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ABSTRACT

The automotive electrical and electronic system I course is designed as one of a group of quinmester courses offered in the field of automotive mechanics. General information will be given along with technical knowledge, basic skills, attitudes and values that are required for job entry level. The nine week (135 clock hour) course overcomes some of the difficulties of teaching electricity through visual aids and student involvement. Basically the course has been designed to provide a solid foundation in electrical and electronic principles and their application to the various automotive systems. A course outline and six pages of post-tests are included. (DS)

AUTHORIZED COURSE OF INSTRUCTION FOR THE QUINMESTER PROGRAM

Course Outline

AUTOMOTIVE ELECTRICAL AND ELECTRONIC SYSTEMS 1

(Automotive Mechanics 2 - 9045)

Department 48 - Course 9045.03

DADE COUNTY PUBLIC SCHOOLS

DIVISION OF INSTRUCTION • 1971

DADE COUNTY PUBLIC SCHOOLS

1410 NORTHEAST SECOND AVENUE

MIAMI, FLORIDA 33132

Course Outline

AUTOMOTIVE MECHANICS 2 - 9045
(Automotive Electrical and Electronic Systems 1)

Department 48 - Course 9045.03

the division of

VOCATIONAL, TECHNICAL AND ADULT EDUCATION

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Miami, Florida 33132

Published by the Dade County School Board

Course Description

9045	48	9045.03	Automotive Electrical and Electronic System I
State Category Number	County Dept. Number	County Course Number	Course Title

This quinmester course is designed as one of a group of quinmester courses offered in the field of automotive mechanics. The student will receive the general information, technical knowledge, basic skills, attitudes and values that are required for job entry level. The applicant must have met the minimum requirements which are as follows:

1. Must have identified personal goals and needs for this program.
2. Must qualify in the standardized tests, which are recorded in the pupils' cumulative guidance record with a minimum of Stanine 5.

This course will be given in a nine-week period for a total of 135 clock hours.

PREFACE

The following quinmester course outline has been designed to provide a solid foundation in electrical and electronic principles and their application to the various automotive systems. "Automotive and Electronic System II," will be offered as the next quinmester course. Course 9045.03 covers electrical fundamentals, the battery, the ignition system, indicating devices and accessory circuits. Course 9045.04 covers the starting and charging systems and lighting circuits.

Electricity has always been one of the more difficult subjects to teach because of its intangible nature. This difficulty can be overcome to a great degree by the use of a multitude of visual aids and emphasis on student involvement. Instructors must break away from the traditional approach in teaching this course. Modern concepts in education should be applied. Small group projects, peer learning, and individualized instruction are but a few suggested approaches.

Testing frequently to determine the degree of progress and weak areas to be reinforced should be mandatory. Here again, the instructor is urged to break away from the traditional testing approach. Tests can be made interesting by making them more subjective and individualized. Behavioral objectives are subjective in nature and tests should be built around this premise. Objective tests in this subject area are not valid, when used to the exclusion of performance tests. If, for example, one objective states, "The student will be able to attach the leads of a voltmeter to the ignition system and determine proper coil polarity," the instructor should determine by performance testing that each student is able to do so. Tests of this type preclude "guessing" which has no place in the field of automotive electricity.

This outline consists of five blocks of instruction, which are subdivided into several units each. This course is 135 hours in length.

In addition to mock-ups, working models, cut aways and test equipment, there are a variety of slides, transparencies, films and filmstrips available from school and industry sources. Judicious use of such material is of great value in getting through to the student. A partial listing of resource material will be found at the end of this course outline.

This outline was developed through the cooperative efforts of the instructional and supervisory personnel, the Quinmester Advisory Committee, and the Vocational Teacher Education Service, and has been approved by the Dade County Vocational Curriculum Committee.

TABLE OF CONTENTS
with Suggested Hourly Breakdown

GOALS

The automotive electrical technician trainee must be able to demonstrate:

1. A basic understanding of electrical and electronic fundamentals in order that he may apply these to diagnostic and service work in this field.

2. The ability to diagnose, service and maintain the automotive battery.

3. The skills and knowledge required to accurately diagnose ignition troubles and perform an ignition tune-up to industry standards using modern test equipment.

4. Good safety habits and shop behavior in order to prevent accidents.

5. The ability and desire to continue to advance his knowledge and skills in the automotive area.

SPECIFIC BLOCK OBJECTIVES

BLOCK I - ORIENTATION

The student must be able to:

1. Demonstrate a positive attitude toward the world of work by following safety rules, good shop practices, and taking pride in his workmanship.
2. State, by writing a short paragraph, what will be expected of him as an automotive electrician.
3. Evidence an understanding of what is expected of him behaviorally throughout the course and the methods by which he will be evaluated.

BLOCK II - ELECTRICAL FUNDAMENTALS

The student must be able to:

1. Demonstrate by written examination, an understanding of the electron theory and Ohm's Law.
2. Exhibit a complete understanding of electrical circuits and their operational rules by performance of the principles involved.
3. Demonstrate by written examination, an understanding of the laws of magnetism and its role in the field of electricity.
4. Explain orally the methods used to produce an electromotive force.
5. Demonstrate an understanding of the construction, operational theory, and safety precautions in the use of meters by performance.
6. Demonstrate an understanding of the various automotive electrical circuits, including symbols, schematics, and interrelationships by diagraming the principles involved.
7. Demonstrate an understanding of the fundamentals of electronics as applied to the automobile by diagraming typical electronic circuits.

BLOCK III - THE AUTOMOTIVE BATTERY

The student must be able to:

1. Explain orally the construction and nomenclature of the lead-acid storage battery.
2. Demonstrate an understanding of the chemistry of charging and discharging the battery by written examination.
3. Demonstrate an understanding of the various battery sizes and ratings by performance.
4. Perform the standard battery test procedures using modern test equipment.
5. Explain orally battery charging methods and safety precautions involved.
6. Perform battery service and maintenance procedures observing the safety rules.

BLOCK IV - THE IGNITION SYSTEM

The student must be able to:

1. Demonstrate an understanding of ignition system fundamentals including operational theory and component part function by examination.
2. Diagram the primary and secondary ignition systems and discuss component parts and their function.
3. Determine proper coil polarity by use of the voltmeter and oscilloscope.
4. Demonstrate an understanding of distributor design and testing procedures by performance.
5. Diagram the distributor advance curve using the distributor tester.
6. Demonstrate an understanding of the spark plug including types, heat ranges, and service procedures by performance.
7. Diagram a transistor ignition system and explain the function of its component parts.
8. Exhibit the ability to use ignition test equipment and explain the role of each in diagnosis and trouble shooting.
9. Exhibit the ability to perform a live ignition time-up using available test equipment and observing good safety practices.

BLOCK V - INDICATING DEVICES AND ACCESSORY CIRCUITS

The student must be able to:

1. Demonstrate an understanding of the operational theory of indicating gauges and lights by written examination.
2. Exhibit the ability to troubleshoot, remove and replace dash gauges and indicating lights.
3. Diagram a typical accessory circuit and explain the component parts and their functions
4. Exhibit the ability to disassemble, repair and reassemble a small automotive electric motor.

Course Outline

AUTOMOTIVE MECHANICS 2 - 9045
(Automotive Electrical and Electronic Systems 1)

Department 48 - Course 9045.03

I. ORIENTATION

A. Objectives of the Course
   1. Discussion of goals and objectives
   2. Standards

B. Student Responsibilities
   1. School policies and expenses
   2. Safety regulations
   3. Shop rules and procedures:
      a. Care of hand tools
      b. Use and care of equipment
      c. Appropriate dress
      d. Reporting defective equipment
      e. Reporting loss of equipment
      f. Materials and supplies
      g. Housekeeping
      h. Employee-employer relations
      i. Employee-customer relations

C. Methods of Student Evaluation
   1. Written tests
   2. Performance tests with relation to behavioral objectives
   3. Diagnosis and job performance

D. Teaching Methods

E. The Automotive Electrician
   1. The scope of the trade
   2. Job opportunities
   3. Qualifications for employment:
      a. Job competency
      b. Pride of workmanship
      c. Attitudes
      d. Dependability
      e. Trade certificate
      f. Foundation for additional training
      g. Experience

II. ELECTRICAL FUNDAMENTALS

A. The Electron Theory
   1. Structure of the atom:
      a. Electrons
      b. Neutrons

II. ELECTRICAL FUNDAMENTALS (Contd.)

c. Protons
2. Like and unlike charges
3. How electrons flow
4. Direct current
5. Alternating current:
   a. The sine wave in A.C.
   b. Single phase A.C.
   c. Three phase A.C.

B. Ohm's Law
1. Definition and measurement of voltage
2. Definition and measurement of amperage
3. Definition and measurement of resistance
4. The forms and application of this law

C. Basic Electrical Circuits
1. Structure and rules of series circuits
2. Structure and rules of parallel circuits
3. Structure and rules of the series-parallel circuit
4. Circuit components - their function:
   a. Power source
   b. Conductors
   c. Load
   d. Switches
5. Types of circuit protection
6. Relationship of wire size and current carrying ability in the circuit

D. Magnetism
1. Theory of permanent and electromagnets
2. Use of magnetism in the electrical system
3. Definition of lines of force, polarity, permeability, and induction

E. The Production of Electricity (EMF): Manner in which Heat, Light, Friction, Pressure, Chemistry, and Magnetism Function To Product EMF (Electromotive Force)

F. The Measurement of Electricity
1. Construction and operational theory of the basic meter
2. Construction and operational theory of the voltmeter
3. Construction and operational theory of the ammeter
4. Construction and operational theory of the ohmmeter
5. Construction and operational theory of the oscilloscope
6. Safety precautions in the use of various meter types

G. Automotive Electrical Circuits
1. Structure and rules of series circuits
2. Structure and rules of parallel circuits
3. Structure and rules of the series-parallel circuit
4. Circuit components - their function

II. ELECTRICAL FUNDAMENTALS (Contd.)

H. A Look at Automotive Electronics:
   1. Definition of electronics
   2. The role of electronics in the modern automobile
   3. The future in automotive electronics

III. THE AUTOMOTIVE BATTERY

A. Construction and Nomenclature of the Lead-Acid Storage Battery

B. The Chemistry of Charging and Discharging the Lead-Acid Battery

C. Battery Sizes and Ratings

D. Standard Battery Test Procedures
   1. Visual inspection
   2. Hydrometer test
   3. Light load test
   4. Capacity testing with the carbon pile battery-starter tester
   5. The electronic hydrometer

E. Battery-Charging Methods:
   1. Manner in which charger functions
   2. Slow charging
   3. Fast charging
   4. Trickle charging
   5. Computing charging rates and times
   6. Safety precautions in battery charging

F. Battery Servicing Methods:
   1. Demonstrate how to remove and replace a battery
   2. "In car" service procedures
   3. Activating a "dry" charge battery: safety precautions

G. Battery Maintenance
   1. Prevention of corrosion at terminals
   2. Proper electrolyte levels
   3. Results of over - and undercharging
   4. Battery repairs
   5. Analysis of battery failures
   6. Proper storage methods

IV. THE IGNITION SYSTEM

A. Ignition System Fundamentals
   1. Basic operational theory
   2. Functions of component parts:
      a. Battery
      b. Ignition switch
      c. Ignition (ballast) registor

IV. THE IGNITION SYSTEM (Contd.)

d. Ignition coil
e. Distributor
f. Contact points
g. Condenser
h. Rotor
i. Distributor cap
j. High tension (plug) wires
k. Spark plugs

B. Primary (Low Tension) and Secondary (High Tension) Systems
1. Function of each system
2. Components of each system
3. Theory of coil polarity

C. Distributor Design and Testing
1. Theory of dwell angle
2. Advance mechanisms
3. Single and dual advance types
4. Operational principles of distributor testing machines

D. The Spark Plug
1. Types
2. Heat ranges
3. Types of plug failure
4. Plug cleaning and testing procedures

E. Transistor Ignition Systems
1. Theory of operation
2. Types of transistor systems
3. Advantages and disadvantages
4. Test procedures and precautions

F. Ignition Test Equipment
1. Importance and theory of operation of:
a. Compression gauge
b. Vacuum gauge
c. Tach-dwell meter
d. Combustion analyzer
e. Timing light
f. Ignition scope (oscilloscope)
g. Coil-condenser tester
h. Plug scopes
2. Techniques of Use

G. Ignition Timing
1. Theory of initial timing
2. Advance curves and specification

V. INDICATING DEVICES AND THE ACCESSORY CIRCUITS

A. Operational Theory of Indicating Devices
1. Gauges

V. INDICATING DEVICES AND THE ACCESSORY CIRCUITS (Contd.)

2. Indicating lights

B. Test Procedures

C. Operational Theory of Accessory Circuits
1. Wiper motors
2. Automatic windshield washers
3. Seat motors
4. Electric window motors

D. Repair Procedures on Small Electric Motors

VI. QUINMESTER POST TEST

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(Automotive Electrical and Electronic Systems 1)

Basic References:

1. Crouse, William H. Automotive Electrical Equipment. York, Pa.: Webster Division, McGraw Hill Book Co., 1966. Pp. 1-109, 384-477.

2. _____. Automotive Mechanics. York, Pa.: Webster Division, McGraw-Hill Book Co., 1965. Pp. 233-247.

3. Wetzel, Guy F. Automotive Diagnosis and Tune-Up. York, Pa.: McKnight and McKnight Publishers, 1969. Pp. 9-23, 101-181.

Supplementary References:

4. Chilton Auto Repair Manual. Philadelphia: Chilton Company.

5. Glenn Auto Repair Manual. Philadelphia: Chilton Company.

6. Motors Auto Repair Manual. New York: Motor Magazine.

7. Stockel, Martin W. Auto Mechanics. Chicago: Goodheart-Wilcox Co., Inc.

8. Tobolt, William K., and Johnson, Larry. Motor Services Automotive Encyclopedia. Chicago: Goodheart-Willcox, Inc.

Films:

		Dade County Film Ordering Number
1.	Amperes, Volts, and Ohms. 16 mm. 15 min. B/W. Sound.	1-05424
2.	Basic Electricity. 16 mm. 20 min. B/W. Sound.	1-02962
3.	Basic Electronics. 16 mm. 17 min. Color. Sound.	1-12963
4.	Current and Electromotive Force. 16 mm. 11 min. B/W. Sound	1-05604
5.	Electric Circuits. 16 mm. 10 min. B/W. Sound.	1-01890
6.	Electricity - How To Make A Circuit. 16 mm. 11 min. Color. Sound.	1-03543
7.	Electrons at Work. 16 mm. 14 min. Color. Sound.	1-10762
8.	Ohm's Law. 16 mm. 19 min. B/W. Sound.	1-13196

Dade County
Film Ordering
Number

9. Voltaic Cell, Dry Cell, and Storage Battery. 16 mm. 18 min. B/W. Sound. 1-13179

10. Wire Sizes and Voltage Drop. 16 mm. 13 min. B/W. Sound. 1-05598

Transparencies:

11. Ignition System Typical Firing Order. C.DCA (2-00 355)

12. Spark Plugs. C.DCA (2-00 356)

13. The Ignition Coil and Condenser. C.DCA (2-00 362)

14. The Ignition Distributor. C.DCA (2-00 361)

Color Slides with Technical Manuals:

15. Electrical Systems. Moline, Illinois: John Deere, Service Publications.

Ford Audio-Visual Courses:

1. Ignition Systems #1200. Detroit, Michigan: Ford Motor Company.

2. Electrical Fundamentals #13001. Detroit, Michigan: Ford Motor Company.

SOURCES OF MATERIALS

1. Ford Film Library
   "The American Road"
   Dearborn, Michigan 48121

2. Modern Pictures
   Attn.: Mr. Thomas L. Gunther
   714 Spring Street, N. W.
   Atlanta, Georgia

3. Sterling Movies
   43 West 61st Street
   New York, N. Y. 10023

4. Technical Literature Department
   Delco-Remy
   Division of General Motors Corporation
   Anderson, Indiana

A P P E N D I X

Quinmester Post Test Sample

Name _____ Date _____ Score _____

1. The heart of the automotive electrical system is the:

   a. Starter
   b. Battery
   c. Solenoid
   d. Ammeter

2. Correct battery polarity is particularly important in modern automobiles because of probable damage to the:

   a. Generator
   b. Cables
   c. Regulator
   d. Alternator

3. Batteries are best carried by a:

   a. Pair of pliers
   b. Two pairs of pliers
   c. Battery strap carrier
   d. Large board

4. If battery acid is low, always add:

   a. Distilled water
   b. Tap water
   c. Sulfuric acid
   d. Muriatic acid

5. A hydrometer reading of 1.190 would indicate a:

   a. Fully charged battery
   b. Sulfated battery
   c. Half charged battery
   d. Discharged battery

6. A pitted negative point would indicate:

   a. An under capacity condenser
   b. A cheap set of points
   c. An over capacity condenser
   d. That the plugs are too hot

7. The most important factor to consider when selecting spark plugs is:

   a. The manufacturer
   b. The price
   c. The type of electrode
   d. The heat range

8. When installing plugs, always use a:

   a. Torque wrench
   b. Large Stilson wrench
   c. Ratchet and correct socket
   d. Crescent wrench

9. Taper base plugs without gaskets should be torqued to:

   a. 40 foot pounds
   b. 18 foot pounds
   c. 30 inch pounds
   d. 100 foot pounds

10. The ignition points are actually a form of:

   a. Solenoid
   b. Electrode
   c. Switch
   d. Clutch

11. If ignition points are adjusted without removing the distributor, always:

   a. Put a drop of oil on them
   b. Bend the movable point
   c. Recheck the timing
   d. Ground the primary

12. The most important preliminary tune-up test is the:

   a. Compression test
   b. Coil test
   c. Condenser test
   d. Point resistance test

13. The dwell angle refers to:

   a. Points closed time
   b. Points open time
   c. Distributor speed
   d. Coil discharge

14. The ignition timing mark is usually found on the:

   a. Battery
   b. Block
   c. Vibration damper
   d. Distributor cap

15. The voltage required to jump from rotor to distributor cap electrode is approximately:

   a. 30,000 volts
   b. 20,000 volts
   c. 10,000 volts
   d. 2,000 volts

16. In a series circuit containing a twelve-volt battery and a resistance of two ohms, the current flow would be:

a. 2 volts
b. 6 volts
c. 6 amperes
d. 24 amperes

17. In a parallel circuit with branch resistance of two, four and six ohms, the total resistance would be:

a. Less than 2 ohms
b. 12 ohms
c. More than 2 ohms
d. None of the above

18. An example of a variable resistor is:

a. Dimmer switch
b. Dome light switch
c. Horn relay
d. Dash light switch

19. The current indicating gauge on cars so equipped is called:

a. A voltmeter
b. An ohmmeter
c. An ammeter
d. A hydrometer

20. The battery can be tested with:

a. A load tester
b. An ohmmeter
c. A scope
d. None of the above

21. In performing a compression test:

a. Remove one plug
b. Remove the distributor
c. Keep the choke closed
d. Remove all the plugs

22. If the scope pattern shows one plug spike to be excessively high, this would indicate:

a. A faulty scope
b. A wide plug gap
c. A hot coil
d. Points not adjusted properly

23. A frequent cause of trouble in small electric motors is:

a. A dirty commutator
b. Worn brushes
c. Weak brush springs
d. All of the above

24. Coil polarity can be checked with:

a. A coil tester
b. An ohmmeter
c. An ammeter
d. A voltmeter

25. The protective device for a transistor is called:

a. A vacuum tube
b. A rectifier
c. A zener diode
d. A variable

26. The scope pattern shows both time and:

a. Current flow
b. Voltage
c. Fuel flow
d. Battery condition

27. The ignition coil is a form of:

a. Tube
b. Diode
c. Capacitor
d. Transformer

28. The meter used to test diodes is called:

a. Transistor tester
b. Ammeter
c. Dwellmeter
d. Ohmmeter

29. The check for voltage drop actually is a test for:

a. Resistance
b. Current
c. Voltage
d. None of the above

30. "Sulfation" is a term associated with:

a. Hea lights
b. Dash gauges
c. Wiper motors
d. Batteries

31. In a series circuit containing a 12-volt battery, a current flow of 3 amperes is required. The value of the resistor to be added would be:

a. 3 ohms
b. 4 ohms
c. 40 ohms
d. 20 ohms

32. In a parallel circuit with two legs each containing a #97 light bulb, what would happen if one bulb burned out? The remaining bulb would:

a. Burn out
b. Not change
c. Burn brighter
d. Burn dimmer

33. In order to make a simple series circuit, four items are required. They are: a power source, conductors, a switch and:

a. A battery
b. Wires
c. Points
d. A load

ANSWER KEY TO QUINMESTER POST TEST

1. b
2. d
3. c
4. a
5. d
6. a
7. d
8. a
9. b
10. c
11. c
12. a
13. a
14. c
15. d
16. c
17. a
18. d
19. c
20. a
21. d
22. b
23. d
24. d
25. c
26. b
27. d
28. d
29. a
30. d
31. b
32. b
33. d