ABSTRACT

Units of instruction at four levels are designed for use by teachers preparing industrial arts courses in electricity and electronics in junior high and high school. Exploring Electricity-Electronics introduces the subject with attention to circuits, laws, and applications. Basic Electricity-Electronics covers batteries, magnetism, transformers, residential wiring, and other subjects. The Communications Electronics level goes into such things as vacuum tubes, amplifiers, and semiconductors. Industrial Electronics is concerned with microwave and computer systems. Each level suggests textbooks, reference books, films, and filmstrips, with suppliers’ addresses. Appendixes list sources of materials and information, a suggested supply list for each level, and a 101-item bibliography. (MS)
CURRICULUM GUIDE FOR
INDUSTRIAL ARTS
EDUCATION

MISSOURI STATE DEPARTMENT OF EDUCATION

ELECTRICITY - ELECTRONICS

ARTHUR MALLORY
COMMISSIONER OF EDUCATION

FILMED FROM BEST AVAILABLE COPY

INDUSTRIAL ARTS
ELECTRICITY-ELECTRONICS

A CURRICULUM GUIDE
FOR
INTERMEDIATE AND SECONDARY LEVEL
PROGRAMS

1972 EDITION

MISSOURI STATE DEPARTMENT OF EDUCATION

ARTHUR MALLORY
COMMISSIONER OF EDUCATION

JEFFERSON CITY, MISSOURI
Photographs courtesy of
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Lee's Summit High School
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This curriculum guide was formulated by a committee under the auspices of the Missouri Council for Industrial Arts Education. In preparing and publishing this curriculum guide, the appointed committee, cooperating with supervisory personnel of the State Department of Education, worked toward the goal of initiating and improving electricity-electronics instruction in Missouri.

This guide is designed to aid teachers in establishing course objectives and course content, as well as planning teaching methods and evaluation procedure.

It is intended that the individuals and groups that review and use this publication will find the suggested content, activities and teaching aids presented in a manner that will enable the user to adopt or adapt them in a meaningful manner.

The background experiences of the members of the committee in electricity-electronics included a variety of teaching experiences and educational qualifications so necessary in formulating a functional publication of this type. Their donation of time and effort indicates the importance they place on electricity-electronics in industrial arts and in the overall education program. Special recognition also goes to the state and national professional industrial education organizations whose materials were reviewed.

Arthur T. Malloy

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FOR DEVELOPING
THE GUIDE FOR
INDUSTRIAL ARTS ELECTRICITY-ELECTRONICS

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I would like to take this opportunity to express my deepest appreciation to those people who have given of their time to help with this project. I would especially like to thank the members of my committee who have spent tireless hours working on the curriculum guide. The other individuals who have spent many hours working on this guide are too numerous to mention. Some of these people are those who took time to answer our questionnaires, offered suggestions, and supplied information to our committee. Then there are the people who read and corrected the material and did all the typing and other clerical duties which were required. Without the help and cooperation of all of these people, this project would not have been possible.

The biggest debt of thanks should go to the State Department of Education and to Mr. Brightwell who originated this project. Without men in the State Department of Education who see the need for improvement in education, there would not be the opportunity for improvement.

To all these people, a heartfelt thank you for a job well done.

James D. VanBlarcum, Chairman
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INTRODUCTION

We are living in what future historians may call the age of electricity-electronics. The impact that electronics is having on almost every phase of our daily lives is tremendous, and the future holds even greater possibilities. Electronics is now one of the largest industries in the United States, and if present trends continue, it will soon be the largest by its integration into other industries. With this in mind, the student can no longer afford to wait until he has completed high school to begin his electronics training.

In this new age, there is an urgent and immediate need for engineers, technicians, skilled workers, sales and service people, and teachers in the electricity-electronics field. Even the general public, today's consumer, can benefit greatly from the knowledge of and the ability to safely and correctly use electricity and electronics products.

While the terms electricity and electronics are used synonymously, they actually designate two areas within the same field. Electricity refers to the flow of current through wires, coils, and resistors; electronics refers to the flow of current through vacuum tubes and semiconductor devices. Although these areas are closely related, a knowledge of basic electricity is necessary to understand electronics.

This curriculum guide is designed to aid the instructor in developing a more complete course of study and in presenting a more consistent electricity-electronics program for intermediate and secondary school students in the state of Missouri. Each teacher using this guide should make adaptations to meet his teaching conditions and classroom facilities.

Consequently, the main purposes of the school then are to provide the knowledge and learning experiences that will prepare the student for his place in modern society. This learning involves stimulating the student's interest, his creative ability, his productivity, and his development of safe work habits. Since there is an almost universal use of electricity and electronics today, the school must include for our boys and girls adequate instruction in this field.
POINT OF VIEW AND OBJECTIVES
POINT OF VIEW AND OBJECTIVES

A principal purpose of American education is to assist each individual in his development as a productive member of society. The achievement of this purpose enables him to provide for his basic needs, to produce more than he consumes, and to contribute more than he receives. It also involves the development of ideals and goals, the acceptance of social responsibility, and the acquisition of desirable character traits.

Behavioral changes within the individual are affected through experiences and the interpretation of these experiences. The experiences provided by the school permit one to acquire the skills and knowledges which allow the individual to develop to his maximum potential with profit to himself and society. The learner's interpretation of these educational experiences provide for the further development of desirable character traits which lead to the wise application of the acquired skills and knowledges.

Industrial arts contributes to the purpose of American education by aiding individuals as they gain an understanding of their industrial-technological environment. In order that each individual may understand and learn to exercise some control over this environment, experiences in industrial arts must be an integral part of the overall educational program for all students, both boys and girls, and should be available at all grade levels. The importance of this experience is recognized in Missouri where credit in the practical arts, which includes industrial arts, is a secondary school graduation requirement.

Industrial arts education provides an opportunity for individuals to participate in direct experiences involving industrial skills and processes which fosters an awareness of industry in American culture. These experiences are concrete, meaningful, and educational as they aid the individual in understanding abstract ideas. These experiences provide opportunity for an individual to apply mathematics, science, art, language arts, and other school subjects in purposeful situations.

Through the application of grouping and special instructional techniques, industrial arts in the secondary school can be organized to meet the needs of students of varying abilities. Individuals expecting to enter professional occupations as well as future industrial workers should benefit from industrial arts experiences. The need for industrial arts instruction has little relationship to the economic status of the student. Every person must be aware of and familiar with the concepts taught in industrial arts education if he is to live effectively in our industrial society.

Industrial arts education aids in the discovery and development of personal interests, aptitudes, creative thinking and technical abilities. Responsible and resourceful actions and judgments are matured through problem solving and self-expression in an environment related to industry. The future scientist or engineer may learn to solve technical problems, and the future technician or craftsman may develop skills and related understandings in industrial arts courses.

Realistic objectives, clearly stated, are essential to a sound program of industrial arts education. The following statements of purpose are fundamental to quality industrial arts education as it provides opportunities for students to:
Develop an insight and understanding of tools, machines, materials, and processes as they relate to the production and servicing aspects of industry.

The field of industrial arts education is concerned with the study of materials and processes of industry and the creative use of design. Students of industrial arts education have an opportunity to gain a better understanding of mass production, automation, and other industrial methods if they actively participate in meaningful experiences dealing with the manufacturing of consumer goods, utilization and generation of energy as well as the servicing, testing, and repairing of industrial products.

Discover and develop abilities, aptitudes, and interests related to the technical pursuits and applied sciences.

Opportunities for students to have experiences which assist in the discovery of abilities and to develop their potentialities to the fullest is essential to the basic education of all youth. Allowance for differences of abilities, interests, and needs should be incorporated into the curriculum offerings so the student can better assess his abilities and interests for making an occupational choice, understanding his environment, and preparing himself to meet the changing demands of a technological society.

Develop basic skills in the safe and proper use of industrial materials, tools, machines, and processes.

Students are provided with experiences which help them develop basic skills relevant to industrial production; and servicing through these experiences, students gain a basis for making occupational choices. In addition, the skills provide a basis for a specialized occupational preparation. Many workers of the future will be required to train and retrain for different occupations during their lifetime. Fundamental skills and knowledge in diversified areas is most essential if this retraining is to be accomplished in an efficient manner.

Develop problem-solving and creative abilities relating to the tools, machines, materials, processes, and products of industry.

The industrial arts education program provides opportunities for solving various types of technical problems through experimentation and research as well as project planning and construction. The industrial arts laboratory setting provides an environment which makes possible a concrete, understandable approach to teaching problem-solving and critical thinking. Problem-solving in industrial arts education involves creative thinking and provides experiences which allow students to find solutions to problems and to evaluate the effectiveness of these solutions.

*Taken from the Handbook for Industrial Arts Education, Missouri State Department of Education, 1969.*
Photographs courtesy of Trenton Junior High School
EXPLORING ELECTRICITY - ELECTRONICS

Exploring Electricity and Electronics is intended for use as a guide by teachers and administrators preparing industrial arts curriculums on the junior high school level. It should be remembered that in most cases this will represent the student's first formal opportunity for experiences in this area. It is important, therefore, that these experiences be such that his interest is awakened and his curiosity aroused, and that he be given an opportunity for exploratory manipulative experiences with as many devices and concepts as his maturity and ability may warrant.

While some degree of uniformity in industrial arts programs is desirable, it is recognized that this may not always be possible. This guide is therefore prepared with a certain amount of flexibility in mind. Instructors may achieve this flexibility by varying the emphasis placed on certain units of instruction and by varying the degree and kinds of student experiences in these units. Instructors desiring greater emphasis in the area of electricity-electronics will find sufficient material in this guide to meet their needs.

While sequence of instructional units and course content is often a matter of individual preference, it is felt that this guide is so arranged as to enable the instructor to direct the student activities in a meaningful and logical manner. Experiences arranged in the sequence suggested will allow for progression from elementary to more advanced concepts, with each unit laying a foundation of knowledge for the units that are to follow.

SPECIFIC OBJECTIVES
FOR EXPLORING ELECTRICITY - ELECTRONICS

To develop in each individual the ability to read and interpret elementary electrical drawings.

To develop in each individual an awareness of electrical hazards and the habit of proceeding in a manner which will avoid these hazards.

To develop in each individual an interest in and awareness of electric devices and concepts.

To develop in each individual an understanding of basic electrical concepts.

To develop in each individual an awareness and knowledge of the occupations and opportunities in the field of electricity-electronics.

To develop in each individual an awareness of the implications which this industry has for his future.
## PART I

### EXPLORING ELECTRICITY-ELECTRONICS

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<tr>
<td>1. The electron and the atom.</td>
<td>Draw diagrams of several simple atoms and label the particles.</td>
<td>Use transparencies or charts to explain theory of atomic structure.</td>
<td>BKS Teaching Chart #EC-1.</td>
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<td>Film 4-&quot;A&quot; is for Atom.</td>
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<td>Draw diagrams of an atom to show positive, negative and neutral conditions.</td>
<td>Demonstrate laws of electrical charges.</td>
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<td>2. Forms of electricity.</td>
<td>Use fur, cloth and rods to produce static electricity.</td>
<td>Demonstrate ways to make static electricity.</td>
<td>Film 15-Electricity For Beginners.</td>
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<td></td>
<td>Experiment with an electroscope.</td>
<td>Demonstrate the use of an electroscope.</td>
<td>Film 19-Static Electricity.</td>
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<td>Study the effects of static electricity.</td>
<td>Discuss industrial applications of static electricity.</td>
<td>Film 21-Electrostatics.</td>
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<td>Use a telephone generator and an argon lamp to produce alternating current and study its action.</td>
<td>Show alternating and direct current patterns with an oscilloscope.</td>
<td>Film 12-Current and Electromotive Force.</td>
</tr>
<tr>
<td>3. Electrical quantities.</td>
<td>Learn the meaning of the terms voltage, current and resistance, and briefly study their relationship.</td>
<td>Discuss voltage and current definitions and relationships.</td>
<td>Film 11-Conductors and Semi-Conductors.</td>
</tr>
<tr>
<td>4. Sources of electric energy.</td>
<td>Use actual devices to briefly discuss and describe the various sources of electric energy.</td>
<td></td>
<td>Telephone generator &amp; Argon bulb in socket mounted on board.</td>
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### 6. Resistors and semiconductors.

- Use an ohmmeter to study the conductance of various materials and self.
- Make lists of conductor and non-conductor materials.
- Use an ohmmeter to study silicon diodes for forward and reverse effect.
- Use an ohmmeter to study resistive materials.
- Use knowledge of color coding to determine resistance of various resistors and check with ohmmeter.
- Use bar magnets to study laws of magnetism.
- Study lodestones and learn why they became magnetized.
- Use bar and horseshoe magnets to study field patterns with iron filings.
- Demonstrate the use of an ohmmeter.
- Show examples of various materials used as conductors and non-conductors.
- Show flow of electrons through a conductor with mock-up or animation.
- Discuss semi-conductor materials and their characteristics.
- Demonstrate factors which affect resistance.
- Introduce students to resistors and show how resistance changes with color coding.
- Discuss atomic theory of magnetism.
- Use chart to show how magnetized and demagnetized steels differ in atomic structure.
- Using a coil operating on AC voltage, show how to demagnetize a horseshoe magnet.

### Sample materials (conductors) mounted on boards.

- Mock-up or model, using marbles.
- Several silicon diodes.
- Sample resistive materials mounted.
- Pocket color code cards.
- Large color code chart.
- Bar magnets and lodestones.
- BKS Teaching Chart EC-1.
- Film 30-Magnetism.

A large shop-made electromagnet with extra outside cores and coils and provisions for AC & DC hook-up is essential for this course.
<table>
<thead>
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<th>COURSE CONTENT</th>
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<th>TEACHER ACTIVITIES</th>
<th>INSTRUCTIONAL AIDS</th>
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<tr>
<td>2. Electromagnetism.</td>
<td>De-magnetize and magnetize a horseshoe magnet. Learn technology of magnets and magnetic fields. Use a hollow core electromagnet with removable soft iron and steel cores to discover residual magnetism. Study field effects of electromagnet operating on both AC &amp; DC voltage. Try to hold a piece of aluminum on shop-made electromagnet operating on AC voltage. Determine factors affecting the strength of an electromagnetic field.</td>
<td>Using a coil operating on DC voltage, show how to re-magnetize a horseshoe magnet. Demonstrate broken magnet effect. Discuss electron theory of electromagnetism. With a compass and DC voltage, show field around current-carrying wire. Show how polarity is determined. Discuss field effects around a coil.</td>
<td>Film 29-Magnetic Effects of Electricity. Film 22 - Electromagnets: How They Work.</td>
</tr>
<tr>
<td>3. Heating effects.</td>
<td>Experiment with nichrome wire and DC voltage to produce heat. Determine the factors which influence the amount of heat a wire will produce. Examine the construction of commercial heating elements.</td>
<td>Explain the characteristics of nichrome and other resistive conductors. Demonstrate how heat from a wire varies with length, voltage and size.</td>
<td>Film 23-Heat &amp; Light From Electricity. Various lengths of nichrome wire of different diameters. A collection of commercial elements.</td>
</tr>
<tr>
<td>4. Lighting effects.</td>
<td>Become familiar with the different kinds of lamps, their operation and uses.</td>
<td>Show examples of the different kinds of lamps, discuss operation and uses.</td>
<td>Film 28-Infrared.</td>
</tr>
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</table>
Common DC Circuits.

I. Electrical symbols.

1. Draw symbols for the common electrical components.

2. Use a component identification board to learn to match component with symbol.

II. Wiring Diagrams.

2. Draw wiring diagrams of low voltage series and parallel lamp circuits and wire these circuits.

3. Learn the characteristics of a series circuit.

4. Learn the characteristics of a parallel circuit.

5. Wire different flashing neon lamp circuits from diagrams, in progressive order of difficulty.

III. Series-parallel circuits.

1. Discuss the importance of electrical symbols and why they are used.

2. Use "flash cards" to assist students in learning to recognize symbols.

3. Discuss the structure of series and parallel circuits.

4. Demonstrate how current and voltage behave in series.

5. Demonstrate how current and voltage behave in parallel.

6. Discuss characteristics of neon lamp circuits and how they operate.

IV. Basic Electrical Measurements.

1. Volts.

2. Become familiar with the terms "EMF," "voltage," & "source voltage."

3. Learn how to connect a voltmeter to a circuit.

4. Learn the function of the voltmeter and its controls.

5. Review information previously presented concerning voltage.

6. Demonstrate the proper way to connect a voltmeter to a circuit.

7. Demonstrate the use of the voltmeter, range settings, function of controls, etc.

BKS1-BE-11 symbol identification board.

Circuit boards and power supplies.

Film 13-Electric Circuits.

Film 17-Electricity: How To Make A Circuit.

Circuit boards and power supplies.

Film 18-Electricity: Measurement.

Film 31-Measurement Of Electricity.

Film 3-Amperes, Volts, and Ohms.

One multimeter for each two students.
<table>
<thead>
<tr>
<th>COURSE CONTENT</th>
<th>STUDENT ACTIVITIES</th>
<th>TEACHER ACTIVITIES</th>
<th>INSTRUCTIONAL AIDS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2. Amperes.</strong></td>
<td>Practice reading the voltmeter on its various scales from a mock-up. Practice taking various voltage readings on AC &amp; DC circuits. Become familiar with the terms “ampere,” “current,” and “milliampere.” Learn to connect an ammeter in a circuit. Learn to read an ammeter on its various ranges by taking practice readings on a mock-up. Set up various low voltage circuits in series and parallel and take current readings with an ammeter and milliammeter.</td>
<td>Set a mock-up on various readings throughout its ranges for students to read. Review that which has previously been learned about current and amperes. Demonstrate the proper way to connect an ammeter in a circuit. Set a mock-up on various readings on all ranges to give the student practice in reading an ammeter.</td>
<td>Large mock-up of meter.</td>
</tr>
<tr>
<td><strong>3. Ohm’s.</strong></td>
<td>Become familiar with the terms “resistance” and “Ohm’s.” Learn how to read an ohmmeter on its various ranges. Learn how to connect an ohmmeter to a circuit.</td>
<td>Review that which should have been previously learned regarding resistance. Have students read various settings of an ohmmeter mock-up. Demonstrate proper method of connecting an ohmmeter to a circuit.</td>
<td>Film 20-Electrodynamics. Film 36-Principles Of Electricity.</td>
</tr>
</tbody>
</table>
Learn the meaning of the terms "power" and "watts."

Hook up voltmeter and ammeter in a circuit to determine the power in watts consumed.

Learn meaning of the terms "kilowatt" and "kilowatt hour."

Read a kilowatt hour meter.

Hook up resistors in series, compute and measure total resistance.

Hook up resistors in parallel, compute and measure total resistance.

Learn Ohm's Law symbols.

Learn Ohm's Law formulas.

Learn and observe Ohm's Law relationships.

Compute and measure voltage in a series circuit.

Compute and measure current in a series circuit.

Compute and measure voltage in a parallel circuit.

Explain how to find the total resistance of a series circuit.

Explain how to compute the total resistance of a parallel circuit.

Explain Ohm's Law symbols and formulas.

Demonstrate Ohm's Law relationships.

Explain and demonstrate how voltage behaves in a series circuit.

Explain and demonstrate how current behaves in a series circuit.

Explain and demonstrate how voltage behaves in a parallel circuit.
<table>
<thead>
<tr>
<th>COURSE CONTENT</th>
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</thead>
<tbody>
<tr>
<td>VI. Sources of Electricity:</td>
<td>Compute and measure current in a parallel circuit.</td>
<td>Explain and demonstrate how current behaves in a parallel circuit.</td>
<td>Film 41-Sources of Electricity.</td>
</tr>
<tr>
<td>1. Electrostatics.</td>
<td>Make a &quot;coin cell&quot; or &quot;lemon cell&quot; and measure its potential with a sensitive meter.</td>
<td>Review that which should have been learned about static electricity in Unit I.</td>
<td>Film 7-Battery Electricity.</td>
</tr>
<tr>
<td>2. Cells and batteries.</td>
<td>Study primary and secondary cell structure and characteristics.</td>
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<td>Film 10-Charging Storage Batteries.</td>
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<td></td>
<td>Connect dry cells in series and in parallel and study the results.</td>
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<td></td>
<td>Use a telephone generator and argon bulb to produce alternating current and observe its action.</td>
<td></td>
<td>Film 16-Electricity: How It Is Generated.</td>
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<tr>
<td></td>
<td>With a coil, magnet, and center reading meter, produce a voltage by induction.</td>
<td>Demonstrate how to produce a voltage across a coil with a magnet.</td>
<td>Film 25-How To Produce Electric Current With Magnets.</td>
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<tr>
<td></td>
<td>Hook up an experimental motor so that it will function as a generator and observe its output.</td>
<td>Discuss the principles of operation of the generator.</td>
<td>Film 32-Mechanical Generation of Energy.</td>
</tr>
<tr>
<td></td>
<td>Learn the difference between AC and DC generators.</td>
<td>Discuss AC and DC generators.</td>
<td>AC &amp; DC generators disassembled or mock-up.</td>
</tr>
</tbody>
</table>
4. Photo-electric cells.

Experiment with a solar cell.

Study and experiment with photo-voltaic and photo-resistive cells.

Experiment with a thermocouple, using a source of heat and a meter.

Observe the output of a phonograph cartridge on scope or meter.

VII.
Electric Circuits and Control Devices.

1. Switches.

Draw symbols for SPST, SPDT, DPST, DPDT, and rotary switches.

Show examples of each type of switch, using knife switches when possible.

Using lamps, diagram and wire various low voltage switching circuits.

Diagram and wire a switch circuit to reverse a small electric motor.

With a rotary switch, diagram and wire a circuit to control several branch circuits.

Experiment with a hollow core coil and soft iron core to observe solenoid action.

Diagram and wire a circuit controlled by a solenoid.

Demonstrate the action of devices employing solenoids in their operation.

2. Solenoids.

Discuss the uses of photo-electric cells.

Discuss the uses of the thermocouple in industry.

Explain the term piezo-electricity and how electricity is produced in this manner.

Learn to identify the electrical characteristics of a switch from its appearance and with a meter.

Discuss applications for the various types of switches.

Film 8-Bell Solar Cell.

Cells mounted.
<table>
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<tr>
<td>3. Relays.</td>
<td>Wire circuits involv-</td>
<td>Explain relay opera-</td>
<td>Film 26-How Trans-</td>
</tr>
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<td>ing one or more relays.</td>
<td>tion and function.</td>
<td>formers Work.</td>
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<td></td>
<td>Draw wiring diagrams</td>
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<td>Film 27-Inductance.</td>
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<td>for relays and relay</td>
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<td></td>
<td>circuits.</td>
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<td>4. Transformers.</td>
<td>Using an experi-</td>
<td>Discuss transformer</td>
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<td>mental transformer,</td>
<td>theory.</td>
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<td>wind on several dif-</td>
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<td>ferent secondaries</td>
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<td>and measure vol-</td>
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<td>Draw symbols for va-</td>
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<td>Draw diagrams of cir-</td>
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<td>Learn why transfor-</td>
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<td>5. Fuses and cir-</td>
<td>Learn reasons for o-</td>
<td>Demonstrate need for</td>
<td>Film 1-AB Circuit</td>
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<td>cuit-breakers.</td>
<td>ver-current protec-</td>
<td>over-current protec-</td>
<td>Breakers.</td>
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<td>Study and examine v-</td>
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<td>cy of &quot;Abe Lincoln&quot;</td>
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<td>vices.</td>
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<td>Learn to locate and</td>
<td>Explain purpose and</td>
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<td>reset a thrown brake-</td>
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<td>Learn to locate and</td>
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<td>replace a blown fuse.</td>
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<td>ed and unfiltered,</td>
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<td>6. DC controls.</td>
<td>Study rectifiers and</td>
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<td>Explain purpose and</td>
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<td>scope.</td>
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<td>Explain various types</td>
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<td>gram, wire a simple</td>
<td>of rectifier circuits,</td>
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<td>such as full wave,</td>
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<td>rious stages with a</td>
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<td>scope.</td>
<td>etc.</td>
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</tbody>
</table>
Applications of Electricity.

1. Motors.
   - Experiment with a St. Louis motor.
   - Experiment with simple telegraph key and sounder. Option to learn code.
   - Experiment with telephone circuits.
   - Wire simple radio receiver using diodes and transistors. Work from wiring diagram. Test each one.

2. Communications.
   - Write a short report explaining how electrical discoveries have made space exploration possible.
   - Write a short report on the use of atomic energy to produce electricity.

3. Space and power.
   - Discuss motor theory.
   - Discuss operation of telegraph.
   - Discuss the importance of electricity in space exploration.
   - Discuss methods of producing electrical power.
   - Discuss areas of employment opportunity.

IX. Opportunities in the World of Electricity and Electronics.

- St. Louis Motors.
- Film 9 - Beyond All Barriers.
- Film 33 - Mr. Bell.
- Film 35 - Plane Talk.
- Film 2 - A Missile Named Mac.
- Film 5 - Atom and the kilowatt.
- Film 44 - Electrical Workers.
- Film 45 - Television Workers.
- Film 46 - Telephone Linemen.
TEXTBOOKS FOR EXPLORING ELECTRICITY AND ELECTRONICS


REFERENCE BOOKS FOR EXPLORING ELECTRICITY AND ELECTRONICS

Lush, Clifford and Glenn E. Engle. *Industrial Arts Electricity*. Peoria: Chas. A. Bennett Company.


Collings, Merle D. *Projects in Electricity*. Bloomington: McKnight and McKnight Publishing Company.


FILMS FOR EXPLORING ELECTRICITY-ELECTRONICS

1. AB Circuit Breakers – 10 min., b/w. (Westinghouse, free loan.)
2. A Missile Named Mac – 7 min., color. (LTO, free loan.)
3. Amperes, Volts, and Ohms – 10 min., b/w. (TAI, rental 2.50.)
4. “A” is for Atom – 15 min., color. (AEC, free loan.)
5. Atom and the Kilowatt – 12 min., color. (Univ. of Mich., 1.00 rental.)
6. Basic Electricity – 20 min., color (Almanac, free loan.)
7. Battery Electricity – 11 min., b/w. (Univ. of Ill., 2.15 rental.)
8. The Bell Solar Battery – 13 min., color. (LTO, free loan.)
9. Beyond All Barriers – 27 min., color. (LTO, free loan.)
10. Charging Storage Batteries – 15 min., b/w. (TAI, 3.00 rental.)
11. Conductors and Semi-Conductors – 13 min., color. (LTO, free loan.)
12. Current and Electromotive Force – 11 min., b/w. (Navy, free loan.)
13. Electric Circuits – 11 min., b/w. (Univ. of Ill., 2.15 rental.)
14. Electric Circuit Faults – 19 min., b/w. (NET, 2.90 rental.)
15. Electricity For Beginners – 10 min., color. (NET, 3.90 rental.)
17. Electricity: How To Make A Circuit – 11 min., color. (Univ. of Mich., 2.25 rental.)
20. Electrodynamics – 11 min., b/w. (TAI, 2.50 rental.)
21. Electrostatics – 11 min., b/w. (TAI, 2.50 rental.)
22. Electromagnets: How They Work – 10 min., color. (NET, 3.50 rental.)
23. Heat and Light From Electricity – 17 min., b/w. (NET, 1.65 rental.)
24. How Magnets Produce Electricity – 4 min., b/w. (Navy, free loan.)
25. How To Produce Electric Current With Magnets – 10 min., color. (NET, 2.15 rental.)
26. How Transformers Work – 15 min., b/w. (MSU, 1.00 rental.)
27. Inductance – 20 min., color. (Allis-Chalmers, free loan.)

28. Infrared – 15 min., color. (Aerojet, free loan.)

29. Magnetic Effects of Electricity – 14 min., b/w. (Univ. of Ill., 1.65 rental.)

30. Magnetism – 11 min., color (Coronet, 1.75 rental.)

31. Measurement of Electricity – 12 min., color. (Coronet, 2.00 rental.)

32. Mechanical Generation of Energy – 15 min., color. (MSU, 1.00 rental.)

33. Mr. Bell – 32 min., color. (LTO, free loan.)

34. Ohm’s Law – 19 min., b/w. (TAI, 3.00 rental.)

35. Plane Talk – 20 min., color. (LTO, free loan.)

36. Principles of Electricity – 20 min., color. (GE, 1.00 rental.)

37. Principle of the Genera: – 10 min., b/w. (NET, 2.15 rental.)

38. Project Telstar – 14 min., color. (LTO, free loan.)

39. Receiving Radio Messages – 11 min., b/w. (MSU, 2.25 rental.)

40. Series and Parallel Circuits – 10 min., b/w. (TAI, 2.50 rental.)

41. Sources of Electricity – 10 min., b/w. (Univ. of Ill., 2.15 rental.)

42. Using Ohm’s Law To Understand Circuits – 15 min., b/w. (MSU., 1.00 rental.)

43. Watts, Watthours, and Watthour meters – 15 min., b/w. (MSU., 1.00 rental.)

44. Electrical Workers – Purdue University. Write.

45. Television Workers – Purdue University. Write.

46. Telephone Linemen – Purdue University. Write.
FILM DISTRIBUTOR ADDRESSES


Aerojet General Corporation, Corporate Public Relations, 900 E. Flair Ave., El Monte, California 91734


Coronet Films, Coronet Building, Chicago, Illinois.

GE – General Electric Company, 1 River Road, Schenectady 5, New York.

LTO – Local Telephone Office. Allow at least three months before showing date, preferably a year.

MSU – Michigan State University, Instructional Media Center, East Lansing, Michigan 48823.

Navy, 9th Naval District, Building, Great Lakes, Illinois 60085.

NET – NET Film Service, Audio-visual Center, Indiana University, Bloomington, Indiana 47405.

Purdue University, Audio-visual Center, West Lafayette, Indiana.

TAI – Teaching Aids, Inc., P. O. Box 3527, Long Beach, California

University of Illinois, Visual Aids Service, Division of University Extension, Champaign, Illinois.

University of Michigan, Audio-visual Center, 416 Fourth Street, Ann Arbor, Michigan 48103.

Westinghouse Electric Corp., Film Library, Pittsburg, Pennsylvania
This course in Basic Electricity-Electronics is designed to present a broader course with in-depth experiences for the students who have developed an interest in and who have seen a further need for study in the field of electricity-electronics.

Suggested teaching time is one period per day, five days per week for thirty-six weeks. Ninth, tenth, eleventh, and twelfth grade students who want to learn more about basic electricity-electronics may enroll in this course.

SPECIFIC OBJECTIVES FOR BASIC ELECTRICITY-ELECTRONICS

1. To develop safe habits and practices in the use of electricity.

2. To develop consumer knowledge in the purchase and maintenance of electrical equipment and appliances.

3. To develop an understanding of electrical theories, circuits, symbols, and terminologies.

4. To develop desirable habits of orderly procedure in planning and completing individual and group projects.

5. To enable the student to make a more intelligent choice of leisure time and vocational activities.
# BASIC ELECTRICITY-ELECTRONICS

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<tr>
<td><strong>I.</strong> Introduction.</td>
<td><strong>Study shop safety.</strong></td>
<td><strong>Demonstrate proper ways to use tools and equipment.</strong></td>
<td><strong>Safety charts and tool charts.</strong></td>
</tr>
<tr>
<td>Class objectives and policies.</td>
<td><strong>Make simple solder joints.</strong></td>
<td><strong>Display new and broken equipment.</strong></td>
<td><strong>Representative from electricity or electronics industries.</strong></td>
</tr>
<tr>
<td>Safety and first aid care, and use of tools and equipment.</td>
<td><strong>Prepare a written paper on important men pertaining to electricity.</strong></td>
<td><strong>Display electricity-electronic equipment.</strong></td>
<td><strong>Filmstrip – Safe and sure with electricity.</strong></td>
</tr>
<tr>
<td>Occupational opportunities.</td>
<td><strong>Become acquainted with industrial job opportunities and leisure time activities in the electricity-electronics field.</strong></td>
<td><strong>Demonstrate proper way to make a solder joint.</strong></td>
<td><strong>Element chart.</strong></td>
</tr>
<tr>
<td>Famous men pertaining to the field of electricity.</td>
<td><strong>Compare elements using the element chart.</strong></td>
<td><strong>Demonstrate the insulative and conductive ability of various materials.</strong></td>
<td><strong>Demonstration board with conductors, insulators, and semi-conductors.</strong></td>
</tr>
<tr>
<td><strong>II.</strong> Basic Concepts</td>
<td><strong>Become familiar with the VOM.</strong></td>
<td><strong>Demonstrate ways to make static electricity.</strong></td>
<td><strong>Charts of electrical symbols.</strong></td>
</tr>
<tr>
<td>Atomic theory.</td>
<td><strong>Practice the use of symbols and schematic diagrams.</strong></td>
<td><strong>Display various ways of producing electricity.</strong></td>
<td><strong>Transparencies.</strong></td>
</tr>
<tr>
<td>Laws of charges, conductors, insulators, and semi-conductors.</td>
<td><strong>Collect and check examples of insulators, conductors, and semi-conductors with a meter.</strong></td>
<td></td>
<td><strong>Meters.</strong></td>
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<tr>
<td>Static and dynamic electricity.</td>
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<td><strong>Filmstrip – Experimenting with static electricity.</strong></td>
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<tr>
<td>Sources of electricity.</td>
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</table>
Schematic drawings.
Block diagrams.
Line diagrams.
Wiring diagrams.

III. Basic Electrical Quantities

Volt.
Coulomb.
Ampere.
Ohm.

Factors that influence resistance.
Conductance.
Resistance color code.
Watt.

Learn electrical units and their conversions.
Study copper wire table and compare wire sizes with the amount of resistance.
Examine and disassemble several resistors.
Become familiar with the use of the resistance color code.
Measure the resistance of different types of resistors.
Complete the worksheet covering a hypothetical light bill.

Display and discuss various resistors.
Discuss voltage and current definitions.
Connect fixed and variable resistors in a simple circuit.
Explain different formulas for finding electrical power.
Show examples of light bills from local power companies.

IV. Common D C Circuits

Ohm's Law.
Characteristics of series, parallel, and series-parallel circuits.
Kirchhoff's Laws.
Equivalent circuits.

Calculate simple circuit characteristics.
Connect dry cells in series and parallel.
Study on Ohm's Law and Kirchhoff's Laws.

Demonstrate characteristics of basic circuits, using chalkboard, overhead projector, meters and circuit boards.
Explain how to simplify a complex circuit by the use of an equivalent circuit.

Film - Introduction to electricity.
Film - Electrons at work.
Flash cards.
Transparencies.
Display board of resistors.
Chart of color code table.
Circuit boards with series, parallel, and combination circuits.
Worksheet over light bill.
Film - Elements of electrical circuits.
Film - Wire sizes and voltage drop.
Ohm's Law charts or circular pie aid.
Transparencies.
Dry cells and hook-up wire.
Various circuit worksheets.
Circuit boards with series, parallel, and combination circuits.
Film - Ohm's Law.
### BASIC ELECTRICITY-ELECTRONICS

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<tr>
<td><strong>V.</strong> Cells and Batteries</td>
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<tr>
<td>Voltaic cell.</td>
<td>Check dry cells for local action.</td>
<td>Make a primary cell with a citrus fruit and coins.</td>
<td>Cell and battery transparencies.</td>
</tr>
<tr>
<td>Internal resistances.</td>
<td>Check current and voltage of primary cells made from different citrus fruits and coins.</td>
<td>Demonstrate the chemical steps of primary and secondary cells with the chalkboard or overhead projector.</td>
<td>Plastic cased motorcycle battery.</td>
</tr>
<tr>
<td>Primary cell.</td>
<td>Check dry cells for voltage and current output, also check voltage drop under load.</td>
<td>Demonstrate the hydrometer and voltage checks on the lead acid battery.</td>
<td>Sectional battery.</td>
</tr>
<tr>
<td>Leclanche cell.</td>
<td>Connect cells in series and parallel and compare voltage and current readings.</td>
<td>Demonstrate charging the lead acid and nickel cadmium batteries.</td>
<td>Charts, pamphlets, and handout sheets of battery characteristics.</td>
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<tr>
<td>Silver cell.</td>
<td>Observe lead acid battery under charge.</td>
<td></td>
<td>Film - Primary Cell.</td>
</tr>
<tr>
<td>Secondary cell.</td>
<td>Compare cell sizes, shapes and material compositions.</td>
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<td>Film - Story of the Modern Storage Battery.</td>
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<tr>
<td>Alkaline primary and secondary cells.</td>
<td>Complete work sheets over various cells and batteries.</td>
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<td>Film - Bell Solar Battery.</td>
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<tr>
<td>Edison cell.</td>
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<td>Lead acid cell.</td>
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<td>Nickel-Cadmium cell.</td>
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<td>Charging and discharging.</td>
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<td>Advantages and disadvantages of various cells.</td>
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<tr>
<td><strong>VI.</strong> Magnetism</td>
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<tr>
<td>Types of magnets.</td>
<td>Examine different materials for magnetic properties.</td>
<td>Demonstrate lines of force with magnet and filings.</td>
<td>Iron filings, magnet compass, dry cell, and wire.</td>
</tr>
<tr>
<td>Laws of magnets.</td>
<td>Compare magnets for size, shape and strength.</td>
<td>Use the compass to identify the poles and characteristics of the magnet field.</td>
<td>Simple motors, generators, meters, and bells.</td>
</tr>
<tr>
<td>Magnetic fields.</td>
<td></td>
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</tr>
</tbody>
</table>
Compare molecular and domain theory.

Observe domains of a magnetized material under a microscope.

Examine several uses of magnets and electromagnetic. (Examples—doorbell, meter, solenoid, relay, motor, and generators.)

Experiment by building simple electromagnets with various wire sizes and number of turns.

Demonstrate magnetizing and demagnetizing temporary and permanent materials.

Demonstrate left hand rule.

Pass a small amount of DC current through a wire and use a compass to show the presence of magnetic lines of force.

Make several loops and place a core in the loops to show increase of magnetism.

Use a permanent magnet and a nail to demonstrate magnetic induction.

Demonstrate various meters and their characteristics. (Example—galvanometer, voltmeter, ammeter, Wheatstone Bridge, multimeter.)

Demonstrate the use of shunts, multipliers and rectifiers.

Compare various meters and their movements.

Practice reading the common meters.

Make continuity tests. (Example—fuses.)

Measure resistance of series, parallel, and combination circuits.

Test voltage and amperage of simple circuits.

Complete worksheets over meter movements, shunts, multipliers and rectifiers.

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Compare various meters and their movements.

Practice reading the common meters.

Make continuity tests. (Example—fuses.)

Measure resistance of series, parallel, and combination circuits.

Test voltage and amperage of simple circuits.

Complete worksheets over meter movements, shunts, multipliers and rectifiers.

Demonstrate various meters and their characteristics. (Example—galvanometer, voltmeter, ammeter, Wheatstone Bridge, multimeter.)

Demonstrate the use of shunts, multipliers and rectifiers.
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<td>Rectifier type.</td>
<td>Ammeter.</td>
<td>Flash cards.</td>
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<tr>
<td>Rectifier type.</td>
<td>Ohmmeter.</td>
<td>Transparencies.</td>
</tr>
<tr>
<td>Rectifier type.</td>
<td>Watt meter.</td>
<td>Film - The Oscilloscope, what it is and what it does.</td>
</tr>
</tbody>
</table>

**VIII. Alternating Current**

- Definition of AC
- History of AC
- Characteristics of AC
- Amplitude
- Frequency
- Cycle
- Peak value
- R.M.S. or effective value
- Average value

- Work problems over R.M.S., peak and average values.
- Check meters for R.M.S. and peak values.
- Measure R.M.S. and peak voltage.
- Complete worksheets covering problems over peak, R.M.S. and average values.
- Measure P-P with the oscilloscope.

- Plot sine wave.
- Show sine wave with the oscilloscope.
- Demonstrate alternating current.

**IX. Inductance**

- Study Lenz's Law, units of inductance, and inductors in series and parallel.
- Plot the rise and fall of current in an inductive circuit at various frequencies.

- Flash cards.
- Transparencies.
- Film - The Oscilloscope, what it is and what it does.
Units of inductance.

Factors that determine inductance.

Time constant inductors in series and parallel.

Types of inductors.

Application of inductors.

Examine and compare several inductors.

Measure DC resistance of inductors.

Observe inductors in action.

Demonstrate various forms of inductors.

Display inductors.

Discuss why current lags voltage across an inductor.

Display board of inductors.

Film – Inductance.

X.

Transformers

Voltage relationship between primary and secondary.

Transformer core.

Construction.

Transformer losses.

Turns per volt ratio.

Ratio of primary to secondary.

Current and voltage transformers.

Maximum power transfer.

Autotransformer.

Application of transformers.

Work problems over voltage and current relationship between primary and secondary.

Inspect and measure the voltage of a sample transformer.

Examine and compare various transformers.

Trace transformer action from the generating plant to the home.

Use the oscilloscope to compare the amplitude of the primary voltage to the secondary voltage.

Discuss transformer cores and construction features.

Demonstrate power transfer with transformers.

Explain power losses and methods of cooling transformers.

Use oscilloscope to demonstrate the amplitude of the primary voltage compared to the secondary voltage.

Charts or posters of the distribution of electricity.

Transformers and coils.

Handout sheets of problems over relationship between primary and secondary.

Sectional transformer.

Transparencies.

Film – How transformers work.

Examine and compare several inductors.

Measure DC resistance of inductors.

Observe inductors in action.

Examine and compare several inductors.

Measure DC resistance of inductors.

Observe inductors in action.

Examine and compare several inductors.

Measure DC resistance of inductors.

Observe inductors in action.

Examine and compare several inductors.

Measure DC resistance of inductors.

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Examine and compare several inductors.

Measure DC resistance of inductors.

Observe inductors in action.
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<td>XI. Capacitance</td>
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<tr>
<td>Elementary concepts.</td>
<td>Study units of capacitance and work problems over capacitors in series and parallel.</td>
<td>Demonstrate charging and discharging a capacitor.</td>
<td>Display board of capacitors.</td>
</tr>
<tr>
<td>Factors determining capacitance.</td>
<td>Experiment with charging and discharging various capacitors.</td>
<td>Discuss the physical characteristics of various capacitors and the electrical effect of capacitance.</td>
<td>Transparencies.</td>
</tr>
<tr>
<td>Units of capacitance.</td>
<td>Observe capacitors in operation.</td>
<td>Plot time constant.</td>
<td>R.C. flasher.</td>
</tr>
<tr>
<td>Dielectric constant and strength.</td>
<td></td>
<td>Demonstrate time constant with the R.C. flasher.</td>
<td>Hand out sheet of problems over time constant and capacitors in series and parallel.</td>
</tr>
<tr>
<td>Time constant.</td>
<td></td>
<td></td>
<td>Film – Capacitance.</td>
</tr>
<tr>
<td>Capacitor in series and parallel.</td>
<td></td>
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<tr>
<td>Common types of capacitors.</td>
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<tr>
<td>Capacitor application.</td>
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<tr>
<td>XII. Inductance, Resistance, and Capacitance in A.C. Circuits</td>
<td></td>
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<tr>
<td>Ohmic resistance.</td>
<td>Work problems on calculating inductive and capacitive reactance, impedance and Ohm’s Law for circuits containing inductance, capacitance, and resistance.</td>
<td>Plot the phase relationship of current and voltage in A.C. circuits.</td>
<td>Flashcards.</td>
</tr>
<tr>
<td>Phase relationship between voltage and current.</td>
<td>Use the meter to measure circuits containing impedance.</td>
<td>Demonstrate vector and computation methods for solving impedance.</td>
<td>Transparencies.</td>
</tr>
<tr>
<td>Inductive reactance.</td>
<td></td>
<td></td>
<td>Handout sheets on impedance.</td>
</tr>
<tr>
<td>Impedance.</td>
<td></td>
<td>Use oscilloscope to show resonance in a circuit.</td>
<td>Oscilloscope.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Film – R.C.L. resistance and capacitance.</td>
</tr>
</tbody>
</table>
Vector and computation methods.
Capacitive reactance.
Circuits containing resistance, capacitance, and inductance.
Characteristics of series and parallel resonance circuits.
Power in A C circuits.

XIII. Generators
A.C. generator characteristics.
Alternator frequency.
Polyphase generators.
Types of three-phase connections.
D C generator characteristics.
Series field generator.
Shunt field generator.
Compound generators (cumulative and differential).
Separately excited generator.
Generator efficiency.
Generator control.

Examine, disassemble and reassemble A C and D C generators.
Compare differences between the D C generator and the modern day alternator.
Examine generator controls.

Demonstrate factors involved in generation: physical characteristics of D C and A C generators.
Explain right-hand rule for generators.
Explain methods of generator control.

Cutaways of different types of generators.
Model of simple generator.
Flashcards.
Charts.
Transparencies.
Field trip to local power generating station.
Filmstrip - Building an electric generator.
Film - Fundamentals of A C and D C generators.
Film - Making Electricity.
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<td>XIV. Motors</td>
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<tr>
<td>D C motors.</td>
<td>Examine, disassemble, and assemble various motors.</td>
<td>Explain importance of the information on the name plate.</td>
<td>Transparencies.</td>
</tr>
<tr>
<td>Series field motor.</td>
<td>Reverse direction of run on motors that will reverse.</td>
<td>Demonstrate various types of motor controls.</td>
<td>Handout sheets over motor name plates.</td>
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<tr>
<td>A C motors.</td>
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<tr>
<td>Universal motor.</td>
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<tr>
<td>Induction-polyphase motor.</td>
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<tr>
<td>Split phase induction motor.</td>
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<tr>
<td>Inductance start motor.</td>
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<tr>
<td>Capacitance start motor.</td>
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<td>Shaded pole motor.</td>
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<tr>
<td>Synchronous motor.</td>
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<td>Motor controls.</td>
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<tr>
<td>Motor rating and efficiency.</td>
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<td>XV. Application of Electricity</td>
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<tr>
<td>Thermoelectric effect.</td>
<td>Compare several heating elements and check their resistances.</td>
<td>Demonstrate heat produced by current flowing through a wire.</td>
<td>Electroplater.</td>
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<tr>
<td>Welding.</td>
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<td>Meters.</td>
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<td>Furnaces.</td>
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<td>Samples of various types of bulbs.</td>
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<tr>
<td>Inductive and capacitive heating.</td>
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<tr>
<td>Luminous effect.</td>
<td>Compare lumens of various types of bulbs.</td>
<td>Demonstrate electroplating.</td>
<td>Small electroluminescent plug-in units for 120V A.C.</td>
</tr>
<tr>
<td>Fluorescent.</td>
<td>Check the action of relays, buzzers and circuit-breakers.</td>
<td>Discuss electrical codes and laboratories.</td>
<td>Samples of relays, buzzers and circuit-breakers.</td>
</tr>
<tr>
<td>Neon.</td>
<td>Electroplating. Electrc refinement.</td>
<td>Demonstrate wiring outlet and switch circuits that would be used in residential wiring.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Electrical codes. Underwriters' laboratories.</td>
<td>Study wiring symbols and switching circuits.</td>
<td>Handout sheets over symbols, circuits, materials, and supplies.</td>
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<tr>
<td>2-11</td>
<td></td>
<td></td>
<td>Mockup of heavy industrial wiring practices.</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>Film - <em>The Electrician</em>.</td>
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<td>Film - <em>Electrical wiring with aluminum</em>.</td>
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### BASIC ELECTRICITY-ELECTRONICS

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<td><strong>XVII. Automotive Electricity</strong></td>
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<tr>
<td>Cranking system.</td>
<td>Sketch schematics of the electrical systems.</td>
<td>Explain grounding systems used to complete circuits (both plus &amp; minus ground).</td>
<td>Transparencies.</td>
</tr>
<tr>
<td>Ignition system.</td>
<td>Examine and trace the electrical systems on a modern automobile.</td>
<td>Explain starting circuit controls and application of the D C motor.</td>
<td>Mockup of a complete automobile electrical system.</td>
</tr>
<tr>
<td>Charging system.</td>
<td>Disassemble a starting motor and generator.</td>
<td>Demonstrate the use of step-up transformer, condenser, pulsating D C current and distribution.</td>
<td>Lighting demonstration board.</td>
</tr>
<tr>
<td>Lighting system.</td>
<td>Examine a distributor and a coil.</td>
<td>Explain A C and D C generators, charging and controls of the charging circuit.</td>
<td>Service manual of schematics for various automobiles.</td>
</tr>
<tr>
<td>Special electrical systems.</td>
<td>Check the voltage of a storage battery under load.</td>
<td>Demonstrate the operation of various lights on the automobile.</td>
<td>Filmstrip-Records - <em>The cranking circuit and how it works.</em></td>
</tr>
<tr>
<td>Power windows and seats.</td>
<td>Check the condition of the diodes in an alternator.</td>
<td></td>
<td>20,000 volts under the hood.</td>
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<tr>
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<td>Delcotron generator and a new charging circuit.</td>
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<td>Regulation and the charging circuit.</td>
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<td><strong>XVIII. Rectifiers, Vacuum Tubes and Semiconductors</strong></td>
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<tr>
<td>Copper oxide rectifier.</td>
<td>Examine several different rectifiers.</td>
<td>Demonstrate half and full wave rectification with the oscilloscope.</td>
<td>Transparencies.</td>
</tr>
<tr>
<td>Selenium rectifier.</td>
<td>Check rectifiers to find direction of high resistance.</td>
<td>Demonstrate the action of the filter circuit.</td>
<td>Oscilloscope.</td>
</tr>
<tr>
<td>Half and full wave rectifiers.</td>
<td>Identify transistor leads.</td>
<td></td>
<td>Various types of rectifiers and transistors.</td>
</tr>
<tr>
<td>Mercury pool rectifiers.</td>
<td>Disassemble a diode and triode tube and identify the parts.</td>
<td>Introduce the characteristics of N.P.N. and P.N.P. type transistor.</td>
<td>Display board of a disassembled tube.</td>
</tr>
<tr>
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<tr>
<td>Diode and Triode tube.</td>
<td>Check transistor bias.</td>
<td></td>
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<tr>
<td>Filter circuits.</td>
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<tr>
<td>Crystal diode.</td>
<td></td>
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<tr>
<td>Transistors (N. P. N. – P.N.P. types).</td>
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### XIX.

Electricity for Communication

- Telegraph (modern).
- Telephone.
- Radio.
  - Waves. Essential parts.
- Radar.
- Télévision.
- Citizens-band transceiver.

**2-13**

- Examine a cutaway view telephone.
- Draw a block diagram of a radio receiver.
- Sketch a schematic of a simplified radio.
- Draw a block diagram of a T.V. receiver.
- Compare T.V. channel frequencies.
- Examine citizen radio license application form.
- Draw block diagram of pulse and frequency shift radar systems.
- Examine a T.V. for various parts and circuits.
- Wire simple radio receiver.
- Demonstrate the operation of the telephone.
- Show the radio wave with the oscilloscope.
- Demonstrate using the citizen-band transceiver.
- Explain the action of a cathode ray tube.
- Demonstrate wave forms at various points within the radio and T.V. set.
- Flashcards.
- Cutaway view of a telephone.
- Oscilloscope.
- Transistor radio demonstrator.
- Field trip to local radio, television or radar station.
- Representative from the local telephone company.
- Film – *Your Voice and the Telephone*.
- Film – *Radio Waves*.
- Film – *Receiving Radio Messages*.
- Film – *Radio Receivers, Principles and Typical Circuits*. 
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REFERENCE BOOKS FOR
BASIC ELECTRICITY-ELECTRONICS

Sears, Roebuck and Company. *Simplified Electric Wiring Handbook*. Kansas City:


Montgomery Ward. *Wiring Simplified Book*. Kansas City:


Basic Electricity Electronics. Indianapolis: Howard W. Sams. (Book one)


<table>
<thead>
<tr>
<th>No.</th>
<th>Title</th>
<th>Duration</th>
<th>University/Provider</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Introduction to Electricity</td>
<td>11 min.</td>
<td>Arkansas State University.</td>
</tr>
<tr>
<td>2.</td>
<td>Electrons At Work</td>
<td>14 min.</td>
<td>Missouri University.</td>
</tr>
<tr>
<td>3.</td>
<td>Elements of Electrical Circuits</td>
<td>10 min.</td>
<td>Missouri University.</td>
</tr>
<tr>
<td>5.</td>
<td>Ohm's Law</td>
<td>6 min.</td>
<td>Illinois University.</td>
</tr>
<tr>
<td>6.</td>
<td>Primary Cell</td>
<td>10 min.</td>
<td>Illinois University.</td>
</tr>
<tr>
<td>10.</td>
<td>Ferromagnetic Domains</td>
<td>22 min.</td>
<td>Bell Telephone System.</td>
</tr>
<tr>
<td>12.</td>
<td>The Oscilloscope, What it is and What it Does</td>
<td>9 min.</td>
<td>Tektronic, Inc.</td>
</tr>
<tr>
<td>17.</td>
<td>RCL: Resistance and Capacitance</td>
<td>34 min.</td>
<td>Teaching Aids, Inc.</td>
</tr>
<tr>
<td>19.</td>
<td>Making Electricity</td>
<td>10 min.</td>
<td>Missouri University.</td>
</tr>
<tr>
<td>21.</td>
<td>The Electrician</td>
<td>10 min.</td>
<td>Missouri University.</td>
</tr>
<tr>
<td>22.</td>
<td>Electrical Wiring with Aluminum</td>
<td>15 min.</td>
<td>Association Films, Inc.</td>
</tr>
<tr>
<td>23.</td>
<td>The Transistor</td>
<td>10 min.</td>
<td>Bell Telephone System.</td>
</tr>
</tbody>
</table>


34. *Quest*, 13.5 min., Association Films, Inc.

**16MM FILM DISTRIBUTORS’ ADDRESSES**

University of Missouri, Extension Division, Audio-Visual and Communication Service, 119 Whitten Hall, Columbia, Missouri 65201

University of Illinois, Visual Aids Service, Division of University Extension, Champaign, Illinois

Bell Telephone Company, Nearest Local Bell Telephone Company Business Office

Tektronix Incorporated, Film Library, P. O. Box 500, Beaverton, Oregon

Teaching Aids, Inc., P. O. Box 3527, Long Beach, California

Michigan State University, Instructional Media Center, East Lansing, Michigan 48823

University of Michigan, Audio-Visual Center, 416 Fourth Street, Ann Arbor, Michigan 48103

Arkansas State University, Audio-Visual Center, State College, Arkansas 72032

United States Department of the Interior, Motion Pictures, 4800 Forbes Avenue, Pittsburgh, Pennsylvania 15213

University of Iowa, Audio-Visual Center, Iowa City, Iowa 52240

Association-Sterling Films, 600 Madison Avenue, New York, New York 10022

**TRANSPARENCIES**

Transparencies Pac Set  
McKnight and McKnight Publishing Company  
Bloomington, Illinois 61701

Electricity and Basic Electronics  
D.C.A. Educational Products, Inc.  
4865 Stenton Avenue  
Philadelphia, Pennsylvania 19144
Basic Electronics Transparencies  
Educational Technologies, Inc.  
3546 Dakota Avenue  
Minneapolis, Minnesota 55416

Battery Operation, Construction, and Testing

Fundamentals of Electricity

Alternators Principles of Operation  
Ford Motor Company  
Service Training  
Dearborn, Michigan

Electricity one-seven  
Hayden Book Company, Inc., New York  
116 W. 14th Street  
New York, New York 10011

FILMSTRIPS

Electricity Series No. 11330  
Experimenting with Static Electricity  
Electricity by Chemical Reaction  
Electricity in Circuits  
Electricity and Heat  
Electricity and Magnetism  
Building an Electric Generator  
Transformers

Encyclopedia Britannica Educational Corporation  
425 North Michigan Avenue, Chicago, Illinois 60611

Electricity and Magnetism Set A-6  
588 Safe and Sure with Electricity  
561 How Batteries Work  
577 How A C and D C Motors Work  
602 Modern Theories of Magnetism  
605 Electric Fields  
621 Alternating Current Circuits  
640 Electric Instruments

Popular Science Publishing Company, Inc.  
Audio-Visual Division  
1355 Lexington Avenue  
New York, New York 10017

Electricity Set No. 3 170050  
How Television Works  
Distributing Electric Power  
Putting Electrolysis to Work  
What is Electronics  
What is Magnetism
SINGLE CONCEPT FILM LOOPS

Electrical House Wiring Film Loop Set

1. The third wire can save your life.
2. Rewiring a lamp.
3. Wiring an attachment plug.
4. Trouble shooting a bell circuit.
5. Outlet box installation.
6. Wiring a box with armored cable.
7. Connecting wires in an outlet box.
8. Installing a convenience outlet.
Photographs courtesy of
Electricity-Electronics Department
Lee's Summit High School
Mike Ford, Photographer
COMMUNICATIONS ELECTRONICS

This course in electronics is for one full year and is for both boys and girls who desire more advanced experience in electronics. It is recommended that students have satisfactorily completed the course Basic Electricity-Electronics or advanced science courses. The purpose of this course is to give the student a detailed foundation of theoretical knowledge, instrumentation, and practical application of electronics. It also affords the student an opportunity to learn if he is suited for continued work in electronics and to determine the level at which he should prepare himself (engineer, technician, repairman, sales person, etc.). This course in electronics offers an excellent base on which the student may build his vocational pursuits or additional education in the field of electronics.

SPECIFIC OBJECTIVES FOR COMMUNICATIONS ELECTRONICS

The Specific Objectives for Communications Electronics are as follows:

1. To develop interest in and an understanding of the role which electronics plays in his home, in his community, and in his industrial-technical world.

2. To acquire consumer knowledge which will permit effective selection, care, and use of various electronic products and testing devices.

3. To develop safe and efficient work habits and techniques relating to electronic and electrically powered equipment.

4. To acquire information and have exploratory experiences with various aspects of the electronics industry in order to gain a better understanding of occupational opportunities in the broad field of electronics.

5. To develop a depth of understanding of electronic principles and competencies necessary to perform a wide variety of fundamental tasks in applied electronics leading to possible gainful employment in the field of electronics.

6. To develop respect for others and willingness to assist in individual or group projects.
# Communications Electronics

<table>
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<tr>
<th>COURSE CONTENT</th>
<th>STUDENT ACTIVITIES</th>
<th>TEACHER ACTIVITIES</th>
<th>INSTRUCTIONAL AIDS</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Review basic symbols, schematic diagrams and basic electrical theory.</td>
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</tbody>
</table>
IV. ELECTRONIC INSTRUMENT

Basic circuitry and uses of the VTVM, oscilloscope, sine-square wave, R.F. generators, signal injector, T.V. alignment generator, transistor checker, and capacitance checker.

Practice the use of VTVM and oscilloscope. Observe waveforms and use signal generator to make Lissajous figures on the oscilloscope. Measure D.C. and A.C. voltages, also R.F. and A.F. voltages. Learn the proper procedure to correctly locate malfunctions in radio and T.V. circuits.

Give circuitry of VTVM: Explain its use in high impedance circuit. Introduce use of oscilloscope, instruct in operation, demonstrate versatility for measurements.

Explain and demonstrate the correct technique for using the instruments in troubleshooting. Give individual instruction where needed.

V. POWER SUPPLIES

Design, construction and performance of the basic sources of power: Photo-electric, vacuum and semi-conductor.

Measure voltage and current from various basic sources. Hook up half wave, full wave, and bridge rectifier and observe on oscilloscope. Experiment with and observe the effect of filters and loading on a power supply. Construct power supply section of superheterodyne receiver.

Explain power sources. Explain rectification and types of power supplies. Demonstrate with oscilloscope the effects of filters. Explain vacuum tube, semi-conductor rectifiers and controlled rectifiers. Explain how gas diodes may regulate voltages in a power supply.

Film 8: Oscilloscope Draws a Graph.
Film 7: Oscilloscope: What It Is, What It Does.
Film 14: Measurement Of Electricity.
Film 15: Circuit Testing, Etc.
Transparencies: Basic Electronics Series.

Overhead Demonstration Meter.
Operation manuals for specific instruments.

Film 16: The Diode: Principle and Application.
Film 17: The Principle of the Gas Filled Tube.
Film 18: Vacuum Tubes.
Transparencies: Basic Electronic Series.
## VI. REACTANCE, IMPEDANCE AND RESONANCE

Characteristics, application and calculations pertaining to inductive and capacitive reactance, impedance and resonant circuits.

Experiment with inductors and capacitors in DC circuits; observe and solve for time constants. Do experiments with inductors and capacitors in AC circuits; observe and solve for resultant voltages. Observe inductance and capacitance at varying frequencies for resonance and calculate resonant frequencies. Introduce projects.

Example: Electronic projects from Popular Electronics or other electronic magazines. Project should be from schematic. Also could introduce TV repair.

Review AC and DC circuits; resistance, inductance, capacitance and time constant. Introduce inductive and capacitive reactance; vectors and impedance calculation. Demonstrate how to measure phase angle with the oscilloscope.

### STUDENT ACTIVITIES
Build simple single stage audio amplifier. Check detection, amplifier circuits of radio receiver. Experience in using signal generator and tube tester.

### TEACHER ACTIVITIES
Show mock-up or cutaway tube along with symbols and explanation of various types of tubes. Discuss problems of triodes which led to development of multi-grid tubes. Mention specialized tubes; thyatrons, klystrons, magnetrons, compactrons, etc. Introduce common tube parameters.

### INSTRUCTIONAL AIDS
- Film 19: Inductance
- Film 20: Induced Electric Current
- Film 21: Capacitance
- Film 22: RCL: Resistance Capacitance
- Film 23: Vectors
- Transparencies: Basic Electronic Series
- Model: Cutaway Tube
- Film 24: The Triode: Amplification
- Film 25: Cathode Ray Tube
- Transparencies: Basic Electronic Series

## VII. VACUUM TUBE FUNCTIONS

Symbols, construction and principles of operation and application to include: diodes rectification, detection, switching and multiplier circuits. Triode amplification and oscillation. Uses for multigrid and multi-purpose tube.

Build simple single stage audio amplifier. Check detection, amplifier circuits of radio receiver. Experience in using signal generator and tube tester.

Show mock-up or cutaway tube along with symbols and explanation of various types of tubes. Discuss problems of triodes which led to development of multi-grid tubes. Mention specialized tubes; thyatrons, klystrons, magnetrons, compactrons, etc. Introduce common tube parameters.

### INSTRUCTIONAL AIDS
- Model: Cutaway Tube
- Film 24: The Triode: Amplification
- Film 25: Cathode Ray Tube
- Transparencies: Basic Electronic Series
Characteristics and principles of Audio, Video, Voltage and Power Amplifiers.

Design and assemble a multistage audio amplifier; test and observe voltage relationships, wave forms and amplification. Test differences in resistance, impedance and transformer coupling. Add audio sections to the superheterodyne receiver.

Discuss the following: nature of sound, positive tube parameters, feedback, inverse feedback, loading, impedance matching, and de-coupling. Wide band and R.F. amplifiers, classes of amplification, voltage and power amplifiers, Hi-Fi and stereo amplifiers, tone controls and volume controls.

Radio communication principles. Stages of AM and/or FM radio. Detectors, Oscillators, Tuners, Converters, Transmitters and TV circuits.

Build or complete superheterodyne radio. Observe voltages, frequencies, and wave forms of a radio. Align a radio. Build a simple transmitter, try various modulation systems. Suggested project.

First project: troubleshoot, repair and align an AM and FM receiver.

Second project: troubleshoot, repair and align a TV receiver.

Discuss: Communications and nature of radio signals, unmodulated carrier, amplitude modulation, frequency modulation, modulation methods, types of detectors, tuners, antennas, types of oscillators. TRF and superheterodyne receivers, amateur radio and citizens band, television, teletype and facsimile.

Introduce projects made from the schematic. May be some TV repair work.

Discuss TV receiver sections; RF & converter, vertical and horizontal sweep and sync, high voltage deflection, CTR and composite signal.

Film 26: Radio Waves.
Film 27: Oscillators, Amplifiers and Radio.
Transparencies: Basic Electronic Series.
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<tr>
<th>COURSE CONTENT</th>
<th>STUDENT ACTIVITIES</th>
<th>TEACHER ACTIVITIES</th>
<th>INSTRUCTIONAL AIDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>X. TRANSMITTER CIRCUIT APPLICATION</td>
<td>Construct and test a low power oscillator circuit. Construct, tune, and test a low power CW transmitter. Construct, tune, and test a low power radio-telephone transmitter.</td>
<td>Discuss the purposes and circuits of each section of an AM transmitter. Demonstrate the tuning and loading of a transmitter. Discuss the circuits and purposes of each section of an FM transmitter. Explain how both AM &amp; FM systems are used in television.</td>
<td>Film 35: Oscillators. Film 36: Radio Transmitter Principles.</td>
</tr>
</tbody>
</table>
XII. SEMICONDUCTORS

Symbols, construction, principles of operation, and application to include: semiconductor diodes — rectification, demodulation, amplification, timing circuits, multivibrators and zener diodes.

Construct single stage transistor amplifier. Observe voltage, current and waveform values. Construct transistor receiver.

Suggested project: Transistorized Transmitter. Transistor Electronic by Garrish, page 270.

Introduce history: atomic structures, N and P types P-N junctions, forward, reverse bias, and transistor action. Types of circuit configuration, diodes, transistors, and integrated circuits.

Film 28: Genesis of the Transistor.

Film 29: Principles of Transistor.

Manuals: Transistor and Semiconductor Series.

Transparencies: Transistor and Semiconductor Series.

XIII. SEMI-CONDUCTOR SPECIALIZED

Integrated circuits, oscillator circuits, photoelectric control circuits, and circuits using specialized semiconductors.

Construct circuits using the specialized semiconductors and study the effect upon the circuit.


Introduce specialized semiconductors: Humidity sensor, strain gauge, thermometer, tunnel diode, SCR, unijunction transistor, field effect transistors, insulated gate field effect transistors and frigistors.

Transparencies: Transistor and Semiconductor Series.
TEXTBOOKS FOR COMMUNICATIONS ELECTRONICS


REFERENCE BOOKS FOR COMMUNICATIONS ELECTRONICS


*Basic Electricity Electronics*, Book II. Indianapolis: Howard W. Sams.


FILMS FOR COMMUNICATIONS ELECTRONICS

1. Vacuum Tubes. 11 min., Missouri University.
2. Electronics. 13 min., Missouri University.
4. World of Semiconductors. 44 min., Illinois University.
5. Radio Waves. 27 min., Iowa University.
6. Receiving Radio Messages. 11 min., Iowa University.
7. The Oscilloscope, What It Is and What It Does. 9 min., Free films.
8. The Oscilloscope Draws A Graph. 20 min., Free films.
15. Circuit Testing. Etc. 33 min., Army or University of Iowa.
18. Vacuum Tubes. 30 min., Brigham Young University.
19. Inductance. 33 min., University of Illinois.
20. Induced Electric Current. 30 min., Brigham Young University.
22. RCL: Resistance Capacitance. 30 min., University of Illinois.
23. Vectors. 11 min., University of Illinois.


TRANSPARENCIES

Semi-conductor Transparencies:
   Educational Technologies, Inc.
   3546 Dakota Avenue
   Minneapolis, Minnesota 55416

Transparencies Pac Set:
   McKnight and McKnight Publishing Company
   Bloomington, Illinois 61701

Electricity and Basic Electronics:
   D.C.A. Educational Products, Inc.
   4865 Stenton Avenue
   Philadelphia, Pennsylvania 19144

Transparencies Electricity Electronics: Series 601-602-603-604
   Lab Volt Educational Systems
   Buck Engineering Company, Inc.
   Farmingdale, New Jersey 07727

Transparencies Electricity Electronics:
   Brodhead Garrett
   4560 East 71st Street
   Cleveland, Ohio 44105

SUPER 8 SINGLE CONCEPT FILMS

1. 100 Series – Tubes and Tube Circuits.

   300 Series – Transistors and Transistor Circuits.

   500 Series – Alternating Current Theory.

   Animated Electronic Films
   P. O. Box 2036, Eads Station
   Arlington, Virginia 22202

2. Television Symptom Diagnosis
   Thirty three single concept film loops.

   Howard W. Sams & Company, Inc.
   4300 West 62nd Street
   Indianapolis, Indiana 46268
16MM FILM DISTRIBUTORS' ADDRESSES

University of Missouri, Extension Division, Audio-Visual and Communication Service, 119 Whitten Hall, Columbia, Missouri 65201

University of Illinois, Visual Aids Service, Division of University Extension, Champaign, Illinois

Tektronix Incorporated, Film Library, P. O. Box 500, Beaverton, Oregon

Bell Telephone Company, Nearest Local Bell Telephone Company Business Office

Coronet Films, Coronet Building, Chicago, Illinois

Encyclopedia Britannica, Educational Corporation, 425 North Michigan Avenue, Chicago, Illinois 60611

University of Iowa, Audio-Visual Center, Iowa City, Iowa 52240

University of Arizona, Audio-Visual Center, Tucson, Arizona 85722

Arizona State University, Audio-Visual Center, Tempe, Arizona 85281

Radio Corporation of America Institute, Education Programs, Rt. 33 East Haddonfield Road, Building 204-1, Cherry Hill, New Jersey 08108

Modern Talking Pictures Service, 3718 Broadway, Kansas City, Missouri 64111

Brigham Young University, Audio-Visual Center, Provo, Utah 84601

McGraw-Hill Films, 828 Custer Avenue, Evanston, Illinois 60202

United World Films, 221 Park Avenue South, New York, New York 10003

University of Colorado, Audio-Visual Center, Boulder, Colorado 80302

Public Information Officer, United States Army, Fort Huachua, Arizona 85613
Photographs courtesy of Electricity-Electronics Department
Lee's Summit High School
Mike Ford, Photographer
INDUSTRIAL ELECTRONICS

The course in Industrial Electronics is designed to provide opportunity for advanced study of electronic circuits as applied to the control of industrial equipment and processes. The various applications of gaseous tubes, photoelectric devices, relays, servomechanisms, and electronic heating together with digital principles and applications are studied and applied in experimental and practical situations.

Instruction in this course should be built upon a strong foundation of basic and advanced electronics and should be limited to those students who have completed at least two years of prior instruction in the field. The instructor may wish to select topics for instruction which are pertinent to student needs and which are commensurate with their background.

SPECIFIC OBJECTIVES FOR INDUSTRIAL ELECTRONICS

1. To expand student knowledge of electronic applications – particularly those applications pertaining to the control of industrial equipment and processes.

2. To provide students first hand experiences in setting up, checking, operating, testing, and troubleshooting electronic circuitry as used in industry.

3. To increase student proficiency and confidence in the use of electronic test equipment.

4. To provide students the opportunity to construct electronic devices which operate on the principles studied in the course.

5. To foster proper attitudes toward fellow workers and toward the maintenance of shop facilities.
# INDUSTRIAL ELECTRONICS

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<th>TEACHER ACTIVITIES</th>
<th>INSTRUCTIONAL AIDS</th>
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<tbody>
<tr>
<td>II. EMPLOYMENT AND EDUCATIONAL OPPORTUNITIES</td>
<td>Survey Missouri and U.S. Employment Service publications for job opportunities. Do a self-evaluation profile for self-study. Make a study of and compare different schools of advanced education (college trade, etc.).</td>
<td>Give the students a breakdown of the advantages for a non-high school, high school, trade school and college graduate.</td>
<td>Speakers: Personnel Manager from Industry; Counselor: College, Vocational School or Trade School; Film 4: Choosing Your Occupation.</td>
</tr>
</tbody>
</table>
Principles of operation and application of various control systems.

Hookup and test:
- photo-cell control circuit, time delay control circuit, proximity alarm circuit, electronic tachometer, and synchro system.

Present nomenclature and symbols used in industrial electronics.
- Demonstrate gas-filled and mercury-pooled rectifiers
- Poly-phase rectifier circuits
- Electrostatic precipitators and safety precautions
- Industrial X-ray machines and safety precautions
- Induction and dielectric heating systems
- Basic principles of a servo system
- Inductive and capacitive spot welding systems
- Demonstrate sequential timing control systems
- Thyatron and silicon controlled rectifier (SCR)
- Gaseous voltage regulators
- Application of electronics in medicine

Samples of MV Rectifiers, Thyatron, Mercury Pool Rectifiers, etc.

Working Models of Induction and Dielectric Heating Systems, and Electronic Spot Welders

Film 5: Automatic Machines.

Film 7: IBM Control Systems at Work.
### Course Content

<table>
<thead>
<tr>
<th>V. Microwave Systems</th>
<th>Student Activities</th>
<th>Teacher Activities</th>
<th>Instructional Aids</th>
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</thead>
<tbody>
<tr>
<td>Principles of operation and application of basic circuits for communications and radar.</td>
<td>Construct: UHF oscillator, UHF receiver, UHF directional antenna. Measure the power output and wave length of a UHF oscillator.</td>
<td>Discuss comparisons between microwave and lower frequency radiations. Discuss skin effect, wave guides, coaxial cables and cavity reasonators. Discuss and demonstrate microwave generators. Discuss and demonstrate microwave receivers. Discuss microwave antennas (launchers). Discuss the conventional and doppler radar systems. Discuss capabilities and limitations of computers. Illustrate basic computer mathematics-binary code. Demonstrate or illustrate basic logic circuits: &quot;and,&quot; &quot;or,&quot; &quot;nor,&quot; &quot;gates,&quot; and &quot;adders.&quot; Discuss memory devices and systems: pulse controlled bistable multivibrator, and flip-flop counting circuit.</td>
<td>Microwave Demonstration Unit Samples of Wave Guides, Cavity Resonators, Klystrons, Magnetrons, etc. Film 8: Radar and T.V. Film 9: Coaxial and Microwave Miracles Film 10: Scatter Radar</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>VI. Basic Computer Systems</th>
<th>Student Activities</th>
<th>Teacher Activities</th>
<th>Instructional Aids</th>
</tr>
</thead>
</table>
TEXTBOOKS FOR INDUSTRIAL ELECTRONICS

Suggested Textbooks


REFERENCE BOOKS FOR INDUSTRIAL ELECTRONICS


FILMS, TRANSPARENCIES,
AND SUPER 8 SINGLE CONCEPT FILMS
FOR INDUSTRIAL ELECTRONICS

4. Automatic Machines. 20 min., Massachusetts Institute of Technology.
8. Coaxial and Microwave Miracles. 10 min., University of Colorado.
10. Thinking Machines. 20 min., color, University of Missouri.
11. Memory Devices. 29 min., University of Arizona.
15. Radioisotope Applications in Industry. (91946), 26-1/2 min., B/W (AEC).
18. By the Numbers. 1962, 16 min., color, (IBM).
30. The Information Machine. 1958, color, 10 min., (IBM).
32. Machines That Think. 1962, 29 min., (AEC).
37. Solving the Unbalanced Bridge. 1964, 17 min., (TKTR).
16MM FILM DISTRIBUTORS' ADDRESSES

T.A.I.  Teaching Aids Incorporated, Post Office Box 5527, Long Beach 8, California

NAVY  9th Naval District, Building 1, Great Lakes, Illinois 60085

NET  NET Film Service, Audio-Visual Center, Indiana University, Bloomington, Indiana

MU  University of Missouri, Extension Division, Audio-Visual and Communication Service, 119 Whitten Hall, Columbia, Missouri 65201


LNCO  Leeds & Northrup Co., Rockland and Stenton Avenue, Philadelphia, Pennsylvania 19144

USEM  U. S. Electrical Motors, Division of Emerson Electric Company, Old Gate Lane, Milford, Connecticut 06460

RMCO  Rockwell Manufacturing Company, Power Tool Division, Rockwell Building, Pittsburgh, Pennsylvania 15208

I.B.M.  International Business Machines, 301 East Armour, Kansas City, Missouri

ADCP  Admiral Corporation, 3800 West Cortland Street, Chicago, Illinois 60647

BELL  Nearest Local Bell Telephone Company Business Office

HUAC  Hughes Aircraft Corporation, 500 Superior Avenue, Newport Beach, California 92660

TKTR  Tektronix Incorporated, Film Library, P. O. Box 500, Beaverton, Oregon

AEC  United States Atomic Energy Commission, P. O. Box 62, Oak Ridge, Tennessee 37830

NBOS  National Bureau of Standards, United States Department of Commerce, Clearing House, Springfield, Virginia 22151

NASA  George C. Marshall, Space Flight Center, Public Affairs Office, Huntsville, Alabama 35812

AISI  American Iron & Steel Institute, Teaching Aids Distribution Center, Bedford Hills, New York 10507

GM-DR  Delco-Remy Division, General Motors Corporation, Technical Literature Section, Anderson, Indiana 46011
NTEA  Norelco Training and Educational Aids, North American Phillips Company, Incorporated, Professional Products Division, 100 East 42nd Street, New York, New York 10017

EBEC  Encyclopedia Britannica, Educational Corporation, 425 North Michigan Avenue, Chicago, Illinois 60611

AEFC  Animated Electronic Film Co., P. O. Box 2036 Eads Station, Arlington, Virginia 22202

35MM FILMSTRIPS


The Optical Comparator Story. (1962), Color, 35 min., (Jones & Lawson – A Textrons Co.)

Science, Technology and Society. (1965), Color, 68 Frames, American Iron & Steel Institute (will supply one print to any school system).


Regulation and the Charging Circuit. Color, 12 min., (Delco-Remy Division).

The Thyatron. 27 Frames, Color, $8.50, (NORELCO).

The Ignitron. 24 Frames, Color, $8.50, (NORELCO).

Photo-Electric Emission. 31 Frames, Color, $8.50, (NORELCO).

Cold Cathode Tubes. 28 Frames, Color, $8.50, (Switching – Relay Tube – Counter and Indicator Tubes), (NORELCO).

Industrial Electronics Series. GE, SD.
1. Thy-Mo-Trol
2. Photoelectric Relay Systems

FILM DIRECTORIES


Guide to Military – Loan Film (16mm.), Serina Press, 70 Kennedy Street, Alexandria, Virginia 22305.


Film Catalog, University of Missouri – Columbia, Extension Division, Audiovisual and Communication Service, 119 Whitten Hall, Columbia, Missouri 65211.
SUPER 8MM FILM LOOPS

System of Twos S(80085) – Color $17.60

Sine Function S(80102) – Color $17.60

Vectors No. 1 S(80881) – Color $22.00

What does 10 mean? S(80176) – Color $22.00

Encyclopedia Britannica
Educational Corporation
425 N. Michigan Avenue
Chicago, Illinois 60611

Transistorized Multivibrator #320 – Color $17.00, (AEFC)

Series LCR Circuits – Color $17.00, (AEFC)

Series LCR Circuits-part II – Color $17.00

Transistor Characteristic Curves – Color $17.00

Audio Voltage Amplifier (with NPN Transistor) – Color $17.00

Animated Electronic Film Company
P. O. Box 2036, Eads Station
Arlington, Virginia 22202
INDUSTRIAL ELECTRONICS PROJECT TEXTS


## INDUSTRIAL ELECTRONICS PROJECTS

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<tr>
<th>PROJECT</th>
<th>USE</th>
<th>CONCEPTS</th>
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<tr>
<td>Universal Timer*</td>
<td>Same</td>
<td>Mosfet Trica</td>
</tr>
<tr>
<td>Lamp Dimmer*</td>
<td>Same</td>
<td>Triac</td>
</tr>
<tr>
<td>Enlarger Exposure Meter*</td>
<td>Same</td>
<td>Photo Cell</td>
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<td></td>
<td></td>
<td>Full-wave Bridge</td>
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<tr>
<td>Meter Speed Control*</td>
<td>Same</td>
<td>S-C-R</td>
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<tr>
<td></td>
<td></td>
<td>Diodes Transistors</td>
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<tr>
<td>Positive Action Light-</td>
<td>Same</td>
<td>Relay Photocell</td>
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<tr>
<td>Operated Switch*</td>
<td></td>
<td>Transistors</td>
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<tr>
<td>Electronic Heat Control**</td>
<td>Switch on AMC Fan at</td>
<td>Thermistor SCR</td>
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<td></td>
<td>predetermined heat level</td>
<td>Transistors Diodes</td>
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<tr>
<td>Heater Power Control**</td>
<td>Control heat of a hot</td>
<td>S-C-R</td>
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<td></td>
<td>plate</td>
<td>Transistors Diodes</td>
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<tr>
<td>Electronic Time Delay**</td>
<td>Camera Delay Timer</td>
<td>SCR Transistor Diodes</td>
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<tr>
<td></td>
<td>for games</td>
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</tr>
<tr>
<td>Universal Decade Counter***</td>
<td>Experimentation</td>
<td>Integrated Circuits</td>
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<tr>
<td></td>
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<td>Nixie Tube</td>
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<td>Flip-Flop Circuits</td>
</tr>
<tr>
<td>Digital Volt-OHM Meter***</td>
<td>Test Equipment &amp;</td>
<td>Integrated Circuits</td>
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<td></td>
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<tr>
<td></td>
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<td>Zener Diodes</td>
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</tbody>
</table>

* RCA Solid State Hobby Circuits Manual  
** RCA Experimenter's Manual, Silicon Control Rectifier  
*** Southwest Technical Products Corp., 219 W. Rhapsody, San Antonio, Texas 78216
APPENDICES

Photographs courtesy of
Lee's Summit Junior High School
Mike Ford, Photographer
<table>
<thead>
<tr>
<th>ITEM</th>
<th>SOURCE</th>
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<tr>
<td>Analog Computer Instruction Manual</td>
<td>American Basic Science Club, Inc.</td>
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<tr>
<td></td>
<td>501 East Crockett Street</td>
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<td></td>
<td>San Antonio 6, Texas</td>
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<tr>
<td>Leaflet of handy tips covering computer technology terms</td>
<td>Bud Electronics</td>
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<td></td>
<td>Division of Bud Company, Inc.</td>
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<tr>
<td></td>
<td>43-22 Queens Street</td>
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<tr>
<td>Educators Progress Service</td>
<td>Educators Guide to Free Science Materials</td>
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<td></td>
<td>Randolph, Wisconsin 53956</td>
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<td>Automation/Computers A-2481 Booklet</td>
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<td>IRC Solar Cell and Photo Cell Handbook</td>
<td>International Rectifier Corporation</td>
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<td></td>
<td>El Segundo, California</td>
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<tr>
<td>Automatic Digital Computers</td>
<td>Los Alamos Scientific Lab. /limit 10 copies</td>
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<tr>
<td>What are they? How do they work?</td>
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<td>P. O. Box 1663</td>
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<td></td>
<td>Los Alamos, New Mexico 87544</td>
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<tr>
<td>Pamphlet 6D-207 Transistor Circuits and Troubleshooting</td>
<td>United Motor-Service</td>
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<td>General Motors Building</td>
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<td>B-7940 Thermoelectric Handbook</td>
<td>Westinghouse Electric Corporation</td>
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<td>Box 146</td>
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<td>Pittsburg, Pennsylvania</td>
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<td>Electric Utility Industry Booklets</td>
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<td>750 3rd Avenue</td>
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<td>Light and Man Series</td>
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<td>ARRL Pamphlet</td>
<td>American Radio Relay League, Incorporated</td>
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<td>Cleveland, Ohio 44101</td>
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<td>Government material</td>
<td>Superintendent of Documents</td>
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<td></td>
<td>Government Printing Office</td>
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<td></td>
<td>Washington, D.C. 20402</td>
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</table>
MAGAZINES AND TECHNICAL BULLETINS
INDUSTRIAL ELECTRONICS

* Instruments and Control Systems, 845 Ridge Avenue, Pittsburgh 12, Pennsylvania
* Instruments and Apparatus News, 845 Ridge Avenue, Pittsburgh 12, Pennsylvania
+ Tekoscope, Tektronix, Inc. (Free), P. O. Box 500, Beaverton, Oregon 97005
+ Rectifier News (Free), International Rectifier, 233 Kansas Street, El Segundo, California 90245
* Automation (Free to engineers), Fenton Publishing Co., Fenton Building, Cleveland 13, Ohio
* I.S.A. Journal, Instrumentation-Systems-Automatic Control, Instrument Society of America, 313 Sixth Avenue, Pittsburgh, Pennsylvania
+ Measurement News (Free), Hewlett-Packard Journal, 1501 Page Mill Road, Palo Alto, California 94304
+ Frequency Technology, Frequency, Inc., 795 Washington Street, Norwood, Mass. 02062
* Electronics, McGraw-Hill Building, 330 W. 42nd Street, New York, New York 10036
* School Shop (Free), School Shop, P. O. Box 1929, Clinton, Iowa 52732
* Circuits Manufacturing (Free), Circuits Manufacturing, P. O. Box 193, Arlington, Massachusetts 02174
* Popular Electronics, Popular Electronics, P. O. Box 1096, Flushing, New York 11352
* Electronics World, Electronics World, P. O. Box 1093, Flushing, New York 11352
* Electronic Technician/Dealer, Electronic Technician/Dealer, Post Office Box 6016, Duluth, Minnesota 55802
* Radio-Electronics, Radio-Electronics, Subscription Department, Boulder, Colorado 80302
+ Technical Bulletins
* Magazines
Appendix II

Teaching Systems


7. Electronic Aids Incorporated, 6101 Falls Road, Baltimore, Maryland 21209.

8. RCA Electronic Trainers, RCA Service Company, A Division of Radio Corporation of America, Camden, New Jersey 08101.


10. Educational Technologies, Incorporated, 3546 Dakota Avenue, Minneapolis, Minnesota 55446.

11. Electronic Kits Supply Company, 1261 South Boyle Avenue, Los Angeles, California 90054.

ELECTRONICS SUPPLIES

Electronics Kits Supply Company 1261 South Boyle Avenue, Los Angeles, California 5546, (Lab Equipment).

Educational Technologies Incorporated 3546 Dakota Avenue, Minneapolis, Minnesota 55416.

Science Electronics 1085 Commonwealth Avenue, Boston, Massachusetts 02215, (Lab Equipment).

Heath Company Benton Harbor, Michigan 49022.


Brodhead-Garrett Company 4560 East 71st Street, Cleveland, Ohio 44105.
## Appendix III

### TOOL LIST

**LEVELS 1 and 2; 3 and 4**

**ELECTRICITY-ELECTRONICS**

<table>
<thead>
<tr>
<th>I. Small Tools and Equipment</th>
<th>Introductory</th>
<th>Quantity</th>
<th>Advanced</th>
<th>Quantity</th>
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<td>Alignment Tool (set)</td>
<td>X</td>
<td>2</td>
<td>X</td>
<td>2</td>
</tr>
<tr>
<td>Bit, Screwdriver (set) square tang, 1/4&quot;, 5/16&quot;, 3/8&quot;, 1/2&quot;</td>
<td>X</td>
<td>1</td>
<td>X</td>
<td>1</td>
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<tr>
<td>Brace, Ratchet (10&quot;)</td>
<td>X</td>
<td>1</td>
<td>X</td>
<td>1</td>
</tr>
<tr>
<td>Brush-Bench</td>
<td>X</td>
<td>4</td>
<td>X</td>
<td>4</td>
</tr>
<tr>
<td>Coil Winder</td>
<td>X</td>
<td>1</td>
<td>X</td>
<td>1</td>
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<tr>
<td>Compass</td>
<td>X</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Countersink,* High speed steel 1/4&quot; shank, 1/2&quot; size</td>
<td>X</td>
<td>1</td>
<td>X</td>
<td>1</td>
</tr>
<tr>
<td>Die, Letter (3/16&quot;)*</td>
<td>X</td>
<td>1</td>
<td>X</td>
<td>1</td>
</tr>
<tr>
<td>Die, Number (set) (3/16&quot;)*</td>
<td>X</td>
<td>1</td>
<td>X</td>
<td>1</td>
</tr>
<tr>
<td>Divider, Wing (6&quot;)</td>
<td>X</td>
<td>1</td>
<td>X</td>
<td>1</td>
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<tr>
<td>Drill, Electric Portable (1/4&quot;)</td>
<td>X</td>
<td>1</td>
<td>X</td>
<td>1</td>
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<tr>
<td>Drill, Hand (1/4&quot;)</td>
<td>X</td>
<td>1</td>
<td>X</td>
<td>1</td>
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<tr>
<td>Drill Stand, Fractional (1/16&quot;-1/2&quot; by 64ths)</td>
<td>X</td>
<td>1</td>
<td>X</td>
<td>1</td>
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<tr>
<td>Drill, Twist, Straight shank (Fractional Set) high speed steel, (1/16&quot;-1/2&quot; by 64ths)</td>
<td>X</td>
<td>1</td>
<td>X</td>
<td>1</td>
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<tr>
<td>Extension cord 25', heavy duty, grounded</td>
<td>X</td>
<td>2</td>
<td>X</td>
<td>2</td>
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<tr>
<td>Files (see specifications for listing) 6&quot;, mill (flat), second cut</td>
<td>X</td>
<td>4</td>
<td>X</td>
<td>4</td>
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<tr>
<td>File Card and Brush*</td>
<td>X</td>
<td>6</td>
<td>X</td>
<td>6</td>
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5-6
<table>
<thead>
<tr>
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<th>Introductory</th>
<th>Quantity</th>
<th>Advanced</th>
<th>Quantity</th>
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<tbody>
<tr>
<td>File, Jeweler's (set)</td>
<td>X</td>
<td>1</td>
<td>X</td>
<td>1</td>
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<tr>
<td>assorted shapes, 4&quot;-6&quot;</td>
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<td>X</td>
<td>1</td>
<td>X</td>
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<tr>
<td>set of 12-5-1/2&quot;L</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Gauge, Thickness*</td>
<td>X</td>
<td>1</td>
<td>X</td>
<td>1</td>
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<tr>
<td>(&quot;feeler&quot;)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>minimum 6 leaf,</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1/2&quot; x 2-1/2&quot; x</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>.0015&quot;-.015&quot;</td>
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<tr>
<td>Gauge, Wire and sheet metal</td>
<td>X</td>
<td>2</td>
<td>X</td>
<td>1</td>
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<tr>
<td>metal (American)*</td>
<td></td>
<td></td>
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<tr>
<td>sizes 0-36</td>
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<tr>
<td>Goggles (spectacles),</td>
<td>X</td>
<td>12</td>
<td>X</td>
<td>12</td>
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<tr>
<td>Clear observation</td>
<td></td>
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<tr>
<td>Hammer, Ball peen (12oz.)</td>
<td>X</td>
<td>1</td>
<td>X</td>
<td>1</td>
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<tr>
<td>Hammer, Claw (16oz.)</td>
<td>X</td>
<td>1</td>
<td>X</td>
<td>6</td>
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<tr>
<td>Hydrometer</td>
<td>X</td>
<td>1</td>
<td>X</td>
<td>1</td>
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<tr>
<td>Knife, Electrician's</td>
<td>X</td>
<td>6</td>
<td>X</td>
<td>6</td>
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<tr>
<td>Label Maker*</td>
<td>X</td>
<td>2</td>
<td>X</td>
<td>1</td>
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<tr>
<td>Magnet, Bar</td>
<td>X</td>
<td>12</td>
<td>X</td>
<td>24</td>
</tr>
<tr>
<td>minimum size</td>
<td></td>
<td></td>
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<tr>
<td>1/4&quot; x 1/2&quot; x 3&quot;</td>
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<td>Nibbler, Hand operated</td>
<td>X</td>
<td>2</td>
<td>X</td>
<td>6</td>
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<tr>
<td>capacity 18&quot; steel</td>
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<td>Oilier, Bench</td>
<td>X</td>
<td>1</td>
<td>X</td>
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<tr>
<td>1/2 pint size, 5&quot; steel spout</td>
<td></td>
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<tr>
<td>Oilstone, Combination</td>
<td>X</td>
<td>2</td>
<td>X</td>
<td>2</td>
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<td>India course and fine grits.</td>
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<tr>
<td>8&quot; x 2&quot; x 1&quot;</td>
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<tr>
<td>Pliers, Combination (6&quot;)</td>
<td>X</td>
<td>6</td>
<td>X</td>
<td>6</td>
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<tr>
<td>Pliers, Duckbill (6&quot;)*</td>
<td>X</td>
<td>6</td>
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<tr>
<td>Insulated</td>
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<tr>
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<td>X</td>
<td>12</td>
<td>X</td>
<td>12</td>
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<tr>
<td>Insulated</td>
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### TOOL LIST
#### LEVELS 1 and 2; 3 and 4
#### ELECTRICITY-ELECTRONICS

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<th>Small Tools and Equipment (cont.)</th>
<th>Introductory</th>
<th>Quantity</th>
<th>Advanced</th>
<th>Quantity</th>
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<tr>
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<td>X</td>
<td>24</td>
<td>X</td>
<td>24</td>
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<td>Pliers, Side-cutting (6&quot;) Insulated</td>
<td>X</td>
<td>12</td>
<td>X</td>
<td>12</td>
</tr>
<tr>
<td>Pliers, Vise-grip wrench (7&quot;)</td>
<td>X</td>
<td>3</td>
<td>X</td>
<td>3</td>
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| Press, Drill*  
15" cap. variable speed, number 2 Morse Tap in spindle, Model 1/2HP, magnetic switch | X            | 1        | X        | 1        |
| Punch, Center (set)*  
4'L, 1/16"-1/2" by 32nds | X            | 2        | X        | 2        |
| Punch, Center Automatic | X            | 1        | X        | 1        |
| Punch, Chassis (round set)  
2 piece dies,  
7/8", 3/4", 1", 1-1/8" | X            | 1        | X        | 1        |
| Punch, Chassis (square set)  
2 piece dies,  
1/2", 3/4", 1" | X            | 1        | X        | 1        |
| Punch, Pin (set)*  
4"L, 1/16"-1/2" by 32nds | X            | 2        | X        | 2        |
| Reamer, Electrician's hand  
1/8" tip, tapered, 5"L | X            | 1        | X        | 1        |
| Rivet tool (pop rivet tool) | X            | 1        | X        | 1        |
| Rule, Steel (12")  
gradiated to 1/16" | X            | 6        | X        | 6        |
| Rule, Mechanical | X            | 6        | X        | 6        |
| Saw, Hack (hand)  
adjustable to receive 9" to 12" blade | X            | 1        | X        | 1        |
| Scissors (8") | X            | 1        | X        | 1        |
| Screwdriver, Insulated (set)  
regular blades.  
3/16" by 9/32" with 4", 6", and 8" shafts | X            | 1        | X        | 1        |
# TOOL LIST

**LEVELS 1 and 2; 3 and 4**

**ELECTRICITY - ELECTRONICS**

<table>
<thead>
<tr>
<th>Small Tools and Equipment (cont.)</th>
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<th>Quantity</th>
<th>Advanced</th>
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<td>1</td>
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<tr>
<td>set with points #1, #2, #3</td>
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<td></td>
<td></td>
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<tr>
<td>Screwdriver, Retaining type</td>
<td>X</td>
<td>2</td>
<td>X</td>
<td>2</td>
</tr>
<tr>
<td>3/16&quot; blade</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shield, Face</td>
<td>X</td>
<td>6</td>
<td>X</td>
<td>6</td>
</tr>
<tr>
<td>Snips, Tinner's, Straight (#8)</td>
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<td>X</td>
<td>1</td>
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<td>Soldering Aid</td>
<td>X</td>
<td>12</td>
<td>X</td>
<td>12</td>
</tr>
<tr>
<td>Soldering, Copper, Electric (60W)</td>
<td>X</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1/4&quot; copper tip</td>
<td></td>
<td></td>
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<tr>
<td>Soldering Copper, Electric pencil (30W)</td>
<td>X</td>
<td>6</td>
<td>X</td>
<td>6</td>
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<tr>
<td>7&quot; slim handle</td>
<td></td>
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<tr>
<td>Soldering Gun, Electric</td>
<td>X</td>
<td>12</td>
<td>X</td>
<td>12</td>
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<tr>
<td>dual heat, 240/325W, spot light</td>
<td></td>
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<tr>
<td>Square, Combination</td>
<td>X</td>
<td>3</td>
<td>X</td>
<td>3</td>
</tr>
<tr>
<td>12&quot; rule</td>
<td></td>
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</tr>
<tr>
<td>Tap and Die (set)</td>
<td>X</td>
<td>1</td>
<td>X</td>
<td>1</td>
</tr>
<tr>
<td>sizes 6-32, 8-32, 10-24, 12-24 and 1/4&quot;-20</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vise Combination (size 2&quot;)</td>
<td>X</td>
<td>1</td>
<td>X</td>
<td>1</td>
</tr>
<tr>
<td>Wire Stripper, adjustable</td>
<td>X</td>
<td>6</td>
<td>X</td>
<td>6</td>
</tr>
<tr>
<td>Wrench, Adjustable end (6&quot;)</td>
<td>X</td>
<td>4</td>
<td>X</td>
<td>4</td>
</tr>
<tr>
<td>Wrench, Allen key (hex) (set)</td>
<td>X</td>
<td>2</td>
<td>X</td>
<td>2</td>
</tr>
<tr>
<td>1/1-1/2, #12</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wrench, Nutdriver (set)</td>
<td>X</td>
<td>12</td>
<td>X</td>
<td>12</td>
</tr>
<tr>
<td>Wrench, Open end (set) sizes 1/4&quot;-1&quot;</td>
<td>X</td>
<td>1</td>
<td>X</td>
<td>1</td>
</tr>
</tbody>
</table>

5-9
## TOOL LIST

### LEVELS 1 and 2; 3 and 4

#### ELECTRICITY-ELECTRONICS

<table>
<thead>
<tr>
<th>Small Tools and Equipment (cont.)</th>
<th>Introductory Quantity</th>
<th>Advanced Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wrench, Socket (3/8&quot; driv. (set)) 10 piece set, 7 standard sockets, sizes 3/8&quot;-3/4&quot; by 16ths</td>
<td>X 1</td>
<td>X 1</td>
</tr>
</tbody>
</table>

### II. POWER SUPPLY

<table>
<thead>
<tr>
<th>Power Supply, Variable output 0-20V AC and DC at 10 amperes 0-40V AC and DC</th>
<th>X 12</th>
<th>X 12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Supply, Variable output, Filtered 0-300V DC at 100 ma.</td>
<td>X 6</td>
<td>X 6</td>
</tr>
<tr>
<td>Signal Generator</td>
<td>X 6</td>
<td>X 4</td>
</tr>
</tbody>
</table>

### III. TEST EQUIPMENT

<table>
<thead>
<tr>
<th>Capacitor Substitution Box 100 mmf.-.111 mmd., 350VDC</th>
<th>X 1</th>
<th>X 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oscilloscope (5&quot; screen)</td>
<td>X 6</td>
<td>X 6</td>
</tr>
<tr>
<td>Resistance Substitution Box</td>
<td>X 1</td>
<td>X 1</td>
</tr>
<tr>
<td>Signal Tracer</td>
<td>X 2</td>
<td>X 2</td>
</tr>
<tr>
<td>Tester, Transistor</td>
<td>X 1</td>
<td>X 1</td>
</tr>
<tr>
<td>Tester, Tube</td>
<td>X 1</td>
<td>X 1</td>
</tr>
</tbody>
</table>

### IV. METERING EQUIPMENT

<table>
<thead>
<tr>
<th>Meter, Ammeter (AC) range 0-25 amps.</th>
<th>X 1</th>
<th>X 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meter, Galvanometer 500-0-500 micro amperes</td>
<td>X 1</td>
<td></td>
</tr>
</tbody>
</table>
## TOOL LIST

### LEVELS 1 and 2, 3 and 4

### ELECTRICITY-ELECTRONICS

<table>
<thead>
<tr>
<th>Tool Name</th>
<th>Introductory</th>
<th>Quantity</th>
<th>Advanced</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meter, Grip dip (400 KC 250 MC)</td>
<td></td>
<td></td>
<td>X</td>
<td>1</td>
</tr>
<tr>
<td>Meter, Volt-ohm (multi-range)</td>
<td>X</td>
<td>12</td>
<td>X</td>
<td>12</td>
</tr>
<tr>
<td>Meter, VTVM, Latest Design</td>
<td>X</td>
<td>3</td>
<td>X</td>
<td>6</td>
</tr>
<tr>
<td>Electronic Switch</td>
<td></td>
<td></td>
<td>X</td>
<td>6</td>
</tr>
<tr>
<td>Field Effect Multimeter</td>
<td></td>
<td></td>
<td>X</td>
<td>1</td>
</tr>
<tr>
<td>T.V. Sweep and Marker Generator</td>
<td></td>
<td></td>
<td>X</td>
<td>1</td>
</tr>
<tr>
<td>D.C. Bias Supply</td>
<td></td>
<td></td>
<td>X</td>
<td>1</td>
</tr>
<tr>
<td>Color Bar Generator</td>
<td></td>
<td></td>
<td>X</td>
<td>1</td>
</tr>
<tr>
<td>Vectorscope</td>
<td></td>
<td></td>
<td>X</td>
<td>1</td>
</tr>
</tbody>
</table>

### V. GENERAL FURNISHINGS

<table>
<thead>
<tr>
<th>Item Name</th>
<th>Introductory</th>
<th>Quantity</th>
<th>Advanced</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bench, Eight Student Laboratory Work Center</td>
<td>X</td>
<td>3</td>
<td>X</td>
<td>3</td>
</tr>
<tr>
<td>Bench, Electric demonstration</td>
<td></td>
<td></td>
<td>X</td>
<td>1</td>
</tr>
<tr>
<td>0' x 30'' cabinet storage</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-120V AC and DC outlets</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bookcase</td>
<td>X</td>
<td>1</td>
<td>X</td>
<td>1</td>
</tr>
<tr>
<td>approximate 60''H x 16-12''D x 72''L, 3 adjustable shelves, wood or metal</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cabinet, Filing</td>
<td>X</td>
<td>1</td>
<td>X</td>
<td>1</td>
</tr>
<tr>
<td>4 drawer, 52''H x 15''W x 28-1/2''D</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cabinet, Instrument storage</td>
<td>X</td>
<td>2</td>
<td>X</td>
<td>2</td>
</tr>
<tr>
<td>30''W x 18''D x 72''H, with adjustable shelves and lock</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## TOOL LIST

**LEVELS 1 and 2; 3 and 4**

**ELECTRICITY-ELECTRONICS**

<table>
<thead>
<tr>
<th>V. General Furnishings</th>
<th>Introductory</th>
<th>Quantity</th>
<th>Advanced</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cabinet, Parts storage metal, 100 drawers</td>
<td>X</td>
<td>1</td>
<td>X</td>
<td>1</td>
</tr>
<tr>
<td>Cabinet, Tool storage approximate</td>
<td>X</td>
<td>1</td>
<td>X</td>
<td>1</td>
</tr>
<tr>
<td>approx 62&quot;W x 22&quot;D x 84&quot;H</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chair, Teacher's welded steel construction, swivel, with casters</td>
<td>X</td>
<td>1</td>
<td>X</td>
<td>1</td>
</tr>
<tr>
<td>approx 62&quot;W x 22&quot;D x 84&quot;H</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Desk, Teacher's welded steel construction approx. 42&quot; x 30&quot; x 29&quot;</td>
<td>X</td>
<td>1</td>
<td>X</td>
<td>1</td>
</tr>
<tr>
<td>Fire Blanket</td>
<td>X</td>
<td>1</td>
<td>X</td>
<td>1</td>
</tr>
<tr>
<td>Fire Extinguisher</td>
<td>X</td>
<td>3</td>
<td>X</td>
<td>3</td>
</tr>
<tr>
<td>First Aid Kit</td>
<td>X</td>
<td>1</td>
<td>X</td>
<td>1</td>
</tr>
<tr>
<td>Pencil Sharpener, Standard</td>
<td>X</td>
<td>1</td>
<td>X</td>
<td>1</td>
</tr>
<tr>
<td>Projector,* Filmstrip (35mm)</td>
<td>X</td>
<td>1</td>
<td>X</td>
<td>1</td>
</tr>
<tr>
<td>and slide (2&quot; x 2&quot;)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Projector,* Motion picture, Sound</td>
<td>X</td>
<td>1</td>
<td>X</td>
<td>1</td>
</tr>
<tr>
<td>Screen, Projection</td>
<td>X</td>
<td>1</td>
<td>X</td>
<td>1</td>
</tr>
<tr>
<td>60&quot; x 60&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Table, Overhead projector portable, 26&quot; high</td>
<td>X</td>
<td>1</td>
<td>X</td>
<td>1</td>
</tr>
</tbody>
</table>

*Items which are helpful but are not necessary for a beginning program.
Appendix IV

ELECTRICITY - ELECTRONICS

BIBLIOGRAPHY


Collings, M. D. Projects in Electricity. 1958. McKnight & McKnight.

Cook, S. R. Electrical Things Boys Like To Make. 1954. Bruce.


Evans, R. N. Experimental Basic Electronics 1958. McKnight & McKnight.


Langford-Smith. Radiotron Designer's Handbook. 1952. RCA.


Loper & Ahr. Introduction to Electricity and Electronics. 1968. Delmar.


Publishers Address List

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and others