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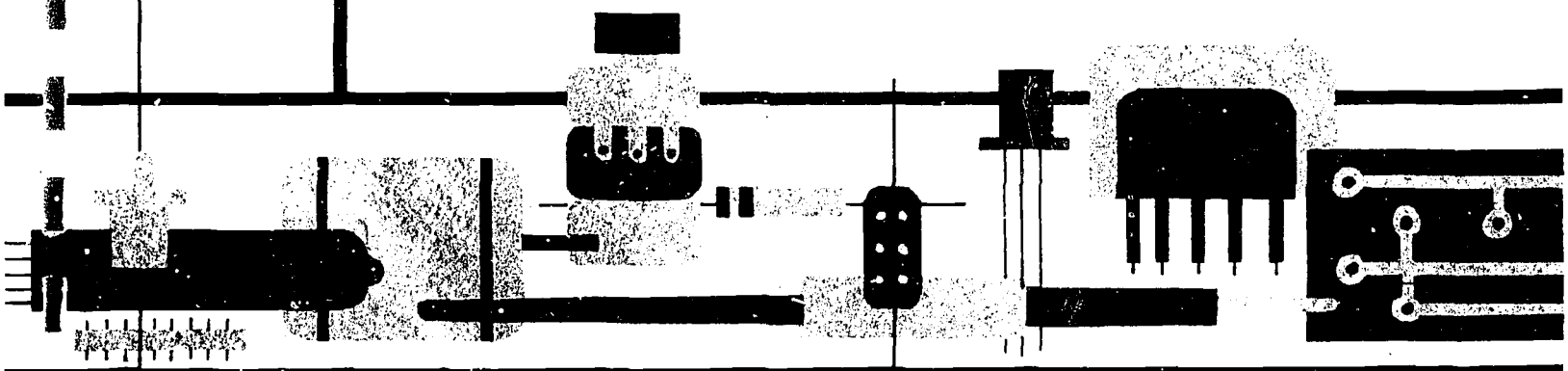
ABSTRACT

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

ELECTRICITY - ELECTRONICS



MISSOURI STATE DEPARTMENT OF EDUCATION

ARTHUR MALLORY
COMMISSIONER OF EDUCATION

INDUSTRIAL ARTS

ELECTRICITY-ELECTRONICS

A CURRICULUM GUIDE FOR INTERMEDIATE AND SECONDARY LEVEL PROGRAMS

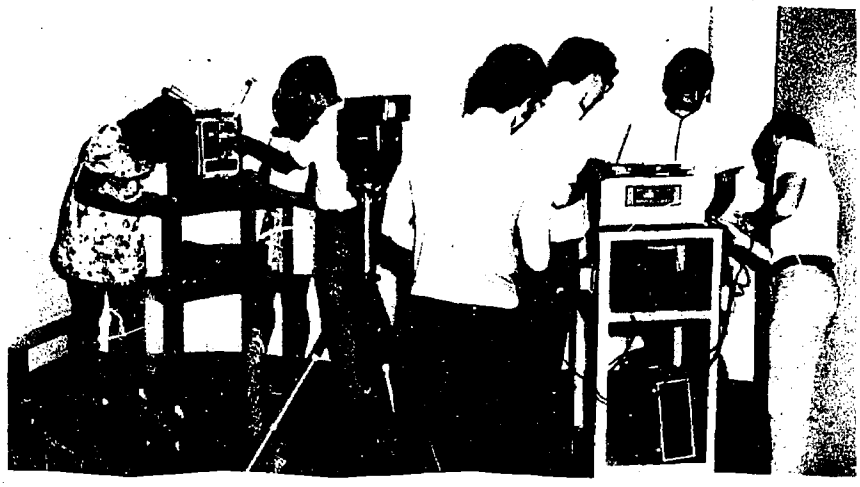
1972 EDITION

MISSOURI STATE DEPARTMENT OF EDUCATION

ARTHUR MALLORY

COMMISSIONER OF EDUCATION

JEFFERSON CITY, MISSOURI



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Electricity-Electronics Department
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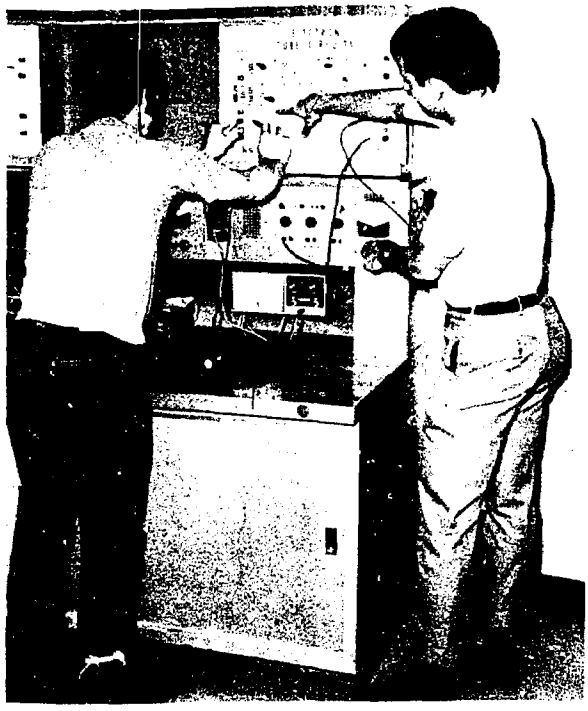
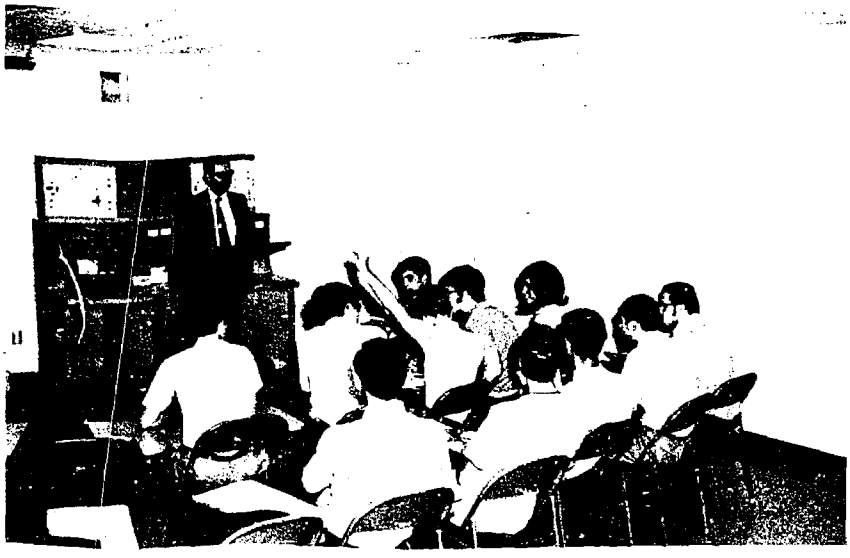
ELECTRICITY – ELECTRONICS





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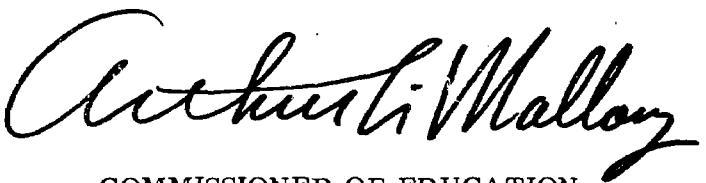
FOREWORD

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.



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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 also 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.

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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.

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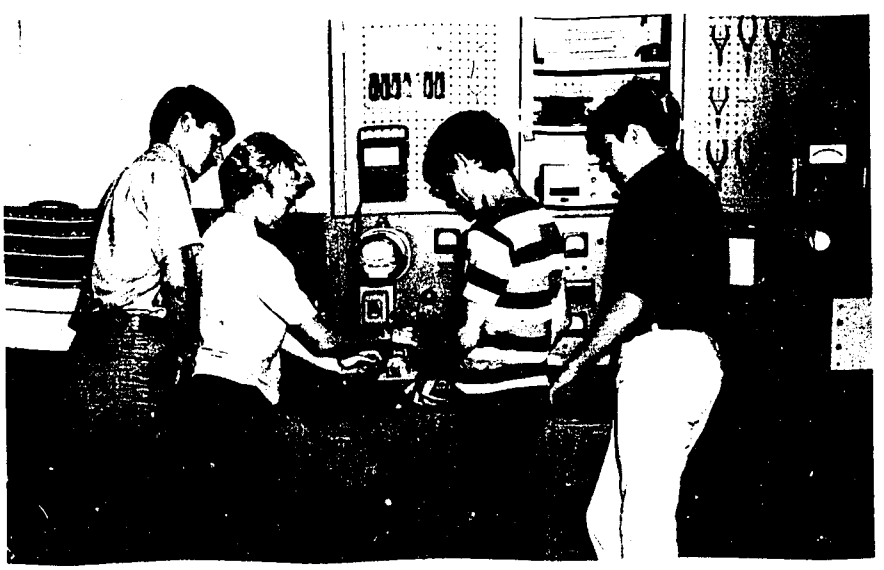
POINT OF VIEW AND OBJECTIVES



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.

Behavorial 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.

EXPLORING ELECTRICITY AND ELECTRONICS LEVEL I

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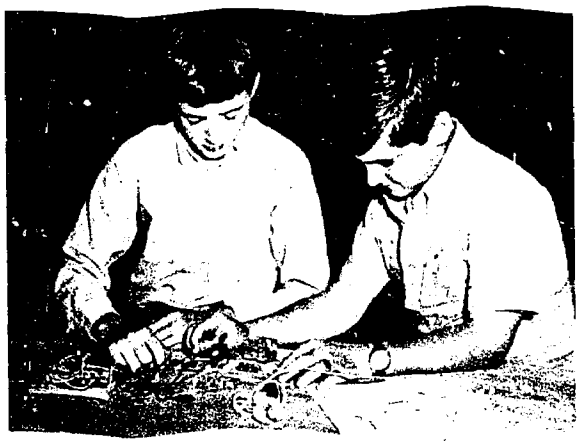

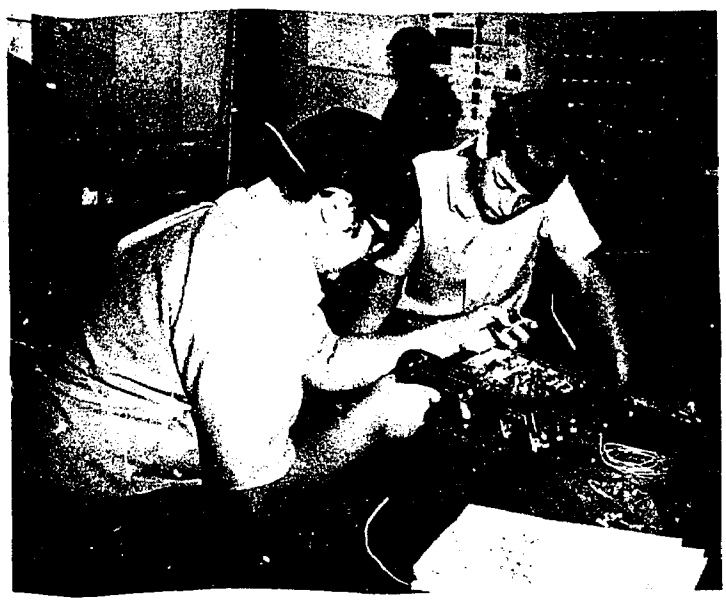

EXPLORING ELECTRICITY - ELECTRONICS

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

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

Conductors and non-conductors.	Use an ohmmeter to study the conductance of various materials and self. Make lists of conductor and non-conductor materials.	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.	Sample materials (conductors) mounted on boards. Mock-up or model, using marbles.
6. Resistors and semi-conductors.	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.	Discuss semi-conductor materials and their characteristics. Demonstrate factors which affect resistance. Introduce students to resistors and show how resistance changes with color coding.	Several silicon diodes. Sample resistive materials mounted. Pocket color code cards. Large color code chart.
II. Effects of Electricity.			
1. Magnetism.	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.	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.	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.

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

Common DC Circuits.			
1. Electrical symbols.	Draw symbols for the common electrical components.	Discuss the importance of electrical symbols and why they are used.	BKS1-BE-11 symbol identification board.
	Use a component identification board to learn to match component with symbol.	Use "flash cards" to assist students in learning to recognize symbols.	
2. Wiring Diagrams.	Draw wiring diagrams of low voltage series and parallel lamp circuits and wire these circuits.	Discuss the structure of series and parallel circuits.	Circuit boards and power supplies.
3. Series circuits.	Learn the characteristics of a series circuit.	Demonstrate how current and voltage behave in series.	Film 13-Electric Circuits.
4. Parallel circuits.	Learn the characteristics of a parallel circuit.	Demonstrate how current and voltage behave in parallel.	Film 17-Electricity: How To Make A Circuit.
5. Series-parallel circuits.	Wire different flashing neon lamp circuits from diagrams, in progressive order of difficulty.	Discuss characteristics of neon lamp circuits and how they operate.	Circuit boards and power supplies.
IV. Basic Electrical Measurements.			
1. Volts.	Become familiar with the terms "EMF," "voltage," & "source voltage."	Review information previously presented concerning voltage.	Film 18-Electricity: Measurement.
			Film 31-Measurement Of Electricity.
	Learn how to connect a voltmeter to a circuit.	Demonstrate the proper way to connect a voltmeter to a circuit.	Film 3-Amperes, Volts, and Ohms.
	Learn the function of the voltmeter and its controls.	Demonstrate the use of the voltmeter, range settings, function of controls, etc.	One multimeter for each two students.

COURSE CONTENT	STUDENT ACTIVITIES	TEACHER ACTIVITIES	INSTRUCTIONAL AIDS
	Practice reading the volt meter on its various scales from a mock-up.	Set a mock-up on various readings throughout its ranges for students to read.	Large mock-up of meter.
	Practice taking various voltage readings on AC & DC circuits.		Circuit boards and power supplies.
2. Amperes.	Become familiar with the terms "ampere," "current," and "milliampere."	Review that which has previously been learned about current and amperes.	Film 20-Electrodynamics.
	Learn to connect an ammeter in a circuit.	Demonstrate the proper way 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 a mock-up on various readings on all ranges to give the student practice in reading an ammeter.	
	Set up various low voltage circuits in series and parallel and take current readings with an ammeter and milliammeter.		
3. Ohm's.	Become familiar with the terms "resistance" and "Ohm's."	Review that which should have been previously learned regarding resistance.	
	Learn how to read an ohmmeter on its various ranges.	Have students read various settings of an ohmmeter mock-up.	Film 36-Principles Of Electricity.
	Learn how to connect an ohmmeter to a circuit.	Demonstrate proper method of connecting an ohmmeter to a circuit.	

4. Watts.	Learn the meaning of the terms "power" and "watts."		Film 43-Watts, Watthours, and Watthour Meters.
	Hook up voltmeter and ammeter in a circuit to determine the power in watts consumed.	Explain that the watts is basically volts times amperes.	AC volt and ammeter.
	Learn meaning of the terms "kilowatt" and "kilowatt hour."		
	Read a kilowatt hour meter.		Watthour meter, old style.
V. Electrical Laws.			
1. Resistance in series.	Hook up resistors in series, compute and measure total resistance.	Explain how to find the total resistance of a series circuit.	Circuit boards.
2. Resistance in parallel.	Hook up resistors in parallel, compute and measure total resistance.	Explain how to compute the total resistance of a parallel circuit.	
3. Ohm's Law formulas.	Learn Ohm's Law symbols.	Explain Ohm's Law symbols and formulas.	Film 6-Basic Electricity.
	Learn Ohm's Law formulas.		
	Learn and observe Ohm's Law relationships.	Demonstrate Ohm's Law relationships.	Film 40-Series & Parallel Circuits.
	Compute and measure voltage in a series circuit.	Explain and demonstrate how voltage behaves in a series circuit.	
	Compute and measure current in a series circuit.	Explain and demonstrate how current behaves in a series circuit.	
	Compute and measure voltage in a parallel circuit.	Explain and demonstrate how voltage behaves in a parallel circuit.	

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

Photo-electric cells.	Experiment with a solar cell. Study and experiment with photo-voltaic and photo-resistive cells.	Discuss the uses of photo-electric cells.	Film 8-Bell Solar Cell. Cells mounted.
5. Thermocouples.	Experiment with a thermocouple, using a source of heat and a meter.	Discuss the uses of the thermocouple in industry.	
6. Piezo-electricity.	Observe the output of a phonograph cartridge on scope or meter.	Explain the term piezo-electricity and how electricity is produced in this manner.	
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.	Learn to identify the electrical characteristics of a switch from its appearance and with a meter. Discuss applications for the various types of switches.	
2. Solenoids.	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.	

COURSE CONTENT	STUDENT ACTIVITIES	TEACHER ACTIVITIES	INSTRUCTIONAL AIDS
3. Relays.	Wire circuits involving one or more relays. Draw wiring diagrams for relays and relay circuits.	Explain relay operation and function.	
4. Transformers.	Using an experimental transformer, wind on several different secondaries and measure voltage of each. Draw symbols for various types of transformers. Draw diagrams of circuits requiring transformers. Learn why transformers are a necessity.	Discuss transformer theory. With the shop-made electromagnet, extra core, coil and NE-2 lamp, demonstrate electromagnetic induction. Using DC voltage, switch coil on and off rapidly to produce moving magnetic field which NE-2 lamp indicates. Show how AC voltage produces this field without switching.	Film 26-How Transformers Work. Film 27-Inductance.
5. Fuses and circuit-breakers.	Learn reasons for over-current protection. Study and examine various protective devices. Learn to locate and reset a thrown breaker. Learn to locate and replace a blown fuse.	Demonstrate need for over-current protection. Demonstrate deficiency of "Abe Lincoln" fuse.	Film 1-AB Circuit Breakers.
6. DC controls.	Study rectifiers and diodes and observe their action with a scope. From a wiring diagram, wire a simple power supply and observe current at various stages with a scope.	Explain purpose and operation of a rectifier. Explain various types of rectifier circuits, such as full wave, half wave, filtered and unfiltered, etc.	

pplications of Electricity.			
1. Motors.	Experiment with a St. Louis motor.	Discuss motor theory.	St. Louis Motors.
2. Communications.	Experiment with simple telegraph key and sounder. Option to learn code.	Discuss operation of telegraph.	Film 9-Beyond All Barriers.
	Experiment with telephone circuits.		Film 33-Mr. Bell.
	Wire simple radio receiver using diodes and transistors. Work from wiring diagram. Test each one.		Film 35-Plane Talk.
3. Space and power.	Write a short report explaining how electrical discoveries have made space exploration possible.	Discuss the importance of electricity in space exploration.	Film 2-A Missile Named Mac.
	Write a short report on the use of atomic energy to produce electricity.	Discuss methods of producing electrical power.	Film 5-Atom and the kilowatt.
IX. Opportunities in the World of Electricity and Electronics.	Write a short report on some area of employment in the electricity-electronics field.	Discuss areas of employment opportunity.	Film 44-Electrical Workers.
			Film 45-Television Workers.
			Film 46-Telephone Linemen.

TEXTBOOKS FOR EXPLORING ELECTRICITY AND ELECTRONICS

Brown, Walter C., Willis H. Wagner, T. Garnder Boyd and Howard H. Gerrish. *Modern General Shop.* South Holland, Ill.: Goodheart-Willcox Company, Inc.

Introduction to Electronics. Chicago: DeVry Technical Institute.

Groneman, Chris H. and John L. Feirer. *General Shop.* New York: McGraw-Hill Book Company.

Arnold, Joseph P. and Kenneth L. Schnak. *Exploratory Electricity.* Bloomington: McKnight & McKnight Publishing Company.

Gerrish, Howard H. *Exploring Electronics.* South Holland, Ill.: The Goodheart-Willcox Company, Inc.

REFERENCE BOOKS FOR EXPLORING ELECTRICITY AND ELECTRONICS

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

Ford, Walter B. *Adventures With Electronics.* Milwaukee: Bruce Publishing Company.

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

McFate, K. L. and E. J. Constien. *4H Electric Program, Workbook Number 1.* Columbia: 4H Circular 160, University of Missouri, Extension Division.

McFate, K. L. and E. J. Constien. *4H Electric Program, Workbook Number 2.* Columbia: 4H Circular 173, University of Missouri, Extension Division.

McFate, K. L. and E. J. Constien. *4H Electric Program, Workbook Number 3.* Columbia: 4H Circular 180, University of Missouri, Extension Division.

Ford, Walter B. *Electrical Projects.* Milwaukee: Bruce 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.)
16. *Electricity: How It Is Generated* – 13 min., color. (NET, 3.90 rental.)
17. *Electricity: How To Make A Circuit* – 11 min., color. (Univ. of Mich., 2.25 rental.)
18. *Electricity: Measurement* – 12 min., color. (Ind. Univ., 3.40 rental.)
19. *Electricity: Static Electricity* – 11 min., color. (Ind. Univ., 3.40 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 Generator* – 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

Allis-Chalmers Mfg. Co., Milwaukee, Wisconsin.

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

AEC – Atomic Energy Commission. Write regional office, if known. If unknown, write Audio-Visual Branch, Division of Public Information, U.S. Atomic Energy Commission, Washington, D.C.

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

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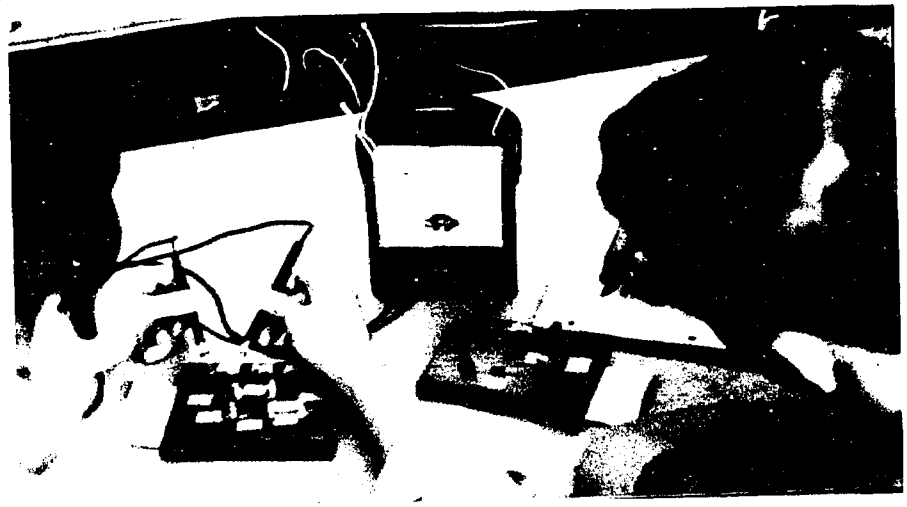
Electricity-Electronics Department
Knox County High School

BASIC ELECTRICITY AND ELECTRONICS LEVEL 2



BASIC ELECTRICITY-ELECTRONICS

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

COURSE CONTENT	STUDENT ACTIVITIES	TEACHER ACTIVITIES	INSTRUCTIONAL AIDS
I. **Introduction.** Class objectives and policies. Safety and first aid care, and use of tools and equipment. Occupational opportunities. Famous men pertaining to the field of electricity.	Study shop safety. Make simple solder joints. Prepare a written paper on important men pertaining to electricity. Become acquainted with industrial job opportunities and leisure time activities in the electricity-electronics field.	Demonstrate proper ways to use tools and equipment. Display new and broken equipment. Display electricity-electronic equipment. Demonstrate proper way to make a solder joint. Display eye catchers. (Example – Jacob's Ladder)	Safety charts and tool charts. Representative from electricity or electronics industries. Filmstrip – *Safe and sure with electricity.*
II. **Basic Concepts** **Atomic theory.** Laws of charges, conductors, insulators, and semi-conductors. Static and dynamic electricity. Sources of electricity. Electrical symbols. Interpreting meters.	Compare elements using the element chart. Become familiar with the VOM. Practice the use of symbols and schematic diagrams. Collect and check examples of insulators, conductors, and semi-conductors with a meter.	Demonstrate the insulative and conductive ability of various materials. Demonstrate ways to make static electricity. Display various ways of producing electricity.	Element chart. Demonstration board with conductors, insulators, and semi-conductors. Charts of electrical symbols. Transparancies. Meters. Filmstrip – *Experimenting with static electricity.*

Schematic drawings. Block diagrams. Line diagrams. Wiring diagrams.			Film – *Introduction to electricity.* Film – *Electrons at work.*
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.	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.*
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. Hook up several experimental circuits and measure current, volts and ohms.	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.	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.*

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

Molecular theory. Domain theory. Magnetic induction. Magnetic resistance. Magnetizing and demagnetizing. Electro-magnetism. Magnetic shielding. Magnetic constants and units. Laws of magnetic circuits.	Compare molecular and domain theory. Observe domains of a magnetized material under a microscope. Examine several uses of magnets and electromagnets. (Examples – doorbell, meter, solenoid, relay, motor, and generators.) Experiment by building simple electro magnets 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 D C 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.	Flash cards. (Example – left hand rule.) Transparencies. Microscope. Filmstrip – *Modern Theories of Magnetism.* Film – *Magnetism.* Film – *Ferromagnetic Domains.*
VII. Basic Measuring Instruments Common construction features of meters. Types of scales and calibrations. Galvanometers. Moving iron or solenoid type. Thermal or hot-wire type. Iron vane type. D'Arsonval instruments. Electro static instruments. Thermocouple instruments.	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.	Meter mockups. Meter transparencies. Worksheets over meters. Resistance boards. Filmstrip – *640-Electric Instruments.* Film – *Circuit testing with meters and multimeters.*

COURSE CONTENT	STUDENT ACTIVITIES	TEACHER ACTIVITIES	INSTRUCTIONAL AIDS
Rectifier type. Ammeter. Voltmeter. Ohmmeter. Bridge method. Watt meter. Multi meter.			
VIII. **Alternating Current** Definition of A C History of A C Characteristics of A C 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.	Flash cards. Oscilloscope. Transparencies. Handout sheets. Film - *The Oscilloscope, what it is and what it does.* Film - *Charles Proteus Steinmetz, The Man Who Made Lightning.*
IX. **Inductance** Lenz's Law Self and mutual 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.

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 D C 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.*

COURSE CONTENT	STUDENT ACTIVITIES	TEACHER ACTIVITIES	INSTRUCTIONAL AIDS
XI. **Capacitance**			
Elementary concepts. Leyden jar. Factors determining capacitance. Units of capacitance. Dielectric constant and strength. Time constant. Capacitor in series and parallel. Common types of capacitors. Capacitor application.	Study units of capacitance and work problems over capacitors in series and parallel. Examine and compare constructional details of capacitors. Experiment with charging and discharging various capacitors. Observe capacitors in operation.	Demonstrate charging and discharging a capacitor. Disassemble a paper capacitor. Discuss the physical characteristics of various capacitors and the electrical effect of capacitance. Plot time constant. Demonstrate time constant with the R.C. flasher.	Display board of capacitors. Charts. Transparencies. R.C. flasher. Hand out sheet of problems over time constant and capacitors in series and parallel. Film – *Capacitance.*
XII. **Inductance, Resistance, and Capacitance in A C Circuits**			
Ohmic resistance. Phase relationship between voltage and current. Inductive reactance. Impedance.	Work problems on calculating inductive and capacitive reactance, impedance and Ohm's Law for circuits containing inductance, capacitance, and resistance. Use the meter to measure circuits containing impedance.	Plot the phase relationship of current and voltage in A.C. circuits. Demonstrate vector and computation methods for solving impedance. Use oscilloscope to show resonance in a circuit.	Flashcards. Transparencies. Handout sheets on impedance. Oscilloscope. Film – *R.C.L. resistance and capacitance.*

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.*

COURSE CONTENT	STUDENT ACTIVITIES	TEACHER ACTIVITIES	INSTRUCTIONAL AIDS
XIV. Motors Basic motor characteristics. D C motors. Series field motor. Shunt field motor. Compound motor (cumulative and differential). A C motors. Universal motor. Induction-polyphase motor. Split phase induction motor. Inductance start motor. Capacitance start motor. Shaded pole motor. Synchronous motor. Motor controls. Motor rating and efficiency.	Study D C and A C motor characteristics. Examine, disassemble, and assemble various motors. Reverse direction of run on motors that will reverse. Become familiar with motor name plate information. Examine and observe motor controls in operation.	Demonstrate A C and D C motor characteristics. Explain importance of the information on the name plate. Demonstrate various types of motor controls.	Flashcards. Transparencies. Handout sheets over motor name plates. Cross-sectional model of a motor. Filmstrip - *577 - How A C and D C Motors Work.*
XV. Application of Electricity Thermoelectric effect. Heating elements. Welding. Furnaces. Inductive and capacitive heating. Soldering.	Compare several heating elements and check their resistances. Check room lighting with a light meter.	Demonstrate heat produced by current flowing through a wire. Explain method of figuring total lumens for various rooms.	Electroplater. Heating elements. Meters. Samples of various types of bulbs.

Luminous effect. Incandescent. Fluorescent. Mercury vapor. Neon. Electroluminescence. Chemical effect. Electroplating. Electrc refinement. Magnetic effect. Relays. Buzzers. Circuit-breakers.	Compare lumens of various types of bulbs. Electroplate keys and other small articles. Check the action of relays, buzzers and circuit-breakers.	Demonstrate electroplating. Demonstrate the effect of relays in a circuit.	Small electroluminescent plug-in units for 120V A.C. Transparencies. Samples of relays, buzzers and circuit-breakers. Film - *Decision Electric.*
XVI. **Residential Wiring** Electrical codes. Underwriters' laboratories. Wiring materials and supplies. Electrical splices. Underwriters' knots. Circuit overload protectors. Wiring symbols. Residential wiring plans. Types of switching circuits. Commercial wiring.	Complete handout sheets over wiring materials and supplies. Study wiring symbols and switching circuits. Wire convenience outlets and switching circuits. Sketch or draw a wiring plan for a new home. Examine several service panels.	Discuss electrical codes and laboratories. Demonstrate electrical splices. Demonstrate wiring outlet and switch circuits that would be used in residential wiring.	Display boards with wiring material and supplies. Handout sheets over symbols, circuits, materials, and supplies. Transparencies. Mockup of heavy industrial wiring practices. Film - *The Electrician.* Film - *Electrical wiring with aluminum.*

COURSE CONTENT	STUDENT ACTIVITIES	TEACHER ACTIVITIES	INSTRUCTIONAL AIDS
XVII. Automotive Electricity			
Cranking system. Ignition system. Charging system. Lighting system. Special electrical systems. Power windows and seats.	Sketch schematics of the electrical systems. Examine and trace the electrical systems on a modern automobile. Disassemble a starting motor and generator. Examine a distributor and a coil. Check the voltage of a storage battery under load. Check the condition of the diodes in an alternator.	Explain grounding systems used to complete circuits (both plus & minus ground). Explain starting circuit controls and application of the D C motor. Demonstrate the use of step-up transformer, condenser, pulsating D C current and distribution. Explain A C and D C generators, charging and controls of the charging circuit. Demonstrate the operation of various lights on the automobile.	Transparencies. Mockup of a complete automobile electrical system. Lighting demonstration board. Service manual of schematics for various automobiles. Filmstrip-Records – *The cranking circuit and how it works.* 20,000 volts under the hood. Delcotron generator and a new charging circuit. Regulation and the charging circuit.
XVIII. Rectifiers, Vacuum Tubes and Semi-conductors			
Copper oxide rectifier. Selenium rectifier. Half and full wave rectifiers.	Examine several different rectifiers. Check rectifiers to find direction of high resistance. Identify transistor leads.	Demonstrate half and full wave rectification with the oscilloscope. Demonstrate the action of the filter circuit.	Transparencies. Oscilloscope. Various types of rectifiers and transistors.

cury pool rectifiers. e and Triode rube. Filter circuits. Crystal diode. Transistors (N. P. N. – P.N.P. types).	Disassemble a diode and triode tube and identify the parts. Check transistor bias.	Introduce the characteristics of N.P.N. and P.N.P. type transistor.	Display board of a disassembled tube.
XIX. **Electricity for Communication** Telegraph (modern). Telephone. Radio. Waves. Essential parts. Radar. Television. Citizens-band transceiver.	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.*

COURSE CONTENT	STUDENT ACTIVITIES	TEACHER ACTIVITIES	INSTRUCTIONAL AIDS
XX. Employment and Educational Opportunities Immediate employment versus advanced education in the field of electronics. Salary versus opportunity.	Library study of salaries and job opportunities in electronics. Survey Missouri and U.S. Employment Service Publications.	Discuss areas of employment opportunity. Discuss enlarged earning power in electronics field with advanced education.	Film 12: *Your Future in Electronics.* Speaker: Personnel manager from Industry. Counselor: College, Vocational or Trade School.

TEXTBOOKS FOR BASIC ELECTRICITY-ELECTRONICS

Miller, Rex and Fred Culpepper, Jr., *Energy, Electricity and Electronics.* Bloomington: McKnight and McKnight Publishing Company, 1964.

Buban, Peter and Marshall L. Schmitt. *Understanding Electricity and Electronics.* Chicago: McGraw-Hill Book Company, Inc.

Cornetet, Wendell H. and Wendell H. Cornetet, Jr. *Principles of Electricity and Basic Electronics.* Bloomington: McKnight and McKnight Publishing Company, 1963.

Wellman, William R. *Elementary Electricity.* Princeton: VanNostrand Company, Inc., 1959.

Graham, Kennard C. *Fundamentals of Electricity.* Chicago: American Technical Society.

Marcus, Abraham. *Basic Electricity.* Englewood-Cliffs: Prentice-Hall, Inc., 1964.

Loper and AHR. *Introduction to Electricity and Electronics.* Albany: Delmar Publishers, Inc., 1968.

REFERENCE BOOKS FOR BASIC ELECTRICITY-ELECTRONICS

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

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FILMS FOR BASIC ELECTRICITY-ELECTRONICS

1. Introduction to Electricity, 11 min., Arkansas State University.
2. Electrons At Work, 14 min., Missouri University.
3. Elements of Electrical Circuits, 10 min., Missouri University.
4. Wire Sizes and Voltage Drop, 11 min., Illinois University.
5. Ohm's Law, 6 min., Illinois University.
6. Primary Cell, 10 min., Illinois University.
7. Story of the Modern Storage Battery, 27 min., Bureau of Mines.
8. Bell Solar Battery, 15 min., Bell Telephone System.
9. Magnetism, 11 min., Iowa University.
10. Ferromagnetic Domains, 22 min., Bell Telephone System.
11. *Circuit Testing with Meters and Multimeters,* 37 min., Illinois University.
12. *The Oscilloscope, What it is and What it Does,* 9 min., Tektronic, Inc.
13. *Charles Proteus Steinmetz - The Man Who Made Lightning,* 15 min., Illinois University.
14. *Inductance,* 34 min., Teaching Aids, Inc.
15. *How Transformers Work,* 15 min., Michigan State University.
16. *Capacitance,* 31 min., University of Michigan.
17. *RCL: Resistance and Capacitance,* 34 min., Teaching Aids, Inc.
18. *Fundamentals of A C and D C Generators,* 19 min., Illinois University.
19. *Making Electricity,* 10 min., Missouri University.
20. *Electric Decision,* 18 min., Association Films.
21. *The Electrician,* 10 min., Missouri University.
22. *Electrical Wiring with Aluminum,* 15 min., Association Films, Inc.
23. *The Transistor,* 10 min., Bell Telephone System.
24. *Vacuum Tubes,* 11 min., Missouri University.
25. *Principles of the Transistor,* 21 min., Illinois University.
26. *Electronics,* 13 min., Missouri University.

27. *World of Semi-conductors,* 44 min., Illinois University.

28. *Your Voice and the Telephone,* 7 min., Bell Telephone System.

29. *Sounds Familiar,* 24 min., Bell Telephone System.

30. *Radio Waves,* 27 min., Iowa University.

31. *Receiving Radio Messages,* 11 min., Iowa University.

32. *Radio Receivers, Principles, and Typical Circuits,* 17 min., Illinois University.

33. *Television, How It Works,* 11 min., Missouri University.

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

16MM FILM DISTRIBUTORS' ADDRESSES

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

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Basic Electronics Transparencies
Educational Technologies, Inc.
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Service Training
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FILMSTRIPS

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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
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Electricity Set No. 3 170050
How Television Works
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What is Electronics
What is Magnetism

McGraw-Hill Film Division of McGraw-Hill Book Company
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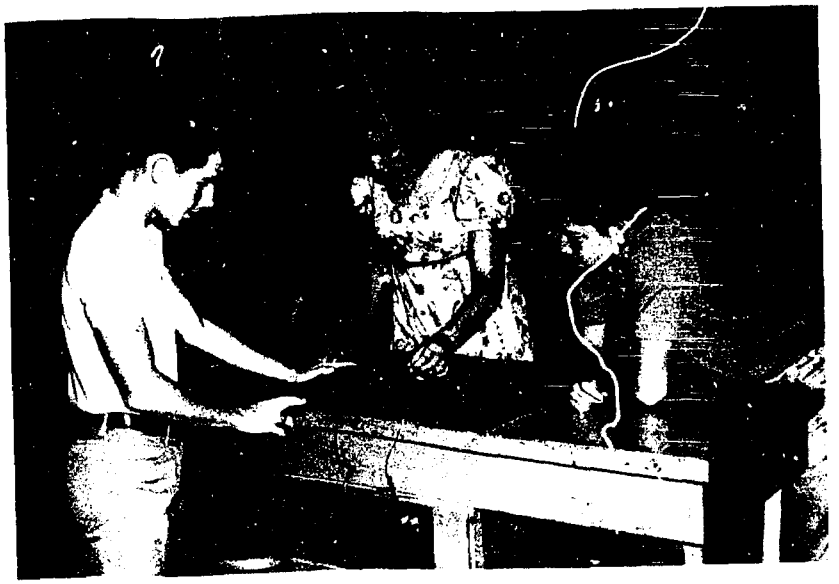

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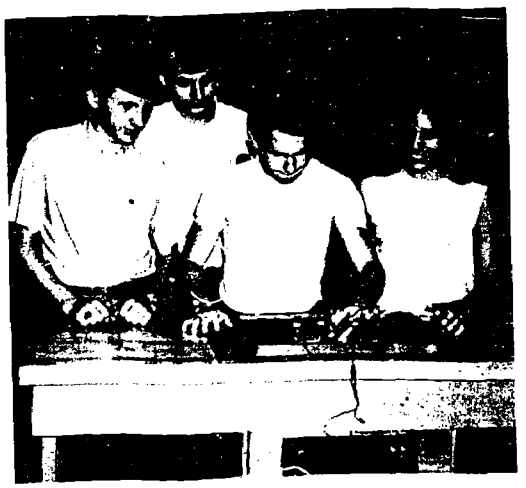
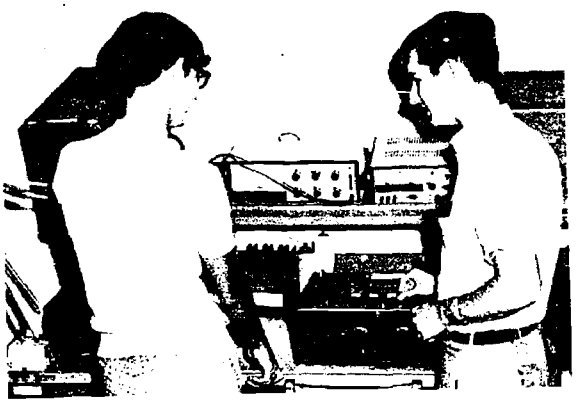
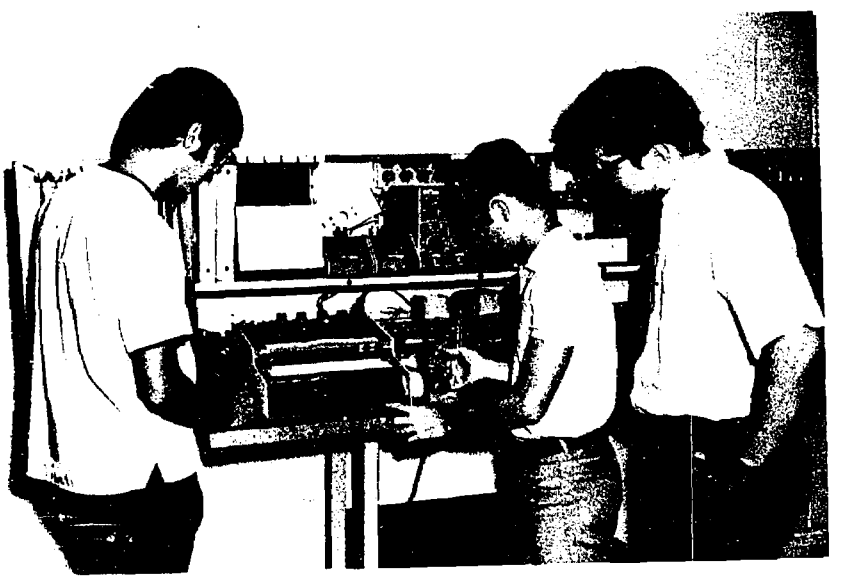
COMMUNICATIONS ELECTRONICS LEVEL 3







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 the 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

COURSE CONTENT	STUDENT ACTIVITIES	TEACHER ACTIVITIES	INSTRUCTIONAL AIDS
I. **SAFETY PRACTICES AND BASIC SKILLS** Personal safety procedures, proper use and care of tools and instruments. Reviewed as necessary during the year. Introduce closed circuit television. How to operate and how to maintain the equipment.	Practice shop rules. Safety test on shop rules. Learn how to operate and maintain closed circuit television equipment.	Review safety rules. Demonstration on operation and maintenance of closed circuit television equipment.	Closed circuit television tape on shop safety. Film 10: *Electricity Principle and Safety.* Film 11: *ABC's of Hand Tools.*
II. **EMPLOYMENT AND EDUCATIONAL OPPORTUNITIES** Immediate employment versus advanced education in the field of electronics. Salary versus opportunity.	Library study of salaries and job opportunities in electronics. Survey Missouri and U.S. Employment Service Publications.	Discuss enlarged earning power in electronics field with advanced education.	Film 12: *Your Future in Electronics.* Speaker: Personnel manager from Industry. Counselor: College, Vocational or Trade School.
III. **BASIC ELECTRONIC SKILLS** Review symbols, schematic diagrams and basic electrical theory.	Practice meter reading. Hook up simple circuits from schematics.	Review how to read schematics. Review basic A.C. and D.C. circuits and theorems.	Film 13: *The Electronic Technician.* Transparencies: *Basic Electronics Series.*

LECTRONIC STRUMENT			
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 Lissajons 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.	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.
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 pow-supply.	Film 16: *The Diode: Principle and Application.* Film 17: *The Principle of the Gas Filled Tube.* Film 18: *Vacuum Tubes.* Transparencies: *Basic Electronic Series.*

COURSE CONTENT	STUDENT ACTIVITIES	TEACHER ACTIVITIES	INSTRUCTIONAL AIDS
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 D C circuits; observe and solve for time constants. Do experiments with inductors and capacitors in A C 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 Poplar Electronics or other electronic magazines. Project should be from schmatic. Also could introduce T V repair.	Review A C and D C 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.	Film 19: *Inductance.* Film 20: *Induced Electric Current.* Film 21: *Capacitance.* Film 22: *RCL: Resistance Capacitance.* Film 23: *Vectors.* 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 multipurpose 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; thyratrons, klystrons, megnetrons, compactrons, etc. Introduce common tube parameters.	Model: Cutaway Tube. Film 24: *The Triode: Amplification.* Film 25: *Cathode Ray Tube.* Transparencies: *Basic Electronic Series.*

IPLIFICATION D AMPLIFIERS			
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.	Film 26: *Radio Waves.* Film 27: *Oscillators, Amplifiers and Radio.* Transparencies: *Basic Electronic Series.*
IX. RECEIVER SYSTEMS APPLICATIONS			
Radio communication principles. Stages of AM and/or FM radio. Detectors, Oscillators, Tuners, Converters, Transmitters and T V 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 T.V. 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, ameteur radio and citizens band, television, teletype and facsimile. Introduce projects made from the schmatic. May be some T V repair work. Discuss T.V. 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.* CCTV tape: *Electronic Construction Technique.* Film 30: *The Television System.* Film 31: *Television Receivers.* Film 32: *Practical T V Alignment.* Film 33: *Television: How It Works.* Film 34: *Basic Principles Of FM.*

COURSE CONTENT	STUDENT ACTIVITIES	TEACHER ACTIVITIES	INSTRUCTIONAL AIDS
X. TRANSMITTER CIRCUIT APPLICATION Basic AM & FM transmitter circuits and tuning principles.	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.	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 & FM systems are used in television.	Film 35: *Oscillators.* Film 36: *Radio Transmitter Principles.*
XI. ELECTROMAGNETIC RADIATION Propagation, antenna transmission lines, and impedance matching.	Select and safely install an outside antenna. Complete frequency to wave length conversions. Compute antenna and tuned transmission line lengths. Transmission line, source, and load impedance matching.	Discuss the radio frequency spectrum and how electromagnetic radiation takes place. Discussion of antennas: types orientation, gain, radiation patterns, dimensions, radiation resistance, harmonies. Discussion of transmission lines: types, impedance matching, harmonic operation, standing waves, installation and safety precautions. Illustrate antenna and transmission line computations and antenna feedpoints.	Film 37: *Electromagnetic Waves.* Film 38: *Effects of the Ionoshere on Radio Wave Propogation.* Film 39: *Mirror in the Sky.* Film 40: *Transmission Lines.* Film 41: *Standing Waves on Transmission Lines.*

EMICONDUCTORS Symbols, construction, principles of operation. and application to include: semi-conductor 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 transister action. Types of circuit configuration, diodes, transistors, and integrated circuits.	Film 28: *Genesis of the Transistor.* Film 29: *Principles of Transistor.* Manuals: *Transistor Manuals.* Transparencies: *Transistor and Semi-conductor Series.*
XIII. SEMI-CONDUCTOR SPECIALIZED Integrated circuits, oscillator circuits, photoelectric control circuits, and circuits using specialized semi-conductors.	Construct circuits using the specialized semi-conductors and study the effect upon the circuit. Suggested. projects: FET timer. *Transistor Electronics* by Gerrish. Page 315.	Introduce specialized semiconductors: Humidity sensor, strain gauge, thermistor, tunnel diode, SCR, unijunction transistor, field effect transistors. insulated gate field effect transistors and frigistors.	Transparencies: *Transistor and Semi-Conductor Series.*

TEXTBOOKS FOR COMMUNICATIONS ELECTRONICS

Marcus, Abraham and William. *Elements of Radio,* 5th ed. New Jersey: Prentice-Hall, 1965.

Mileaf, Harry. *Electricity One-Seven,* 1st ed. New York: Hayden Book Company, Inc., 1966.

Grob, Bernard. *Basic Electronics,* 2nd ed. St. Louis: McGraw-Hill Book Company, 1965.

Garrish, Howard H. *Transistor Electronics,* 1st ed. Homewood: The Goodheart-Willcox Co., Inc., 1969.

Garrish, Howard H. *Electricity and Electronics.* Homewood: The Goodheart-Willcox Co., Inc., 1964.

Marcus, Abraham. *Basic Electronics,* 1st ed. Englewood Cliffs: Prentice-Hall, 1964.

REFERENCE BOOKS FOR COMMUNICATIONS ELECTRONICS

Delpit, George H. and Charles A. Johnson. *Electronics in Action.* Peoria: Charles A. Bennett Company, Inc.

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

Smith, Donald A. *ABC of Vacuum Tubes.* Indianapolis: Howard W. Sams, 1967.

Smith, Paul C. *Know Your Oscilloscope.* Indianapolis: Howard W. Sams, 1958.

Kalish. Israel H. *Microminiature Electronics.* Indianapolis: Howard W. Sams, 1967.

Malmstadt, H. V., et al. *Electronics for Scientists.* New York: W. A. Benjamin, Inc., 1963.

Sams Photofacts. Indianapolis: Howard W. Sams.

Radio Amateur Handbook. ARRL Staff, American Radio Relay League, Current Issue.

Grob, Bernard. *Basic Electronics,* 2nd ed. New York: McGraw-Hill Book Co., 1964.

Grob, Bernard. *Basic Television,* 3rd ed. New York: McGraw-Hill Book Co., 1964.

Radio Servicing, 3rd ed. Englewood Cliffs: Prentice-Hall, Inc., 1960.

Grob, Bernard and M. S. Kiver. *Applications of Electronics,* 1st ed. New York: McGraw-Hill Book Co., 1966.

Electricity and Electronics Fundamentals, 2nd ed. Philco Staff, Philco Ford, 1968.

Johannsen, Lawrence A. and Russell P. Journigan. *Basic Electronics.* 1st ed. Albany: Delmar Publishers Inc.

Buchsbaum, Walter H. *Color TV Servicing.* 2nd ed. Englewood Cliffs: Prentice-Hall, Inc.

Romanowitz, H. Alex and Russell E. Puckett. *Introduction to Electronics.* 1st ed. New York: John Wiley & Sons, Inc.

FILMS FOR COMMUNICATIONS ELECTRONICS

1. *Vacuum Tubes.* 11 min., Missouri University.
2. *Electronics.* 13 min., Missouri University.
3. *Charles Protens Steinmetz - The Man Who Made Lightning.* 15 min., Illinois University.
4. *World of Semi-conductors.* 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.
9. *Cathode-Ray Tube, Window to Electronics.* 35 min., Free films.
10. *Electricity: Principles and Safety.* 11 min., University of Arizona.
11. *ABC's of Hand Tools.* 18 min., Arizona State University.
12. *Your Future in Electronics.* 24 min., RCA Institute.
13. *The Electronic Technician.* Modern Talking Pictures Service.
14. *Measurement of Electricity.* 22 min., University of Arizona.
15. *Circuit Testing.* Etc. 33 min., Army or University of Iowa.
16. *The Diode: Principles and Applications.* 17 min., University of Illinois.
17. *The Principle of the Gas Filled Tube.* 15 min., University of Illinois.
18. *Vacuum Tubes.* 30 min., Brigham Young University.
19. *Inductance.* 33 min., University of Illinois.
20. *Induced Electric Current.* 30 min., Brigham Young University.
21. *Capacitance.* 30 min., University of Illinois.
22. *RCL: Resistance Capacitance.* 30 min., University of Illinois.
23. *Vectors. 11 min.,* University of Illinois.
24. *The Triode: Amplification.* 14 min., University of Illinois.

25. *Cathode-Ray Tube.* 25 min., Tektronix, Inc.

26. *Radio Waves.* 27 min., Arizona State University.

27. *Oscillators, Amplifiers, and Radios.* 30 min., University of Illinois.

28. *Genesis of the Transistor.* 20 min., Bell Telephone Company.

29. *Principles of Transistors.* 22 min., University of Illinois.

30. *The Television System.* McGraw-Hill.

31. *Television Receivers.* McGraw-Hill.

32. *Practical T.V. Alignment.* McGraw-Hill.

33. *Television - How It Works.* 11 min., ASU, (Coronet).

34. *Basic Principles of FM.* 31 min., U.S. Army, Ft. Huachuca.

35. *Oscillators. 28 min.*, U.X.N./United World Films.

36. *Radio Transmitter Principles.* 17 min., University of Illinois.

37. *Electromagnetic Waves.* 17 min., ASU (Encyclopedia Britannica Films).

38. *Effects of the Ionosphere on Radio Wave Propagation.* 29 min., United States Army, Ft. Huachuca.

39. *Mirror in the Sky.* 22 min., University of Colorado.

40. *Transmission Lines.* 23 min., Tektronics Incorporated.

41. *Standing Waves on Transmission Lines.* 22 min., University of Illinois.

TRANSPARENCIES

Semi-conductor Transparencies:
Educational Technologies, Inc.
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4865 Stenton Avenue
Philadelphia, Pennsylvania 19144

Transparencies Electricity Electronics: Series 601-602-603-604
Lab Volt Educational Systems
Buck Engineering Company, Inc.
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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. 38 East Haddonfield Road, Building 204-1, Cherry Hill, New Jersey 08108

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

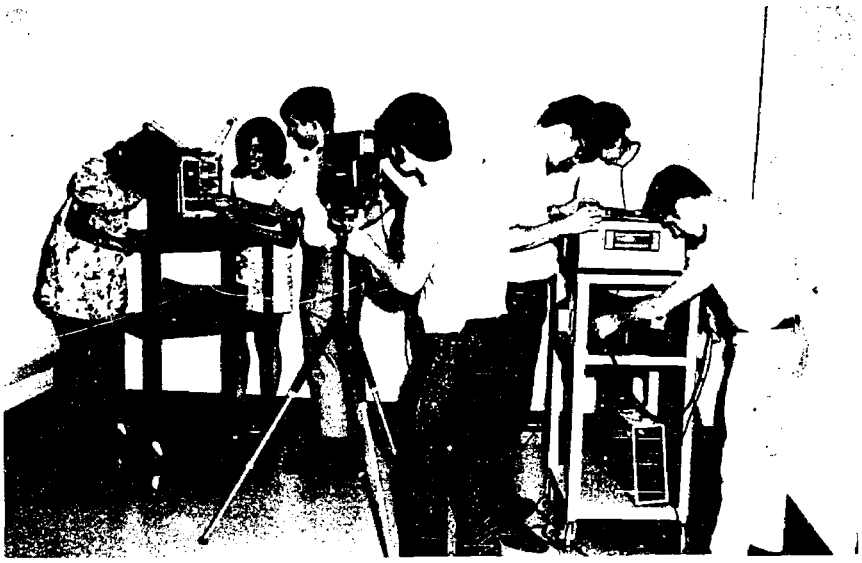
Brigham Young University, Audio-Visual Center, Provo, Utah 84601

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 Huachuca, Arizona 85613



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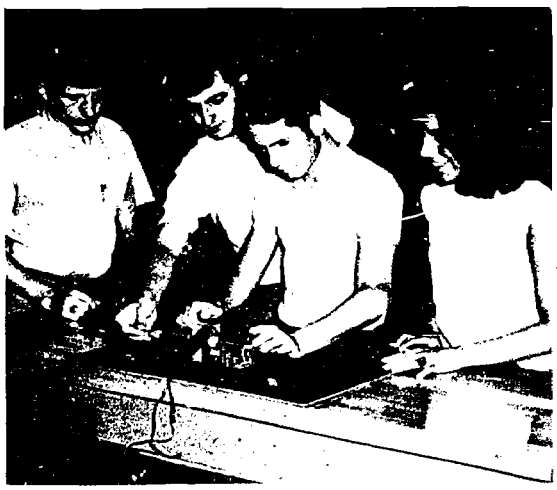
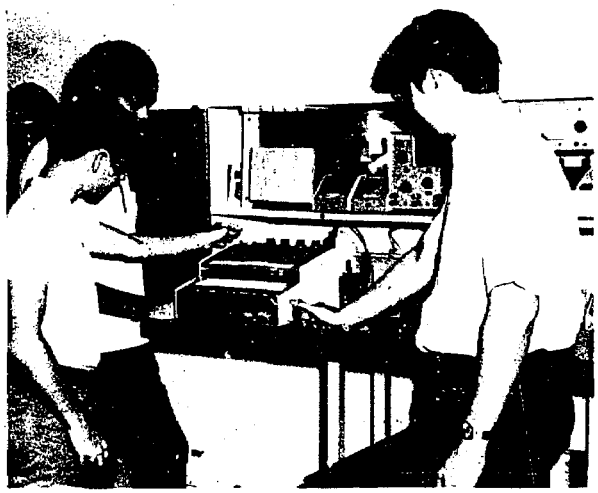
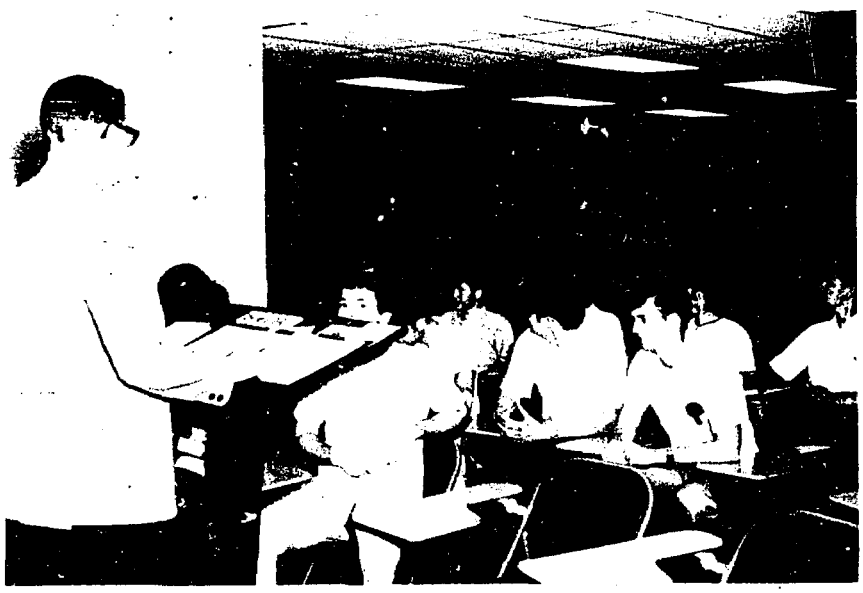


INDUSTRIAL ELECTRONICS LEVEL 4





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

COURSE CONTENT	STUDENT ACTIVITIES	TEACHER ACTIVITIES	INSTRUCTIONAL AIDS
I. **SAFETY PRACTICES** Personal shop safety applying to work with electronic circuits. Repeat as needed during the year.	Review of resuscitation practices and first aid. If needed pass a shop safety test.	Demonstration on safety and first aid in the field of electronics.	Film 2: *Safety Precautions for Electronic Personnel* Film 3: *Proper Handling of Cathode-Ray Tubes.*
II. **EMPLOYMENT AND EDUCATIONAL OPPORTUNITIES** The advantages of advanced education versus immediate employment with on the job training.	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.).	Give the students a breakdown of the advantages for a non-high school, high school, trade school and college graduate.	Speakers: Personnel Manager from Industry Counselor: College, Vocational School or Trade School Film 4: *Choosing Your Occupation.*
III. **MATHEMATICS OF ELECTRONIC CIRCUITS** Review the mathematical analysis of resistive and reactive circuits. Introduce vector analyses and decibel - power conversion.	Review problems about reactive and resistive circuits. Solve problems using vectors and power-decibel conversion.	Review basic circuit rules, laws and theorens for A.C. and D.C. circuits. Review how to solve for decibels; the use of vectors to solve A.C. network problems.	Live mockups for circuits containing R, Xc, and X_L.

NDUSTRIAL
LECTRONIC
CONTROL SYSTEMS

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

Thyratron and silicon controlled rectifier (SCR)

Gaseous voltage regulators

Application of electronics in medicine

Samples of MV Rectifiers Thyratrons, 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	STUDENT ACTIVITIES	TEACHER ACTIVITIES	INSTRUCTIONAL AIDS
V. MICROWAVE SYSTEMS Principles of operation and application of basic circuits for communications and radar.	Construct: UHF oscillator, UHF receiver, UHF directional antenna. Measure the power output and wave length of a UHF oscillator.	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).	Microwave Demonstration Unit Samples of Wave Guides, Cavity Resonators, Klystrons, Magentrons, etc. Film 8: *Radar and T.V.* Film 9: *Coaxial and Microwave Miracles* Film 10: *Scatter Radar*
VI. BASIC COMPUTER SYSTEMS Principles of computer mathematics, operations, and basic circuits.	Hookup and operate a basic passive analog computer circuit. Convert digital to decimal codes and vice versa. Hookup a simple logic circuit; "adder," "and," "or," and "nor" configurations.	Discuss the conventional and doppler radar systems. Discuss capabilities and limitations of computers. Compare analog and digital computers. Illustrate basic computer mathematics-binary code. Demonstrate or illustrate basic logic circuits: "and," "or." "nor," "gates," and "adders." Discuss memory devices and systems: pulse controlled bistable multivibrator, and flip-flop counting circuit.	Demonstrator: Digital and/or Analog Computer Mockup of Single Logic Circuits Film 11: *Thinking Machine.* Film 12: *Memory Devices* Film 13: *Electronic Computers and Applied Math.*

TEXTBOOKS FOR INDUSTRIAL ELECTRONICS

Suggested Textbooks

Lytel, Allan. Industrial Electronics. New York: McGraw-Hill Book Co., 1962.

REFERENCE BOOKS FOR INDUSTRIAL ELECTRONICS

Barker, I. F. and F. J. Wheeler. *Mathematics for Electronics*. Reading, Massachusetts: Addison-Wesley Publishing Company, Inc., 1968.

Cutler, Phillip. *Electronic Circuit Analysis*. New York: McGraw-Hill Book Company, 1960.

Grob, Bernard. *Basic Electronics*. New York: McGraw-Hill Book Co., 1965.

Schure, Alexander, Ed. *R-C and R-L Time Constant*. New York: John R. Rider, Publisher, Inc.

Automatic Control, A Scientific American Book. New York: Simon and Schuster, 1955.

Bartee, Thomas C. *Digital Computer Fundamentals*. New York: McGraw-Hill Book Company, 1966.

Benedict, R. R. and N. Weiner. *Industrial Electronic Circuits and Applications*. Englewood Cliffs: Prentice-Hall, Inc., 1965.

Bukstein, Edward. *Industrial Electronic Circuits Handbook*. Indianapolis: Howard Sams Publishing Co.

Considine, D. M., ed. *Process Instruments and Controls Handbook*. New York: McGraw-Hill Book Company, Inc., 1957.

The Controlled Rectifier, Volume I. El Segundo, California: International Rectifier Corporation, 1962.

Dean and Douglas. *Semi-conductor and Conventioned Strain Gauges*. New York: Academic Press, 1962.

Electronic and Electrical Fundamentals, Volume VI, Industrial and Microwave Technology, Philco Corporation (Philco Techrop Division, Philadelphia, Pennsylvania) Philadelphia: Williams Brothers Printing Company, 1960.

Engineering Handbook. El Segundo, California: International Rectifier Corporation, 1960.

Fishlock, David, ed. *A Guide to the Laser*. New York: American Elsevier Publishing Co., 1968.

Fribance, Austine. *Industrial Instrumentation Fundamentals.* New York: McGraw-Hill Book Co., 1962.

Fundamentals of Synchros with System Applications. Philco Corp., 1962.

Giles, A. F. *Electronic Sensing Devices.* Cleveland: Chemical Rubber Co. Press, 1966.

Grob, Bernard and M. S. Kiver. *Applications of Electronics.* New York: McGraw-Hill Book Co., 1966.

Gutzqiller, F. W., ed. *S C R Manual.* Chicago: General Electric Company, latest edition.

McIntyre, R. L. *Electric Motor Control Fundamentals.* New York: McGraw-Hill Book Co., 1966.

O'Higgins, Patrick. *Basic Instrumentation.* New York: McGraw-Hill Book Co., 1966.

Principles of Servos and Servomechanism Systems. Philco Corp., 1963.

Solar Cell and Photocell Handbook. El Segundo, California: International Rectifier Corp., 1960.

Thomas H. E. and C. A. Clarke. *Handbook of Electronic Instruments and Measurement Techniques.* Englewood Cliffs: Prentice-Hall, Inc., 1967.

Turner, R. P. *Basic Electronic Test Procedures.* New York: Holt, Rinehart and Winston, Inc., 1961.

Turner, R. P. *Semi-conductor Devices.* New York: Holt, Rinehart and Winston, Inc., 1961.

Zener Diode Handbook. El Segundo, California: International Rectifier Corporation, 1960.

Marcus, Abraham. *Automatic Industrial Controls,* 1st ed. Englewood Cliffs: Prentice-Hall, Inc., 1966.

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

1. *Electric Power Generation in Space.* (HQ155) 26-1/2 min., color, 1967 (NASA).
2. *Safety Precautions for Electronic Personnel.* 20 min., University of Illinois.
3. *Proper Handling of Cathode-Ray Tubes.* 20 min., color, 1962 (TKTR).
4. *Automatic Machines.* 20 min., Massachusetts Institute of Technology.
5. *Automation.* 30 min., B/W, (USOE).
6. *IBM Control Systems at Work.* 5 min., B/W, 1962, (IBM).
7. *Radar and T.V.* Encyclopedia Britannica Films.
8. *Coaxial and Microwave Miracles.* 10 min., University of Colorado.
9. *Scatter Radar.* 22-1/2 min., color, 1963, (NBOS).
10. *Thinking Machines.* 20 min., color, University of Missouri.
11. *Memory Devices.* 29 min., University of Arizona.
12. *Electronic Computers and Applied Mathematics.* 23 min., University of Colorado.
13. *Electric Propulsion.* (HQ96) 1965, 24 min., color (NASA).
14. *Power for the Moonship.* (HQK-SR4), 1966, 28-1/2 min., B/W (AEC).
15. *Radioisotope Applications in Industry.* (91964), 26-1/2 min., B/W (AEC).
16. *Nuclear Power for Space-Snap 9A.* 1963, 12 min., B/W, (AEC).
17. *The Atom in Industry.* 1954, 12-1/2 min., B/W, (AEC).
18. *By the Numbers.* 1962, 16 min., color, (IBM).
19. *Modern Heat Treating Methods.* 1965, 15 min., color (LNCO).
20. *Varidyne AC Controlled Speed Systems.* 1962, color, 22 min., (USEM).
21. *The Story of a Value.* 1957, color, 30 min., (RMCO).
22. *Prescan - An/SPS42.* Color, 7 min., (HUAC).
23. *The Control Revolution.* B/W, 29 min., $5.40, (NET).
24. *Automation in Air Traffic Control.* Color, 10 min., $1.15, (NET).
25. *Transistors: Switching.* 1959, B/W, 14 min., free, Navy.

26. *Transistors.* Part I: Introduction – 1961, B/W, free, Navy.

27. *Transistors: Servicing Techniques.* 1960, B/W, free, Navy.

28. *Transistors: Triode Fundamentals.* 1957, B/W, free, Navy.

29. *Genesis of the Transistor.* 1965, color, 15 min., (BELL).

30. *The Information Machine.* 1958, color, 10 min., (IBM).

31. *Instrument Assembly and Production Flow.* 1961, color, 27 min., (TKTR).

32. *Machines That Think.* 1962, 29 min., (AEC).

33. *The New Giant.* Color, 15 min., (HUAC).

34. *Pax Atomis: Snap-7.* 1965, color, 25 min., (AEC).

35. *Snapshot.* 1965, color, 30 min., (AEC).

36. *Tektronic and the World of Measurement.* 1966, color, 23 min., (TKTR).

37. *Solving the Unbalanced Bridge.* 1964, 17 min., (TKTR).

38. *Oscilloscopes and Transducers.* 1968, color, 15 min., (TKTR).

39. *Circuit Boards - Design and Manufacturing.* 1967, color, 30 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
USOE	U. S. Office of Education, Department of Health, Education, and Welfare, 330 Independence Avenue SW, Washington, D. C. 20201
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, Pittsburg, 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

Electric Propulsion. (1965), Color, 24 min., (NASA).

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).

Space Navigation. (1967), Color, 69 Frames, Emphasis use of computers in space flights. (NASA).

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

The Thyratron. 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 Government – Loan Film (16mm.), 1969-70, Serina Press, 70 Kennedy Street, Alexandria, Virginia 22305.

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

Index to 16mm. Educational Films (1967), McGraw-Hill Book Company, New York, New York 10023.

Educators Guide to Free Films (1967), Educators Progressive Service, Randolph, Wisconsin 53956.

Film Catalog, University of Missouri – Columbia, Extension Division, Audiovisual and Communication Service, 119 Whitten Hall, Columbia, Missouri 65201.

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

Boschen, Lee. *Computer Circuit Projects You Can Build,* (No. BOC-1). Indianapolis: Howard Sams Publishing Company.

RCA, *Solid State To BB4 Circuits Manual,* RCA Electronic Components. Harrison, New Jersey, 1967.

RCA, *Experimenter's Manual,* Silicon Controlled Rectifier, RCA Electronic Components and Devices. Harrison, New Jersey, 1967.

INDUSTRIAL ELECTRONICS PROJECTS

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

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

Photographs courtesy of
Lee's Summit Junior High School
Mike Ford, Photographer

APPENDICES

Appendix I

FREE MATERIALS LIST

ITEM	SOURCE
Analog Computer Instruction Manual	American Basic Science Club, Inc. 501 East Crockett Street San Antonio 6, Texas
Leaflet of handy tips covering computer technology terms	Bud Electronics Division of Bud Company, Inc. 43-22 Queens Street Long Island City, New York
Educators Progress Service	Educators Guide to Free Science Materials Randolph, Wisconsin 53956
Automation/Computers A-2481 Booklet	Field Enterprises Educational Corporation Educational Services Merchandise Mart Plaza Chicago, Illinois 60654
IRC Solar Cell and Photo Cell Handbook	International Rectifier Corporation El Segundo, California
Automatic Digital Computers What are they? How do they work?	Los Alamos Scientific Lab./limit 10 copies Public Relations Office P. O. Box 1663 Los Alamos, New Mexico 87544
Pamphlet 6D-207 Transistor Circuits and Troubleshooting	United Motor Service Central Office General Motors Building Detroit 2, Michigan
B-7940 Thermoelectric Handbook	Westinghouse Electric Corporation Box 146 Pittsburg, Pennsylvania
Alternating Current Simply Explained	Wagner Electric Corporation 6400 Plymouth Avenue St. Louis, Missouri 63133
Automotive Electricity	Delco-Remy Technical Literature Department Division of General Motors Corporation Anderson, Indiana 46011
Electricity	General Motors Corporation Public Relations Staff General Motors Building Detroit, Michigan 48202

ITEM	SOURCE
Electric Utility Industry Booklets	Edison Electric Institute 750 3rd Avenue New York, New York 10017
Light and Man Series	Sylvania Electric Products, Incorporated Sylvania Lighting Center Danvers, Massachusetts 01923
Nuclear Energy	United States Atomic Energy Commission Post Office Box 62 Oak Ridge, Tennessee 37830
ARRL Pamphlet	American Radio Relay League, Incorporated 225 Main Street Newington, Connecticut 06111
Storage Batteries	ESB Brands, Incorporated Post Office Box 6949 Cleveland, Ohio 44101
Government material	Superintendent of Documents Government Printing Office Washington, D.C. 20402

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

+ Tekscope, Tektronix, Inc. (Free), P. O. Box 500, Beaverton, Oregon 97005

+ Rectifier News (Free), International Rectifier, 233 Kansas Street, El Segundo, California 90245

* Industrial Electronics (Available free to engineers), Sutton Publishing Company, Inc., 172 South Broadway, White Plains, New York

* Automation (Free to engineers), Penton Publishing Co., Penton Building, Cleveland 13, Ohio

* Control Engineering, Instrumentation and Control Systems, McGraw-Hill Building, 330 W. 42nd Street, New York, New York

* I.S.A. Journal, Instrumentation-Systems-Automatic Control, Instrument Society of America, 313 Sixth Avenue, Pittsburg, Pennsylvania

+ Measurement News (Free), Hewlett-Packard Journal, 1501 Page Mill Road, Pala Alto, California 94304

+ Frequency Technology, Frequency, Inc., 795 Washington Street, Norwood, Mass. 02062

* Electronics World, Ziff Davis Publishing Company, 307 N. Michigan Avenue, Chicago, Illinois 60601

* 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

1. Lab Volt Educational Systems, Buck Engineering Company, Incorporated, Farmingdale, New Jersey 07727.

2. Heath/Malmstadt-Enke Lab and Systems, Benton Harbor, Michigan 49022.

3. Simpson Electrical and Electronic Teaching Systems, 5200 W. Kinzie Street, Chicago, Illinois 60644.

4. McKnight's Instructional Programs in Electricity and Electronics. McKnight and McKnight Publishing Company, Bloomington, Illinois 61701.

5. DeVry Industries Incorporated, Educational Electronics Training Systems, 4141 W. Belmont Avenue, Chicago, Illinois 60641.

6. Electronics Training Aids, Incorporated, 308 South Hindry Avenue, Englewood, California 90301.

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.

9. Philco Technical Republic Division, Post Office Box 10, 51 South Pennsylvania Avenue, Fort Washington, Pennsylvania 19034.

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

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

12. Brodhead-Garrett Electricity-Electronic Learning Units, 4560 East 71 Street, Cleveland, Ohio 44105.

ELECTRONICS SUPPLIES

Electronics Kits Supply Company 1261 South Boyle Avenue, Los Angeles, California 9 .54, (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.

Allied Electronics Corporation A Subsidiary of Tandy Corporation, 2400 W. Washington Boulevard, Chicago, Illinois 60680.

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

Appendix III

TOOL LIST
LEVELS 1 and 2; 3 and 4
ELECTRICITY-ELECTRONICS

I. Small Tools and Equipment	Introductory	Quantity		Advanced	Quantity
I. SMALL TOOLS AND EQUIPMENT					
Alignment Tool (set)	X	2		X	2
Bit, Screwdriver (set) square tang, 1/4", 5/16", 3/8", 1/2"	X	1		X	1
Brace, Ratchet (10")	X	1		X	1
Brush-Bench	X	4		X	4
Coil Winder	X	1		X	1
Compass	X	6			
Countersink,* High speed steel 1/4" shank, 1/2" size	X	1		X	1
Die, Letter (set) (3/16")*	X	1		X	1
Die, Number (set) (3/16")*	X	1		X	1
Divider, Wing (6")	X	1		X	1
Drill, Electric Portable (1/4")	X	1		X	1
Drill, Hand (1/4")	X	1		X	1
Drill Stand, Fractional (1/16"-1/2" by 64ths)	X	1		X	1
Drill, Twist, Straight shank (Fractional Set) high speed steel, (1/16"-1/2" by 64ths)	X	1		X	1
Extension cord 25', heavy duty, grounded	X	2		X	2
Files (see specifications for listing)					
6", mill (flat), second cut	X	4		X	4
6", half-round, second cut	X	4		X	4
File Card and Brush*	X	6		X	6

TOOL LIST
LEVELS 1 and 2; 3 and 4
ELECTRICITY-ELECTRONICS

Small Tools and Equipment (cont.)	Introductory	Quantity		Advanced	Quantity
File, Jeweler's (set) assorted shapes, 4"-6"	X	1		X	1
File, Needle (set) set of 12-5-1/2"L	X	1		X	1
Gauge, Thickness* ("feeler") minimum 6 leaf, 1/2" x 2-1/2" x .0015"-.015"	X	1		X	1
Gauge, Wire and sheet metal (American)* sizes 0-36	X	2		X	1
Goggles (spectacles), Clear observation	X	12		X	12
Hammer, Ball peen (12oz.)	X	1		X	1
Hammer, Claw (16oz.)	X	1		X	6
Hydrometer	X	1		X	1
Knife, Electrician's	X	6		X	6
Label Maker*	X	1		X	1
Magnet, Bar minimum size 1/4" x 1/2" x 3"	X	24		X	24
Nibbler, Hand operated capacity 18" steel	X	2		X	2
Oiler, Bench 1/2 pint size, 5" steel spout	X	1		X	1
Oilstone, Combination, India course and fine grits. 8" x 2" x 1"	X	2		X	2
Pliers, Combination (6")	X	6		X	6
Pliers, Duckbill (8")* Insulated	X	6		X	6
Pliers, Diagonal cutting (6") Insulated	X	12		X	12

TOOL LIST
LEVELS 1 and 2; 3 and 4
ELECTRICITY-ELECTRONICS

Small Tools and Equipment (cont.)	Introductory	Quantity		Advanced	Quantity
Pliers, Needle nose (6") Insulated	X	24		X	24
Pliers, Side-cutting (6") Insulated	X	12		X	12
Pliers, Vise-grip wrench (7")	X	3		X	3
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") graduated 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

Small Tools and Equipment (cont.)	Introductory	Quantity		Advanced	Quantity
Screwdriver, Phillips (set) set with points #1, #2, #3	X	1		X	1
Screwdriver, Retaining type 3/16" blade	X	2		X	2
Shield, Face	X	6		X	6
Snips, Tinner's, Straight (#8)	X	1		X	1
Soldering Aid	X	12		X	12
Soldering, Copper, Electric (60W) 1/4" copper tip	X	1			
Soldering Copper, Electric pencil (30W) 7" slim handle	X	6		X	6
Soldering Gun, Electric dual heat, 240/325W, spot light	X	12		X	12
Square, Combination 12" rule	X	3		X	3
Tap and Die (set) sizes 6-32, 8-32, 10-24, 12-24 and 1/4"-20	X	1		X	1
Vise Combination (size 2")	X	1		X	1
Wire Striper, adjustable	X	6		X	6
Wrench, Adjustable end (6")	X	4		X	4
Wrench, Allen key (hex) (set) #1-1/2, #12	X	2		X	2
Wrench, Nutdriver (set) set of 8 drivers, sizes 3/6", 1/4", 9/32", 5/16", 11/32", 3/8", 7/16", 1/2"	X	12		X	12
Wrench, Open end (set) sizes 1/4"-1"	X	1		X	1

TOOL LIST
LEVELS 1 and 2; 3 and 4
ELECTRICITY-ELECTRONICS

Small Tools and Equipment (cont.)	Introductory	Quantity		Advanced	Quantity
Wrench, Socke (3/8" driv , (set) 10 piece set, 7 standard sockets, sizes 3/8"-3/4" by 16ths	X	1		X	1
II. POWER SUPPLY					
Power Supply, Variable output 0-20V AC and DC at 10 amperes 0-40V AC and DC	X	12		X	12
Power Supply, Variable output, Filtered 0-300V DC at 100 ma.	X	6		X	6
Signal Generator	X	6		X	4
III. TEST EQUIPMENT					
Capacitor Substitution Box 100 mmf.-.111 mmd., 350WVDC	X	1		X	1
Oscilloscope (5" screen)	X	6		X	6
Resistance Substitution Box	X	1		X	1
Signal Tracer	X	2		X	2
Tester, Transistor	X	1		X	1
Tester, Tube	X	1		X	1
IV. METERING EQUIPMENT					
Meter, Ammeter (AC) range 0-25 amps.	X	1		X	1
Meter, Galvanometer 500-0-500 micro amperes				X	1

TOOL LIST
LEVELS 1 and 2; 3 and 4
ELECTRICITY-ELECTRONICS

II. Power Supply	Introductory	Quantity		Advanced	Quantity
Meter, Grip dip 400 KC 250 MC				X	1
Meter, Volt-ohm (multi-range)	X	12		X	12
Meter, VTVM, Latest Design	X	3		X	6
Electronic Switch				X	6
Field Effect Multimeter				X	1
T.V. Sweep and Marker Generator				X	1
D.C. Bias Supply				X	1
Color Bar Generator				X	1
Vectorscope				X	1
V. GENERAL FURNISHINGS					
Bench, Eight Student Laboratory Work Center	X	3		X	3
Bench, Electric demonstration 6' x 30" cabinet storage 0-120V AC and DC outlets				X	1
Bookcase approximate 60"H x 10-12"D x 72"L, 3 adjustable shelves, wood or metal	X	1		X	1
Cabinet, Filing 4 drawer, 52"H x 15"W x 28-1/2"D	X	1		X	1
Cabinet, Instrument storage 30"W x 18"D x 72"H, with adjustable shelves and lock	X	2		X	2

TOOL LIST
LEVELS 1 and 2; 3 and 4
ELECTRICITY-ELECTRONICS

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

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

Appendix IV

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