72</td>
</tr>
<tr>
<td>Content Outline, Section III — Trade Electronics</td>
<td>80</td>
</tr>
</tbody>
</table>
USING THE SYLLABUS

The syllabus consists of three separate volumes, which should be collected in a ring-binder when received. This section should be maintained as a unit, while Section II — Trade Electricity, and Section III — Trade Electronics consist of specialization module options which should be separated and rearranged. Modules pertaining to job instruction not offered or minimally covered by the local program should be placed beneath pertinent modules, for reference or possible future inclusion. The teacher and the curriculum specialist, guided by the local advisory committees, should then develop a locally-effective course of study, using the syllabus as a foundation — but never as walls or ceiling.

The syllabus' sections are divided into units, each of which presents one instructional concern as expressed by a unit performance objective. The units are organized in a three-column format: content, objectives, and teaching suggestions, with a resource list and suggested equipment list appended. The first column, CONTENT, consists of items of instruction — again in a logical, though not necessarily teaching, sequence. The second column, OBJECTIVES, states in performance terms the student achievement which must result from the item of instruction. The third column, TEACHING SUGGESTIONS, presents a variety of methods by which the content may be taught, all intended to stimulate the teacher's ingenuity rather than to be prescriptive.

A local education agency which wishes to grant State credit should keep on file a course of study, based on this syllabus, prepared by the teacher(s) of the offered course(s) in trade electricity-electronics. The first step in this development is to become familiar with the syllabus' content column, adding any items needed for local effectiveness, or, for the specialization sections, deleting that which is not pertinent to local needs. The second step is to realign the content items into a teaching progression tailored to student and teacher characteristics. The third step is to write clear concise performance objectives for each instructional item. The final step is to write tentative methods of teaching the content items — tentative, because the "best" method of teaching any item depends upon the student being taught at a given moment! The resulting course of study is the teacher's set of specifications for effective instruction. As in the trade, however, the "specs" aren't enough — schematic and wiring diagrams are needed. The curriculum equivalent of these diagrams is the lesson plan. While the course of study is a semistatic document, needing revision as course content changes, each teacher must constantly rewrite lesson plans to take advantage of his ever-increasing knowledge of the strengths and weaknesses of each student, and professional understanding of how best to present the instruction's content.

A sample course of study for Section I — Basic Electricity is provided. It is a sample course; one of an infinite number of ways in which the syllabus can be developed. Inclusion of this example in this syllabus should not be construed as provision of a State course of study which can be merely adopted by every local program. It is provided only as an aid to creating the syllabus-based course of study, tailored to local conditions, which is a key to effective occupational education.
Upon completion of this unit the student will be able to identify the safe general work practices, and the employment opportunities, of the electrical-electronics field.

<table>
<thead>
<tr>
<th>CONTENT</th>
<th>OBJECTIVES</th>
<th>TEACHING SUGGESTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Safety</td>
<td>The student should be able to:</td>
<td></td>
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<tr>
<td></td>
<td>List and perform all functions necessary for maintaining a safe school shop.</td>
<td></td>
</tr>
<tr>
<td>Accident Prevention</td>
<td></td>
<td>Develop procedures list.</td>
</tr>
<tr>
<td>Good Housekeeping</td>
<td></td>
<td>Use life examples of need for good housekeeping practices.</td>
</tr>
<tr>
<td>Shop and Industry procedures</td>
<td></td>
<td>Union information sheets.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Safety posters from industry.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Safety films.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Guest speakers from industry and other local organizations; e.g., Fire Department, State Safety Inspector.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Safety orientation should be as brief as effectiveness permits, since safety instruction will be an inherent part of every subsequent unit, as it is taught.</td>
</tr>
</tbody>
</table>
- Personal Apparel
  - Shop requirements
    - Prohibited clothing
      - Jewelry
    - OSHA requirements
  - Safety Equipment
    - Shop requirements
      - Safety glasses
      - Bump helmet
    - Gloves
      - Safety belt
      - Screens
      - Curtains
- Proper Use of Equipment and Tools
  - List the general safe operating procedures common to the use of equipment and tools.

- State reasons why specific types of clothing and jewelry may be hazardous.
- State applicable OSHA requirements.

- Identify all in-shop safety equipment, state the reason for each item and the method of maintenance of each.

- Documented examples; e.g., newspaper clippings, magazine articles.
- Prototype equipment.
- Newspaper clippings.
- Narrative stories.
- Films.
- Posters.

- Tool display.
- Equipment display.
- Demonstrate safe operation of equipment and tools.
- List of general safety procedures.
<table>
<thead>
<tr>
<th>CONTENT</th>
<th>OBJECTIVES</th>
<th>TEACHING SUGGESTIONS</th>
</tr>
</thead>
</table>
| - Proper Use of Chemicals and Solvents
  - Instructions as a guide to proper use
  - Protection of skin and eyes | The student should be able to:
  - List types of chemicals and solvents and describe their uses.
  - Identify precautions to be taken. | Read sample instructions carefully, emphasizing important points.
  - Safety posters.|
|   |   | Safety films.|
|   |   | Newspaper clippings.|
|   |   | Moving and Lifting Equipment
  - Demonstrate correct methods of moving and lifting sample objects. | Films.|
|   |   | Posters.|
|   |   | Guest speakers (e.g., Council on Safety).|
|   |   | Information sheet.|
| - Ladder Safety
  - Ladder types
  - Proper use of each type
  - Setting up and removing | Identify various types of ladder, list the basic rules of ladder safety, and demonstrate proper use. | Films.|
|   |   | Two-man use.|
|   |   | Posting of signs.|
|   |   | Teacher demonstration.|
|   |   | Supervised student practice.|
| - Horseplay
  - Hazards | State "Do Nots" of shop safety in regard to horseplay. | Safety posters.|
|   |   | Safety list displayed. |
Electrical Shock

- Causes
  - Carelessness
  - Rules violations

- Effects
  - Injury
  - Death

- Prevention
  - Shop procedure
  - Industry procedure

- First-Aid

- Fire

- Causes
  - Spontaneous Combustion
  - Unsafe conditions

Identify the common causes and effects of electrical shock.

Narrate stories of electrical shock and its effects.

Newspaper, bulletin board.

Speakers from related fields.

Itemize shock effect on body.

Identify and demonstrate electrical accident prevention procedures.

Develop student-oriented safety program.

Discuss OSHA requirements.

Demonstration of, and student participation in, rescue techniques.

Power company safety man as guest speaker and trainer.

List and describe causes and effects of fires in shop and industry.

Safety posters.

Safety films.

Demonstrate under controlled conditions.
CONTENT

- Effects
  - Life, property, and job loss

- Extinguishers
  - Classification
  - Use
  - Location
  - Maintenance

Employment Market

- Career Opportunities
- Apprenticeship Programs

OBJECTIVES

The student should be able to:

- List the classes of extinguisher and describe the burning materials on which each is used.
- Discuss the broad range of career opportunities in the electricity-electronics field.
- Identify entry requirements and benefits of apprenticeship program.

TEACHING SUGGESTIONS

- Emphasize the cost factor.
- Demonstrate correct extinguisher use on different types of simulated shop fires (outdoors) — Use Fire Department personnel if required.

- Representatives from industry.
- Government publications.
- Newspaper want ads.
- Bulletin board.
- Government publications.
- Union publications.
- Management publications.
- Guest speakers.
UNIT II: ELECTRONS AS CHARGE CARRIERS

Upon completion of this unit the student will be able to properly list and identify the nature of the electron within the atom, and its role as a charge carrier in static and dynamic states.

OBJECTIVES

The student should be able to:

- Identify the most common particles of matter.
- Identify the atomic structure and forces found within the atom.
- Identify the relative mass, weight, and charges of the most common sub-atomic particles.

TEACHING SUGGESTIONS

Project a transparency of the solar system.

Project a transparency of atomic structure.

Illustrate the three methods of electrifying a neutral body.

Illustrate the electrostatic field.

Demonstrate the laws of electrostatics (Pith balls, electroscope).
Dynamic Charges

- Methods of Generating Dynamic Charges

- Conductors, Semiconductors, and Insulators

  - Valence electrons

**OBJECTIVES**

The student should be able to:

- Describe the transfer of electrical energy.
- State the number of valence electrons in conductors, semiconductors, and insulators.
- Identify samples of common conductors and insulators.

**TEACHING SUGGESTIONS**

- Use "falling dominoes" as a simile.
- Project a transparency of a material and its valence electrons, representing each classification.
Upon completion of this unit, the student will be able to correctly identify basic circuit components in relation to each item of the unit's content.

<table>
<thead>
<tr>
<th>CONTENT</th>
<th>OBJECTIVES</th>
<th>TEACHING SUGGESTIONS</th>
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</thead>
<tbody>
<tr>
<td>Sources of EMF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chemical</td>
<td>The student should be able to:</td>
<td>Demonstrate practical concepts of EMF from the listed</td>
</tr>
<tr>
<td>Mechanical</td>
<td>List and describe sources of EMF</td>
<td>sources.</td>
</tr>
<tr>
<td>Heat</td>
<td>and state an application for each.</td>
<td>Films.</td>
</tr>
<tr>
<td>Light</td>
<td></td>
<td>Overhead transparencies.</td>
</tr>
<tr>
<td>Pressure</td>
<td></td>
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</tr>
<tr>
<td>Controls</td>
<td>Explain how a control affects a circuit.</td>
<td>Demonstrate controls and their applications.</td>
</tr>
<tr>
<td>Loads</td>
<td>Explain the transfer of energy from source to</td>
<td>Demonstrate the relationship of loads in the circuit.</td>
</tr>
<tr>
<td></td>
<td>load.</td>
<td></td>
</tr>
<tr>
<td>CONTENT</td>
<td>OBJECTIVES</td>
<td>TEACHING SUGGESTIONS</td>
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<td>-------------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------</td>
</tr>
<tr>
<td>Overcurrent Devices</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Circuit Breakers</td>
<td>The student should be able to:</td>
<td>Demonstrate the function of a circuit breaker using a see-through type.</td>
</tr>
<tr>
<td>- Fuses</td>
<td>Describe the purpose of circuit breakers and fuses.</td>
<td>Show samples of various type fuses.</td>
</tr>
<tr>
<td></td>
<td>Identify a circuit breaker and a fuse.</td>
<td></td>
</tr>
<tr>
<td>Color-Coded Resistors</td>
<td>Select, by color code, resistors of indicated resistive values.</td>
<td>Color code wall charts and information sheets.</td>
</tr>
<tr>
<td></td>
<td>Select, by color code, resistors of specific tolerances.</td>
<td>Emphasize that the color code does not identify the type of components.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EIA system of color coding.</td>
</tr>
</tbody>
</table>
Upon completion of this unit the student will be able to define, and apply in simple circuits, Ohm's, Kirchoff's, and Watt's laws.

<table>
<thead>
<tr>
<th>CONTENT</th>
<th>OBJECTIVES</th>
<th>TEACHING SUGGESTIONS</th>
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<tbody>
<tr>
<td><strong>Ohm's</strong></td>
<td>The student should be able to:</td>
<td>Problem solving.</td>
</tr>
<tr>
<td>- Define E, I, R</td>
<td>Define E, I, and R, state the three forms of Ohm's Law, and solve simple problems using each form.</td>
<td>Dynamic demonstration of simple circuits, with calculations verified by measurements.</td>
</tr>
<tr>
<td>- (I = \frac{E}{R}; E = IR; \frac{E}{I})</td>
<td></td>
<td>Overhead transparencies.</td>
</tr>
</tbody>
</table>

<p>| <strong>Kirchoff's</strong> | State the voltage and current laws, and solve simple problems involving their use. | Problem solving. |
| - Voltage Laws | | Dynamic demonstration of simple circuits, with calculations verified by measurements. |
| - Current Laws | | Overhead transparencies. |</p>
<table>
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<tr>
<th>CONTENT</th>
<th>OBJECTIVES</th>
<th>TEACHING SUGGESTIONS</th>
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</thead>
<tbody>
<tr>
<td>Watt's</td>
<td>The student should be able to:</td>
<td></td>
</tr>
<tr>
<td>$W = E \cdot I$, $W = I^2R$, $W = \frac{E^2}{R}$</td>
<td></td>
<td></td>
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</table>
Upon completion of this unit, the student will be able to apply the underlying theories and technical information to construction of simple circuits.

<table>
<thead>
<tr>
<th>CONTENT</th>
<th>OBJECTIVES</th>
<th>TEACHING SUGGESTIONS</th>
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</thead>
<tbody>
<tr>
<td>Series Circuits</td>
<td>The student should be able to: Demonstrate the single path of the circuit. Demonstrate that current in the circuit is constant throughout the circuit. Translate Kirchoff's law of voltages into truthful equations.</td>
<td>Overhead transparencies. Set up actual circuit demonstrations. Solve sample equation problems on chalkboard.</td>
</tr>
<tr>
<td>Parallel Circuits</td>
<td>List and explain the fundamental characteristics of a parallel circuit. Demonstrate application of Ohm's Law to parallel circuits. Design a simple parallel circuit which will meet specified requirements.</td>
<td>Overhead transparencies. Set up actual circuit demonstrations. Solve sample equation problems on chalkboard.</td>
</tr>
</tbody>
</table>
## SERIES-PARALLEL CIRCUITS

### OBJECTIVES

The student should be able to:

- Determine and verify experimentally, the laws concerning resistance, voltage, and current in a series-parallel circuit.

### TEACHING SUGGESTIONS

- Overhead transparencies.
- Set up actual circuit demonstrations.
- Solve sample equation problems on chalkboard.

## ENERGY SOURCES IN COMBINATION

### Batteries

- Define battery as a source of electrical energy.
- List and identify types of batteries.
- Determine the voltage combinations which result from connecting dry cells in series and in parallel.

### TEACHING SUGGESTIONS

- Use posters and overhead transparencies to show how a simple dry cell is constructed.
- Obtain kits and have students construct, test, and use batteries.
- Demonstrate batteries in series, parallel, and series-parallel connections.
Upon completion of this unit the student will be able to identify and explain magnetism as a field of force.

### CONTENT

**Magnetic Theory**

- Upon completion of this unit the student will be able to identify and explain magnetism as a field of force.

### OBJECTIVES

**The student should be able to:**

- Describe and explain the behavior known as the "Law of Poles" (Gilbert).
- Explain the molecular theory of magnetism.

### TEACHING SUGGESTIONS

- Emphasize terminology.
- Relate back to structure of matter.
- Overhead transparencies and films.

**Permanent Magnets**

- Identify materials that make up permanent magnets.
- List uses of permanent magnets.

**Electromagnets**

- Construct a simple electromagnet.
- Explain Fleming's right-hand rule.
- Cite several uses of electromagnets.

- Demonstrate samples of permanent magnets; i.e., horseshoe, bar, blocks; magnetite, Alnico.
- Use metal shavings to show lines of force.

- Construct a display of the operation of solenoids, bells, relays, and circuit breakers, and explain how electromagnetism works in each.
<table>
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<tr>
<th>CONTENT</th>
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<th>TEACHING SUGGESTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Principles of Electric Generators</td>
<td>The student should be able to: Explain how voltage is generated when a conductor is moved through a magnetic field, or a magnetic field cuts a conductor.</td>
<td>Use a galvanometer to demonstrate generation of electricity through magnetism. Demonstrate a model generator and relate to preceding demonstrations.</td>
</tr>
<tr>
<td>Principles of Electric Motors</td>
<td>List the similarities of an electric generator and an electric motor. Describe the principles of motor action.</td>
<td>Use magnets, loop of wire, and current supply to construct an electric motor and demonstrate its action and principles. Have students construct models of electric motors to study principles of the electric motor.</td>
</tr>
<tr>
<td>Principles of Transformers</td>
<td>Explain the principles of induced voltage. Identify the factors affecting magnitude of induced voltages; i.e., number of turns, strength of magnetic field.</td>
<td>Display and operate various basic types of transformers and explain their differences.</td>
</tr>
<tr>
<td>Relays</td>
<td>Correctly define a relay as a magnetically operated switch. List examples of where relays may be properly used.</td>
<td>Display and demonstrate different types of relays and explain their functions and uses. Films.</td>
</tr>
</tbody>
</table>
Upon completion of this unit the student will be able to demonstrate knowledge of the care and use of batteries as a source of the EMF that moves electrons in a circuit.

<table>
<thead>
<tr>
<th>CONTENT</th>
<th>OBJECTIVES</th>
<th>TEACHING SUGGESTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Types of Batteries</td>
<td><strong>The student should be able to:</strong> Identify primary cells and secondary cells. Identify carbon-zinc, silver oxide, manganese oxide, and mercury cells as primary cells. Identify lead-acid and nickel-cadmium construction as secondary cells.</td>
<td>Provide information sheets, and project transparencies of batteries. Provide a display of actual samples of each type. Construct &quot;simple&quot; cells with use of: coins, blotting paper, and salt solution; a lemon with zinc nail and copper wire.</td>
</tr>
<tr>
<td>Construction</td>
<td>List the components and explain the construction of a &quot;dry&quot; cell.</td>
<td>Show cut-away sections of cells to demonstrate the construction. Show cut-away sections of cells in circuit formation. (Obtain from manufacturer.) Have students construct cells from kits, and test them for voltage and current.</td>
</tr>
<tr>
<td>- Primary cell</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CONTENT</td>
<td>OBJECTIVES</td>
<td>TEACHING SUGGESTIONS</td>
</tr>
<tr>
<td>---------</td>
<td>------------</td>
<td>----------------------</td>
</tr>
<tr>
<td>Storage Battery</td>
<td><em>The student should be able to:</em> List the components and explain the construction of a typical storage battery.</td>
<td>Display &quot;see-through&quot; model of typical lead-acid storage battery.</td>
</tr>
<tr>
<td>Maintenance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary Cell</td>
<td>Explain &quot;shelf-life&quot; and &quot;local action.&quot;</td>
<td>Show a disassembled lead-acid battery and explain the function of the plates and separators.</td>
</tr>
<tr>
<td>Storage Battery</td>
<td>Explain the term &quot;specific gravity.&quot;</td>
<td>Demonstrate the condition of dry cells in various stages of physical deterioration.</td>
</tr>
<tr>
<td></td>
<td>Test a lead-acid battery to determine capacity.</td>
<td>Show why and how &quot;local action&quot; takes place. Discuss its effects.</td>
</tr>
<tr>
<td></td>
<td>Accurately charge a lead-acid battery and measure the capacity of a fully charged lead-acid battery.</td>
<td>Explain the operation of a battery charger.</td>
</tr>
<tr>
<td>Safety</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary cell</td>
<td>Describe the potential danger to equipment resulting from carelessness in inspecting cells.</td>
<td>Show damaged equipment resulting from &quot;leaking&quot; dry cells.</td>
</tr>
</tbody>
</table>
Explain the dangers of over-charging a storage battery.

List all safety precautions necessary in handling and storing the acid used in lead-acid batteries.

Demonstrate the safe method of handling battery acids.

Describe the proper venting of a storage battery being charged, and of the immediate area.

Demonstrate the effects of battery acids upon metals, clothing, wood, and painted surfaces.

Show the proper method of storing and handling battery acid.

Emphasize the importance of prohibiting smoking, electrical discharges, and other fire near lead-acid batteries being charged.
Upon completion of this unit the student will be able to explain and demonstrate the periodic reversal of the direction of current flow.

**OBJECTIVES**

The student should be able to:

- Define a rotating vector.

Describe the period of an AC voltage or current of sine wave form, as a function of a rotating vector.

- Define frequency.

Explain the frequency of an alternating current or voltage.

- Use necessary formulas to calculate the average voltage value.

**TEACHING SUGGESTIONS**

- Explain rotating vector.

- Overhead transparencies.

- Explain frequency.

- Use a basic alternating current generator to explain AC theory in terms of sine wave frequency and cycle.

- Use an oscilloscope to show the "picture" of a sine wave.

- Explain and demonstrate the relationship of the various values.
Use formulas necessary for finding the effective value of an AC voltage or current of sine wave form.

Define and relate effective, average, peak, and peak-to-peak values.
Upon completion of this unit the student will be able to use basic testing equipment.

**CONTENT**

**Voltmeter**
- DC

**Ammeter**
- DC

**OBJECTIVES**

**The student should be able to:**

- Explain how a voltmeter is used to measure potential between two points in a circuit.
- Define polarity as it relates to use of the DC voltmeter.
- Differentiate between the DC voltmeter and the AC voltmeter.
- Explain how an ammeter is used to measure the flow of current in a circuit.
- Define polarity as it relates to ammeters.

**TEACHING SUGGESTIONS**

- Demonstrate the relationship of the voltmeter and pressure gauge.
- Explain the terminology of deflection and linearity.
- Illustrate the technique of using a voltmeter by measuring volts in a two-resistor series DC circuit.
- Demonstrate using the large, double-side demonstration voltmeter.
- Repeat the preceding experiment but use an AC circuit.
- Use the demonstration meter.

- Repeat the preceding experiments, but using the ammeter to measure amperes in a DC circuit.
- Use the demonstration meter.
<table>
<thead>
<tr>
<th>Instrument</th>
<th>Task Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ohmmeter</td>
<td>Describe the difference between AC ammeters and DC ammeters.</td>
</tr>
<tr>
<td></td>
<td>Define nonlinear scale.</td>
</tr>
<tr>
<td></td>
<td>Demonstrate use of ohmmeter.</td>
</tr>
<tr>
<td>V.O.M.</td>
<td>Describe the uses of V.O.M.</td>
</tr>
<tr>
<td>Continuity Testers</td>
<td>Describe the proper and safe use of the continuity tester.</td>
</tr>
</tbody>
</table>

Using the demonstration meter, set up AC experiment with two resistors in series and take current readings.

Demonstrate correct use of the ohmmeter and demonstration meter in the circuits used in the preceding experiments.

Explain the logic and safety precautions for use of all test equipment. Use overhead projector and transparencies of meter movement.

Demonstrate the versatility of the V.O.M. as it relates to aforementioned meters.

Demonstrate several types of continuity testers; i.e., use of the ohmmeter, a dry cell and bulb, a transformer and buzzer.

Show how students may construct their own continuity testers.
Upon completion of this unit the student will be able to identify the proper type and size of wire for a given application, and demonstrate suitable methods of interconnection in electric-electronic circuits.

OBJECTIVES

The student should be able to:
- Identify wire sizes with the aid of a standard American Wire gauge.
- Calculate wire sizes and their current carrying capacities, through the use of tables.
- Demonstrate the proper method of cutting and stripping wire.
- Demonstrate proper methods of splicing and making joints.

TEACHING SUGGESTIONS

- Demonstrate the American Wire gauge system.
- Provide tables stating the capacity of conductors, as rated by the National Electric Code.
- Using tables and wire gauge, demonstrate selection of the wire size required for a specified application.
- Demonstrate the safe and proper use of the electrician's knife.
- Demonstrate methods of making splices and joints in sizes 10, 12, and 14 AWG such as:
  - Western Union Pigtail
  - Tee Tap
  - Fixture
- Demonstrate the proper method of handling and using electrician's pliers.
**Soldering/Desoldering**

Demonstrate correct soldering/desoldering techniques.

Demonstrate the proper methods of using the various soldering tools.

Demonstrate solder types and uses, and flux types and uses.

Have the student solder the splices made in the preceding suggestion.

Demonstrate the uses of various tapes and discuss their characteristics.

**Taping**

Visually identify rubber, friction, and plastic tapes.

**Insulation**

Identify the insulation type and voltage rating of selected cables.

Explain the lettering symbols: T, R, A, H, W, N.

Display the types of insulation and discuss their characteristics.

National Electric Code.

**Circuit Construction**

**Point-to-Point**

Describe various methods of point-to-point wiring used in basic electrical and electronics construction.

Sample display and illustrations of basic wiring.

Sample display and illustrations of basic harnesses.

Sample display and illustrations of Nonmetallic Transmission.

**Harness Construction**

Describe basic harnessing methods.

**Cable**

Describe various types of cable.

Sample display and illustrations of Nonmetallic Transmission (Electronics)
Upon completion of this unit the student will be able to demonstrate safe and proper use of basic hand and power tools used in electrical-electronic construction.

<table>
<thead>
<tr>
<th>CONTENT</th>
<th>OBJECTIVES</th>
<th>TEACHING SUGGESTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identification</td>
<td>The student should be able to:</td>
<td>Demonstrate types of tools.</td>
</tr>
<tr>
<td></td>
<td>Identify by name the basic tools and equipment used in the electrical industry.</td>
<td>Hand out sheets with pictures of various tools. Have student identify each tool by inserting the correct tool name in space provided.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Resource material.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Industrial tool catalogues.</td>
</tr>
<tr>
<td>Selection and Use</td>
<td>Identify the equipment necessary to perform a specified job.</td>
<td>Demonstrate the use of various tools and equipment.</td>
</tr>
<tr>
<td>Maintenance</td>
<td>Describe and perform the required procedures for maintaining tools and equipment.</td>
<td>Demonstrate the maintenance and upkeep of tools and equipment.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Develop student-operated maintenance and inspection methods and schedules.</td>
</tr>
</tbody>
</table>
List safe operating procedures for tools and equipment.

Demonstrate safe operating procedures.

Safety posters.

Develop student-operated safety team.
Upon completion of this unit the student will be able to identify and construct simple electrical-electronic circuits from schematics and from wiring diagrams.

<table>
<thead>
<tr>
<th>CONTENT</th>
<th>OBJECTIVES</th>
<th>TEACHING SUGGESTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>The student should be able to:</td>
<td>Provide samples of each type.</td>
</tr>
<tr>
<td>Schematics</td>
<td>Identify simple drawings as either schematics or wiring diagrams.</td>
<td>Demonstrate the use and advantages of each type, and how each is prepared.</td>
</tr>
<tr>
<td>Wiring Diagrams</td>
<td>Prepare a schematic or wiring diagram of simple circuits.</td>
<td></td>
</tr>
<tr>
<td>Symbols</td>
<td>Identify the symbols common to electricity-electronics.</td>
<td>Demonstrate by drawing a pictorial view of what each symbol represents.</td>
</tr>
<tr>
<td>Interpretation</td>
<td>Transfer information from various drawings to the actual construction of simple jobs.</td>
<td>Demonstrate samples, in mock-up construction, of the various phases of installations.</td>
</tr>
</tbody>
</table>
Upon completion of this unit the student will be able to identify, and relate to, basic recordkeeping procedures.

<table>
<thead>
<tr>
<th>CONTENT</th>
<th>OBJECTIVES</th>
<th>TEACHING SUGGESTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parts Ordering</td>
<td><strong>The student should be able to:</strong> Identify various forms and methods used in parts ordering.</td>
<td>Provide copies of orders from various shops and contractors.</td>
</tr>
<tr>
<td>Material Lists</td>
<td>Prepare accurate and complete material lists.</td>
<td>Present a company's purchasing agent as a visiting resource person.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Provide copies of material lists and daily work sheets.</td>
</tr>
<tr>
<td>Billing</td>
<td>Use various forms for preparing billings.</td>
<td>Provide sample forms.</td>
</tr>
<tr>
<td>Inventories</td>
<td>Identify various inventory procedures by completing provided forms.</td>
<td>Provide sample forms.</td>
</tr>
</tbody>
</table>
RESOURCE LIST

BOOKS

Teacher Reference


Student Reference


**PERIODICALS**


*Electronics Illustrated*. Fawcett Building, Greenwich, Connecticut 06830.

*Electronic Servicing*. Intertec Publishing Corp., 1014 Wyandotte Street, Kansas City, Missouri 64105.


*School Shop*. 416 Longshore Drive, Ann Arbor, Michigan 48107.


**FILMS**

National Electrical Association. 470 Atlantic Avenue, Boston, Massachusetts 02210.

*The electrician*. 

74
Basic electricity as applied to electronic control systems; #50416.

Electrical circuit faults; ref. B., #51358.

Electricity: distribution; ref. B., #60098.

Electricity and magnetism; ref. B., #80834.

Electricity: how it is generated; ref. B., #01136.

Electricity: measurement; #58800.

The electron: an introduction; #01901.

TRANSPARENCIES

Keuffel and Esser Company, Educational Audio Division, 300 Adams Street, Hoboken, New Jersey 07030.

Alternating current (sinewave) — Demonstrates the movement of electrons periodically changing direction.

Atomic structure — Acquaints students with the common structure of most atoms.

Dry cell — Terminology and construction of the secondary cell.

Electron movement — Shows electrons moving.

Law of charges — Demonstrates how some objects are attracted or repelled.

Like poles repel and unlike poles attract — Principle laws of magnetism.

Matter, molecules, and atoms — Successive overlays demonstrating the analogy between water and matter.

Molecular theory of magnetism — Illustrates one approach to the fundamental principle of magnetism.

Ohm's law — Relationship between voltage, current, and resistance.
Parallel circuits — Illustrates concepts associated with parallel circuits.

Parts of a circuit — Familiarizes the students of electricity with the different parts of a circuit.

Series circuits — Illustrates concepts associated with series circuits.

Unbalance cause electrification — Excess and deficiency of electrons creates ions.

Texas A & M University. Vocational Instructional Services. F. E. Box 182, College Station, Texas 77840.

Electrical fundamentals.

3-M Company. Business Products Division, 505 White Plains Road, Tarrytown, New York 10591.

Electricity & electronics. Overhead Transparency Masters.

WALL CHARTS


Parts of a dry cell.

EICO Electronic Instrument Company. 131-01 39th Avenue, Flushing, New York 11352.

IRE-EIA electronic schematic symbols.

Exide Sales. Automotive Division. Box 6266, Cleveland, Ohio 44101.

Parts and assembly of a lead type storage battery.

The automotive storage battery and electrical system.

Graymark Enterprises, Inc. P. O. Box 54343, Los Angeles, Cal. 90054.

Color code.

Electronic formulas.
Electronic schematic symbols.

Soldering.

5-tube radio.

R.C.A. Electronic Components and Devices. 415 So. Fifth Street, Harrison, New Jersey 07029.

Standard unit symbols for electronic engineers.

Sylvania Electric Products, Inc. Emporium, Pa. 15834.

Equations based on Ohm's law.

CATALOGS — AUDIOVISUALS

Coronet Films, Sales Department, 65 E. Southwater Street, Chicago, Illinois 60607.


General Electric Company, Production and Distribution Department, 570 Lexington Avenue, New York, New York 10022.

General Motors Corp., Public Relations Department, Film Library, General Motors Building, Detroit, Michigan 48202.

Indiana University, Audiovisual Center, Bloomington, Indiana 47401.


New York Telephone Company, Program Bureau, Public Relations Department, c/o Local Office.

University of Michigan, Audiovisual Education Center, Ann Arbor, Michigan 48103.

Wayne State University, Audiovisual Utilization Center, Detroit, Michigan 48202.

Western Electric, Public Relations Department, 195 Broadway, New York, New York 10007.
CATALOGS — MATERIALS

Allied Radio Corporation
114 North Western Avenue
Chicago, Illinois 60680

Brodhead Garrett Corporation
4560 East 71st Street
Cleveland, Ohio 44105

Burstein Applebee Company
1012 McGee Street
Kansas City, Missouri 64106

Edmund Scientific Company
300 Edscorp Building
Barrington, New Jersey 08001

EICO Electronic Instrument Company
131-01 39th Avenue
Flushing, New York 11352

Gem Electronics
57 Willoughby Street
Brooklyn, New York 11201

Graymark Enterprises, Inc.
P. O. Box 54343
Los Angeles, California 90054

Harrison Radio Corporation
225 Greenwich Street
New York, New York 10017

Harvey Radio Corporation
103 West 43d Street
New York, New York 49022

Lafayette Radio Electronics
111 Jericho Turnpike
Syosset, New York 11791

Radio Shack Corporation
730 Commonwealth Avenue
Boston, Massachusetts 02117

Howard W. Sams & Co., Inc.
4300 West 62d Street
Indianapolis, Indiana 46206

McGraw-Hill Book Company
1221 Avenue of the Americas
New York, New York 10020

Prentice-Hall Co.
Educational Book Division
Englewood Cliffs, New Jersey 07632
TOOLS, EQUIPMENT, AND MATERIALS

This listing contains only the tools and equipment considered essential to properly instruct a class-group of 20 students in Basic Electricity. Items essential to other modules of the trade electricity-electronics program, or useful but not essential to this module, are not included. Items listed here which are also listed for other modules should not be duplicated in the school supply, unless the respective modules are to be taught concurrently to different class-groups. Class-groups of more than 20 students will, of course, require a corresponding increase in the quantities suggested.

TOOLS

1 set Bits; auger, 1/4 to 1 in.
1 set Bits; drill, fractional
1 set Bits; drill, number
1 set Bits; speed, 3/8 to 1 in.
3 Bender; EMT, 1/2 in.
5 Pryce; ratchet
5 Center Punch
10 Compass; pocket type
5 Drill; portable electric, variable speed, reversible, 3/8 in. capacity
1 Drill Press (optional)
1 set Files; flat, assorted cut
1 set Files; round, assorted cut
1 Fish Tape; 50 ft.
4 Fuse Puller; 70-200 amp., with safety grip
1 Grinder; 7 in. wheels
6 Hacksaw; 12 in. frame
5 Hammer; ball pein, 16 oz.
8 Hammer; curved claw, 16 oz.
8 Hammer; rip claw, 16 oz.
5 Hammer; soft face
1 set Hole Punches; 1/2 to 1 1/4 in.
1 set Hole Punches; 1 1/2 to 3 in.
20 Knife; electrician's
10 Level; torpedo, 12 in.
5 Level; spirit, 24 in.
1 set Nutdrivers
20 Pliers; diagonal side cutter, with insulated handle, 6 in.
20 Pliers; lineman's, with insulated handle, 8 in.
<table>
<thead>
<tr>
<th>Quantity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>Pliers; needle nose, with insulated handle, 8 in.</td>
</tr>
<tr>
<td>4</td>
<td>Pliers; vise-grip type</td>
</tr>
<tr>
<td>20</td>
<td>Pliers; water pump, with insulated handle, 8\frac{1}{2} in.</td>
</tr>
<tr>
<td>1 set</td>
<td>Reamers</td>
</tr>
<tr>
<td>8</td>
<td>Saw; keyhole, 12 in.</td>
</tr>
<tr>
<td>20</td>
<td>Screwdriver; Phillips #1</td>
</tr>
<tr>
<td>20</td>
<td>Screwdriver; Phillips #2</td>
</tr>
<tr>
<td>20</td>
<td>Screwdriver; standard, 4 in. x 1/8 in.</td>
</tr>
<tr>
<td>20</td>
<td>Screwdriver; standard, 4 in. x 1/4 in.</td>
</tr>
<tr>
<td>2</td>
<td>Snips; curved left</td>
</tr>
<tr>
<td>2</td>
<td>Snips; curved right</td>
</tr>
<tr>
<td>6</td>
<td>Snips; straight cut</td>
</tr>
<tr>
<td>20</td>
<td>Soldering Aid; point and fork</td>
</tr>
<tr>
<td>20</td>
<td>Soldering Aid; wirebrush and scraper</td>
</tr>
<tr>
<td>20</td>
<td>Soldering Gun; dual heat, 120 volt, 240 and 325 watt</td>
</tr>
<tr>
<td>4</td>
<td>Soldering Iron; electric, 120 volt, 110 watt</td>
</tr>
<tr>
<td>10</td>
<td>Soldering Pencils; electric, 25 watt</td>
</tr>
<tr>
<td>20</td>
<td>Tool pouch; electrician's</td>
</tr>
<tr>
<td>5</td>
<td>Vise; machinist's, 4 in. capacity</td>
</tr>
<tr>
<td>1</td>
<td>Wire stripper; automatic</td>
</tr>
<tr>
<td>20</td>
<td>Wire stripper; insulated handle</td>
</tr>
<tr>
<td>3</td>
<td>Wrench; adjustable, 4 in.</td>
</tr>
<tr>
<td>3</td>
<td>Wrench; adjustable, 6 in.</td>
</tr>
</tbody>
</table>

**TEST EQUIPMENT**

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Ammeter; 0 to 15-amp.</td>
</tr>
<tr>
<td>4</td>
<td>Ammeter; AC, bench panel, dual scale 0 to 15-amps/0 to 5-amps</td>
</tr>
<tr>
<td>2</td>
<td>Continuity Tester; portable, battery type with buzzer and bulb</td>
</tr>
<tr>
<td>10</td>
<td>Continuity Tester; standard</td>
</tr>
<tr>
<td>10</td>
<td>Galvanometer</td>
</tr>
<tr>
<td>1</td>
<td>Ohmmeter</td>
</tr>
<tr>
<td>1</td>
<td>Oscilloscope</td>
</tr>
<tr>
<td>3</td>
<td>Voltmeter; pocket type, AC, 50 to 300-volts</td>
</tr>
<tr>
<td>10</td>
<td>Voltmeter; portable, 0 to 300-volts</td>
</tr>
<tr>
<td>5</td>
<td>V.O.M.; AC/DC</td>
</tr>
</tbody>
</table>
### MEASURING EQUIPMENT

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Item Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Gage; Standard American Wire</td>
</tr>
<tr>
<td>1</td>
<td>Micrometer; 0 to 1 in.</td>
</tr>
<tr>
<td>10</td>
<td>Rule; steel, 12 in.</td>
</tr>
<tr>
<td>20</td>
<td>Rule; wood, zig-zag, 6 ft.</td>
</tr>
<tr>
<td>5</td>
<td>Tape Measure; 8 ft.</td>
</tr>
</tbody>
</table>

### LAYOUT EQUIPMENT

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Item Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>Scratch Awl</td>
</tr>
<tr>
<td>10</td>
<td>Square; combination</td>
</tr>
<tr>
<td>10</td>
<td>Template; schematic, electrical</td>
</tr>
<tr>
<td>10</td>
<td>Template; schematic, electronic</td>
</tr>
</tbody>
</table>

### MISC. EQUIPMENT

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Item Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ammeter; double-sided demonstration</td>
</tr>
<tr>
<td>1</td>
<td>Autotransformer; variable</td>
</tr>
<tr>
<td>1</td>
<td>Battery Carrier</td>
</tr>
<tr>
<td>10</td>
<td>Belt; safety</td>
</tr>
<tr>
<td>21</td>
<td>Book; electrical code</td>
</tr>
<tr>
<td>1</td>
<td>Bookcase; catalog, code book, manufacturers' data</td>
</tr>
<tr>
<td>1</td>
<td>Charger; storage battery</td>
</tr>
<tr>
<td>5</td>
<td>Curtain</td>
</tr>
<tr>
<td>1</td>
<td>Display Case; project</td>
</tr>
<tr>
<td>1 set</td>
<td>Dominoes</td>
</tr>
<tr>
<td>5</td>
<td>Dynamo; fractional horsepower generator</td>
</tr>
<tr>
<td>5</td>
<td>Dynamo; fractional horsepower motor</td>
</tr>
<tr>
<td>5</td>
<td>Electromagnet</td>
</tr>
<tr>
<td>20</td>
<td>Fire Protective Device</td>
</tr>
<tr>
<td>3 each</td>
<td>Fire Extinguisher; Type A, Type B/C</td>
</tr>
<tr>
<td>1</td>
<td>First-Aid Kit; commercial</td>
</tr>
<tr>
<td>1</td>
<td>Generator; demonstration</td>
</tr>
<tr>
<td>20 pair</td>
<td>Gloves</td>
</tr>
<tr>
<td>20</td>
<td>Helmet; safety</td>
</tr>
<tr>
<td>5 set</td>
<td>Assortment; Magnets; horseshoe, bar, block, and Alnico</td>
</tr>
<tr>
<td>1</td>
<td>Ohmmeter; demonstration</td>
</tr>
<tr>
<td>20</td>
<td>Photoelectric cell</td>
</tr>
</tbody>
</table>
1 Power Supply; portable, DC, 0 to 24 volts/10 amps.
1 Projection screen; 60 in. minimum
1 Projector; combination filmstrip and 2 in. slide
1 Projector; overhead
1 Projector; soundfilm, 16 mm (ready availability)
20 Thermocouple Unit
1 Transformer; isolation
1 Voltmeter; double-sided demonstration, AC/DC
1 V.O.M.; double-sided demonstration
5 Worksta . on; 4-person
3 Bench Test Consoles, equipped with:
   . Ammeter; 0 to 15 amps. and 0 to 5 amps.
   . Ohmmeter
   . Voltmeter; 0 to 300-volts
   . Low-Voltage Set-Up, including —
     Bells and buzzers
     Variable transformer with taps from 4-volts to 24-volts
     Variac, 0 to 150-volts

MATERIAL

24 Balloon
60 Battery; dry cell, carbon zinc
  Battery; lead-acid
  Battery; manganese alkaline
  Battery; mercury
  Battery; nickel cadmium
  Battery; silver oxide
  Assortment 2 Battery; storage, display cut-away
  Assortment 60 Assortment 4 Assortment 2 Assortment 20 Assortment 20 1 4 Assortment 4 Assortment 20 Assortment 1 4 20 88
Assortment

Insulators, various materials

20 Light Socket; 3 volts/150 ma, with bulbs

4 Mat; rubber, 2 ft. x 2 ft. (storage batteries)

3 Motor; display cutaway

5 lbs Nails; zinc, 1½ in.

24 Pith Ball

20 each Resistor; 1-watt color-coded — 1-ohm, 10-ohm, 100-ohm, 150-ohm, 1,000-ohm, 33,000-ohm, 1-megohm

5 Solder; 60/40, 16 ga., 1-lb rolls

5 Solder; Resistor core, 16 ga., 1-lb rolls

5 cans Soldering Paste

20 Switch; on/off

10 rolls Tape; friction

500 yds. Tape; lacing

10 rolls Tape; plastic

10 rolls Tape; rubber

250 Ft. Wire; copper, 14 ga.

250 Ft. Wire; copper, 12 ga.

250 Ft. Wire; copper, 10 ga.

½ rolls Wire; copper, 14/2 with ground

Assortment Outlet Boxes; switch plates; switches; receptacles; covers.
SAMPLE COURSE OF STUDY

This sample course is included as an example of how the syllabus might be developed locally. It is not a suggested State course of study! Each teacher must develop a syllabus-based course of study, selecting format, content sequence, and activities calculated to be most effective under specific local conditions.

<table>
<thead>
<tr>
<th>CONTENT</th>
<th>ENABLING OBJECTIVE</th>
<th>STUDENT ACTIVITY</th>
<th>TEACHER ACTIVITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>COURSE ORGANIZATION (Syllabus Unit-1)</td>
<td>The student should be:</td>
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<tr>
<td>- Instructional Goals</td>
<td>Acquainted with the &quot;Education for employment&quot; nature of the course, and with the various jobs for which the course prepares.</td>
<td></td>
<td>Lecture, followed by questioning and discussion.</td>
</tr>
<tr>
<td>- Daily Routine</td>
<td>Made aware of the behavior patterns required between beginning and end of the school day.</td>
<td></td>
<td>Provide student handbook or handout sheets. Discuss the provisions, including why they are beneficial and necessary.</td>
</tr>
<tr>
<td>- Evaluation</td>
<td>Acquainted with the criteria for evaluating accomplishment, and with the form used for reporting.</td>
<td></td>
<td>Provide copies of the grading scale. Explain what each symbol represents, and how the individual's grade is determined.</td>
</tr>
</tbody>
</table>
The student will be able to:

- List three common causes of fires in school shops and in industry, and the effects of such fires.
- View films and demonstrations on fire safety.
- Show safety films.
- Perform carefully controlled demonstrations.
- Stage "violations" of safe shop conditions.

- Causes

- List the three classes of fire, and describe the combustibles comprising each.
- Classify a list of various burning materials.
- Classify pictures or sketches of various extinguishers.
- Describe the classes of fire, explaining why there are separate classes.

- Extinguishing Equipment

- Identify with 100 percent accuracy, the class of any specified extinguisher.
- Prepare a shop floor plan, indicating locations of fire extinguishers, by type.
- Explain how a particular extinguisher discharges its contents, and how the agent extinguishes by excluding oxygen and/or reducing temperature below the material's kindling point.

- Describe the method of operation of each type extinguisher.
- List in sequence the "Do's and Don'ts" in operating specific extinguishers.
- Demonstrate, or have the Fire Department demonstrate, use of the various extinguishers. Emphasize safety, and the undesirable side-effects of extinguishing agents.

- Evacuation

- Describe shop guidelines for decision on "Report First, or Fight First."
- Describe prescribed evacuation routine.
- Respond to hypothetical discovery of fire while alone, or while with a partner.
- Fire drills.
- Describe conditions under which the student should attempt to extinguish a fire before notifying, or while notifying, the teacher of its existence (local regulations permitting).
<table>
<thead>
<tr>
<th>CONTENT</th>
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</thead>
<tbody>
<tr>
<td>EMPLOYMENT MARKET (Syllabus Unit 1)</td>
<td>The student will be able to:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Career Opportunities</td>
<td>List four career opportunities in the electrical-electronics industry.</td>
<td>Discussion.</td>
<td>Provide excerpts from industry, union, and government publications. Discuss.</td>
</tr>
<tr>
<td>. Trade</td>
<td>List two job titles in each career area.</td>
<td></td>
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<tr>
<td>. Industrial</td>
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<td>. Technical</td>
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<tr>
<td>. Sales</td>
<td></td>
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</tr>
<tr>
<td>Employment Opportunities</td>
<td>Describe the current opportunities in the electricity-electronics field — national, regional, and local.</td>
<td>Survey the &quot;want ads&quot; for items relating to the electricity-electronics industry.</td>
<td>Provide U. S. Department of Labor forecasts. Compare with &quot;want ads.&quot; Discuss.</td>
</tr>
<tr>
<td>. National</td>
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<tr>
<td>. Regional</td>
<td></td>
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<td></td>
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<tr>
<td>. Local</td>
<td></td>
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<tr>
<td>Apprenticeship</td>
<td>List five requirements for entry into an apprenticeship program.</td>
<td>Discuss apprentice program with acquaintances who are union members, and with those who learned the trade without formal apprenticeship.</td>
<td>Provide materials from union and government publications.</td>
</tr>
<tr>
<td></td>
<td>Describe five benefits of membership in an apprenticeship program.</td>
<td>Class discussion of apprentice programs and apprenticeship.</td>
<td>Have official of local union discuss apprenticeship with class.</td>
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<tr>
<td></td>
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<td></td>
<td>Have graduated student, presently serving apprenticeship, talk with the class.</td>
</tr>
<tr>
<td>GENERAL SAFETY (Syllabus Unit 1)</td>
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<tr>
<td>Housekeeping</td>
<td>Perform to industrial standards, all the functions of maintaining a safe shop environment.</td>
<td>Perform the duties indicated on a provided housekeeping checklist.</td>
<td>Emphasize the importance of maintaining a safe shop on the bases of personal benefit, concern for others, and as a factor in keeping a job.</td>
</tr>
<tr>
<td>Procedure</td>
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</tbody>
</table>
Shop Industry

- Apparel
  - Required
  - Prohibited
  - Unregulated

- Basic Tools and Equipment

- Chemicals
  - Solvents

Explain the basis for difference in school and industry requirements.

List applicable OSHA requirements.

List any special school requirements.

Meet all standards of personal apparel before beginning work.

Identify the basic tools and equipment of the trade by name, and state the principal uses of each.

Describe accepted procedure and list any specific rules for safe and efficient use of basic tools and equipment.

Demonstrate safe and proper use of tools and equipment in every instructional procedure.

State the uses of any common trade chemical.

Select any specified trade chemical from shop stockroom.

Evaluate the acceptability of specific housekeeping jobs.

Evaluate the "safe-shop" condition of the facilities, with, and then without, the aid of a checklist.

Match items on a list of required or prohibited apparel with a corresponding list of job hazards.

Name tools and equipment by labeling pictures or sketches.

Select from tool room stock any specified basic tool or equipment.

Select any specified trade chemical from shop stockroom.

Evaluate the acceptability of specific housekeeping jobs.

Evaluate the "safe-shop" condition of the facilities, with, and then without, the aid of a checklist.

Match items on a list of required or prohibited apparel with a corresponding list of job hazards.

Name tools and equipment by labeling pictures or sketches.

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 Match items on a list of required or prohibited apparel with a corresponding list of job hazards.
 Name tools and equipment by labeling pictures or sketches.
 Select from tool room stock any specified basic tool or equipment.
 Select any specified trade chemical from shop stockroom.
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<tr>
<td>Flux</td>
<td>The student will be able to: Identify common trade chemicals by odor.</td>
<td>Match items on a list of trade chemicals with a corresponding list of hazardous characteristics.</td>
<td>Emphasize the importance of not inhaling an unidentified — and possibly corrosive — substance when attempting odor identification.</td>
</tr>
<tr>
<td>Other</td>
<td>Describe accepted procedure in using trade chemicals, and the precautions necessary to avoid undesirable side-effects.</td>
<td></td>
<td>Use news clippings and personal industrial experience to highlight the hazards of careless or improper use of trade chemicals.</td>
</tr>
<tr>
<td>Horseplay</td>
<td>Demonstrate proper procedure in use of trade chemicals.</td>
<td>Each make a list of ten unsafe or distracting horseplay actions. Discuss with classmates.</td>
<td>Maintain a file of student-signed and dated tests on safe and proper use of trade chemicals, which students must pass before being allowed their use.</td>
</tr>
<tr>
<td>Ladders</td>
<td>List, prior to instruction, ten actions of horseplay which he regards as unsafe practices or as distracting or disturbing others.</td>
<td>Match sketches or pictures of ladders with the correct item from a list of names.</td>
<td>Relate incidents from personal industrial experience in which horseplay caused, or nearly caused, serious damage or injury.</td>
</tr>
<tr>
<td></td>
<td>Describe the various types of ladder and the uses of each.</td>
<td></td>
<td>Identify shop ladders by type, indicating points of identification.</td>
</tr>
<tr>
<td></td>
<td>List the &quot;Do's and Don'ts&quot; of ladder safety.</td>
<td></td>
<td>Relate &quot;ladder&quot; stories from industrial experience.</td>
</tr>
</tbody>
</table>
Lifting and Moving

- Properly set up, use, and remove each type ladder.

- Demonstrate proper procedures in lifting or moving equipment and materials.

- Describe the anatomical bases for the prescribed procedures and the problems which may result from improper procedure.

- Demonstrate safe ladder use.

- List the "Do's and Don'ts" of lifting and moving procedures and explain why each is important.

- Apply all rules of procedure when lifting or moving heavy or bulky items.

- Enforce continual observance of safe practice.

- Use visuals wherever possible, especially posters at materials and equipment storage, which show correct procedures.

- Demonstrate, and always personally observe, proper lifting and moving procedures.

- Continually enforce student observance of proper procedures.

ELECTRICAL SHOCK
(Syllabus Unit 1)

- Causes

  - List three common causes of electrical shock.

  - Describe three effects of electrical shock on the human body.

  - Contribute to class discussion of electrical shock — its nature, effects, and causes.

  - Complete a written test concerning the causes of electrical shock, and the effects on the body in terms of burns, unconsciousness and death.

  - Show safety films.

  - Post newspaper clippings.

  - Relate happenings from industrial experience.

- Preventive Procedure

  - Industry

    - Determine from provided OSHA regulations sheets, and describe in detail, eight procedures required to prevent electrical shock in school and industrial situations.

    - List OSHA shock prevention requirements.

    - Show films on shock prevention.

    - Develop a student-oriented safety program.

  - School

    - List school shock prevention regulations.

    - Note the similarity.

    - Drill students in OSHA procedures.
<table>
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<tbody>
<tr>
<td>First-Aid</td>
<td>The student will be able to:</td>
<td>Study the American Red Cross First-Aid manual's section on electrical shock.</td>
<td>Perfect personal First-Aid skills.</td>
</tr>
<tr>
<td></td>
<td>List the symptoms of electrical shock.</td>
<td>Practice First-Aid procedures on simulated injured.</td>
<td>Obtain Red Cross certified First-Aid person to teach shock procedures to the class.</td>
</tr>
<tr>
<td></td>
<td>Describe the &quot;Do's and Don'ts&quot; of first-aid for electrical shock.</td>
<td></td>
<td>Maintain students' skills through unscheduled periodic &quot;shock drills.&quot;</td>
</tr>
<tr>
<td></td>
<td>Demonstrate two techniques in administering standard procedures of first-aid for electrical shock.</td>
<td></td>
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<tr>
<td>CONTENT</td>
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<td>TEACHER ACTIVITY</td>
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<tr>
<td>WIRE</td>
<td>The student will be able to:</td>
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<tr>
<td>(Syllabus Unit 10)</td>
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<tr>
<td>Identification</td>
<td>Determine the numerical size of samples of #14, #12, and #10 TW copper wire.</td>
<td>Use the American Standard Wire gauge to determine size of provided samples.</td>
<td>Demonstrate use of the wire gauge.</td>
</tr>
<tr>
<td>Cutting</td>
<td>Measure and cut wire to within 1/8-inch of a given length.</td>
<td>Use rule and side cutters to obtain lengths needed for a planned construction.</td>
<td>Be alert to student difficulties in use of the rule.</td>
</tr>
<tr>
<td>Stripping</td>
<td>Remove 1-inch of insulation with knife or strippers, without ringing or scoring the wire.</td>
<td>Practice stripping salvaged wire or short pieces to attain skill.</td>
<td>Emphasize safety in use of cutters, and handling wire ends.</td>
</tr>
<tr>
<td>Connecting</td>
<td>Connect given lengths of #14 and #12 TW copper wire with wire nuts.</td>
<td>Select and install the proper size wire nuts.</td>
<td>Use visuals and actual materials in demonstrating these procedures.</td>
</tr>
<tr>
<td>Wire nuts</td>
<td></td>
<td></td>
<td>Emphasize the importance of joining &quot;clean&quot; wire.</td>
</tr>
<tr>
<td>Splices</td>
<td>Join given lengths of #14, #12, and #10 TW copper wire with Tee Tap, Pigtail, Fixture, and Western Union splices, the work being equal in strength to that of the original conductor.</td>
<td>Practice splices first on small lengths, then on circuit mock-ups.</td>
<td>Demonstrate splice-testing methods.</td>
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<td></td>
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<td></td>
<td>Have students save practice splices for soldering practice.</td>
</tr>
<tr>
<td>CONTENT</td>
<td>ENABLING OBJECTIVE</td>
<td>STUDENT ACTIVITY</td>
<td>TEACHER ACTIVITY</td>
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<tr>
<td>SOLDERING (Syllabus Unit 10)</td>
<td>The student will be able to:</td>
<td></td>
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</tr>
<tr>
<td>- Flux</td>
<td>Describe the function of flux in the soldering process.</td>
<td>Select equipment and perform practice soldering operations outlined on job sheets.</td>
<td>Use visuals and actual items in teaching recognition of soldering equipment and materials.</td>
</tr>
<tr>
<td>- Soldering Tools</td>
<td>Differentiate between soldering guns and irons, and between electrical and externally heated irons.</td>
<td></td>
<td>Demonstrate trade procedures in soldering and desoldering such diverse items as electronic components and #10 copper wire.</td>
</tr>
<tr>
<td>- Procedure</td>
<td>Prepare and solder joints on #10 or lighter copper wire, the work meeting trade standards of strength and appearance.</td>
<td>Solder previously made splices.</td>
<td>Emphasize the need for &quot;clean&quot; components.</td>
</tr>
<tr>
<td></td>
<td>Solder and desolder components of electronic circuits.</td>
<td>Remove and replace specified parts of old TV and transistor radios.</td>
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<tr>
<td>TAPING</td>
<td></td>
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</tr>
<tr>
<td>- Types</td>
<td>Identify by sight, samples of each type of tape.</td>
<td>Select and apply tape as outlined on job sheets,</td>
<td>Describe the characteristics of the various tapes which govern selection for specific applications.</td>
</tr>
<tr>
<td>. Rubber</td>
<td>Describe the proper uses of each type tape.</td>
<td></td>
<td>Describe the characteristics of each type, by which it is recognized.</td>
</tr>
<tr>
<td>. Plastic</td>
<td></td>
<td></td>
<td>Demonstrate the techniques of application of the tapes.</td>
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<tr>
<td>. Friction</td>
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</tbody>
</table>
# BASIC ELECTRICITY

## UNIT III — ELECTRONS AS CHARGE CARRIERS

<table>
<thead>
<tr>
<th>CONTENT</th>
<th>ENABLING OBJECTIVE</th>
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<tbody>
<tr>
<td>ELECTRONS WITHIN MATTER</td>
<td>The student should be able to:</td>
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<tr>
<td>(Syllabus Unit 2)</td>
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<tr>
<td>Matter</td>
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<tr>
<td>Elements</td>
<td>Define and differentiate between elements, compounds, and alloys; atoms and molecules.</td>
<td></td>
<td>Use a variety of visuals — charts, transparencies, samples — in discussing the structure of matter. Define all terms.</td>
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<tr>
<td>The Atom</td>
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<tr>
<td>Compounds</td>
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<tr>
<td>The Molecule</td>
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<tr>
<td>Alloys</td>
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<tr>
<td>Atomic Structure</td>
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<tr>
<td>Proton</td>
<td>Define proton, neutron, and electron.</td>
<td></td>
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<tr>
<td>Neutron</td>
<td>Describe the structure of the typical atom, and its two associated forces.</td>
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<tr>
<td>Electron</td>
<td></td>
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</tr>
<tr>
<td>Static Charges</td>
<td>List the three methods used to electrify a neutral body.</td>
<td>Electrify a neutral body by each method.</td>
<td>Demonstrate electrification of a neutral body by contact, conduction, and induction. Use balloons, rubber combs, and pith balls. Discuss the procedures.</td>
</tr>
<tr>
<td></td>
<td>State the laws of charged bodies.</td>
<td>State the laws of electrostatics.</td>
<td>State the laws of electrostatics and relate them to the demonstration.</td>
</tr>
<tr>
<td>CONTENT</td>
<td>ENABLING OBJECTIVE</td>
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<td>TEACHER ACTIVITY</td>
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<tr>
<td>Dynamic Charges</td>
<td>The student should be able to: Explain how dynamic electron charges cause an electrical effect.</td>
<td>Fill a transparent cylinder with balls. Observe and explain the reaction of the balls within the cylinder to insertion of a ball at one end.</td>
<td>Relate to the student activity an explanation of how electrons, as charge carriers, have an effect approaching the speed of light.</td>
</tr>
<tr>
<td>CONDUCTORS, SEMICONDUCTORS, AND INSULATORS (Syllabus Unit 2)</td>
<td>Explain why the valence electrons of a substance determine whether the substance is a conductor, a semiconductor, or an insulator. Name and diagram the structure of an example of each.</td>
<td>Use the periodic table of the elements, or other reference, to list the valence electrons of copper, carbon, and iodine, and classify each according to conductivity.</td>
<td>Explain the relationship of valence electrons to conductivity. Measure the relative resistances of copper, carbon, and iodine to demonstrate the relationship.</td>
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<tr>
<td>CONTENT</td>
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<tr>
<td>ELECTROMOTIVE FORCE</td>
<td><em>The student should be able to:</em></td>
<td>Complete reading assigned texts.</td>
<td>Use transparencies in discussing the sources of EMF.</td>
</tr>
<tr>
<td>(Syllabus Unit 3)</td>
<td>List and describe the five sources of EMF.</td>
<td></td>
<td>Show energy sources film.</td>
</tr>
<tr>
<td>- Sources</td>
<td></td>
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<tr>
<td>. Chemical</td>
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<td>. Mechanical</td>
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<td>. Thermal</td>
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<td>. Pressure</td>
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<tr>
<td>. Light</td>
<td></td>
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</tr>
<tr>
<td>- Applications</td>
<td>State one application for each source of EMF.</td>
<td></td>
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</tr>
<tr>
<td>- CONTROLS</td>
<td></td>
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</tr>
<tr>
<td>- Path</td>
<td>Explain the two general uses of controls in electrical circuits.</td>
<td>Manipulate and describe the functions of various controls wired into a circuit demonstration panel.</td>
<td>Use the circuit demonstration panel to demonstrate the function of controls in changing current paths and conductivity.</td>
</tr>
<tr>
<td>- Conductivity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- LOADS</td>
<td>List and describe three types of loads.</td>
<td>Activate various circuits on a circuit demonstration panel. Identify the types of loads and explain the differences.</td>
<td>Use the demonstration panel to show loads as consumers of electrical energy, as indicated by resulting light, heat, or mechanical motion.</td>
</tr>
<tr>
<td>CONTENT</td>
<td>ENABLING OBJECTIVE</td>
<td>STUDENT ACTIVITY</td>
<td>TEACHER ACTIVITY</td>
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</tbody>
</table>
| **OVERCURRENT DEVICES**  
(Syllabus Unit 3) | The student will be able to: Name and describe the two types of overcurrent protection, and explain their functioning. | Identify the type of protector which reacted to overloads in each of the demonstration board's circuits, and explain the function of each. | Overload the circuits on the demonstration panel to show the functioning of heat and magnetism as excessive current sensors and interruptors. |
| - Fuses | | | |
| - Breakers | | | |
| **RESISTORS**  
(Syllabus Unit 3) | State the purpose of resistors and explain their functioning. | List the nominal range of resistive values of an assortment of color-coded resistors. | Use color-code wall charts in discussing the determination of nominal resistor values and tolerances. |
| - Function | | | |
| - Color-Coding | Determine the nominal value of a resistor by reading its color code. | | Distribute information sheets which describe reading the color code. |
| **WIRE**  
(Syllabus Unit 10) | Use the American wire gage to determine the size of any sample wire. | Use the gage and tables in listing the sizes and capacities of each sample wire in an assorted group. | Demonstrate the use of gage and tables in computing the sectional area of wire. |
| - Sizes | | | |
| - Capacity | Use the tables in calculating the capacity of any sample wire. | | Provide information sheets, and lead the class in practicing computations. |
| **INSULATION**  
(Syllabus Unit 10) | Describe the types of wire insulation. | Use the National Electric Code as a reference in explaining and stating | Demonstrate use of the NEC book as a guide to selection of wires having |
Ratings

Describe the system of voltage-rating of insulation.

Describe the applications of wire whose insulation is marked with the code: T, R, A, H, W, N.

Select one example of each type and rating specified, from an assorted sample.

an application for wire coded: T, R, A, H, W.

Match samples of wire to uses described on a job sheet.

characteristics needed for specific applications.

Distribute job sheets requiring selection of wire, from stock or a sample assortment, which fits the specified application described.
## BASIC ELECTRICITY

### CONTENT

<table>
<thead>
<tr>
<th>TYPES (Syllabus Unit 7)</th>
<th>ENBLING OBJECTIVE</th>
<th>STUDENT ACTIVITY</th>
<th>TEACHER ACTIVITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wet</td>
<td>The student will be able to: Identify by sight, the six types of batteries.</td>
<td>Name each type battery included in a sample assortment, or graphic representation, and state a typical use.</td>
<td>Demonstrate construction of a basic cell from a zinc nail and copper wire inserted in a lemon. Measure the voltage.</td>
</tr>
<tr>
<td>Lead acid</td>
<td>State an application for each of the six battery types.</td>
<td></td>
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</tr>
<tr>
<td>Dry</td>
<td></td>
<td></td>
<td>Differentiate between primary and secondary cells. Discuss inherent factors of economy and convenience of each type, and give examples of efficient uses.</td>
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<tr>
<td>Carbon zinc</td>
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<td>Manganese alkaline</td>
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<tr>
<td>Nickel cadmium</td>
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<td></td>
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<td>Silver oxide</td>
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<td></td>
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<tr>
<td>Mercury</td>
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<tr>
<td>CONSTRUCTION (Syllabus Unit 7)</td>
<td>List the components of a primary cell and explain their functions.</td>
<td>Study cut-away models of cells and graphic representations on which components are identified.</td>
<td>Use cut-away models and transparencies to show the parts of primary and secondary batteries. Explain the functions of the components and discuss the charging capabilities and capacities of each type.</td>
</tr>
<tr>
<td>MAINTENANCE (Syllabus Unit 7)</td>
<td>List the components of a secondary cell and list their functions.</td>
<td>Assemble a primary cell.</td>
<td>Demonstrate battery testing procedures.</td>
</tr>
<tr>
<td></td>
<td>Utilize a check sheet to list maintenance procedure for primary and secondary cells.</td>
<td>Inspect batteries being used in various applications, check off steps in maintenance procedure, and make recommendations for subsequent maintenance.</td>
<td>Explain and demonstrate methods of charging.</td>
</tr>
<tr>
<td>SAFETY</td>
<td>Explain the maintenance procedures listed.</td>
<td>Describe the dangers to health inherent in some batteries, and in the use of batteries.</td>
<td>Describe the potential dangers of equipment damage inherent in specific battery types.</td>
</tr>
</tbody>
</table>
SYMBOLS
(Syllabus Unit 12)

The student will be able to:

- Identify each symbol appearing in a provided identification sheet.
- Match symbols with descriptions on a provided worksheet.

- Identify sample diagrams as being either a wiring diagram or a schematic diagram.
- Draw the symbol for any specified simple circuit component.
- View simple circuits displayed on demonstration board. Prepare schematic and wiring diagrams of the circuits.
- State the uses and describe the advantages of each.
- Prepare diagrams of circuits from specifications.
- Describe the procedure and method of construction of wiring diagrams and schematic diagrams.
- Prepare materials lists from diagrams.
- Convert a provided description of a simple circuit into a schematic diagram and a wiring diagram.

DRAWING TYPES
(Syllabus Unit 12)

- Schematic
- Wiring Diagram

- Match symbols with descriptions on a provided identification sheet.
- Draw the symbol for any specified simple circuit component.
- View simple circuits displayed on demonstration board. Prepare schematic and wiring diagrams of the circuits.
- State the uses and describe the advantages of each.
- Prepare diagrams of circuits from specifications.
- Describe the procedure and method of construction of wiring diagrams and schematic diagrams.
- Prepare materials lists from diagrams.
- Convert a provided description of a simple circuit into a schematic diagram and a wiring diagram.

TEACHER ACTIVITY

- Distribute symbol identification sheets.
- Draw or project a pictorial representation of the circuit part indicated by each symbol.
- Show samples of each type. Describe their differences, and the uses and advantages of each.
- Demonstrate the procedure of constructing each type.
- Distribute a description and list of components for a simple circuit. Have students draw a schematic and a wiring diagram of the circuit.
- Distribute a schematic and wiring diagram of a simple circuit. Have students develop a parts and materials list for the circuit.
### CONTENT
- **SERIES CIRCUITS**  
  (Syllabus Unit 5)

### ENABLING OBJECTIVE
- The student will be able to:
  - Define "series circuit."
  - Describe the path of an electron through a 2-resistor series circuit.

### STUDENT ACTIVITY
- Draw schematics of series circuits from specifications on job sheets.

### TEACHER ACTIVITY
- Draw a schematic on the chalkboard, analyzing the circuit construction.

---

### Ohm's Law  
(Syllabus Unit 4)

### CONTENT
- State Ohm's law and describe the relationship of its three variables.
- Determine and E, I, or R in a 2-resistor series circuit, when the value of two of the three variables is known.

### STUDENT ACTIVITY
- Practice solving problems which verify Ohm's law application to simple series circuits.
- Practice computing total equivalent resistance:
  \[ R_T = R_1 + R_2 \]

### TEACHER ACTIVITY
- Introduce the "Ohm's Law Wheel."
- Demonstrate methods of solving problems.
- Calculate the E, I, and R values of a demonstration series circuit.
- Verify the calculations by measurement.

---

### Kirchoff's Voltage Law  
(Syllabus Unit 9)

### CONTENT
- Describe the relationship stated in Kirchoff's voltage law.

### STUDENT ACTIVITY
- Practice solving problems which verify the statement of the law.

### TEACHER ACTIVITY
- Demonstrate methods of solving problems.
<table>
<thead>
<tr>
<th>CONTENT</th>
<th>ENABLING OBJECTIVE</th>
<th>STUDENT ACTIVITY</th>
<th>TEACHER ACTIVITY</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>The student will be able to:</strong></td>
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<tr>
<td>Determine the value of one unknown voltage drop in a 2-resistor series circuit, where source voltage and remaining drop are known.</td>
<td>Practice solving problems which verify Watt’s law application to simple series circuits.</td>
<td>Demonstrate methods of solving problems.</td>
<td></td>
</tr>
<tr>
<td>Calculate individual and total DC power in a 2-resistor circuit.</td>
<td></td>
<td></td>
<td>Calculate values in a demonstration circuit. Verify the calculations by measurements.</td>
</tr>
<tr>
<td><strong>Power</strong> (Syllabus Unit 4)</td>
<td>State Watt’s law and describe its relationships.</td>
<td>Follows provided schematic or wiring diagrams in constructing simple series circuits, such as a flashlight or a buzzer.</td>
<td>Display sample circuits. Demonstrate construction of various simple series circuits.</td>
</tr>
<tr>
<td><strong>Circuit Construction</strong></td>
<td></td>
<td></td>
<td>Distribute schematic and wiring diagrams for student practice.</td>
</tr>
<tr>
<td>(Syllabus Unit 10)</td>
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</tr>
<tr>
<td>Point-to-Point</td>
<td>Construct a simple series circuit which conforms to a provided diagram, and meets field standards of safety and functioning.</td>
<td>Use meters to measure volts and amperes in series, DC circuits.</td>
<td>Use large, double-side demonstration meter to verify circuit calculations.</td>
</tr>
<tr>
<td>Cable</td>
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<tr>
<td>Harness</td>
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<tr>
<td><strong>Measurement</strong></td>
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<tr>
<td>(Syllabus Unit 9)</td>
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<tr>
<td>Continuity Tester</td>
<td>Identify by name each of the meters in a representative sample and describe its use.</td>
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<tr>
<td>Ohmmeter</td>
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<tr>
<td>Voltmeter (DC)</td>
<td>Demonstrate proper procedure in using each meter.</td>
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</tbody>
</table>
PARALLEL CIRCUITS
(Syllabus Unit 5)

- Ohm's Law
(Syllabus Unit 4)

- Kirchoff's Current Law
(Syllabus Unit 4)

Use each meter to obtain and record accurate measurements of a 2-resistor, series, DC circuit.

Define "parallel circuit."

Describe the various paths of electrons through a 2-branch parallel circuit.

Draw schemes of parallel circuits from specifications on job sheets.

Draw a schematic on the chalkboard, analyzing the circuit construction.

Set up a parallel circuit. Demonstrate the constancy of voltage and division of current in parallel circuits.

Describe the relationship stated in Kirchoff's current law.

Determine any E, I, or R in a 2-resistor parallel circuit, when the value of two of the three variables is known.

Practice solving problems which verify Ohm's law application to parallel circuits.

Practice computing total equivalent resistance:

\[ R_T = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2}} \]

Demonstrate methods of solving problems.

Calculate \( E, I, \) and \( R \) values of a demonstration, parallel circuit.

Verifying calculations by measurement.

Demonstrate methods of solving problems.

Calculate values in a demonstration circuit. Verify the calculations by measurements.

Describe the value of current in one branch of a 2-resistor, parallel circuit, where total current and current value of the remaining branch are known.

Practice solving problems which verify power laws application to parallel circuits.
<table>
<thead>
<tr>
<th>CONTENT</th>
<th>ENABLING OBJECTIVE</th>
<th>STUDENT ACTIVITY</th>
<th>TEACHER ACTIVITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power</td>
<td>The student will be able to:</td>
<td>Practice solving problems which verify power laws application to parallel circuits.</td>
<td>Demonstrate methods of solving problems.</td>
</tr>
<tr>
<td>(Syllabus Unit 4)</td>
<td>Describe the application of power laws to parallel circuits.</td>
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<td></td>
<td>Calculate the individual and total DC power in a 2-resistor parallel circuit.</td>
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</tr>
<tr>
<td>Circuit Construction</td>
<td>Construct a simple parallel circuit which conforms to a provided diagram, and meets field standards of safety and functioning.</td>
<td>Examine variously constructed display circuits.</td>
<td>Display sample parallel circuits.</td>
</tr>
<tr>
<td>(Syllabus Unit 10)</td>
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<tr>
<td>. Point-to-Point</td>
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<td>. Cable</td>
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<tr>
<td>. Harness</td>
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<tr>
<td>Measurement</td>
<td>Demonstrate proper procedure in using each meter in parallel circuits.</td>
<td>Use meters to measure resistance, volts, and amperes in DC parallel circuits.</td>
<td>Distribute information and record sheets.</td>
</tr>
<tr>
<td>(Syllabus Unit 9)</td>
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<tr>
<td>. Continuity Tester</td>
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</tr>
<tr>
<td>. Ohmmeter</td>
<td>Use appropriate meters to obtain and record all E, I, and R values in a 2-resistor, parallel circuit.</td>
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<td>Calculate values in a demonstration circuit. Verify the calculations by meter measurement.</td>
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<tr>
<td>. Voltmeter (DC)</td>
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<td>. Ammeter (DC)</td>
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<tr>
<td>. V.O.M.</td>
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<tr>
<td>SERIES-PARALLEL</td>
<td>Define &quot;complex circuit.&quot;</td>
<td>Draw a schematic of a complex circuit from specifications on job sheets.</td>
<td>Draw a schematic on the chalkboard, analyzing the circuit construction.</td>
</tr>
<tr>
<td>(COMPLEX) CIRCUIT</td>
<td>Describe the various paths of electrons through a 3-resistor, complex circuit.</td>
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<tr>
<td>(Syllabus Unit 5)</td>
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<tr>
<td>Topic</td>
<td>Activity Description</td>
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<tr>
<td>Ohm's Law (Syllabus Unit 4)</td>
<td>Determine any E, I, or R in a 3-resistor, complex circuit when the value of two of the three variables is known. Practice solving problems which verify Ohm's law application to complex circuits.</td>
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</tr>
<tr>
<td>Kirchoff's Voltage and Current Laws</td>
<td>Calculate the values of a 3-resistor complex circuit, where one voltage drop and one branch current are unknown. Practice computing total equivalent resistance. Practice solving problems.</td>
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<tr>
<td>Power (Syllabus Unit 4)</td>
<td>Calculate the individual and total power consumption of a 3-resistor complex circuit. Practice solving problems. Demonstrate methods of solving problems. Calculate values in a demonstration circuit. Verify the calculations by measurement.</td>
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</tr>
<tr>
<td>Circuit Construction (Syllabus Unit 10)</td>
<td>Construct a simple complex circuit which conforms to a provided diagram, and meets field standards of safety and functioning. Examine various display complex circuits. Display sample complex circuits. Demonstrate construction of simple complex circuits.</td>
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<tr>
<td>CONTENT</td>
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<tr>
<td>Cable</td>
<td></td>
<td>Follow provided diagrams in constructing a simple complex circuit.</td>
<td>Distribute schematic and wiring diagrams for student practice.</td>
</tr>
<tr>
<td>Harness</td>
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<tr>
<td>Measurémnt (Syllabus Unit 9)</td>
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<tr>
<td>Continuity Tester</td>
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<tr>
<td>Ohmmeter</td>
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<tr>
<td>Voltmeter (DC)</td>
<td></td>
<td>Use appropriate meters to obtain and record all E, I, and R values in a 3-resistor complex circuit.</td>
<td>Distribute information and record sheets.</td>
</tr>
<tr>
<td>Ammeter (DC)</td>
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<tr>
<td>V.O.M.</td>
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<tr>
<td>ENERGY SOURCES IN COMBINATION (Syllabus Unit 5)</td>
<td>Predict maximum available voltage and current from 1.5-V/10-A</td>
<td>Practice solving problems by calculation. Verify calculations by constructing the circuit and measuring values.</td>
<td>Demonstrate methods of solving problems.</td>
</tr>
<tr>
<td>Batteries</td>
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<tr>
<td>Series</td>
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<tr>
<td>Parallel</td>
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<tr>
<td>Series-Parallel</td>
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<tr>
<td></td>
<td>The student will be able to:</td>
<td>Use meters to measure volts and amperes in DC complex circuits.</td>
<td>Calculate values in a demonstration circuit. Verify the calculations by meter measurement.</td>
</tr>
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<td></td>
<td></td>
<td>Demonstrate proper procedure in using each meter in complex circuits.</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Use appropriate meters to obtain and record all E, I, and R values in a 3-resistor complex circuit.</td>
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</table>

![Diagram of a series circuit with 1.5-V/10-A]
<table>
<thead>
<tr>
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<th>ENABLING OBJECTIVE</th>
<th>STUDENT ACTIVITY</th>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>MAGNETIC THEORY</strong> <em>(Syllabus Unit 6)</em></td>
<td>The student will be able to:</td>
<td></td>
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</tr>
<tr>
<td>- Permanent Magnets</td>
<td>Define and describe &quot;magnetism.&quot;</td>
<td>Match terms with their definitions, on work-sheets.</td>
<td>Emphasize the importance of understanding and correctly using the terminology.</td>
</tr>
<tr>
<td>. Ferrous</td>
<td>Define &quot;permanent&quot; magnet.</td>
<td></td>
<td>Discuss the qualities of ferrous and Alnico magnets, and common uses of each.</td>
</tr>
<tr>
<td>. Alnico</td>
<td>State three common uses of permanent magnets.</td>
<td></td>
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</tr>
<tr>
<td>- Electromagnets</td>
<td>Describe the flux fields created about a conductor — by a single loop; by two adjoining loops; by a coil.</td>
<td>Write a description of the flux fields in an electromagnet of a single loop, two adjoining loops, and a coil.</td>
<td>Demonstrate the effects of magnetism on iron filings and a compass.</td>
</tr>
<tr>
<td>. Construction</td>
<td>State the factors which determine the strength of an electromagnet.</td>
<td></td>
<td>Emphasize that the strength of an electromagnet depends upon the current and on the number of turns of conductor.</td>
</tr>
<tr>
<td></td>
<td>Construct a simple electromagnet which conforms to provided specifications, and field standards of safety and function.</td>
<td>Construct and demonstrate a simple electromagnet.</td>
<td>Distribute job sheets. Have students construct and function-test a simple electromagnet.</td>
</tr>
<tr>
<td>CONTENT</td>
<td>ENABLING OBJECTIVE</td>
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<td>TEACHER ACTIVITY</td>
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<tr>
<td>Uses</td>
<td>The student will be able to:</td>
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</tr>
<tr>
<td>Solenoids</td>
<td>List five commercial uses of electromagnets.</td>
<td></td>
<td>Schedule field trip to industries using electromagnets.</td>
</tr>
<tr>
<td>Relays</td>
<td></td>
<td></td>
<td>Discuss such &quot;hidden&quot; uses as automobile ventilating systems, and house trailer brakes.</td>
</tr>
<tr>
<td>Buzzers</td>
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<tr>
<td>Brakes</td>
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<tr>
<td>Cranes</td>
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<tr>
<td>Principles of Motors and Generators (Syllabus Unit 6)</td>
<td></td>
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</tr>
<tr>
<td>DC</td>
<td>Differentiate between &quot;motor&quot; and &quot;generator.&quot;</td>
<td>Match the parts of the two types of generator, as pictured on a worksheet, with a list of their names.</td>
<td>Demonstrate the operation of a DC generator and an AC generator.</td>
</tr>
<tr>
<td>AC</td>
<td>Name the parts of a DC generator and describe their functions.</td>
<td></td>
<td>Distribute parts/names worksheets.</td>
</tr>
<tr>
<td></td>
<td>Name the parts of an AC generator and describe their functions.</td>
<td></td>
<td>Use magnets, a loop of wire, and a current supply to demonstrate motor and generator principles.</td>
</tr>
<tr>
<td></td>
<td>Describe how a voltage is induced in a conductor moving through a magnetic field.</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Construct a simple model of a motor, which meets field standards of safety and functioning.</td>
<td>Build a motor in conformance to specifications on a provided job sheet.</td>
<td>Operate a demonstration motor in its various configurations.</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>Operate a fractional horsepower motor. Compare with the various configurations of the demonstration motor.</td>
</tr>
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<td></td>
<td>Distribute motor construction job sheets.</td>
</tr>
<tr>
<td>CONTENT</td>
<td>ENABLING OBJECTIVE</td>
<td>STUDENT ACTIVITY</td>
<td>TEACHER ACTIVITY</td>
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</tr>
<tr>
<td>AC THEORY (Syllabus Unit 8)</td>
<td>The student will be able to:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Sine wave</td>
<td>Describe the characteristics of alternating current.</td>
<td></td>
<td>Use a basic AC generator in explaining alternating current theory.</td>
</tr>
<tr>
<td>- Frequency</td>
<td>Construct a sine wave on graph paper when given a rotating vector and values of angles.</td>
<td></td>
<td>Show the &quot;picture&quot; of a sine wave on an oscilloscope.</td>
</tr>
<tr>
<td>- Cycle</td>
<td></td>
<td></td>
<td>Define: Frequency, Cycle, R.M.S., Peak, Peak-to-peak, and Average Voltage Testing.</td>
</tr>
<tr>
<td>CIRCUIT CONCEPTS - RESISTIVE (Syllabus Unit 5)</td>
<td>Determine E, I, or R in a 3-resistor complex circuit by use of Ohm's and Kirchoff's laws.</td>
<td>Practice solving problems which verify application of Ohm's and Kirchoff's laws to an AC complex circuit.</td>
<td>Provide information to students for sine wave construction.</td>
</tr>
<tr>
<td>- Series</td>
<td></td>
<td></td>
<td>Demonstrate methods of solving problems.</td>
</tr>
<tr>
<td>- Parallel</td>
<td></td>
<td></td>
<td>Calculate values in a demonstration circuit. Verify the calculations by measurements.</td>
</tr>
<tr>
<td>- Complex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>POWER (Syllabus Unit 4)</td>
<td>Calculate individual and total AC power consumption in a 3-resistor complex circuit.</td>
<td>Practice solving AC power consumption problems.</td>
<td>Demonstrate methods of solving problems.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Calculate consumption of power in a demonstration circuit. Verify the calculation by measurement.</td>
</tr>
<tr>
<td>CONTENT</td>
<td>ENABLING OBJECTIVE</td>
<td>STUDENT ACTIVITY</td>
<td>TEACHER ACTIVITY</td>
</tr>
<tr>
<td>---------</td>
<td>--------------------</td>
<td>------------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>• MEASUREMENTS (Syllabus Unit 9)</td>
<td>The student will be able to:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Continuity Tester</td>
<td>Measure, then record, all E, I, and R in a 3-resistor complex circuit.</td>
<td>Use pertinent instruments to measure resistance, AC volts, and AC amperes in a complex circuit. Record the values.</td>
<td>Demonstrate the use of instruments in measuring. Calculate the values measured. Compare.</td>
</tr>
<tr>
<td>- Ohmmeter</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Voltmeter (AC)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Ammeter (AC)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- V.O.M.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• PRINCIPLES OF TRANSFORMERS (Syllabus Unit 6)</td>
<td>Describe and explain the concept of induced voltage.</td>
<td>Label the components on a graphic of a transformer.</td>
<td>Display, operate, and explain various types of basic transformers.</td>
</tr>
<tr>
<td></td>
<td>Name and describe the function of each component of a transformer.</td>
<td>Build a transformer in accordance to specifications on the graphic.</td>
<td>Demonstrate input versus output voltages.</td>
</tr>
<tr>
<td></td>
<td>Construct a simple transformer which conforms to provided specifications.</td>
<td></td>
<td>Demonstrate the construction of a simple transformer.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Distribute graphic representation of a transformer with specifications for student construction.</td>
</tr>
<tr>
<td>CONTENT</td>
<td>ENABLING OBJECTIVE</td>
<td>STUDENT ACTIVITY</td>
<td>TEACHER ACTIVITY</td>
</tr>
<tr>
<td>-------------------------</td>
<td>----------------------------------------</td>
<td>----------------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>SUPPLY</td>
<td>The student will be able to:</td>
<td>Select the Parts Order from a group of forms.</td>
<td>Use projected forms in demonstrating the manner of completion.</td>
</tr>
<tr>
<td>(Syllabus Unit 13)</td>
<td></td>
<td>Select the Parts Order from a group of forms.</td>
<td></td>
</tr>
<tr>
<td>- Parts Orders</td>
<td></td>
<td>Prepare an order for parts shown on a provided schematic or wiring diagram.</td>
<td>Provide a selection of forms from which the student must select the Parts Order.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Material Lists</td>
<td>Select the form used for compiling a material list.</td>
<td>Select the Material List from a group of forms.</td>
<td>Demonstrate the sequencing of information required for listing materials.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Prepare a list of materials needed to construct a device or circuit shown on a provided diagram, all entries conforming to field practices.</td>
<td>Provide various forms which the student must select the Material List.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INVENTORY</td>
<td></td>
<td>Complete an inventory, on provided forms, of any specified tool or materials locker, or section thereof.</td>
<td>Use projected forms to demonstrate manner of completion.</td>
</tr>
<tr>
<td>(Syllabus Unit 13)</td>
<td></td>
<td>Select the best procedure for a given inventory task. Complete the inventory on provided forms.</td>
<td></td>
</tr>
<tr>
<td>- Parts and Materials</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CONTENT</td>
<td>ENABLING OBJECTIVE</td>
<td>STUDENT ACTIVITY</td>
<td>TEACHER ACTIVITY</td>
</tr>
<tr>
<td>-----------------------</td>
<td>--------------------</td>
<td>------------------</td>
<td>---------------------------------------</td>
</tr>
<tr>
<td>BILLING (Syllabus Unit 13)</td>
<td>The student will be able to:</td>
<td>Select the form used for billing.</td>
<td>Discuss various inventory procedures.</td>
</tr>
<tr>
<td>Parts and Materials</td>
<td></td>
<td>Record the supplies used and time required to complete a specified job.</td>
<td>Provide inventory forms for student practice.</td>
</tr>
<tr>
<td>Labor</td>
<td></td>
<td>Using current catalog prices and union journeyman wage scale, prepare a billing for the job.</td>
<td>Use a projected form to demonstrate billing.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Provide students with billing forms, supply catalog, union wage scale, and standard overhead rate.</td>
<td></td>
</tr>
</tbody>
</table>

- Discuss various inventory procedures.
- Provide inventory forms for student practice.
UNIT I: ADVANCED ELECTRICITY

Measurement

- Voltage
  - RMS
  - Peak-to-Peak

- Power
  - Single-phase
  - Polyphase

- Power Factor
  - Apparent Power
  - True Power

Phase Relationship

- In Phase

- Lagging

- Leading

Reactance

- Inductive

- Capacitive

- Frequency Effect

Inductance

- Calculation

- Types of Loads

Application

UNIT I Continued

Transformers, Continued

- Core Construction
- Cooling Methods

- Wiring Connections
  - Standard Markings
  - Wye
  - Delta
  - Open Delta
  - Buck and Boost

Generators

- Principles of Operation
  - Magnetic
  - Laws

- Types
  - DC
  - AC
    - Rotating armature
    - Rotating field

- Wiring Connections
  - DC
    - Shunt
    - Compound
  - AC
    - Single-phase
    - Polyphase

- Multiple Units
  - Parallel Operation
  - Synchronization
Calculation
Application

RLC Series Circuits
- Impedance
- Resonance

RLC Parallel Circuits
- Impedance
- Resonance

Power Factor
- Calculation
- Effect
- Power Factor Correction

Transformers
- Principles of Operation
  - Ratios
  - Ratings
  - Polarity
- Types
  - Isolation
  - Autotransformers
- Construction
  - Insulating Materials
  - Windings

- Principles of Operation
- DC Motors
  - Shunt
  - Series
  - Compound
- AC Motors
  - Three-phase
    - Squirrel-cage, induction
    - Wound rotor
    - Synchronous
    - Split-phase
    - Capacitor start
    - Repulsion
    - Universal
    - Shaded-pole
    - Selsyn units
- Motor and Generator Maintenance
  - Test Equipment
    - Meggers
    - Growlers
    - Capacitor testers
    - Prony brake
    - Tachometer
  - Testing
    - Phase balance
    - Dynamometer
  - Mechanical Components
    - Governors
    - Switches
    - Bearing lubrication
- Meters
  - Principles of Operation
  - Use
Appliance Circuit Installation, Continued

- Special Purpose Receptacles

- Fixed Appliance Wiring
  - Oil Burner
  - Water Heater
  - Range

Service Entrance Installation

- Calculations

- Type
  - Weatherhead
  - Cable
  - Masts
  - Underground

- Meter Cabinets

- Service Panels

- Overcurrent Protection
  - Fuses
    - Configuration
    - Performance characteristics
  - Circuit Breakers
    - Types

- Grounding and Bonding

- Subpanels

Surface Raceway Installation

- Selection

- Layout
Wiring Method Selection
- Nonmetallic
- Armored

Box Selection

Switching Circuits
- Line-Voltage
- Low-Voltage

Lighting Fixture Installation
- Type
  - Incandescent
  - Ionized Gas
  - Fluorescent
  - Mercury vapor
  - Other
- Mounting
- Spacing
- Light-Level Computations

Appliance Circuit Installation
- Type
  - Small Appliance
  - Major Appliance
- Cable Selection
  - Armored
  - Metallic
  - Type SE
- Split Circuits
- Fittings
- Bending
- Layout

Electric Heat Installation
- Types
  - Baseboard
  - Unit
  - Radiant
  - Central
- Heat Loss Computation

Heating Control Installation
- Relays
- Thermostats
  - Line-Voltage
  - Low-Voltage

Intercom and Alarm System Installation
- Intercom Circuits
- Alarm Circuits
  - Closed
  - Open
- Sensing Devices
  - Smoke
  - Heat
  - Intruder
Remodeling Wiring
  - Building Construction
  - Supplemental Wiring

Electrical Estimating
  - Material List
  - Labor
  - Overhead

Related Hardware
  - Identification
  - Selection and Use

Related Equipment
  - Hand Tools
  - Power Tools
  - Test Instruments

Code Requirements
  - Type of Code
    - NEC
    - OSHA
    - Local
    - Other

  - Inspection Application
  - Violation Notice

Power Transmission Systems
  - AC Generators
  - Power Plant Wiring – Primary Cable
  - Unit Substation
  - Primary Cable Wiring
  - High Voltage Metering

Polyphase Service Installation
  - Metering Equipment
  - Disconnects
  - Wiring Components

Distribution Equipment Installation
  - Feeder Ducts
  - Power Panels
  - Subpanels
  - Plug-in Duct Systems

UNIT IV: MOTOR CONTROLS

General Principles
  - Purpose

  - Types
    - Manual
    - Disconnect
    - Thermal overload
Rigid Conduit System Installation

- Type
  - Metallic
  - Nonmetallic

- Condulets and Pull Boxes

- Hangers and Supports

- Bending
  - Hand
  - Mechanical
  - Hydraulic

- Cutting and Threading

- Planning and Layout

- Wire Installation
  - Fish Tape and Pullers
  - Lubrication

Transformer Installation and Wiring

- Types
  - Single-phase
    - Autotransfer
    - Isolation
  - Polyphase

- Wiring Connections
  - Parallel Operation
  - Wye
  - Delta
  - Open Delta

- Transformer Vaults and Cabinets

- Control relays
  - Motor starter
  - Overload relays
  - Electronic

- Construction

Manual Motor Control Wiring

- Toggle Switch

- Safety Switch

- Drum Controller

Automatic Motor Control Wiring

- Float Switch

- Pressure Switch

- Temperature Switch

- Hand-off Automatic Control Switch

Magnetic Line-Voltage Starter Wiring

- Sizes

- Selection and Application

Pilot Control Device Wiring

- Selector Switch

- Pushbutton Station
  - Single Station
  - Multiple Station

158
Pilot Control Device Wiring, Continued

- Pilot Lights
- Timing Relays
- Phase-Failure Relays
- Phase-Reversal Relays
- Limit Switches

Reduced-Voltage Starter Wiring

- Resistive and Reactive Starters
- Autotransformer Starters
- Start Winding
- Wye-Delta

Multispeed Controllers

- Separate Winding Starter
- Consequent Pole Starter

Wound-Rotor Control Wiring

- Manual Speed Control
- Automatic Speed Control

Synchronous Motor Control Wiring

- Pushbutton
- Automatic Time Synchronizing

Related Drawings

- Symbols
  - NEMA
  - ASA
- Schematic Diagrams
- Wiring Diagrams
- Target Tables

Code Requirements

- NEC
- NEMA
- OSHA
- Local
- Other
Manual Faceplate Starter
  - Three-point
  - Four-point

Manual Speed Control
  - Above Normal Speed
  - Below Normal Speed

Automatic Motor Control Wiring
  - Counter E.M.F.
  - Voltage-Drop Acceleration Control
  - Series Relay Acceleration

Deceleration Control Wiring
  - Electric Brakes
  - Dynamic Braking
  - Plugging

Motor Drives
  - Belts and Pulleys
    - Belt Sizes
    - Multiple Belt Drive
    - Pulley Ratios
  - Flexible Coupling
    - Selection and Use
    - Alignment
  - Gear Motors
  - Variable Frequency
  - Magnetic Clutches
  - DC Variable Speed Control
UNIT I: AC-DC ELECTRONICS

Network Theorems

- Bridge Circuit
- Two-Generator Circuit
  - Loop
  - Superposition
  - Thevenin's
  - Norton's

DC Meters

- Meter Movement
- Calculation and Construction
  - Multipliers
  - Shunts
- Ohmmeter

Inductance

- Circuits
  - Inductors in Series
  - Inductors in Parallel
- Calculations
  - Reactance
  - Impedance
  - Power Factor
- Phase
  - Calculation
  - Measurement (scope)
- Plotting Vectors

UNIT I Continued

Resonance, Continued

- Calculations
  - Impedance
  - Resonance Frequency
  - Q
  - Bandwidth

Generators and Motors

- Single-Phase Types
  - Calculations
    - Percent Regulation
    - Three-Phase Circuits
      - Voltage
      - Current
      - Power

Drafting

- Electrical-Electronic Drawing
  - Two- and Three-View Drawings

UNIT II: ACTIVE DEVICES

Tubes and Semiconductors

- Emission and Transconduction Measurement
- Ohmmeter Measurement of Semiconductors
- Gain Measurement of Transistors
Capacitance

- Circuits
  - Capacitors in Series
  - Capacitors in Parallel

- Calculations
  - Reactance
  - Impedance
  - Power Factor

- Phase
  - Calculation
  - Measurement (scope)

- Plotting Vectors

Time Constants

- RC and RL Circuits

- Time Calculations
  - Charging
  - Discharging

Complex Numbers for AC Circuits

- Rectangular Coordinate System

- J-Operator

- Polar Coordinate System

Resonance

- RLC Circuits
  - Series
  - Parallel

- Types of Devices
  - Vacuum Tubes
    - Diode
    - Triode
    - Tetrode
    - Pentode
    - Pentagrid converter
  - Semiconductors
    - Diode
    - Bipolar transistor
    - FET
    - Unijunction transistor
    - Zener diode
    - SCR

- Plotting Load Line
  - Tube
  - Transistor

- Constructing Circuits Using IC Chip

Power Supplies

- Component Types
  - Tube
  - Semiconductor

- Circuit Types
  - Half-wave
  - Full-wave
  - Bridge
  - Voltage Doubler
  - Zener Regulated Supply

- Calculations
  - Ripple Frequency
  - Percent Regulations

- Troubleshooting Power Supplies
UNIT II  Continued

Power Supply Filter

- Types
  - Resistive
  - L-C

- Troubleshooting Filter Systems

Audio

- Component Types
  - Transistor
  - Tube

- Calculating Gain

- Plotting Frequency Response

- Troubleshooting Audio

Second Detector

- Troubleshooting AVC

- Troubleshooting Detector

IF

- Gain
  - Calculating
  - Measuring

- Troubleshooting, Using RF Generator

Oscillator

- Basic Types

UNIT IV:  FM & TV

TV Antenna Systems

- Types of Antenna

- Types of Lead-In

- Mounts

- Grounding

- Troubleshooting

FM and Black & White TV

- FM Receivers
  - Mono Alignment and Troubleshooting
    - Detector
    - IF
    - Limiter
    - Front end
    - AFC
    - Tuning indicators
  - Stereo Alignment and Troubleshooting, Using Multiplex Generator
    - Multiplex decoder
    - Stereo indicator
    - Channel separation

- TV Service Adjustments
  - Vertical Linearity
  - Height
  - AGC
  - Other

- Picture Tubes
  - Testing
  - Rejuvenating
  - Replacing
  - Safety
Measuring Frequency
- Scope
- Frequency Counter

Troubleshooting AM Front End

Aligning

Troubleshooting

Troubleshooting AM Radio

UNIT III: INDUSTRIAL ELECTRONICS

Gas and Vapor Filled Tubes
- Thyratron
- Mercury Vapor
- Ignition

Polyphase Rectifiers
- Three-Phase
  - Half-wave
  - Full-wave
- Phase Shift Control

Photoelectric Devices
- Photoconductive
- Photoelectric
- Photosensitive
  - Transistor
  - Tube
- Tuners
  - Cleaning
  - Adjusting Oscillator Coils
  - Aligning, Using Sweep Generator
  - Troubleshooting

Video, Video Detector, and AGC
- Measuring Video Output
  - Gain
  - Response
  - Troubleshooting
  - TV Analyst
  - Scope
- Audio
  - Measuring Frequency Response
  - Troubleshooting
    - Amplification
    - Output
- IF
  - Alignment, Using Sweep Generator
  - Troubleshooting

Vertical Sweep
- Measuring Frequency
- Troubleshooting, Using TV Analyst
  - Vertical Sync
  - Vertical Output
- Synchronization
  - Vertical
  - Horizontal

Horizontal Oscillator
- Measuring Frequency
- Troubleshooting

High-Voltage Supply
- Circuits
UNIT IV Continued

Photoelectric Devices, Continued
High Voltage Supply, Continued

- Horizontal output
- Damper
- High-Voltage rectifier
  - Circuit Components
  - Yoke
  - Flyback
- Troubleshooting
  - Using probe
  - Using analyst

- Low-Voltage Supply

- Remote Controls
  - Transmitter
    - Electrical
    - Mechanical
  - Receiver

- Troubleshooting Black & White TV

Color TV

- Picture Tube Set Up
  - Black & White Adjustments
    - Height
    - Width
  - Centering
  - Purity Adjustment
  - Static Convergence
  - Dynamic Convergence
  - Black & White Tracking

- Color CRT
  - Testing
  - Rejuvenating

UNIT V Continued

Gating Circuits, Continued

- Construction
  - Truth Table
- Circuits, Using Transistors and IC Chip
  - Transistors and IC Chip
  - On Trainer

- Troubleshooting

Flip-Flops

- Types
  - S-R
  - J-K

- Construction
  - Transistor
  - IC Chip
  - Trainer

- Counters

- Shift Register

- Verifying Timing Diagrams

- Troubleshooting
  - Counters
  - Shift Register

Computer Programming and Service

- Program Language
  - Machine
  - Basic

- Peripheral Equipment
Replacing
– Safety

Field Alignment of Color Circuits
– Oscillator
– Phase
– Burst

Troubleshooting Color Circuits

Color High-Voltage Supply
– Regulator
– Adjustment
– Safety

Troubleshooting Color TV

UNIT V: DIGITAL ELECTRONICS

Gating Circuits
– Gates
  – AND
  – OR
  – NAND
  – NOR
  – Inverter
  – Emitter Follower

Circuit Reduction
– Boolean Algebra
  – Karnaugh Map

Converting Between Systems
– Binary
  – Octal
  – Decimal
  – Hexadecimal

Memory
– Core
– Chip

Troubleshooting
– Logic Probe
– Scope

UNIT VI: COMMUNICATIONS

Transmitter, Receiver, Transceiver Types
– FM
– AM
– SSB

FCC Requirements

Antenna Systems
– Types
– Installation
– SWR