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ABSTRACT

This section describes the first of a three part curriculum in trade electricity-electronics (each part is described in a separate volume). It presents a unit of 6 to 10 weeks duration which develops only those competencies necessary to all electricity or electronics employment. A flow chart indicates how an individual student's program can be arranged within, or across, the three curriculum areas. This section is divided into eight units: Orientation, Electrons as Charge Carriers, Circuit Component Identification, Basic Laws; Circuit Concepts, Magnetism, Batteries, Introduction to AC Principles, Use of Test Equipment, Fundamental Skills, Hand and Power Tools, Circuit Drawings, and Recordkeeping. The units are organized in a three-column format: Content, objectives, and teaching suggestions, with a resource list and suggested equipment list appended. The first column, Content, consists of items of instruction; the second column, Objectives, states in performance terms the student achievement which must result from the item of instruction; the third column, Teaching Suggestions, presents a variety of methods by which the content may be taught. Following the eight units is a listing of only the tools and equipment considered essential to properly instruct a class-group of 20 students in basic electricity. A sample course of study for this section of basic electricity is also provided, intended as an aid to creating the syllabus-based course of study, and tailored to local conditions. Content outlines for Section II and III of the curriculum are included. (HD)

SYLLABUS IN TRADE ELECTRICITY-ELECTRONICS

SECTION I —

BASIC ELECTRICITY

The University of The State of New York/The State Education Department
Bureau of Occupational and Career Curriculum/Albany, New York 12234
1976

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FOREWORD

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

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

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

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

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

Gordon E. Van Hooft, *Director*
Division of Curriculum Development

TO THE TEACHER

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

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

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

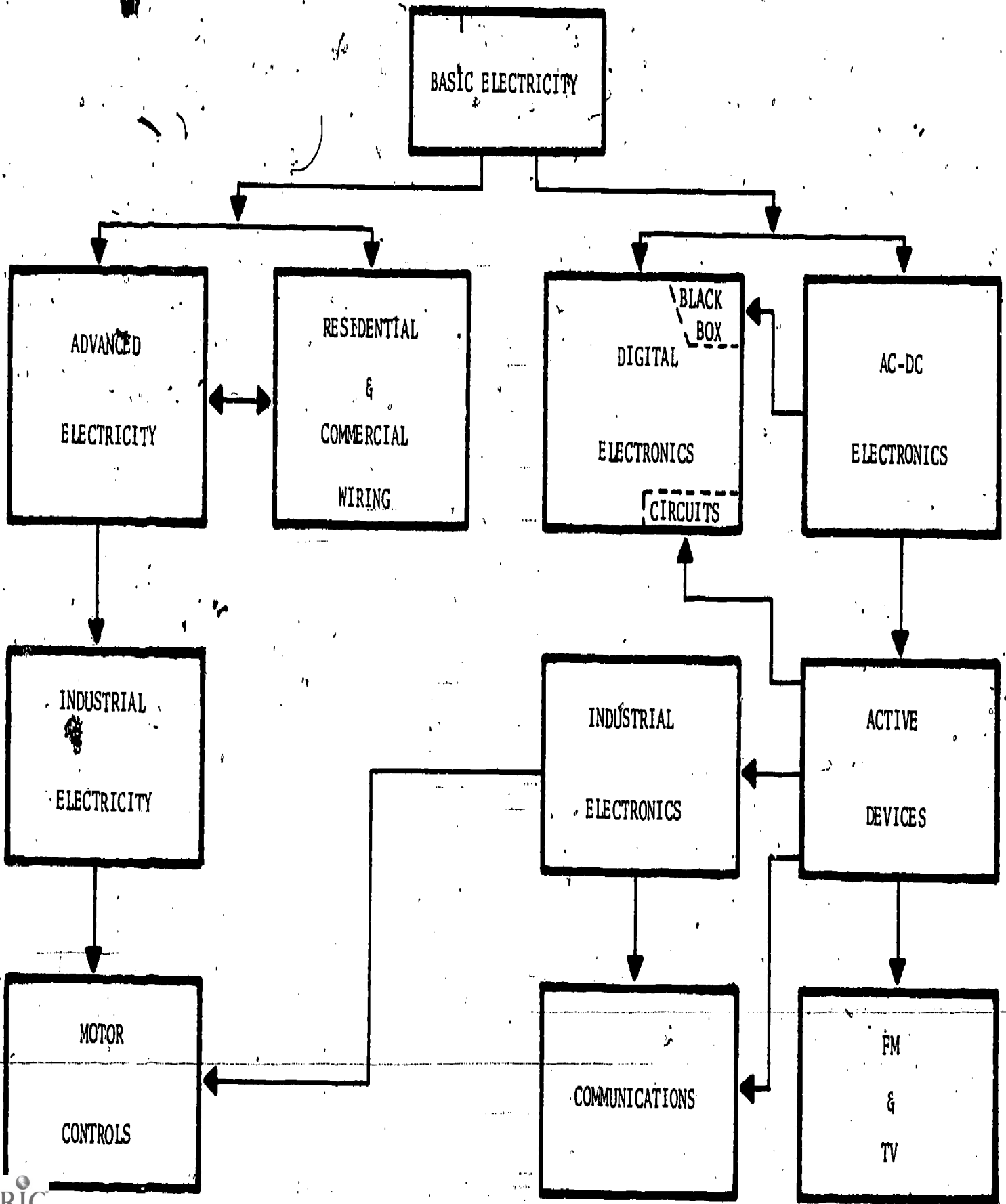
When a local program of instruction conforms to this syllabus, approval to grant State credit is presumed. Only where there is reason to adopt a nonconforming course of study must copy of the course be submitted to the *Bureau of Occupational and Career Curriculum* toward specific approval.

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

Douglas T. Adamson, *Director*
Division of Occupational Education Instruction

FLOW CHART

TRADE ELECTRICITY-ELECTRONICS PROGRAM



CONTENTS

USING THE SYLLABUS

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

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

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

A sample course of study for *Section I — Basic Electricity* is provided. It is a *sample* course; one of an infinite number of ways in which the syllabus can be developed. Inclusion of this *example* in this syllabus should not be construed as provision of a State course of study which can be merely adopted by every local program. It is provided only as an aid to creating the syllabus-based course of study, tailored to local conditions, which is a key to effective occupational education.

SYLLABUS IN TRADE ELECTRICITY-ELECTRONICS

BASIC ELECTRICITY

UNIT I: ORIENTATION

Upon completion of this unit the student will be able to identify the safe general work practices, and the employment opportunities, of the electrical-electronics field.

CONTENT	OBJECTIVES	TEACHING SUGGESTIONS
General Safety • Accident Prevention - Good Housekeeping . Shop and Industry procedures	*The student should be able to:* List and perform all functions necessary for maintaining a safe school shop.	Develop procedures list. Use life examples of need for good housekeeping practices. Union information sheets. Safety posters from industry. Safety films. Guest speakers from industry and other local organizations; e.g., Fire Department, State Safety Inspector. Safety orientation should be as brief as effectiveness permits, since safety instruction will be an inherent part of every subsequent unit, as it is taught.

– Personal Apparel		
. Shop requirements	State reasons why specific types of clothing and jewelry may be hazardous.	Documented examples; e.g., newspaper clippings, magazine articles.
Prohibited clothing		
Jewelry		
. OSHA requirements	State applicable OSHA requirements.	
– Safety Equipment	Identify all in-shop safety equipment, state the reason for each item and the method of maintenance of each.	Prototype equipment.
. Shop requirements		Newspaper clippings.
Safety glasses		Narrative stories.
Bump helmet		Films.
Gloves		Posters.
Safety belt		
Screens		
Curtains		
– Proper Use of Equipment and Tools	List the general safe operating procedures common to the use of equipment and tools.	Tool display.
		Equipment display.
		Demonstrate safe operation of equipment and tools.
		List of general safety procedures.

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

◦ Electrical Shock		
– Causes		
. Carelessness	Identify the common causes and effects of electrical shock.	Narrate stories of electrical shock and its effects.
. Rules violations		Newspaper, bulletin board.
		Speakers from related fields.
– Effects		Itemize shock effect on body.
. Injury		
. Death		
– Prevention	Identify and demonstrate electrical accident prevention procedures.	Develop student-oriented safety program.
. Shop procedure		Discuss OSHA requirements.
. Industry procedure		
– First-Aid	Identify and demonstrate electrical shock first-aid procedures.	Demonstration of, and student participation in, rescue techniques.
		Power company safety man as guest speaker and trainer.
◦ Fire		
– Causes	List and describe causes and effects of fires in shop and industry.	Safety posters.
. Spontaneous Combustion		Safety films.
. Unsafe conditions		Demonstrate under controlled conditions.

CONTENT	OBJECTIVES	TEACHING SUGGESTIONS
– Effects . Life, property, and job loss		Emphasize the cost factor.
– Extinguishers . Classification . Use . Location . Maintenance	*The student should be able to:* List the classes of extinguisher and describe the burning materials on which each is used.	Demonstrate correct extinguisher use on different types of simulated shop fires (outdoors) — Use Fire Department personnel if required.
Employment Market		
◦ Career Opportunities	Discuss the broad range of career opportunities in the electricity-electronics field.	Representatives from industry. Government publications. Newspaper want ads. Bulletin board.
◦ Apprenticeship Programs	Identify entry requirements and benefits of apprenticeship program.	Government publications. Union publications. Management publications. Guest speakers.

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

CONTENT	OBJECTIVES	TEACHING SUGGESTIONS
Electrons Within Matter		
• Particle Nature of Matter	*The student should be able to:* Identify the most common particles of matter.	Project a transparency of the solar system.
• Atomic Structure	Identify the atomic structure and forces found within the atom.	Project a transparency of atomic structure.
• Atomic Dimensions	Identify the relative mass, weight, and charges of the most common sub-atomic particles.	
Static Charges		
• Electrification	Describe the three methods of electrifying a neutral body.	Illustrate the three methods of electrifying a neutral body.
• Electrostatic Fields	Describe an electrostatic field.	Illustrate the electrostatic field.
• Laws of Electrostatics	Describe the laws of electrostatics.	Demonstrate the laws of electrostatics (Pith balls, electroscope).

CONTENT	OBJECTIVES	TEACHING SUGGESTIONS
Dynamic Charges		
◦ Methods of Generating Dynamic Charges	*The student should be able to:* Describe the transfer of electrical energy.	Use "falling dominoes" as a simile.
◦ Conductors, Semiconductors, and Insulators – Valence electrons	State the number of valence electrons in conductors, semiconductors, and insulators. Identify samples of common conductors and insulators.	Project a transparency of a material and its valence electrons, representing each classification.

Upon completion of this unit, the student will be able to correctly identify basic circuit components in relation to each item of the unit's content.

CONTENT	OBJECTIVES	TEACHING SUGGESTIONS
Sources of EMF • Chemical • Mechanical • Heat • Light • Pressure	*The student should be able to:* List and describe sources of EMF and state an application for each.	Demonstrate practical concepts of EMF from the listed sources. Films. Overhead transparencies.
Controls	Explain how a control affects a circuit.	Demonstrate controls and their applications. Information sheets.
Loads	Explain the transfer of energy from source to load.	Demonstrate the relationship of loads in the circuit.

CONTENT	OBJECTIVES	TEACHING SUGGESTIONS
Overcurrent Devices		
• Circuit Breakers • Fuses	*The student should be able to:* Describe the purpose of circuit breakers and fuses. Identify a circuit breaker and a fuse.	Demonstrate the function of a circuit breaker using a see-through type. Show samples of various type fuses.
Color-Coded Resistors	Select, by color code, resistors of indicated resistive values. Select, by color code, resistors of specific tolerances.	Color code wall charts and information sheets. Emphasize that the color code does not identify the type of components. EIA system of color coding.

Upon completion of this unit the student will be able to define, and apply in simple circuits, Ohm's, Kirchoff's, and Watt's laws.

CONTENT	OBJECTIVES	TEACHING SUGGESTIONS
Ohm's o Define E, I, R o I=E/R; E=I·R; R=E/I	*The student should be able to:* Define E, I, and R, state the three forms of Ohm's Law, and solve simple problems using each form.	Problem solving. Dynamic demonstration of simple circuits, with calculations verified by measurements. Overhead transparencies. Ohm's Law wheel or triangle.
Kirchoff's o Voltage Laws o Current Laws	State the voltage and current laws, and solve simple problems involving their use.	Problem solving. Dynamic demonstration of simple circuits, with calculations verified by measurements. Overhead transparencies.

CONTENT	OBJECTIVES	TEACHING SUGGESTIONS
Watt's • Definition of Power • $W = E \cdot I$, $W=I^2R$, $W=\frac{E^2}{R}$	*The student should be able to:* Define wattage, state the three forms of Watt's Law, and solve simple problems using each form.	Problem solving. Dynamic transparencies. Overhead transparencies.

Upon completion of this unit, the student will be able to apply the underlying theories and technical information to construction of simple circuits.

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

CONTENT	OBJECTIVES	TEACHING SUGGESTIONS
Series-Parallel Circuits	*The student should be able to:* Determine and verify experimentally, the laws concerning resistance, voltage, and current in a series-parallel circuit.	Overhead transparencies. Set up actual circuit demonstrations. Solve sample equation problems on chalkboard.
Energy Sources in Combination		
• Batteries	Define battery as a source of electrical energy. List and identify types of batteries. Determine the voltage combinations which result from connecting dry cells in series and in parallel.	Use posters and overhead transparencies to show how a simple dry cell is constructed. Obtain kits and have students construct, test, and use batteries. Demonstrate batteries in series, parallel, and series-parallel connections.

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

CONTENT	OBJECTIVES	TEACHING SUGGESTIONS
Magnetic Theory	*The student should be able to:* Describe and explain the behavior known as the "Law of Poles" (Gilbert).	Emphasize terminology. Relate back to structure of matter.
	Explain the molecular theory of magnetism.	Overhead transparencies and films.
Permanent Magnets	Identify materials that make up permanent magnets.	Demonstrate samples of permanent magnets; i.e., horseshoe, bar, blocks; magnetite, Alnico.
	List uses of permanent magnets.	Use metal shavings to show lines of force.
Electromagnets	Construct a simple electromagnet.	Construct a display of the operation of solenoids, bells, relays, and circuit breakers, and explain how electromagnetism works in each.
	Explain Fleming's right-hand rule.	
	Cite several uses of electromagnets.	

CONTENT	OBJECTIVES	TEACHING SUGGESTIONS
Principles of Electric Generators	*The student should be able to:* Explain how voltage is generated when a conductor is moved through a magnetic field, or a magnetic field cuts a conductor.	Use a galvanometer to demonstrate generation of electricity through magnetism. Demonstrate a model generator and relate to preceding demonstrations.
Principles of Electric Motors	List the similarities of an electric generator and an electric motor. Describe the principles of motor action.	Use magnets, loop of wire, and current supply to construct an electric motor and demonstrate its action and principles. Have students construct models of electric motors to study principles of the electric motor.
Principles of Transformers	Explain the principles of induced voltage. Identify the factors affecting magnitude of induced voltages; i.e., number of turns, strength of magnetic field.	Display and operate various basic types of transformers and explain their differences.
Relays	Correctly define a relay as a magnetically operated switch. List examples of where relays may be properly used.	Display and demonstrate different types of relays and explain their functions and uses. Films.

Upon completion of this unit the student will be able to demonstrate knowledge of the care and use of batteries as a source of the EMF that moves electrons in a circuit.

CONTENT	OBJECTIVES	TEACHING SUGGESTIONS
Types of Batteries	*The student should be able to:* Identify primary cells and secondary cells.	Provide information sheets, and project transparencies of batteries.
	Identify carbon-zinc, silver oxide, manganese oxide, and mercury cells as primary cells.	Provide a display of actual samples of each type.
	Identify lead-acid and nickel-cadmium construction as secondary cells.	Construct "simple" cells with use of: coins, blotting paper, and salt solution; a lemon with zinc nail and copper wire.
Construction		
◦ Primary cell	List the components and explain the construction of a "dry" cell.	Show cut-away sections of cells to demonstrate the construction.
		Show cut-away sections of cells in circuit formation. (Obtain from manufacturer.)
		Have students construct cells from kits, and test them for voltage and current.

CONTENT	OBJECTIVES	TEACHING SUGGESTIONS
• Storage Battery	*The student should be able to:* List the components and explain the construction of a typical storage battery.	Display "see-through" model of typical lead-acid storage battery. Show a disassembled lead-acid battery and explain the function of the plates and separators.
Maintenance		
• Primary Cell	Explain "shelf-life" and "local action."	Demonstrate the condition of dry cells in various stages of physical deterioration. Show why and how "local action" takes place. Discuss its effects.
• Storage Battery	Explain the term "specific gravity." Test a lead-acid battery to determine capacity. Accurately charge a lead-acid battery and measure the capacity of a fully charged lead-acid battery.	Explain the operation of a battery charger. Explain what happens to a battery in terms of charging. Demonstrate the proper method of charging and testing a battery.
Safety		
• Primary cell	Describe the potential danger to equipment resulting from carelessness in inspecting cells.	Show damaged equipment resulting from "leaking" dry cells.

• Storage Battery	Explain the dangers of overcharging a storage battery. List all safety precautions necessary in handling and storing the acid used in lead-acid batteries. Demonstrate the safe method of handling battery acids. Describe the proper venting of a storage battery being charged, and of the immediate area.	Demonstrate the effects of battery acids upon metals, clothing, wood, and painted surfaces. Show the proper method of storing and handling battery acid. Emphasize the importance of prohibiting smoking, electrical discharges, and other fire near lead-acid batteries being charged.

Upon completion of this unit the student will be able to explain and demonstrate the periodic reversal of the direction of current flow.

CONTENT	OBJECTIVES	TEACHING SUGGESTIONS
AC Theory		
◦ Sine Wave	*The student should be able to:* Define a rotating vector.	Explain rotating vector.
	Describe the period of an AC voltage or current of sine wave form, as a function of a rotating vector.	Overhead transparencies.
◦ Frequency	Define frequency.	Explain frequency.
	Explain the frequency of an alternating current or voltage.	Use a basic alternating current generator to explain AC theory in terms of sine wave frequency and cycle.
		Use an oscilloscope to show the "picture" of a sine wave.
Voltage Values	Use necessary formulas to calculate the *average* voltage value.	Explain and demonstrate the relationship of the various values.

Use formulas necessary for finding the effective value of an AC voltage or current of sine wave form.

Define and relate effective, average, peak, and peak-to-peak values.

Upon completion of this unit the student will be able to use basic testing equipment.

CONTENT	OBJECTIVES	TEACHING SUGGESTIONS
Voltmeter	*The student should be able to:*	
◦ DC	Explain how a voltmeter is used to measure potential between two points in a circuit.	Demonstrate the relationship of the voltmeter and pressure gauge.
		Explain the terminology of deflection and linearity.
	Define polarity as it relates to use of the DC voltmeter.	Illustrate the technique of using a voltmeter by measuring volts in a two-resistor series DC circuit.
		Demonstrate using the large, double-side demonstration voltmeter.
◦ AC	Differentiate between the DC voltmeter and the AC voltmeter.	Repeat the preceding experiment but use an AC circuit.
		Use the demonstration meter.
Ammeter		
◦ DC	Explain how an ammeter is used to measure the flow of current in a circuit.	Repeat the preceding experiments, but using the ammeter to measure amperes in a DC circuit.
	Define polarity as it relates to ammeters.	Use the demonstration meter.

• AC		
	Describe the difference between AC ammeters and DC ammeters.	Using the demonstration meter, set up AC experiment with two resistors in series and take current readings.
Ohmmeter	Define nonlinear scale. Demonstrate use of ohmmeter.	Demonstrate correct use of the ohmmeter and demonstration meter in the circuits used in the preceding experiments. Explain the logic and safety precautions for use of all test equipment. Use overhead projector and transparencies of meter movement.
V.O.M.	Describe the uses of V.O.M.	Demonstrate the versatility of the V.O.M. as it relates to aforementioned meters.
Continuity Testers	Describe the proper and safe use of the continuity tester.	Demonstrate several types of continuity testers; i.e., use of the ohmmeter, a dry cell and bulb, a transformer and buzzer. Show how students may construct their own continuity testers.

Upon completion of this unit the student will be able to identify the proper type and size of wire for a given application, and demonstrate suitable methods of interconnection in electric-electronic circuits.

CONTENT	OBJECTIVES	TEACHING SUGGESTIONS
Wire	*The student should be able to:*	
◦ Measurements	Identify wire sizes with the aid of a standard American Wire gauge.	Demonstrate the American Wire gauge system.
◦ Calculations	Calculate wire sizes and their current carrying capacities, through the use of tables.	Provide tables stating the capacity of conductors, as rated by the National Electric Code.
– Ampacity		
– Wire size		Using tables and wire gauge, demonstrate selection of the wire size required for a specified application.
◦ Cutting, Stripping, Splicing, and Connecting	Demonstrate the proper method of cutting and stripping wire.	Demonstrate the safe and proper use of the electrician's knife.
	Demonstrate proper methods of splicing and making joints.	Demonstrate methods of making splices and joints in sizes 10, 12, and 14 AWG such as: Western Union Pigtail Tee Tap Fixture
		Demonstrate the proper method of handling and using electrician's pliers.

◦ Soldering/Desoldering	Demonstrate correct soldering/ desoldering techniques.	Demonstrate the proper methods of using the various soldering tools. Demonstrate solder types and uses, and flux types and uses. Have the student solder the splices made in the preceding suggestion.
◦ Taping	Visually identify rubber, friction, and plastic tapes.	Demonstrate the uses of various tapes and discuss their characteristics.
Insulation	Identify the insulation type and voltage rating of selected cables.	Explain the lettering symbols: T, R, A, H, W, N. Display the types of insulation and discuss their characteristics. National Electric Code.
Circuit Construction		
◦ Point-to-Point ◦ Harness Construction ◦ Cable	Describe various methods of point-to-point wiring used in basic electrical and electronics construction. Describe basic harnessing methods. Describe various types of cable.	Sample display and illustrations of basic wiring. Sample display and illustrations of basic harnesses. Sample display and illustrations of – Nonmetallic Metallic Transmission (Electronics)

Upon completion of this unit the student will be able to demonstrate safe and proper use of basic hand and power tools used in electrical-electronic construction.

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

Safety	List safe operating procedures for tools and equipment.	Demonstrate safe operating procedures. Safety posters. Develop student-operated safety team.

BASIC ELECTRICITY

UNIT XII: CIRCUIT DRAWINGS

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

CONTENT	OBJECTIVES	TEACHING SUGGESTIONS
Type • Schematics • Wiring Diagrams	*The student should be able to:* Identify simple drawings as either schematics or wiring diagrams. Prepare a schematic or wiring diagram of simple circuits.	Provide samples of each type. Demonstrate the use and advantages of each type, and how each is prepared.
Symbols	Identify the symbols common to electricity-electronics.	Demonstrate by drawing a pictorial view of what each symbol represents.
Interpretation	Transfer information from various drawings to the actual construction of simple jobs.	Demonstrate samples, in mock-up construction, of the various phases of installations.

Upon completion of this unit the student will be able to identify, and relate to, basic recordkeeping procedures.

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

RESOURCE LIST

BOOKS

Teacher Reference

DeFrance, J. J. *Electrical fundamentals.* Englewood Cliffs, N. J. Prentice-Hall. 1969.

Grob, Bernard. *Basic electronics; 3d ed.* New York. McGraw-Hill. 1971.

Jackson, H. W. *Introduction to electric circuits; 3d ed.* Englewood Cliffs, N. J. Prentice-Hall. 1970.

Kaufman, Milton & Wilson, J. A. *Basic electricity: theory & practice.* New York. McGraw-Hill. 1973.

Lytell, Allan. *ABC's of electric motors and generators.* Indianapolis. Sams. 1974.

Mandl, Matthew. *Fundamentals of electronics; 2d ed.* Englewood Cliffs, N. J. Prentice-Hall. 1965.

Timbie, T. and others. *Essential of electricity.* New York. Wiley. 1974.

Zbar, Paul B. *Basic electricity.* New York. McGraw-Hill. 1968.

Student Reference

Brandwein, Paul. *Energy.* New York. Harcourt. 1972.

Buban, Peter & Schmitt, Marshall. *Understanding electricity and electronics; 3d ed.* New York. McGraw-Hill. 1975. (with study guide)

Burke, W. and others. *Basic AC principles.* Indianapolis. Sams. 1969.

_____. *Basic DC principles.* Indianapolis. Sams. 1969.

Dugger, W. and others. *Basic electronic systems technology.* New York. Bruce. 1973.

Gerrish, Howard H. *Electricity and electronics.* Homewood, Illinois. Goodheart-Willcox. 1968.

Hamilton, J. R. *Using electricity.* Englewood Cliffs, N. J. Prentice-Hall. 1971.

Herrick, Clyde. *Electronic assembly techniques.* Woburn, Massachusetts. Hickok. 1970.

Loper, Orla & Ahr, Arthur. *Introduction to electricity & electronics.* New York. Delmar. 1973.

Lytell, Allan. *ABC's of electric motors and generators.* Indianapolis. Sams. 1974.

Mileaf, Harry. *Electricity one-seven.* New York. Hayden. 1966.

Marcus, A. & Marcus, R. *Basic electricity.* Englewood Cliffs, N. J. Prentice-Hall. 1974.

PERIODICALS

Electrical Construction & Maintenance. McGraw-Hill Inc., P. O. Box 510, Hightstown, New Jersey 08520.

Electronics. McGraw-Hill Inc., 1221 Avenue of the Americas, New York, New York 10020.

Electronics Illustrated. Fawcett Building, Greenwich, Connecticut 06830.

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

Electronic Technician/Dealer. Harcourt, Brace, Jovanovich, 757 Third Avenue, New York, New York 10017.

Popular Electronics. 434 South Wabash Avenue, Chicago, Illinois 60605.

Popular Science. Boulder, Colorado 80313.

Radio-Electronics. Gernsback Publications, Inc., 200 Park Avenue South, New York, New York 10003.

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

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

FILMS

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

The electrician.

University of Illinois. Division of University Extension. Champaign, Illinois 61820.

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

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

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

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

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

Electricity: measurement; #58800.

The electron: an introduction; #01901.

TRANSPARENCIES

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

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

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

Dry cell – Terminology and construction of the secondary cell.

Electron movement – Shows electrons moving.

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

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

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

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

Ohm's law – Relationship between voltage, current, and resistance.

Parallel circuits – Illustrates concepts associated with parallel circuits.

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

Series circuits – Illustrates concepts associated with series circuits.

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

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

Electrical fundamentals.

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

Electricity & electronics. Overhead Transparency Masters.

WALL CHARTS

Clevide Corporation. Burgess Battery Division. Freeport, Illinois 61032.

Parts of a dry cell.

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

IRE-EIA electronic schematic symbols.

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

Parts and assembly of a lead type storage battery.

The automotive storage battery and electrical system.

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

Color code.

Electronic formulas.

Electronic schematic symbols.

Soldering.

5-tube radio.

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

Standard unit symbols for electronic engineers.

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

Equations based on Ohm's law.

CATALOGS – AUDIOVISUALS

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

Educators Progress Service, Randolph, Wisconsin 53956. Educators Guide to Free Films.

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

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

Indiana University, Audiovisual Center, Bloomington, Indiana 47401.

Modern Talking Picture Service, 1212 Avenue of the Americas, New York, New York 10003.

National Audiovisual Center, Washington, D. C. 20013. A Catalog of Films and Filmstrips for Sale by the U. S. Government.

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

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

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

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

CATALOGS – MATERIALS

Allied Radio Corporation
110 North Western Avenue
Chicago, Illinois 60680

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

Burstein Applebee Company
1012 McGee Street
Kansas City, Missouri 64106

Edmund Scientific Company
300 Edscorp Building
Barrington, New Jersey 08001

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

Gem Electronics
57 Willoughby Street
Brooklyn, New York 11201

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

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

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

Lafayette Radio Electronics
111 Jericho Turnpike
Syosset, New York 11791

Radio Shack Corporation
730 Commonwealth Avenue
Boston, Massachusetts 02117

PUBLISHERS

Benziger, Bruce & Glencoe, Inc.
8701 Wilshire Blvd.
Beverly Hills, California 90211

Goodheart-Willcox Co., Inc.
123 West Taft Avenue
South Holland, Illinois 60473

Hayden Book Co., Inc.
116 West 14th Street
New York, New York 10011

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

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

Prentice-Hall Co.
Educational Book Division
Englewood Cliffs, New Jersey 07632

TOOLS, EQUIPMENT, AND MATERIALS

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

TOOLS

1 set	Bits; auger, 1/4 to 1 in.
1 set	Bits; drill, fractional
1 set	Bits; drill, number
1 set	Bits; speed, 3/8 to 1 in.
3	Bender; EMT, 1/2 in.
5	Brace; ratchet
5	Center Punch
10	Compass; pocket type
5	Drill; portable electric, variable speed, reversible, 3/8 in. capacity
1	Drill Press (optional)
1 set	Files; flat, assorted cut
1 set	Files; round, assorted cut
1	Fish Tape; 50 ft.
4	Fuse Puller; 30-200 amp., with safety grip
1	Grinder; 7 in. wheels
6	Hacksaw; 12 in. frame
5	Hammer; ball pein, 16 oz.
8	Hammer; curved claw, 16 oz.
8	Hammer; rip claw, 16 oz.
5	Hammer; soft face
1 set	Hole Punches; 1/2 to 1¾ in.
1 set	Hole Punches; 1¾ to 3 in.
20	Knife; electrician's
10	Level; torpedo, 12 in.
5	Level; spirit, 24 in.
1 set	Nutdrivers
20	Pliers; diagonal side cutter, with insulated handle, 6 in.
20	Pliers; lineman's, with insulated handle, 8 in.

20		Pliers; needlenose, with insulated handle, 8 in.
4		Pliers; vise-grip type
20		Pliers; water pump, with insulated handle, 8½ in.
1	set	Reamers
8		Saw; keyhole, 12 in.
20		Screwdrive. Phillips #1
20		Screwdriver; Phillips #2
20		Screwdriver; standard, 4 in. x 1/8 in.
20		Screwdriver; standard, 4 in. x 1/4 in.
2		Snips; curved left
2		Snips curved right
6		Snips; straight cut
20		Soldering Aid; point and fork
20		Soldering Aid; wirebrush and scraper
20		Soldering Gun; dual heat, 120 volt, 240 and 325 watt
4		Soldering Iron; electric, 120 volt, 110 watt
10		Soldering Pencils; electric, 25 watt
20		Tool pouch; electrician's
5		Vise; machinist's, 4 in. capacity
1		Wirestripper; automatic
20		Wirestripper; insulated handle
3		Wrench; adjustable, 4 in.
3		Wrench; adjustable, 6 in.

TEST EQUIPMENT

10	Ammeter; 0 to 15-amp.
4	Ammeter; AC, bench panel, dual scale 0 to 15-amps/0 to 5-amps
2	Continuity Tester; portable, battery type with buzzer and bulb
10	Continuity Tester; standard
1	Galvanometer
10	Ohmmeter
1	Oscilloscope
3	Voltmeter; pocket type, AC, 50 to 300-volts
10	Voltmeter; portable, 0 to 300-volts
5	V.O.M.; AC/DC

MEASURING EQUIPMENT

5	Gage; Standard American Wire
1	Micrometer; 0 to 1 in.
10	Rule; steel, 12 in.
20	Rule; wood, zig-zag, 6 ft.
5	Tape Measure; 8 ft.

LAYOUT EQUIPMENT

20	Scratch Awl
10	Square; combination
10	Template; schematic, electrical
10	Template; schematic, electronic

MISC. EQUIPMENT

1	Ammeter; double-sided demonstration
1	Autotransformer; variable
1	Battery Carrier
10	Belt; safety
21	Book; electrical code
1	Bookcase; catalog, code book, manufacturers' data
1	Charger; storage battery
5	Curtain
1	Display Case; project
1 set	Dominoes
5	Dynamo; fractional horsepower generator
5	Dynamo; fractional horsepower motor
5	Electromagnet
20	Fuse Protective Device
3 each	Fire Extinguisher; Type A, Type B/C
1	First-Aid Kit; commercial
1	Generator; demonstration
20 pair	Gloves
20	Helmet; safety
Assortment	Magnets; horseshoe, bar, block, and Alnico
1	Ohmmeter; demonstration
20	Photoelectric cell

1	Power Supply; portable, DC, 0 to 24 volts/10 amps.
1	Projection screen; 60 in. minimum
1	Projector; combination filmstrip and 2 in. slide
1	Projector; overhead
1	Projector; soundfilm, 16 mm (ready availability)
20	Thermocouple Unit
1	Transformer; isolation
1	Voltmeter; double-sided demonstration, AC/DC
1	V.O.M.; double-sided demonstration
5	Workstation; 4-person
3	Bench Test Consoles, equipped with: . Ammeter; 0 to 15 amps. and 0 to 5 amps. . Ohmmeter . Voltmeter; 0 to 300-volts . Low-Voltage Set-Up, including — Bells and buzzers Variable transformer with taps from 4-volts to 24-volts Variac, 0 to 150-volts

MATERIAL

24	Balloon
60	Battery; dry cell, carbon zinc
4	Battery; lead-acid
4	Battery; manganese alkaline
4	Battery; mercury
4	Battery; nickel cadmium
4	Battery; silver oxide
2	Battery; storage, display cut-away
Assortment	Blueprints; various
Assortment	Circuit Breakers
2	Cleaner; contact, with lubricant, 6 oz. spray can
60	Clip; mounting
20	Comb; rubber
Assortment	Conductor; various materials
20	Control; variable, 100-ohms
1	Cylinder; plastic, with balls to fit inside diameter
4 pads	Form; recordkeeping
Assortment	Fuses; cartridge
Assortment	Fuses; screw-in, instant and delay

Assortment	Insulators, various materials
20	Light Socket; 3 volts/150 ma, with bulbs
4	Mat; rubber, 2 ft. x 2 ft. (storage batteries)
3	Motor; display cutaway
5 lbs	Nails; zinc, 1½ in.
24	Pith Ball
20 each	Resistor; 1-watt color-coded — 1-ohm, 10-ohm, 100-ohm, 150-ohm, 1,000-ohm, 33,000-ohm, 1-megohm
5	Solder; 60/40, 16 ga., 1-lb rolls
5	Solder; Resir core, 16 ga., 1-lb rolls
5 cans	Soldering Paste
20	Switch; on/off
10 rolls	Tape; friction
500 yds.	Tape; lacing
10 rolls	Tape; plastic
10 rolls	Tape; rubber
250 Ft.	Wire; copper, 14 ga.
250 Ft.	Wire; copper, 12 ga.
250 Ft.	Wire; copper, 10 ga.
2 rolls	Wire; copper, 14/2 with ground
Assortment	Outlet Boxes; switch plates; switches; receptacles; covers.

SAMPLE COURSE OF STUDY

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

BASIC ELECTRICITY

UNIT I — ORIENTATIO

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

	The student will be able to:		
◦ FIRE PREVENTION (Syllabus Unit 1)			
– Causes	List three common causes of fires in school shops and in industry, and the effects of such fires.	View films and demonstrations on fire safety. Inspect the school shop, reporting observed violations to the teacher.	Show safety films. Perform carefully controlled demonstrations. Stage "violations" of safe shop conditions.
◦ FIRE PROCEDURE			
– Extinguishing Equipment	List the three classes of fire, and describe the combustibles comprising each. Identify with 100 percent accuracy, the class of any specified extinguisher. Describe the method of operation of each type extinguisher.	Classify a list of various burning materials. Classify pictures or sketches of various extinguishers. Prepare a shop floor plan, indicating locations of fire extinguishers, by type. List in sequence the "Do's and Don'ts" in operating specific extinguishers.	Describe the classes of fire, explaining why there are separate classes. Explain how a particular extinguisher discharges its contents, and how the agent extinguishes by excluding oxygen and/or reducing temperature below the material's kindling point. Demonstrate, or have the Fire Department demonstrate, use of the various extinguishers. Emphasize safety, and the undesirable side-effects of extinguishing agents.
– Evacuation	Describe shop guidelines for decision on "Report First, or Fight First." Describe prescribed evacuation routine.	Respond to hypothetical discovery of fire while alone, or while with a partner. Fire drills.	Describe conditions under which the student should attempt to extinguish a fire before notifying, or while notifying, the teacher of its existence (local regulations permitting).

CONTENT	ENABLING OBJECTIVE	STUDENT ACTIVITY	TEACHER ACTIVITY
◦ EMPLOYMENT MARKET (Syllabus Unit 1)	*The student will be able to:*		
– Career Opportunities . Trade . Industrial . Technical . Sales	List four career opportunities in the electrical-electronics industry. List two job titles in each career area.	Discussion.	Provide excerpts from industry, union, and government publications. Discuss.
– Employment Opportunities . National . Regional . Local	Describe the current opportunities in the electricity-electronics field — national, regional, and local.	Survey the "want ads" for items relating to the electricity-electronics industry.	Provide U. S. Department of Labor forecasts. Compare with "want ads." Discuss.
– Apprenticeship	List five requirements for entry into an apprenticeship program. Describe five benefits of membership in an apprenticeship program.	Discuss apprentice program with acquaintances who are union members, and with those who learned the trade without formal apprenticeship. Class discussion of apprentice programs and apprenticeship.	Provide materials from union and government publications. Have official of local union discuss apprenticeship with class. Have graduated student, presently serving apprenticeship, talk with the class.
◦ GENERAL SAFETY (Syllabus Unit 1)			
– Housekeeping . Procedure	Perform to industrial standards, all the functions of maintaining a safe shop environment.	Perform the duties indicated on a provided housekeeping checklist.	Emphasize the importance of maintaining a safe shop on the bases of personal benefit, concern for others, and as a factor in keeping a job.

		Evaluate the acceptability of specific housekeeping jobs.	
Shop Industry	Explain the basis for difference in school and industry requirements.	Evaluate the "safe-shop" condition of the facilities, with, and then without, the aid of a checklist.	Rotate students through the position of safety inspector. Discuss – one-to-one, and in groups – the student safety inspectors' evaluation.
– Apparel . Required . Prohibited . Unregulated	List applicable OSHA requirements. List any special school requirements. Meet all standards of personal apparel before beginning work.	Match items on a list of required or prohibited apparel with a corresponding list of job hazards.	Maintain a file of newspaper clippings of job accidents. Discuss causes and preventions. Emphasize industrial implementation of OSHA regulations.
– Basic Tools and Equipment	Identify the basic tools and equipment of the trade by name, and state the principal uses of each. Describe accepted procedure and list any specific rules for safe and efficient use of basic tools and equipment. Demonstrate safe and proper use of tools and equipment in every instructional procedure.	Name tools and equipment by labeling pictures or sketches. Select from tool room stock any specified basic tool or equipment.	Display a sample of each tool and piece of equipment on a board bearing the name of each. Use anecdotes from personal industrial experience to highlight hazards of unsafe or improper procedures. Maintain a file of student-signed and dated safety tests, which students must pass before being allowed to use tools and equipment.
– Chemicals . Solvents	State the uses of any common trade chemical.	Select any specified trade chemical from shop stockroom.	Emphasize the importance of accurately identifying any substance before use. *Caution!* Particularly

CONTENT	ENABLING OBJECTIVE	STUDENT ACTIVITY	TEACHER ACTIVITY
. Flux . Other	*The student will be able to:* Identify common trade chemicals by odor. Describe accepted procedure in using trade chemicals, and the precautions necessary to avoid undesirable side-effects. Demonstrate proper procedure in use of trade chemicals.	Match items on a list of trade chemicals with a corresponding list of hazardous characteristics.	emphasize the importance of *not inhaling* an unidentified – and possibly corrosive – substance when attempting odor identification. Use news clippings and personal industrial experience to highlight the hazards of careless or improper use of trade chemicals. Show films on chemical safety. Maintain a file of student-signed and dated tests on safe and proper use of trade chemicals, which students must pass before being allowed their use.
– Horseplay	List, prior to instruction, ten actions of horseplay which he regards as unsafe practices or as distracting or disturbing others.	Each make a list of ten unsafe or distracting horseplay actions. Discuss with classmates.	Relate incidents from personal industrial experience in which horseplay caused, or nearly caused, serious damage or injury.
– Ladders	Describe the various types of ladder and the uses of each. List the "Do's and Don'ts" of ladder safety.	Match sketches or pictures of ladders with the correct item from a list of names.	Identify shop ladders by type, indicating points of identification. Relate "ladder" stories from industrial experience.

	Properly set up, use, and remove each type ladder.	Demonstrate safe ladder use.	Enforce continual observance of safe practice.
– Lifting and Moving	Demonstrate proper procedures in lifting or moving equipment and materials. Describe the anatomical bases for the prescribed procedures and the problems which may result from improper procedure.	List the "Do's and Don'ts" of lifting and moving procedures and explain why each is important. Apply all rules of procedure when lifting or moving heavy or bulky items.	Use visuals wherever possible, especially posters at materials and equipment storage, which show correct procedures. Demonstrate, and always personally observe, proper lifting and moving procedures. Continually enforce student observance of proper procedures.
o ELECTRICAL SHOCK (Syllabus Unit 1)			
– Causes	List three common causes of electrical shock. Describe three effects of electrical shock on the human body.	Contribute to class discussion of electrical shock – its nature, effects, and causes. Complete a written test concerning the causes of electrical shock, and the effects on the body in terms of burns, unconsciousness and death.	Show safety films. Post newspaper clippings. Relate happenings from industrial experience.
– Preventive Procedure . Industry . School	Determine from provided OSHA regulations sheets, and describe in detail, eight procedures required to prevent electrical shock in school and industrial situations.	List OSHA shock prevention requirements. List school shock prevention regulations. Note the similarity.	Show films on shock prevention. Develop a student-oriented safety program. Drill students in OSHA procedures.

CONTENT	ENABLING OBJECTIVE	STUDENT ACTIVITY	TEACHER ACTIVITY
– First-Aid	*The student will be able to:* List the symptoms of electrical shock. Describe the "Do's and Don'ts" of first-aid for electrical shock. Demonstrate two techniques in administering standard procedures of first-aid for electrical shock.	Study the American Red Cross First-Aid manual's section on electrical shock. Practice First-Aid procedures on simulated injured.	Perfect personal First-Aid skills. Obtain Red Cross certified First-Aid person to teach shock procedures to the class. Maintain students' skills through unscheduled periodic "shock drills."

CONTENT	ENABLING OBJECTIVE	STUDENT ACTIVITY	TEACHER ACTIVITY
• WIRE (Syllabus Unit 10)	*The student will be able to:*		
– Identification	Determine the numerical size of samples of #14, #12, and #10 TW copper wire.	Use the American Standard Wire gauge to determine size of provided samples.	Demonstrate use of the wire gauge.
– Cutting	Measure and cut wire to within ±1/8-inch of a given length.	Use rule and side cutters to obtain lengths needed for a planned construction.	Be alert to student difficulties in use of the rule. Emphasize safety in use of cutters, and handling wire ends.
– Stripping	Remove 1-inch of insulation with knife or strippers, without ringing or scoring the wire.	Practice stripping salvaged wire or short pieces to attain skill.	Project a transparency of drawings of proper wire preparation.
– Connecting . Wire nuts	Connect given lengths of #14 and #12 TW copper wire with wire nuts.	Select and install the proper size wire nuts.	Use visuals and actual materials in demonstrating these procedures.
. Splices	Join given lengths of #14, #12, and #10 TW copper wire with Tee Tap, Pigtail, Fixture, and Western Union splices, the work being equal in strength to that of the original conductor.	Practice splices first on small lengths, then on circuit mock-ups.	Emphasize the importance of joining "clean" wire. Demonstrate splice-testing methods. Have students save practice splices for soldering practice.

CONTENT	ENABLING OBJECTIVE	STUDENT ACTIVITY	TEACHER ACTIVITY
◦ SOLDERING (Syllabus Unit 10)	*The student will be able to:*		
– Flux	Describe the function of flux in the soldering process.	Select equipment and perform practice soldering operations outlined on job sheets.	Use visuals and actual items in teaching recognition of soldering equipment and materials.
– Soldering Tools	Differentiate between soldering guns and irons, and between electrical and externally heated irons.		Demonstrate trade procedures in soldering and desoldering such diverse items as electronic components and #10 copper wire.
– Procedure	Prepare and solder joints on #10 or lighter copper wire, the work meeting trade standards of strength and appearance. Solder and desolder components of electronic circuits.	Solder previously made splices. Remove and replace specified parts of old TV and transistor radios.	Emphasize the need for "clean" components.
◦ TAPING			
– Types . Rubber . Plastic . Friction	Identify by sight, samples of each type of tape. Describe the proper uses of each type tape.	Select and apply tape as outlined on job sheets.	Describe the characteristics of the various tapes which govern selection for specific applications. Describe the characteristics of each type, by which it is recognized.
– Procedure	Select the proper tape for any specified job and apply it in workmanlike manner.		Demonstrate the techniques of application of the tapes.

CONTENT	ENABLING OBJECTIVE	STUDENT ACTIVITY	TEACHER ACTIVITY
o ELECTRONS WITHIN MATTER (Syllabus Unit 2)	*The student should be able to:*		
– Matter . Elements The Atom . Compounds The Molecule . Alloys	Define and differentiate between elements, compounds, and alloys; atoms and molecules.		Use a variety of visuals – charts, transparencies, samples – in discussing the structure of matter. Define all terms.
– Atomic Structure . Proton . Neutron . Electron	Define proton, neutron, and electron. Describe the structure of the typical atom, and its two associated forces.	Diagram the structure of a simple atom. Identify the major particles and indicate their forces.	Illustrate the numerical values of weight, size, and relative distances of the subatomic particles.
– Static Charges	List the three methods used to electrify a neutral body. State the laws of charged bodies.	Electrify a neutral body by each method. Demonstrate the laws of electrostatics.	Demonstrate electrification of a neutral body by contact, conduction, and induction. Use balloons, rubber combs, and pith balls. Discuss the procedures. State the laws of electrostatics and relate them to the demonstration.

CONTENT	ENABLING OBJECTIVE	STUDENT ACTIVITY	TEACHER ACTIVITY
– Dynamic Charges	*The student should be able to:* Explain how dynamic electron charges cause an electrical effect.	Fill a transparent cylinder with balls. Observe and explain the reaction of the balls within the cylinder to insertion of a ball at one end.	Relate to the student activity an explanation of how electrons, as charge carriers, have an effect approaching the speed of light.
• CONDUCTORS, SEMICONDUCTORS, AND INSULATORS (Syllabus Unit 2)	Explain why the valence electrons of a substance determine whether the substance is a conductor, a semiconductor, or an insulator. Name and diagram the structure of an example of each.	Use the periodic table of the elements, or other reference, to list the valence electrons of copper, carbon, and iodine, and classify each according to conductivity.	Explain the relationship of valence electrons to conductivity. Measure the relative resistances of copper, carbon, and iodine to demonstrate the relationship.

CONTENT	ENABLING OBJECTIVE	STUDENT ACTIVITY	TEACHER ACTIVITY
◦ ELECTROMOTIVE FORCE (Syllabus Unit 3) – Sources . Chemical . Mechanical . Thermal . Pressure . Light	*The student should be able to:* List and describe the five sources of EMF.	Complete reading assigned texts.	Use transparencies in discussing the sources of EMF. Show energy sources film.
– Applications	State one application for each source of EMF.		
◦ CONTROLS – Path – Conductivity	Explain the two general uses of controls in electrical circuits.	Manipulate and describe the functions of various controls wired into a circuit demonstration panel.	Use the circuit demonstrator panel to demonstrate the function of controls in changing current paths and conductivity.
◦ LOADS	List and describe three types of loads.	Activate various circuits on a circuit demonstration panel. Identify the types of loads and explain the differences.	Use the demonstration panel to show loads as consumers of electrical energy, as indicated by resulting light, heat, or mechanical motion.

CONTENT	ENABLING OBJECTIVE	STUDENT ACTIVITY	TEACHER ACTIVITY
◦ OVERCURRENT DEVICES (Syllabus Unit 3)	*The student will be able to:* Name and describe the two types of overcurrent protection, and explain their functioning.	Identify the type of protector which reacted to overloads in each of the demonstration board's circuits, and explain the function of each.	Overload the circuits on the demonstration panel to show the functioning of heat and magnetism as excessive current sensors and interruptors.
– Fuses			
– Breakers			
◦ RESISTORS (Syllabus Unit 3)			
– Function	State the purpose of resistors and explain their functioning.	List the nominal range of resistive values of an assortment of color-coded resistors.	Use color-code wall charts in discussing the determination of nominal resistor values and tolerances.
– Color-Coding	Determine the nominal value of a resistor by reading its color code.		Distribute information sheets which describe reading the color code.
◦ WIRE (Syllabus Unit 10)			
– Sizes	Use the American wire gage to determine the size of any sample wire.	Use the gage and tables in listing the sizes and capacities of each sample wire in an assorted group.	Demonstrate the use of gage and tables in computing the sectional area of wire.
– Capacity	Use the tables in calculating the capacity of any sample wire.		Provide information sheets, and lead the class in practicing computations.
◦ INSULATION (Syllabus Unit 10)			
– Types	Describe the types of wire insulation.	Use the National Electric Code as a reference in explaining and stating	Demonstrate use of the NEC book as a guide to selection of wires having

		an application for wire coded: T, R, A, H, W, . .	characteristics needed for specific applications.
– Ratings	Describe the system of voltage-rating of insulation.	Match samples of wire to uses described on a job sheet.	Distribute job sheets requiring selection of wire, from stock or a sample assortment, which fits the specified application described.
	Describe the applications of wire whose insulation is marked with the code: T, R, A, H, W, N.		
	Select one example of each type and rating specified, from an assorted sample.		

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

	Explain the maintenance procedures listed.		Distribute an information sheet on maintenance procedures.
• SAFETY (Syllabus Unit 7)	Describe the dangers to health inherent in some batteries, and in the use of batteries.	Explain the precautions exercised to eliminate or control the hazards in a provided list of potentially dangerous conditions.	Discuss in detail, the danger in – . Careless inspection . Overcharging . Insufficient or improper venting . Handling and storing acid batteries . Handling and storing battery acid and demonstrate proper methods.
	Describe the potential dangers of equipment damage inherent in specific battery types.		
	Describe the safe procedure for handling, charging, and using any specified type battery.		

CONTENT	ENABLING OBJECTIVES	STUDENT ACTIVITY	TEACHER ACTIVITY
• SYMBOLS (Syllabus Unit 12)	*The student will be able to:*		
	Identify each symbol appearing on a provided identification sheet.	Match symbols with descriptions on a provided worksheet. Draw the symbol for any specified simple circuit component.	Distribute symbol identification sheets. Draw or project a pictorial representation of the circuit part indicated by each symbol.
• DRAWING TYPES (Syllabus Unit 12) – Schematic – Wiring Diagram	Identify sample diagrams as being either a wiring diagram or a schematic diagram. State the uses and describe the advantages of each. Describe the procedure and method of construction of wiring diagrams and schematic diagrams. Convert a provided description of a simple circuit into a schematic diagram and a wiring diagram.	View simple circuits displayed on demonstration board. Prepare schematic and wiring diagrams of the circuits. Prepare diagrams of circuits from specifications. Prepare materials lists from diagrams.	Show samples of each type. Describe their differences, and the uses and advantages of each. Demonstrate the procedure of constructing each type. Distribute a description and list of components for a simple circuit. Have students draw a schematic and a wiring diagram of the circuit. Distribute a schematic and wiring diagram of a simple circuit. Have students develop a parts and materials list for the circuit.

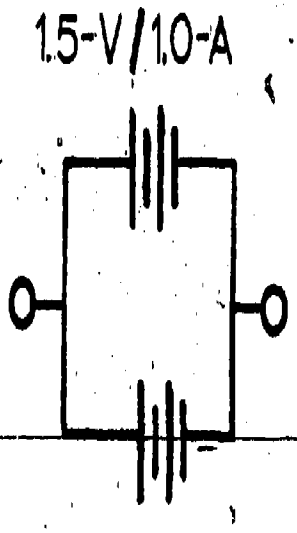
CONTENT	ENABLING OBJECTIVE	STUDENT ACTIVITY	TEACHER ACTIVITY
◦ SERIES CIRCUITS (Syllabus Unit 5)	*The student will be able to:*		
	Define "series circuit."	Draw schematics of series circuits from specifications on job sheets.	Draw a schematic on the chalkboard, analyzing the circuit construction.
	Describe the path of an electron through a 2-resistor series circuit.		Set up a series circuit. Demonstrate the consistency of current and division of voltage in series circuits.
			Distribute series circuit specifications. Have students draw schematics.
– Ohm's Law (Syllabus Unit 4)	State Ohm's law and describe the relationship of its three variables.	Practice solving problems which verify Ohm's law application to simple series circuits.	Introduce the "Ohm's Law Wheel."
	Determine and E, I, or R in a 2-resistor series circuit, when the value of two of the three variables is known.	Practice computing total equivalent resistance: $R_T = R_1 + R_2$	Demonstrate methods of solving problems.
			Calculate the E, I, and R values of a demonstration series circuit.
			Verify the calculations by measurement.
– Kirchoff's Voltage Law (Syllabus Unit 9)	Describe the relationship stated in Kirchoff's voltage law.	Practice solving problems which verify the statement of the law.	Demonstrate methods of solving problems.

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

. Ammeter (DC) . V.O.M.	Use each meter to obtain and record accurate measurements of a 2-resistor, series, DC circuit.		
◦ PARALLEL CIRCUITS (Syllabus Unit 5)	Define "parallel circuit." Describe the various paths of electrons through a 2-branch parallel circuit.	Draw schematics of parallel circuits from specifications on job sheets.	Draw a schematic on the chalkboard, analyzing the circuit construction. Set up a parallel circuit. Demonstrate the constancy of voltage and division of current in parallel circuits. Distribute parallel circuit specifications. Have students draw schematics.
– Ohm's Law (Syllabus Unit 4)	Determine any E, I, or R in a 2-resistor parallel circuit, when the value of two of the three variables is known.	Practice solving problems which verify Ohm's law application to parallel circuits. Practice computing total equivalent resistance: $R_T = \frac{R_1 R_2}{R_1 + R_2}$	Demonstrate methods of solving problems. Calculate E, I, and R values of a demonstration parallel circuit. Verify calculations by measurement.
– Kirchoff's Current Law (Syllabus Unit 4)	Describe the relationship stated in Kirchoff's current law. Determine the value of current in one branch of a 2-resistor, parallel circuit, where total current and current value of the remaining branch are known.	Practice solving problems which verify power laws application to parallel circuits.	Demonstrate methods of solving problems. Calculate values in a demonstration circuit. Verify the calculations by measurements.

CONTENT	ENABLING OBJECTIVE	STUDENT ACTIVITY	TEACHER ACTIVITY
– Power (Syllabus Unit 4)	*The student will be able to:* Describe the application of power laws to parallel circuits. Calculate the individual and total DC power in a 2-resistor parallel circuit.	Practice solving problems which verify power laws application to parallel circuits.	Demonstrate methods of solving problems. Calculate values in a demonstration circuit. Verify the calculations by measurements.
– Circuit Construction (Syllabus Unit 10) . Point-to-Point . Cable . Harness	Construct a simple parallel circuit which conforms to a provided diagram, and meets field standards of safety and functioning.	Examine variously constructed display circuits. Follow provided diagrams in constructing various simple parallel circuits.	Display sample parallel circuits. Demonstrate construction of various simple parallel circuits. Distribute schematic and wiring diagrams for student practice.
– Measurement (Syllabus Unit 9) . Continuity Tester . Ohmmeter . Voltmeter (DC) . Ammeter (DC) . V.O.M.	Demonstrate proper procedure in using each meter in parallel circuits. Use appropriate meters to obtain and record all E, I, and R values in a 2-resistor, parallel circuit.	Use meters to measure resistance, volts, and amperes in DC parallel circuits.	Distribute information and record sheets. Calculate values in a demonstration circuit. Verify the calculations by meter measurement.
– SERIES-PARALLEL (COMPLEX) CIRCUIT (Syllabus Unit 5)	Define "complex circuit." Describe the various paths of electrons through a 3-resistor, complex circuit.	Draw a schematic of a complex circuit from specifications on job sheets.	Draw a schematic on the chalkboard, analyzing the circuit construction.

			Set up a complex circuit. Demonstrate the existence of both series and parallel characteristics in the complex circuit. Distribute complex circuit specifications. Have students draw schematics.
– Ohm's Law (Syllabus Unit 4)	Determine any E, I, or R in a 3-resistor, complex circuit when the value of two of the three variables is known.	Practice solving problems which verify Ohm's law application to complex circuits. Practice computing total equivalent resistance.	Demonstrate methods of solving problems. Calculate values of a demonstration complex circuit. Verify calculations by measurement.
– Kirchoff's Voltage and Current Laws (Syllabus Unit 4)	Calculate the values of a 3-resistor complex circuit, where one voltage drop and one branch current are unknown.	Practice solving problems.	Demonstrate methods of solving problems. Calculate values in a demonstration circuit. Verify the calculations by measurement. Distribute problem sheets.
– Power (Syllabus Unit 4)	Calculate the individual and total power consumption of a 3-resistor complex circuit.	Practice solving problems.	Demonstrate methods of solving problems. Calculate values in a demonstration circuit. Verify the calculations by measurement.
– Circuit Construction (Syllabus Unit 10) . Point-to-Point	Construct a simple complex circuit which conforms to a provided diagram, and meets field standards of safety and functioning.	Examine various display complex circuits.	Display sample complex circuits. Demonstrate construction of simple complex circuits.

CONTENT	ENABLING OBJECTIVE	STUDENT ACTIVITY	TEACHER ACTIVITY
. Cable . Harness		Follow provided diagrams in constructing a simple complex circuit.	Distribute schematic and wiring diagrams for student practice.
– Measurement (Syllabus Unit 9)	*The student will be able to:*		
. Continuity Tester . Ohmmeter . Voltmeter (DC) . Ammeter (DC) . V.O.M.	Demonstrate proper procedure in using each meter in complex circuits. Use appropriate meters to obtain and record all E, I, and R values in a 3-resistor complex circuit.	Use meters to measure volts and amperes in DC complex circuits.	Distribute information and record sheets. Calculate values in a demonstration circuit. Verify the calculations by meter measurement.
• ENERGY SOURCES IN COMBINATION (Syllabus Unit 5) – Batteries . Series . Parallel . Series-Parallel	Predict maximum available voltage and current from –  1.5-V/1.0-A	Practice solving problems by calculation. Verify calculations by constructing the circuit and measuring values.	Demonstrate methods of solving problems. Calculate values in a demonstration circuit. Verify the calculations by measurement. Distribute problem sheets.

CONTENT	ENABLING OBJECTIVE	STUDENT ACTIVITY	TEACHER ACTIVITY
• MAGNETIC THEORY (Syllabus Unit 6)	*The student will be able to:*		
– Permanent Magnets	Define and describe "magnetism."	Match terms with their definitions, on worksheets.	Emphasize the importance of understanding and correctly using the terminology.
. Ferrous	Define "permanent" magnet.		
. Alnico	State three common uses of permanent magnets.		Discuss the qualities of ferrous and Alnico magnets, and common uses of each.
– Electromagnets	Describe the flux fields created about a conductor — by a single loop; by two adjoining loops; by a coil.	Write a description of the flux fields in an electromagnet of a single loop, two adjoining loops, and a coil.	Demonstrate the effects of magnetism on iron filings and a compass.
. Construction	State the factors which determine the strength of an electromagnet.		Emphasize that the strength of an electromagnet depends upon the current and on the number of turns of conductor.
	Construct a simple electromagnet which conforms to provided specifications, and field standards of safety and function.	Construct and demonstrate a simple electromagnet.	Distribute job sheets. Have students construct and function-test a simple electromagnet.

CONTENT	ENABLING OBJECTIVE	STUDENT ACTIVITY	TEACHER ACTIVITY
. Uses	*The student will be able to:*		
Solenoids Relays Buzzers Brakes Cranes	List five commercial uses of electromagnets.		Schedule field trip to industries using electromagnets. Discuss such "hidden" uses as automobile ventilating systems, and house trailer brakes.
• PRINCIPLES OF MOTORS AND GENERATORS (Syllabus Unit 6)	Differentiate between "motor" and "generator."		
– DC	Name the parts of a DC generator and describe their functions.	Match the parts of the two types of generator, as pictured on a worksheet, with a list of their names.	Demonstrate the operation of a DC generator and an AC generator.
– AC	Name the parts of an AC generator and describe their functions.		Distribute parts/names worksheets.
	Describe how a voltage is induced in a conductor moving through a magnetic field.		Use magnets, a loop of wire, and a current supply to demonstrate motor and generator principles.
	Construct a simple model of a motor, which meets field standards of safety and functioning.	Build a motor in conformance to specifications on a provided job sheet.	Operate a demonstration motor in its various configurations. Operate a fractional horsepower motor. Compare with the various configurations of the demonstration motor. Distribute motor construction job sheets.

CONTENT	ENABLING OBJECTIVE	STUDENT ACTIVITY	TEACHER ACTIVITY
• AC THEORY (Syllabus Unit 8)	*The student will be able to:*		
	Describe the characteristics of alternating current.		Use a basic AC generator in explaining alternating current theory.
– Sine wave – Frequency – Cycle	Construct a sine wave on graph paper when given a rotating vector and values of angles.		Show the "picture" of a sine wave on an oscilloscope. Define: Frequency, Cycle, R.M.S., Peak, Peak-to-peak, and Average Voltage Testing. Provide information to students for sine wave construction.
• CIRCUIT CONCEPTS – RESISTIVE (Syllabus Unit 5)	Determine E, I, or R in a 3-resistor complex circuit by use of Ohm's and Kirchoff's laws.	Practice solving problems which verify application of Ohm's and Kirchoff's laws to an AC complex circuit.	Demonstrate methods of solving problems.
– Series – Parallel – Complex			Calculate values in a demonstration circuit. Verify the calculations by measurements.
• POWER (Syllabus Unit 4)	Calculate individual and total AC power consumption in a 3-resistor complex circuit.	Practice solving AC power consumption problems.	Demonstrate methods of solving problems. Calculate consumption of power in a demonstration circuit. Verify the calculation by measurement.

CONTENT	ENABLING OBJECTIVE	STUDENT ACTIVITY	TEACHER ACTIVITY
◦ MEASUREMENTS (Syllabus Unit 9)	*The student will be able to:*		
– Continuity Tester – Ohmmeter – Voltmeter (AC) – Ammeter (AC) – V.O.M.	Measure, then record, all E, I, and R in a 3-resistor complex circuit.	Use pertinent instruments to measure resistance, AC volts, and AC amperes in a complex circuit. Record the values.	Demonstrate the use of instruments in measuring. Calculate the values measured. Compare.
◦ PRINCIPLES OF TRANSFORMERS (Syllabus Unit 6)	Describe and explain the concept of induced voltage.		Display, operate, and explain various types of basic transformers.
	Name and describe the function of each component of a transformer.	Label the components on a graphic of a transformer.	Demonstrate input versus output voltages.
	Construct a simple transformer which conforms to provided specifications.	Build a transformer in accordance to specifications on the graphic.	Demonstrate the construction of a simple transformer. Distribute graphic representation of a transformer with specifications for student construction.

CONTENT	ENABLING OBJECTIVE	STUDENT ACTIVITY	TEACHER ACTIVITY
◦ SUPPLY (Syllabus Unit 13)	*The student will be able to:*		
– Parts Orders	Select the form needed for ordering parts. Prepare an order for parts shown on a provided schematic or wiring diagram.	Select the Parts Order from a group of forms. Take off the parts needed to construct the device shown on a provided diagram. Prepare the Parts Order.	Use projected forms in demonstrating the manner of completion. Provide a selection of forms from which the student must select the Parts Order. Provide a diagram of a simple device for students' use in ordering.
– Material Lists	Select the form used for compiling a material list. Prepare a list of materials needed to construct a device or circuit shown on a provided diagram, all entries conforming to field practices.	Select the Material List from a group of forms. Determine the materials needed to construct the device or circuit shown on a provided diagram. Prepare the Material List.	Demonstrate the sequencing of information required for listing materials. Provide various forms which the student must select the Material List. Provide a diagram of a simple device or circuit for students' use in listing material.
◦ INVENTORY (Syllabus Unit 13)	Complete an inventory, on provided forms, of any specified tool or materials locker, or section thereof.	Select the best procedure for a given inventory task. Complete the inventory on provided forms.	Use projected forms to demonstrate manner of completion.
– Parts and Materials			

CONTENT	ENABLING OBJECTIVE	STUDENT ACTIVITY	TEACHER ACTIVITY
– Tools and Equipment			Discuss various inventory procedures. Provide inventory forms for student practice.
• BILLING (Syllabus Unit 13)	*The student will be able to:*		
– Parts and Materials	Select the form used for billing.	Record the supplies used and time required to complete a specified job.	Use a projected form to demonstrate billing.
– Labor	Restate provided supplies and labor data as required for billing, and enter the information on a billing form.	Using current catalog prices and union journeyman wage scale, prepare a billing for the job.	Provide students with billing forms, supply catalog, union wage scale, and standard overhead rate.

UNIT I: ADVANCED ELECTRICITY

Measurement

- Voltage
  - RMS
  - Peak-to-Peak
- Power
  - Single-phase
  - Polyphase
- Power Factor
  - Apparent Power
  - True Power

Phase Relationship

- In Phase
- Lagging
- Leading

Reactance

- Inductive
- Capacitive
- Frequency Effect

Inductance

- Calculation
- Types of Loads
- Application

UNIT I Continued

Transformers, Continued

- Core Construction
- Cooling Methods
- Wiring Connection
  - Standard Markings
  - Wye
  - Delta
  - Open Delta
  - Buck and Boost

Generators

- Principles of Operation
  - Magnetic
  - Laws
- Types
  - DC
  - AC
    - Rotating armature
    - Rotating field
- Wiring Connections
  - DC
    - Shunt
    - Compound
  - AC
    - Single-phase
    - Polyphase
- Multiple Units
  - Parallel Operation
  - Synchronization

- Calculation
- Application

RLC Series Circuits

- Impedance
- Resonance

RLC Parallel Circuits

- Impedance
- Resonance

Power Factor

- Calculation
- Effect
- Power Factor Correction

Transformers

- Principles of Operation
  - Ratios
  - Ratings
  - Polarity
- Types
  - Isolation
  - Autotransformers
- Construction
  - Insulating Materials
  - Windings
- Principles of Operation
- DC Motors
  - Shunt
  - Series
  - Compound
- AC Motors
  - Three-phase
    - Squirrel-cage, induction
    - Wound rotor
    - Synchronous
  - Split-phase
  - Capacitor start
  - Repulsion
  - Universal
  - Shaded-pole
  - Selsyn units
- Motor and Generator Maintenance
  - Test Equipment
    - Meggers
    - Growlers
    - Capacitor testers
    - Prony brake
    - Tachometer
  - Testing
    - Phase balance
    - Dynamometer
  - Mechanical Components
    - Governors
    - Switches
    - Bearing lubrication
- Meters
  - Principles of Operation
  - Use

Blueprint Reading

- Working Sketches
  - Schematic
  - Wiring diagrams
- Plans
  - Drawings
  - Title Block
  - Scale
- Cable Layout

Wiring Methods

- Installation
  - Cable
    - Support
    - Mechanical
  - Conductors
    - Selection
    - Fishing
  - Conduit and Fittings
  - Overhead (Triplex)
  - Underground
    - Direct burial
    - Conduit
- Termination
- Equipment Grounding

Low-Voltage Wiring

- Bell and Chime Installation
- Transformers

Appliance Circuit Installation, Continued

- Special Purpose Receptacles
- Fixed Appliance Wiring
  - Oil Burner
  - Water Heater
  - Range

Service Entrance Installation

- Calculations
- Type
  - Weatherhead
  - Cable
  - Masts
  - Underground
- Meter Cabinets
- Service Panels
- Overcurrent Protection
  - Fuses
    - Configuration
    - Performance characteristics
  - Circuit Breakers
    - Types
- Grounding and Bonding
- Subpanels

Surface Raceway Installation

- Selection
- Layout

- Wiring Method Selection
  - Nonmetallic
  - Armored
- Box Selection
- Switching Circuits
  - Line-Voltage
  - Low-Voltage

Lighting Fixture Installation

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

Appliance Circuit Installation

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

Electric Heat Installation

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

Heating Control Installation

- Relays
- Thermostats
  - Line-Voltage
  - Low-Voltage

Intercom and Alarm System Installation

- Intercom Circuits
- Alarm Circuits
  - Closed
  - Open
- Sensing Devices
  - Smoke
  - Heat
  - Intruder

Remodeling Wiring

- Building Construction
- Supplemental Wiring

Electrical Estimating

- Material List
- Labor
- Overhead

Related Hardware

- Identification
- Selection and Use

Related Equipment

- Hand Tools
- Power Tools
- Test Instruments

Code Requirements

- Type of Code
  - NEC
  - OSHA
  - Local
  - Other
- Inspection Application
- Violation Notice

Power Transmission Systems

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

Polyphase Service Installation

- Metering Equipment
- Disconnects
- Wiring Components

Distribution Equipment Installation

- Feeder Ducts
- Power Panels
- Subpanels
- Plug-in Duct Systems

UNIT IV: MOTOR CONTROLS

General Principles

- Purpose
- Types
  - Manual
    - Disconnect
    - Thermal overload

Rigid Conduit System Installation

- Type
  - Metallic
  - Nonmetallic
- Condulets and Pull Boxes
- Hangers and Supports
- Bending
  - Hand
  - Mechanical
  - Hydraulic
- Cutting and Threading
- Planning and Layout
- Wire Installation
  - Fish Tape and Pullers
  - Lubrication

Transformer Installation and Wiring

- Types
  - Single-phase
    - Autotransfer
    - Isolation
  - Polyphase
- Wiring Connections
  - Parallel Operation
  - Wye
  - Delta
  - Open Delta
- Transformer Vaults and Cabinets

    - Motor starter
    - Overload relays
  - Electronic
- Construction

Manual Motor Control Wiring

- Toggle Switch
- Safety Switch
- Drum Controller

Automatic Motor Control Wiring

- Float Switch
- Pressure Switch
- Temperature Switch
- Hand-off Automatic Control Switch

Magnetic Line-Voltage Starter Wiring

- Sizes
- Selection and Application

Pilot Control Device Wiring

- Selector Switch
- Pushbutton Station
  - Single Station
  - Multiple Station

Pilot Control Device Wiring, Continued

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

Reduced-Voltage Starter Wiring

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

Multispeed Controllers

- Separate Winding Starter
- Consequent Pole Starter

Wound-Rotor Control Wiring

- Manual Speed Control
- Automatic Speed Control

Synchronous Motor Control Wiring

- Pushbutton
- Automatic Time Synchronizing

Related Drawings

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

Code Requirements

- NEC
- NEMA
- OSHA
- Local
- Other

- Manual Faceplate Starter
  - Three-point
  - Four-point
- Manual Speed Control
  - Above Normal Speed
  - Below Normal Speed
- Automatic Motor Control Wiring
  - Counter E.M.F.
  - Voltage-Drop Acceleration Control
  - Series Relay Acceleration

Deceleration Control Wiring

- Electric Brakes
- Dynamic Braking
- Plugging

Motor Drives

- Belts and Pulleys
  - Belt Sizes
  - Multiple Belt Drive
  - Pulley Ratios
- Flexible Coupling
  - Selection and Use
  - Alignment
- Gear Motors
- Variable Frequency
- Magnetic Clutches
- DC Variable Speed Control

SECTION III — TRADE ELECTRONICS

UNIT I: AC-DC ELECTRONICS

Network Theorems

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

DC Meters

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

Inductance

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

UNIT I Continued

Resonance, Continued

- Calculations
  - Impedance
  - Resonance Frequency
  - Q
  - Bandwidth

Generators and Motors

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

Drafting

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

UNIT II: ACTIVE DEVICES

Tubes and Semiconductors

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

Capacitance

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

Time Constants

- RC and RL Circuits
- Time Calculations
  - Charging
  - Discharging

Complex Numbers for AC Circuits

- Rectangular Coordinate System
- J-Operator
- Polar Coordinate System

Resonance

- RLC Circuits
  - Series
  - Parallel

- Types of Devices
  - Vacuum Tubes
    - Diode
    - Triode
    - Tetrode
    - Pentode
    - Pentagrid converter
  - Semiconductors
    - Diode
    - Bipolar transistor
    - FET
    - Unijunction transistor
    - Zener diode
    - SCR
- Plotting Load Line
  - Tube
  - Transistor
- Constructing Circuits Using IC Chip

Power Supplies

- Component Types
  - Tube
  - Semiconductor
- Circuit Types
  - Half-wave
  - Full-wave
  - Bridge
  - Voltage Doubler
  - Zener Regulated Supply
- Calculations
  - Ripple Frequency
  - Percent Regulations
- Troubleshooting Power Supplies

UNIT II Continued

Power Supply Filter

- Types
  - Resistive
  - L-C
- Troubleshooting Filter Systems

Audio

- Component Types
  - Transistor
  - Tube
- Calculating Gain
- Plotting Frequency Response
- Troubleshooting Audio

Second Detector

- Troubleshooting AVC
- Troubleshooting Detector

IF

- Gain
  - Calculating
  - Measuring
- Troubleshooting, Using RF Generator

Oscillator

- Basic Types

UNIT IV: FM & TV

TV Antenna Systems

- Types of Antenna
- Types of Lead-In
- Mounts
- Grounding
- Troubleshooting

FM and Black & White TV

- FM Receivers
  - Mono Alignment and Troubleshooting
    - Detector
    - IF
    - Limiter
    - Front end
    - AFC
    - Tuning indicators
  - Stereo Alignment and Troubleshooting, Using Multiplex Generator
    - Multiplex decoder
    - Stereo indicator
    - Channel separation
- TV Service Adjustments
  - Vertical Linearity
  - Height
  - AGC
  - Other
- Picture Tubes
  - Testing
  - Rejuvenating
  - Replacing
  - Safety

- Measuring Frequency
  - Scope
  - Frequency Counter
- Troubleshooting

AM Front End

- Aligning
- Troubleshooting

Troubleshooting AM Radio

UNIT III: INDUSTRIAL ELECTRONICS

Gas and Vapor Filled Tubes

- Thyratron
- Mercury Vapor
- Ignition

Polyphase Rectifiers

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

Photoelectric Devices

- Photoconductive
- Photoelectric
- Photosensitive
  - Transistor
  - Tube

- Tuners
  - Cleaning
  - Adjusting Oscillator Coils
  - Aligning, Using Sweep Generator
  - Troubleshooting
- Video, Video Detector, and AGC
  - Measuring Video Output
    - Gain
    - Response
  - Troubleshooting
    - TV Analyst
    - Scope
- Audio
  - Measuring Frequency Response
  - Troubleshooting
    - Amplification
    - Output
- IF
  - Alignment, Using Sweep Generator
  - Troubleshooting
- Vertical Sweep
  - Measuring Frequency
  - Troubleshooting, Using TV Analyst
    - Vertical Sync
    - Vertical Output
- Synchronization
  - Vertical
  - Horizontal
- Horizontal Oscillator
  - Measuring Frequency
  - Troubleshooting
- High-Voltage Supply
  - Circuits

UNIT IV Continued

Photoelectric Devices, Continued
High Voltage Supply, Continued

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

o Low-Voltage Supply

o Remote Controls
- Transmitter
. Electrical
. Mechanical
- Receiver

o Troubleshooting Black & White TV

Color TV

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

o Color CRT
- Testing
- Rejuvenating

UNIT V Continued

Gating Circuits, Continued

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

o Troubleshooting

Flip-Flops

o Types
- S-R
- J-K

o Construction
- Transistor
- IC Chip
- Trainer

o Counters

o Shift Register

o Verifying Timing Diagrams

o Troubleshooting
- Counters
- Shift Register

Computer Programming and Service

o Program Language
- Machine
- Basic

o Peripheral Equipment

- Replacing
- Safety

- Field Alignment of Color Circuits
  - Oscillator
  - Phase
  - Burst

- Troubleshooting Color Circuits

- Color High-Voltage Supply
  - Regulator
  - Adjustment
  - Safety

- Troubleshooting Color TV

UNIT V: DIGITAL ELECTRONICS

Gating Circuits

- Gates
  - AND
  - OR
  - NAND
  - NOR
  - Inverter
  - Emitter Follower

- Circuit Reduction
  - Boolean Algebra
  - Karnaugh Map

- Converting Between Systems
  - Binary
  - Octal
  - Decimal
  - Hexidecimal

- Memory
  - Core
  - Chip

- Troubleshooting
  - Logic Probe
  - Scope

UNIT VI: COMMUNICATIONS

Transmitter, Receiver, Transceiver Types

- FM

- AM

- SSB

FCC Requirements

Antenna Systems

- Types

- Installation

- SWR