2001

Automotive electrical/electronics unit plans for Fontana High School

Ray Franklin Brinkle

Follow this and additional works at: https://scholarworks.lib.csusb.edu/etd-project

Part of the Curriculum and Instruction Commons, and the Vocational Education Commons

Recommended Citation

https://scholarworks.lib.csusb.edu/etd-project/1880

This Project is brought to you for free and open access by the John M. Pfau Library at CSUSB ScholarWorks. It has been accepted for inclusion in Theses Digitization Project by an authorized administrator of CSUSB ScholarWorks. For more information, please contact scholarworks@csusb.edu.
AUTOMOTIVE ELECTRICAL/ELECTRONICS UNIT PLANS

FOR FONTANA HIGH SCHOOL

A Project
Presented to the
Faculty of
California State University,
San Bernardino

In Partial Fulfillment
of the Requirements for the Degree
Master of Arts
in
Education:
Vocational Education

by
Ray Franklin Brinkle
June 2001
AUTOMOTIVE ELECTRICAL/ELECTRONICS UNIT PLANS
FOR FONTANA HIGH SCHOOL

A Project
Presented to the
Faculty of
California State University,
San Bernardino

by
Ray Franklin Brinkle
June 2001

Approved by:

Joseph E. Scarcella, Ph.D., First Reader

Ronald K. Pendleton, Ph.D., Second Reader

4/24/01
ABSTRACT

The automobile of today is highly complex, using multiple computer-controlled systems to control vehicle functions. A person choosing a career in automotive service industry will need to have multiple high-level skills to diagnose and repair these automobiles. The automobile technician with a strong background in electrical/electronics will be the most successful.

The purpose of this project was to develop a two-semester unit plans for the auto electronics course in the automotive technology program at Fontana High School. The unit plans was developed using the priority task list by National Automotive Technicians Education Foundation (NATEF) and the California Department of Education’s Model Curriculum Standards.
ACKNOWLEDGMENTS

I would like to express my sincere appreciation to Joseph Scarcella Ph.D. for his guidance, support, and patience during this challenging project. The insight and passion provided by Dr. Scarcella for vocational education has been an inspiration for me.

Most especially, I would like to thank Timothy Thelander M.A. for all of his help and Michelle Rash M.A., who so generously agreed to take the time to read my project and offer encouragement.

Finally, my deepest gratitude and love goes to SheriSue, my best friend and wife, who supported me, encouraged me, and suffered with me to make this an achievable goal.
# TABLE OF CONTENTS

ABSTRACT ......................................................................................... iii

ACKNOWLEDGMENTS ....................................................................... iv

CHAPTER ONE: BACKGROUND

- Introduction ................................................................. 1
- Context of the Problem ........................................... 1
- Purpose of the Project ............................................... 3
- Significance of the Project ...................................... 3
- Assumptions .......................................................... 3
- Limitations and Delimitation ................................. 4
  - Limitations .......................................................... 4
  - Delimitation ........................................................ 4
- Definition of Terms ................................................ 5
- Organization of the Project ........................................ 6

CHAPTER TWO: REVIEW OF THE LITERATURE

- Introduction ................................................................. 8
- History of the Automobile ......................................... 8
- Future Technology ................................................... 10
- National Automotive Technicians Education
  Foundation ................................................................. 12
- National Institute for Automotive Service
  Excellence (ASE) ......................................................... 14
- Technician Shortage .................................................. 15
- Summary ................................................................. 16

CHAPTER THREE: METHODOLOGY

- Introduction ................................................................. 18
CHAPTER FOUR: CONCLUSIONS AND RECOMMENDATIONS

Introduction .................................................. 21
Conclusions ..................................................... 21
Recommendations .............................................. 21
Summary .......................................................... 22

APPENDIX A: INDUSTRIAL AND TECHNOLOGY EDUCATION MODEL CURRICULUM STANDARDS (IEMCS) .................. 23

APPENDIX B: NATIONAL AUTOMOTIVE TECHNICIANS EDUCATION FOUNDATION TASK LIST .................. 28

APPENDIX C: AUTOMOTIVE ELECTRICAL/ELECTRONICS OUTLINE .................................................. 34

APPENDIX D: UNIT PLAN GUIDELINES .................. 39

APPENDIX E: REFERENCES FOR UNIT PLANS .... 85

REFERENCES ...................................................... 87
CHAPTER ONE
BACKGROUND

Introduction

The content of Chapter One presents an overview of the project. The context of the problem is discussed followed by the purpose, significance of the project, and assumptions. Next, the limitations and a delimitation that apply to this project are reviewed. Finally, definitions of terms are presented.

Context of the Problem

The evolution of today's automobile has created a new environment for those who choose a career in the automotive service industry. Highly complex vehicles with multiple computer-controlled systems have forced the industry to seek service personnel trained with higher skill levels. The auto mechanics of yesterday with low-level skills have been replaced by the automobile technician of today armed with multiple high-level skills. A typical technician today may be required to use computerized shop equipment, work with electronic components, and maintain skills with traditional handtools (Occupational Outlook Handbook, 2000).
To be an automobile technician, a person needs a basic foundation of good reading skills, math skills, and effective communication skills. An electrical/electronics background is essential for a technician to be successful in diagnosing and repairing today's automobiles.

To get an early start on this training, a person can begin by enrolling in the automotive program at their high school. Depending on the school's commitment to a quality program, the basic program standards can vary and make a difference in the skills learned by their students. To keep a program focused on the skills currently needed for employment, some schools have qualified to be certified by a national organization for their program standards. This organization, National Institute for Automotive Service Excellence (ASE) certifies the program after it has been evaluated and met established standards set by the National Automotive Technicians Education Foundation (NATEF). ASE program standards are reviewed and revised every three years to ensure that any changes in technology are addressed.

High school automotive programs across the nation close every year due to mismanagement. A program must be evaluated regularly and make changes if needed. The successful and expanding programs are following this path
knowing that students completing their programs have the skills needed for employment in the auto service industry (Lundquist, 2000).

Purpose of the Project

The purpose of the project was to develop a two-semester unit plans for the auto electronics course in the automotive technology program at Fontana High School. The unit plans were developed using the priority task list by NATEF and the California Department of Education’s Model Curriculum Standards. These unit plans are part of a set of goals to qualify the automotive program to be an ASE-certified program.

Significance of the Project

The current electrical/electronics course was outdated and had not been reviewed and updated for four years. These new unit plans will offer the students training to pass Automotive Service Excellence (ASE) tests to be certified in electrical/electronics systems. An ASE certification enhances a technician’s ability to be employed in the automotive service industry.

Assumptions

The following assumptions were made regarding this project:
1. Electrical/electronics are integral in the automotive service industry.
2. An updated automotive electrical/electronics course was needed.

Limitations and Delimitation

During the development of this project, two limitations and a delimitation were noted. These limitations and delimitation are presented in the next section.

Limitations

The following limitations apply to this project:

1. The electrical/electronics unit plans were developed based on NATEF's priority task list and the Industrial and Technology Education Career Path Guide and Model Curriculum Standards from the State of California Department of Education. The task list is listed in Appendix B and the model curriculum standards are listed in Appendix A.

2. These unit plans were developed specifically for Fontana high school students enrolled in the automotive technology program.

Delimitation

The following delimitation applies to this project:
1. Any automotive program committed to becoming an ASE-certified program may adopt these unit plans.

Definition of Terms

The following terms are defined as they apply to this project.

- **Certification** - The act of certifying; the guaranteeing of the truth or validity of; attestation (Funk & Wagnalls New International Dictionary, 1984).
- **Course** - "Refers to a group of people who are attending some form of training. It may also refer to the whole of the instruction" (Kroehnert, 1995, p. 216).
- **Curriculum** - All the objectives, content, and learning activities arranged in a sequence for a particular instructional area (Carr, 1986).
- **National Automotive Technicians Education Foundation (NATEF)** - An independent, non-profit organization with a mission to evaluate technician training programs against standards developed by the automotive industry and recommend qualifying programs for certification.
by ASE (National Automotive Technicians Education Foundation, 2000).

- **National Institute for Automotive Service Excellence (ASE)** - A non-affiliated, non-profit organization with a mission to improve the quality of vehicle repair and service through the testing and certification of repair and service professionals (National Institute for Automotive Service Excellence, 2000).

- **Unit Plan** - "A unit plan should contain all of the lesson plans that relate to a particular unit of instruction" (Pendleton, 1991, p. 73).

**Organization of the Project**

This project is divided into four chapters. Chapter One provides an introduction to the context of the problem, purpose of the project, significance of the project, limitations and delimitations, and definitions of terms. Chapter Two consists of a review of relevant literature. Chapter Three details the unit plans design and the population served by this project. Chapter Four presents conclusions and recommendations drawn from the development of the project. Project references follow Chapter Four. Finally, the Appendixes, which consist of
the model curriculum standards, NATEF's priority task list, course outline, unit plans guidelines, and references for the unit plans.
CHAPTER TWO

REVIEW OF THE LITERATURE

Introduction

Chapter Two consists of a discussion of the relevant literature. Specifically, the introduction of electronic components in the design of the automobile over the past three decades was discussed. This was followed by a discussion of new electronic technology being developed for future use in the automobile. The mission of the National Automotive Technicians Education Foundation (NATEF) organization and components needed to certify automotive training programs was covered. The benefits of being an ASE certified program were also discussed. The function of the National Institute for Automotive Service Excellence (ASE) and why a technician needs to be certified in today's job market was discussed. Finally, the shortage of qualified automobile technicians is discussed.

History of the Automobile

Technology has made a large impact on history, and possibly the most recognized example of this statement is the automobile. Over the course of time, developments in
automotive engineering have had ramifications throughout our car-dependent nation.

The first significant innovation in the design of the automobile was the self-starter. A crank started the engines on automobiles built in the early 1900’s. This method was quite dangerous. It led to Charles Kettering building the first major electrical device on the automobile, the self-starter (Schwarz, 1996). A person could start the automobile engine without fear of physical injury. The advent of this device allowed many more people to drive, especially women.

The electrical system of the automobile evolved slowly during the first seventy years of the twentieth century. Innovations were sometimes years apart. At the beginning of the 1970’s, electronic components being designed into the automobile began to accelerate. This was the beginning of a pivotal period.

At the first Convergence Transportation Electronics Association Conference of automotive engineers in 1974, they identified 55 probable electronic applications that would evolve into the design of the automobile. By 1982, 67 percent of those, including automatic door locks, cruise control, and onboard diagnostics were in production. The need for onboard diagnostics was brought
about by the placement of a microprocessor in vehicles to manage the fuel and ignition systems more precisely. This was significant because it allowed engineers to make adjustments, or redesign components, by simply putting in a new chip. With multiple microprocessors leading the list of innovations, by 1996, 93 percent of the probable electronic applications from the 1974 conference were in use on the automobile (Wiggins, 2000).

The evolution of electronics in the automobile could be regarded as revolutionary because it involved all the vehicle's subsystems in a very short time. This evolution has made the diagnosis and repair of automobiles challenging for the automotive technician. Coping with the growing need to keep automotive technicians qualified is one of the greatest challenges to the automotive service industry (Molla, 1998).

Future Technology

Electronic technology used in automobile design is growing at a record pace. Designing higher-powered electrical features and functions in the automobile is a challenge for automotive engineers in the future.

The technologies that will lead automotive electronics into the 21st century are led by the placement
of communication and entertainment systems in the vehicle interior. The ability to be connected to the Internet will be a high priority among drivers (Miel, 2000).

Many changes are slated to take place under the vehicle to improve the automobile’s ride, safety, and performance. Sensors and motors will adapt the way a car rides to road-surface changes. A steering system that will control stability in a turn by nudging the brakes and reducing the throttle is under consideration. Performance will improve with the use of higher capacity computers to control engine functions (Port & Armstrong, 1998).

The current electrical system voltage level is inefficient, contributing to lower fuel economy with poor fuel to electrical energy conversion. Current automotive electrical requirements will not be able to power future equipment demands. The next-generation automotive electrical power system being proposed is one based on a 42-volt system. This system will allow the placement of high power systems on the automobile to satisfy the growing consumer demands (Miller, Nicastri, & Zarei, 2000).

Faced with the demand to install today’s rapid changing technology into the automobile at a faster rate, the automotive industry will be challenged to keep pace.
Running parallel with these changes, servicing future technology in the automobile will require technicians to be trained faster and even at higher-skill levels. This will require technicians to be continually trained to keep current on changes in the automobile.

National Automotive Technicians Education Foundation

The National Automotive Technicians Education Foundation (NATEF) was founded in 1983 as an independent, non-profit organization with a single mission. This mission was to evaluate technician training programs against standards developed by the automotive industry and recommend qualifying programs for certification by the National Institute for Automotive Service Excellence (ASE). ASE is the body responsible for the Automobile Technician Training Certification Program.

The purpose of the Automotive Technician Training Certification Program is to improve the quality of training offered at the secondary and post-secondary levels. The eight areas of certification in this program are brakes, electrical/electronics, engine performance, suspension/steering, automatic transmission/transaxle, engine repair, heating/air conditioning, and manual drive train/axles.
To be certified in one of these areas a program is required to have a valid task list for each area. This well-defined task list will serve as a good foundation to build a curriculum for each area and help articulate the program with other schools in the region.

The NATEF priority task list was developed with input from industry and education. A panel of technical service experts from the automotive service industry and vocational educators was assembled to develop and validate the task lists. Every three years NATEF repeats this process to review and revise the task lists to keep current with changes in technology (National Automotive Technicians Education Foundation, 2000).

For a program to meet all the requirements to be ASE certified, it must also have the correct tools and equipment, provide the minimum hours of instruction, and have the instructors ASE certified in the area that they are teaching.

A school benefits in many ways by ASE certification of their program. One of the biggest benefits is overall program improvement. Everyone involved in the program knows what the automotive industry expects from a training program. The standards of the program are clearly stated. Another benefit of ASE certification is increasing
opportunities for receiving funding or donations. Manufacturers and dealerships are more willing to donate time and equipment to a certified program. Recruiting new students into an ASE-certified program is easier having demonstrated program excellence. Students know that the skills taught in a certified program will be needed for employment in the automotive industry (Lundquist, 2000).

National Institute for Automotive Service Excellence (ASE)

Responding to consumer’s desire to identify a competent technician, the non-affiliated, non-profit National Institute for Automotive Service Excellence (ASE) was established in 1972. ASE’s goal is to test and certify automotive technicians. By certifying technicians, the quality of automotive service has increased by forcing technicians to seek training to keep current with changes in automotive technology.

ASE currently has about 440,000 professionals certified in over 40 areas of the automotive service industry. The certifications are in every area of automotive service. They include automobile technicians, collision technicians, engine machinists, parts
specialists, heavy truck technicians, school bus technician, and advanced engine performance technicians.

To become certified a person must pass an exam and have two years of relevant work experience. Upon passing the exam, the person receives ASE credentials that are good for five years. At that time the person must pass a retest to continue to be certified (National Institute for Automotive Excellence, 2000).

There are many reasons for a professional to be ASE certified in their automotive service industry job. The certificate will show peers, supervisors, and the general public the ability to perform to set standards. Being certified give an individual an edge when being considered for a promotion. It may merit a pay increase for being certified. Some automotive service industry employers will not consider a non-certified person for an open position. Entering the automotive service field today, a person will not be recognized as a true professional automotive technician until becoming ASE certified.

Technician Shortage

The need for highly trained technicians is at an all time high. Statistics show more than 15,000 technicians have been retiring or finding other work every year since
1989. This has helped to create a shortage of trained automobile technicians estimated at 60,000 nationwide (Lang, 1999).

Another factor causing the shortage is the declining pool of qualified people to train as a technician. Students are leaving high school without the critical academic, technical, and thinking skills needed to meet the demands of the service industry (McGinty, 1997).

To help reduce this shortage the automotive service industry has implemented strategies to increase technician levels. Car manufacturers are getting involved in the training of automobile technicians by becoming partners and financial supporters of secondary and post-secondary programs across the country. One example is the Automotive Youth Educational System (AYES), a partnership between General Motors, DaimlerChrysler, and Toyota gives students work experience while in high school. This support will allow programs to grow and develop higher skill level students to enter the work force (Buchholz, 2000).

Summary

Chapter Two discussed the introduction of electronic components in the design of the automobile over the past three decades. The new electronic technology being
developed for future use in the automobile was covered.
The mission of the National Automotive Technicians
Education Foundation (NATEF) organization and process used
to certify automotive training programs was discussed.
Also discussed was the function of the National Institute
for Automotive Service Excellence (ASE) and why a
technician needs to be certified in today's job market.
Finally, the technician shortage and strategies to reduce
the shortage were discussed.
CHAPTER THREE

METHODOLOGY

Introduction

Chapter Three describes how the project was developed. First, the student population this course was developed for will be described. Second, the unit plans development process including the unit plans structure and content validation was presented. The chapter concludes with a summary.

Population Served

The population to be served by these unit plans is students enrolled in Auto Electronics at Fontana High School. Students enrolled in Auto Electronics will range from the tenth grade to the twelfth grade. The majority of the students will be eleventh and twelfth grade level.

The unit plans are appropriate for any high school automotive program that is ASE-certified or is in the process of becoming certified.

Unit Plans Development

The next section of the project provides an overview of the unit plans development process. Specifically, the unit plans structure and content validation process are reviewed.
Unit Plans Structure

The contents of the unit plans were developed based on the NATEF task list and the Industrial and Technology Education Career Path Guide and Model Curriculum Standards from the State of California Department of Education. The focus of this class is to implement industry specific work experiences for students.

The unit plans were designed to include extensive diagnostic skill development. The student in this class has received the basic background knowledge in the prerequisite classes. The prerequisites for this class are the passing of Auto One and Auto Two. The student must also have passed Advanced Auto or be currently enrolled.

The outline developed consists of the following: (1) unit title; (2) unit outline; (3) unit objectives; (4) materials and equipment; (5) evaluation; and (6) comprehension.

Unit Plans Validation

Two methods validated the content for these unit plans, the first was through an extensive literature review. The competencies required to be a trained and certified technician in electrical/electronics was included in the unit plans. The second method included the assembling of a panel of experts in the area of automotive
service to review and make suggestions for improvement in the unit plans. The panel included experts from independent and dealer service backgrounds to have input from the major areas of automotive service with electrical/electronic emphasis. The credentials of these experts included being certified by ASE.

Summary

An overview of the steps used to develop this project was presented. The population served was students in the Fontana High School automotive program. The unit plans were designed using the NATEF task list and the Industrial and Technology Education Career Path Guide and Model Curriculum Standards from the State of California Department of Education. The outline chosen for the unit plans was detailed. Finally, an extensive literature review and the assembling of a panel of experts validated the unit plans.
CHAPTER FOUR
CONCLUSIONS AND RECOMMENDATIONS

Introduction

Included in Chapter Four is a presentation of the conclusions gleamed as a result of completing this project. Further, the recommendations extracted from this project are presented. Lastly, the Chapter concludes with a summary.

Conclusions

The conclusion extracted from this project follow:

1. An electrical/electronics background is essential for an individual to be able to both repair today's automobile and adapt to future changes in automotive technology.

Recommendations

The recommendations resulting from this project follow:

1. The unit plans be reviewed and updated annually to ensure that the standards address the fast-paced advances of technology used in the automobile.

2. The automotive program articulate with an area community college to align curriculum and
eliminate unnecessary duplication of instruction.

3. To find talented and experienced technicians to work part time in the automotive program. This will decrease student to teacher ratio and improve instruction while giving the students insight to current working conditions.

4. The automotive program provides an end of program preparation test to ready students for ASE certification tests.

5. Students wear professional attire to develop personal attitudes and work habits appropriate to the automotive service industry.

Summary

The conclusions derived from this project were reviewed in this Chapter. Lastly, the recommendations extracted from this project were presented.
APPENDIX A

INDUSTRIAL AND TECHNOLOGY EDUCATION

MODEL CURRICULUM STANDARDS

(IEMCS)
Transportation Technology

ASE Certification: Electricity and Electronics (370-379)

(IEMCS) Standard 370:

General Diagnosis of Electrical Systems

Students will understand how to diagnose and repair automotive electrical systems. Students will check, test, diagnose, repair, and adjust automotive electrical systems and components.

(IEMCS) Standard 371:

Diagnose and Service of Batteries

Students will understand battery operation, testing, and servicing procedures. Students will inspect, test, clean, charge, and replace batteries and battery-circuit components in accordance with manufacturer’s recommendations.

(IEMCS) Standard 372:

Diagnose and Repair of Starting Systems

Students will understand the operation of, testing of, and repair procedures for starting systems. Students will remove, inspect, test, and repair or replace starting-system components in accordance with industry standards.
(IEMCS) Standard 373:

**Diagnose and Repair of Charging Systems**

Students will understand the operation of, testing of, and repair procedures for charging systems. Students will remove, inspect, test, and repair or replace charging-system components in accordance with industry standards.

(IEMCS) Standard 374:

**Diagnose and Repair of Lighting Systems**

Students will understand the operation, diagnosis, and repair of automotive lighting systems. Students will inspect, test, aim, and repair or replace wires, connectors, bulbs, sockets, and switches in accordance with industry standards.

(IEMCS) Standard 375:

**Diagnose and Repair Driver-Information Systems**

Students will understand the operation of and diagnostic procedures for meters, gauges, warning lamps and devices, relays, and related electrical circuits. Students will remove, inspect, test, repair, and replace system components, using industry-accepted procedures.
(IEMCS) Standard 376:

Diagnosis and Repair of Horns, Wipers, and Washers

Students will understand horn and windshield-wiper circuits, diagnostic techniques, and component-testing procedures. Students will trace circuits and inspect, test, and repair or replace components, using industry-accepted procedures.

(IEMCS) Standard 377:

Diagnosis and Repair of Accessory Circuits

Students will understand the operation of, testing techniques for, and repair procedures for automotive electrical-accessory circuits. Students will trace circuits and inspect, test, and repair or replace components, using industry-accepted procedures.

(IEMCS) Standard 378:

Diagnosis and Repair of Body-Electronics Systems

Students will understand the operation of, diagnosis of, and testing procedures for computer-controlled body-electronics systems. Students will trace circuits and inspect, test, and repair or replace components, using procedures recommended by the manufacturer.
(IEMCS) Standard 379:

Diagnosis and Repair of Engine-Management Systems

Students will understand computer-controlled engine-management systems and the procedures for their diagnosis and testing. Students will trace circuits and inspect, test, and repair or replace components, using procedures recommended by the manufacturer.
APPENDIX B

NATIONAL AUTOMOTIVE TECHNICIANS

EDUCATION FOUNDATION TASK LIST
ELECTRICAL/ELECTRONIC SYSTEMS

A. General Electrical System Diagnosis

1. Use wiring diagrams during diagnosis of electrical circuit problems.

2. Check electrical circuits with a test light; determine necessary action.

3. Check voltage and voltage drop in electrical/electronic circuits using a digital multimeter (DMM); determine necessary action.

4. Check current flow in electrical/electronic circuits and components using an ammeter; determine necessary action.

5. Check continuity and resistance in electrical/electronics circuits and components with an ohmmeter; determine necessary action.

6. Check electrical circuits using jumper wires; determine necessary action.

7. Locate shorts, grounds, opens, and resistance problems in electrical/electronic circuits; determine necessary action.

8. Measure and diagnose the cause(s) of abnormal key-off battery drain; determine necessary action.
9. Inspect and test fusible links, circuit breakers, and fuses; determine necessary action.
10. Inspect and test switches, connectors, relays, and wires of electrical/electronic circuits; perform necessary action.
11. Repair wiring harnesses and connectors.

B. Battery Diagnosis and Service
1. Perform battery state-of-charge test; determine needed service.
2. Perform battery capacity test; determine needed service.
3. Maintain or restore electronic memory functions.
4. Inspect, clean, fill, and replace battery.
5. Perform slow/fast battery charge.
6. Inspect and clean battery cables, connectors, clamps, and hold-downs; repair or replace as needed.
7. Start a vehicle using jumper cables and a battery or auxiliary power supply according to manufacturers recommended specifications.
C. Starting System Diagnosis and Repair

1. Perform starter current draw tests; determine necessary action.
2. Perform starter circuit voltage drop tests; determine necessary action.
3. Inspect and test starter relays and solenoids; replace as needed.
4. Remove and install starter.
5. Perform starter bench tests; determine necessary action.
6. Inspect and test switches, connectors, and wires of starter control circuits; perform necessary action.
7. Disassemble, clean, inspect, and test starter components; replace as needed.

D. Charging System Diagnosis and Repair

1. Perform charging system output test; determine necessary action.
2. Diagnose charging system for the cause of undercharge, no-charge, and overcharge condition.
3. Inspect and adjust generator (alternator) drive belts; replace as needed.
4. Inspect and test voltage regulator/regulating circuit; perform necessary action.

5. Remove, inspect, and install generator (alternator).

6. Disassemble generator (alternator), clean, inspect, and test components; determine necessary action.

7. Perform charging circuit voltage drop tests; determine necessary action.

E. Lighting Systems Diagnosis and Repair

1. Diagnose the cause of brighter than normal, intermittent, dim, or no light operation; determine necessary action.

2. Inspect, replace, and aim headlights and bulbs.

3. Inspect and diagnose incorrect turn signal or hazard light operation; perform necessary action.
F. Gauges, Warning Devices, and Driver Information Systems Diagnosis and Repair.

1. Inspect and test gauges and gauge sending units for cause of intermittent, high, low, or no gauge readings; determine necessary action.

2. Diagnose the cause of incorrect operation of warning devices and other driver information systems; determine necessary action.

G. Horn and Wiper/Washer Diagnosis and Repair

1. Diagnose incorrect wiper operation; diagnose wiper speed control and park problems; perform necessary action.

2. Diagnose incorrect windshield washer operation; perform necessary action.

H. Accessories Diagnosis and Repair

1. Diagnose incorrect operation of motor-driven accessory circuits; determine necessary action.

2. Diagnose supplemental restraint system (SRS) concerns; determine necessary action. (Note: follow manufacturer’s safety procedures to prevent accident deployment).

3. Diagnose incorrect electric lock operation; determine necessary action.
APPENDIX C

AUTOMOTIVE ELECTRICAL/ELECTRONICS OUTLINE
COURSE OUTLINE

COURSE TITLE:

AUTO ELECTRONICS

COURSE INFORMATION:

Prerequisites: Auto 1, Auto 2, Advanced Auto or be currently enrolled

COURSE LENGTH:

Two-semesters in length and 360 hours total

COURSE GOALS:

To provide hands-on training to prepare students for ASE certification in Electrical/Electronics Systems and entry-level job skills appropriate to the local job market.

COURSE DESCRIPTION:

This course is designed to qualify the students to take the ASE certification tests in electrical/electronics. Successful completion of both the course and ASE certification test will prepare the students for entry-level positions in the auto service industry.

COURSE CONTENT:

I. Automotive Safety Practices
   A. Hazardous materials and waste
   B. Fire safety
C. Tool and equipment safety
D. Cleanup procedures
E. Personal safety

II. Basic Electrical System Fundamentals
A. Wiring diagrams
B. Test light operation
C. Digital multimeter operation
D. Ammeter operation
E. Ohmmeter operation
F. Electrical circuit tests
G. Diagnose electrical/electronic system problems
H. Battery drains
I. Circuit protection devices
J. Relay and switch testing
K. Wiring repairing
L. Soldering

III. Diagnosing and Servicing the Battery
A. Battery state-of-charge test
B. Battery capacity test
C. Electronic memory
D. Battery inspection and replacement
E. Battery charging
F. Battery cables
G. Jump starting
IV. Diagnosing and Repairing the Starter System
   A. Starter draw test
   B. Starter voltage drop test
   C. Starter relays and solenoids
   D. Starter removal and installation
   E. Starter bench tests
   F. Starter control circuits
   G. Starter rebuilding and testing

V. Diagnosing and Repairing the Charging System
   A. Alternator output tests
   B. Diagnosing charging system problems
   C. Alternator belt replacement
   D. Voltage regulators
   E. Alternator removal and installation
   F. Alternator rebuilding and testing
   G. Charging system voltage drop tests

VI. Diagnosing and Repairing Lighting Systems
   A. Light operation
   B. Headlights
   C. Turn signal and hazard light operation

VII. Diagnosing and Repairing Gauges, Warning Devices, and Driver Information Systems
    A. Vehicle gauges
B. Brake Warning devices and driver information systems

VIII. Diagnosing and Repairing Horn and Wiper/Washer Systems
A. Horn operation
B. Wiper operation
C. Washer operation

IX. Diagnosing and Repairing Accessory and Safety Systems
A. Motor-driven accessory circuits
B. Supplemental restraint systems
C. Power door lock systems

X. Job Seeking Skills
A. Job sources
B. Job application
C. Resume
D. Letter of application
E. Interview skills
F. Interview follow up
APPENDIX D

UNIT PLAN GUIDELINES
Unit Title: Automotive Safety Practices

Unit Outlines:
Instruction time: 8 hours
1. Personal Safety
2. Lab Safety
IEMCS Standard- 1

Unit Objectives:
Upon completion of this unit the student will be able to:
1. Identify the safe use and disposal of chemicals.
2. Demonstrate the safe use of fire protection equipment.
3. Identify the safe use of and maintenance of hand tools.
4. Demonstrate the use of protective clothing in the lab.
5. Identify the safe use of and maintenance of power tools.
6. Describe safe under-hood practices.
7. Identify safe procedures for using shop equipment.
8. Demonstrate oil and coolant cleanup procedures.

Materials and Equipment:
A vehicle, hand tools, lab equipment, protective clothing, mop and bucket, and a fire extinguisher.

Evaluation:
Class participation, lab projects and participation, quizzes, and tests.

Comprehension:
All students will complete each lesson of this unit with 100% accuracy before proceeding to the next unit.
Unit Title: Wiring Diagrams

Unit Outlines:
Instruction time: 5 hours
1. Electrical Circuits
2. Reading Wiring Diagrams

IEMCS Standard- 370
NATEF- A-1

Unit Objectives:
Upon completion of this unit the student will be able to:
1. Identify basic automotive electrical circuits.
2. Identify wire color codes used in automotive applications.
3. Identify wiring schematic symbols used in automotive applications.
4. Trace a wire through an automotive wiring schematic diagram.
5. Use a wiring diagram to diagnose an electrical problem.

Materials and Equipment:
Various sizes and colors of wire, wiring diagrams, wire color chart, wire size chart, and a chart of wiring diagram symbols.

Evaluation:
Class participation, Lab projects and participation, quizzes, and tests.

Comprehension:
Students will complete each lesson of this unit with 100% accuracy before proceeding to the next unit.
Unit Title: Test Light Procedures

Unit Outlines:
Instruction time: 5 hours
1. Basic Electrical Tests
2. Testing Using Various Test Lights

IEMCS Standard- 370
NATEF- A-2

Unit Objectives:
Upon completion of this unit the student will be able to:

1. Describe a systematic approach to find and correct electrical problems.
2. Describe the symptoms and causes of an open circuit.
3. Describe the symptoms and causes of a short circuit.
4. Use a test light to check for voltage in a circuit.
5. Use a self-powered test light to check for continuity.
6. Use a test light to find a short.

Materials and Equipment:
A vehicle, test lights, self-powered test lights, circuit board mockups, and wiring diagrams.

Evaluation:
Class participation, lab projects and participation, quizzes, and tests.

Comprehension:
Students will complete each lesson of this unit with 100% accuracy before proceeding to the next unit.
Unit Title: Digital Multimeter Operation

Unit Outlines:
Instruction time: 5 hours
1. Digital Multimeter
2. Analog Multimeter
3. High Impedance Multimeter

IEMCS Standard: 370
NATEF: A-3

Unit Objectives:
Upon completion of this unit the student will be able to:
1. Describe the correct procedures to use a digital multimeter.
2. Describe the correct procedures to use an analog multimeter.
3. Describe when to use a digital meter instead of an analog meter.
4. Use a digital multimeter to check for voltage in a circuit.
5. Use an analog multimeter to check resistance in a circuit.
6. Use a high impedance digital multimeter to test a computer circuit.
7. Measure and use voltage drops to check resistance in a circuit.

Materials and Equipment:
Digital multimeter, high impedance multimeter, analog multimeter, circuit boards, and a computer-controlled vehicle.

Evaluation:
Class participation, lab projects and participation, quizzes, and tests.

Comprehension:
Students will complete each lesson of this unit with 100% accuracy before proceeding to the next unit.
Unit Title: Ammeter Operation

Unit Outlines:
Instruction time: 3 hours
1. Circuit Amperage
2. Ammeter Measurements

IEMCS Standard- 370
NATEF- A-4

Unit Objectives:
Upon completion of this unit the student will be able to:
1. Explain amperage flow in a circuit.
2. Describe the correct procedures to connect an ammeter.
3. Explain amperage measurements and how they can be used to check the condition of various components.
4. Use an ammeter to measure amperage in a circuit.

Materials and Equipment:
A multimeter, various electrical circuits, and a vehicle.

Evaluation:
Class participation, lab projects and participation, quizzes, and tests.

Comprehension:
Students will complete each lesson of this unit with 100% accuracy before proceeding to the next unit.
Unit Title: Ohmmeter Operation

Unit Outlines:
Instruction time: 3 hours
  1. Circuit Resistance
  2. Resistance Measurements

IEMCS Standard- 370
NATEF- A-5

Unit Objectives:
Upon completion of this unit the student will be able to:

1. Identify resistance measurements in various circuits.
2. Describe the correct procedure to connect an ohmmeter to a circuit.
3. Describe a reading of zero resistance on an ohmmeter.
4. Describe the correct procedure to test a diode, resistor, coil, and a switch.

Materials and Equipment:
Multimeter, resistors, switches, coils, diodes, and circuit boards.

Evaluation:
Class participation, lab projects and participation, quizzes, and tests.

Comprehension:
Students will complete each lesson of this unit with 100% accuracy before proceeding to the next unit.
Unit Title: Electrical Circuit Tests

Unit Outline:
Instruction time: 4 hours
1. Methods For Electrical Circuit Testing
   IEMCS Standard- 370
   NATEF- A-6

Unit Objectives:
Upon completion of this unit the student will be able to:

1. Identify symptoms of electrical problems.
2. Identify correct techniques to test circuits.
3. Identify the correct meter to use for testing.
4. Describe the correct points to test in a circuit.

Materials and Equipment:
A multimeter, circuit boards, circuit components, and a test light

Evaluation:
Class participation, lab projects and participation, quizzes, and tests.

Comprehension:
Students will complete each lesson of this unit with 100% accuracy before proceeding to the next unit.
Unit Title: Diagnose Electrical/Electronic Problems

Unit Outlines:
Instruction time: 5 hours
  1. Diagnosis Procedures
  2. Troubleshooting

IEMCS Standard- 370
NATEF- A-7

Unit Objectives:
Upon completion of this unit the student will be able to:

  1. Explain troubleshooting procedures.
  2. Identify troubleshooting aids.
  3. Demonstrate knowledge of safety rules for troubleshooting and repair procedures.
  4. Differentiate normal and abnormal operations.
  5. Explain logical support actions taken to troubleshoot.

Materials and Equipment:
A multimeter, circuit boards, test light, repair manuals, and a vehicle.

Evaluation:
Class participation, lab projects and participation, quizzes, and tests.

Comprehension:
Students will complete each lesson of this unit with 100% accuracy before proceeding to the next unit.
Unit Title: Battery Drains

Unit Outline:
Instructional time: 3 hours
1. Battery Discharge

IEMCS Standard- 371
NATEF- A-7, A-9, B-1

Unit Objectives:
Upon completion of this unit the student will be able to:
1. Describe the process that takes place when a battery discharges.
2. Identify sources of battery drain.
3. Explain the troubleshooting procedures to isolate a battery drain.
4. Describe the process of self-discharge of a battery not in use.

Materials and Equipment:
A battery, vehicle, repair manuals, test light, and a multimeter.

Evaluation:
Class participation, lab projects and participation, quizzes, and tests.

Comprehension:
Students will complete each lesson of this unit with 100% accuracy before proceeding to the next unit.
Unit Title: Circuit Protection Devices

<table>
<thead>
<tr>
<th>Unit Outlines:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instructional time: 4 hours</td>
</tr>
<tr>
<td>1. Fuses</td>
</tr>
<tr>
<td>2. Circuit Breakers</td>
</tr>
<tr>
<td>3. Fusible Links</td>
</tr>
<tr>
<td>IEMCS Standard- 370, 374</td>
</tr>
<tr>
<td>NATEF- A-9,</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unit Objectives:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upon completion of this unit the student will be able to:</td>
</tr>
<tr>
<td>1. Explain the purpose of circuit protection devices.</td>
</tr>
<tr>
<td>2. Describe the three basic types of fuses and the use of each type.</td>
</tr>
<tr>
<td>3. Describe the function of a circuit breaker.</td>
</tr>
<tr>
<td>4. Describe the function of a fusible link.</td>
</tr>
<tr>
<td>5. Explain the replacement procedures for fuses, circuit breakers, and fusible links.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Materials and Equipment:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuses, circuit breakers, fusible links, wire connectors, soldering gun, and a vehicle.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evaluation:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class participation, lab projects and participation, quizzes, and tests.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Comprehension:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students will complete each lesson of this unit with 100% accuracy before proceeding to the next unit.</td>
</tr>
</tbody>
</table>
Unit Title: Relay and Switch Testing

Unit Outlines:
Instructional time: 2 hours
1. Relay Operation and Testing
2. Switch Operation and Testing

IEMCS Standard- 370, 374
NATEF- A-10

Unit Objectives:
Upon completion of this unit the student will be able to:
1. Explain the purpose of fundamental electrical components.
2. Describe the operation of a relay.
3. Describe the procedures to test and troubleshoot a relay.
4. Describe the function of a switch.
5. Describe the various switches used on a vehicle.
6. Identify the test methods to troubleshoot switch problems.

Materials and Equipment:
A vehicle, multimeter, test light, switches, relays, and repair manuals.

Evaluation:
Class participation, lab projects and participation, quizzes, and tests.

Comprehension:
Students will complete each lesson of this unit with 100% accuracy before proceeding to the next unit.
Unit Title: Wiring and Repair

Unit Outlines:
Instructional time: 3 hours
1. Automotive Wiring
   2. Methods of Repair

IEMCS Standard- 370, 374
NATEF- A-11

Unit Objectives:
Upon completion of this unit the student will be able to:

1. Describe the two main methods of wire repairing used in automotive wiring harnesses.
2. Identify the three terminal tab sizes used in wiring repair.
3. Identify the various crimp terminals used to repair wiring and connectors.
4. Identify the various wire connectors used in automotive wiring.
5. Perform a wire repair on a vehicle using crimp wire terminals.
6. Perform a wire repair on a vehicle replacing the terminal in a wire connector.
7. Identify the methods used to protect wiring harnesses on vehicle.

Materials and Equipment:
Various sizes of wire, wire crimp connectors, crimping tools, wire connectors, and wire connector terminals.

Evaluation:
Class participation, lab projects and participation, quizzes, and tests.

Comprehension:
Students will complete each lesson of this unit with 100% accuracy before proceeding to the next unit.
Unit Title: Soldering

Unit Outlines:
Instructional Time: 2 hours
1. Soldering Methods
2. Soldering Applications

IEMCS Standard—370
NATEF—A-12

Unit Objectives:
Upon completion of this unit the student will be able to:

1. Describe the procedure to solder two wires together.
2. Identify the three methods of slicing wires in automotive wiring harnesses.
3. Identify the types of solder used for electrical purposes.
4. Describe the heat-shrink tubing process to insulate a solder joint.
5. Demonstrate the correct method to solder two wires together.
6. Demonstrate the correct procedure to insulate a solder joint.

Materials and Equipment:
Solder, various sizes of wire, wire connectors, solder guns, and heat-shrink tubing.

Evaluation:
Class participation, lab projects and participation, quizzes, and tests.

Comprehension:
Students will complete each lesson of this unit with 100% accuracy before proceeding to the next unit.
**Unit Title:** Battery State-of-Charge Test

**Unit Outlines:**
Instructional time: 2 hours
1. Battery Operation
2. Electrolyte
3. State-of-charge test using a hydrometer

IEMCS Standard- 370,371
NATEF- B-1

**Unit Objectives:**
Upon completion of this unit the student will be able to:
1. Describe the battery’s operation within the electrical system of an automobile.
2. Describe the properties of electrolyte.
3. Describe the specific gravity of a battery and scale.
4. Describe the procedure to perform a state-of-charge test.
5. Demonstrate a state-of-charge test on a battery.

**Materials and Equipment:**
A good condition battery, hydrometer, temperature gauge, and rubber gloves.

**Evaluation:**
Class participation, lab projects and participation, quizzes, and tests.

**Comprehension:**
Students will complete each lesson of this unit with 100% accuracy before proceeding to the next unit.
Unit Title: Battery Capacity Test

Unit Outlines:
Instructional time: 2 hours
1. Cold Crank Amperage Rating of a Battery
2. Battery Capacity Test
3. Voltage-Amperage Tester (VAT)

IEMCS Standard- 370, 371
NATEF- B-2

Unit Objectives:
Upon completion of this unit the student will be able to:

1. Describe the cold crank amperage rating for a battery.
2. Describe the procedure to determine the correct amperage draw for the battery capacity test.
3. Describe the procedures for a battery capacity test using a voltage-amperage tester (VAT).
4. Demonstrate a battery capacity test using a voltage-amperage tester (VAT) on a battery in a vehicle.
5. Identify needed repairs based on results of battery capacity test.

Materials and Equipment:
A vehicle, a good condition battery, voltage-amperage tester (VAT), and a pair of rubber gloves.

Evaluation:
Class participation, lab projects and participation, quizzes, and tests.

Comprehension:
Students will complete each lesson of this unit with 100% accuracy before proceeding to the next unit.
Unit Title: Electronic Memory

Unit Outlines:
Instructional time: 2 Hours
1. Maintaining Electronic Memory
   2. Restoring Computer Memory

IEMCS Standard-- 370, 378
NATEF- B-3

Unit Objectives:
Upon completion of this unit the student will be able to:
1. Identify the reasons for maintaining the computer memories on a computer-equipped automobile.
2. Identify other equipment that has memory.
3. Describe the two methods to maintain the memory while the vehicle’s battery is disconnected.
4. Demonstrate connecting a memory saving device to a vehicle.

Materials and Equipment:
A computer-equipped vehicle, a memory saving tool, a battery, and two jumper wires.

Evaluation:
Class participation, lab projects and participation, quizzes, and tests.

Comprehension:
Students will complete each lesson of this unit with 100% accuracy before proceeding to the next unit.
Unit Title: Battery Inspection and Replacement

Unit Outlines:
Instructional time: 1 hour
1. Battery Inspection
2. Battery Replacement
IEMCS Standard- 370, 371
NATEF- B-4

Unit Objectives:
Upon completion of this unit the student will be able to:
1. Identify important inspection checks on an automobile battery.
2. Describe the replacement procedures for a battery.
3. Describe the two methods to ship batteries to suppliers.

Materials and Equipment:
A vehicle, battery, and basic hand tools, and rubber gloves.

Evaluation:
Class participation, lab projects and participation, quizzes, and tests.

Comprehension:
Students will complete each lesson of this unit with 100% accuracy before proceeding to the next unit.
Unit Title: Battery Charging

Unit Outlines:
Instructional time: 2 hours
1. Battery Charging
2. Rates of Charge
3. Sulfation

IEMCS Standard- 370, 371
NATEF- B-5

Unit Objectives:
Upon completion of this unit the student will be able to:

1. Identify the methods to charge a battery.
2. Describe the slow-charge procedure and advantages of this procedure.
3. Describe the fast-charge procedure and advantages of this procedure.
4. Describe the condition of a battery when it becomes sulfated.
5. Perform a slow-charge on a battery.
6. Perform a fast-charge on a battery.

Materials and Equipment:
A good condition battery, a fully discharged battery, voltage-amperage tester, hydrometer, and a battery charger.

Evaluation:
Class participation, lab projects and participation, quizzes, and tests.

Comprehension:
Students will complete each lesson of this unit with 100% accuracy before proceeding to the next unit.
Unit Title: Battery Cables

Unit Outlines:
Instructional time: 3 hours
1. Battery Cable Types
2. Battery Cable Repairs
3. Battery Cable Service

IEMCS Standard- 370, 371
NATEF- B-6

Unit Objectives:

Upon completion of this unit the student will be able to:

1. Identify the two types of cable connectors used on an automobile.
2. Describe the two repair methods for battery cables.
3. Describe the cleaning procedure for battery cables and posts.
4. Perform a solder repair to a battery cable.
5. Perform a crimp repair to a battery cable.
6. Perform a battery cable cleaning procedure.

Materials and Equipment:

Battery cables, battery cable ends, propane torch, crimping tool, battery, vehicle, baking soda, water, battery cable cleaner brush, and rubber gloves.

Evaluation:

Class participation, lab projects and participation, quizzes, and tests.

Comprehension:

Students will complete each lesson of this unit with 100% accuracy before proceeding to the next unit.
Unit Title: Jump Starting

Unit Outlines:
Instructional time: 2 hours
1. Dead Battery Conditions
2. Jump Start Procedures

IEMCS Standard- 370,371
NATEF- B-7

Unit Objectives:
Upon completion of this unit the student will be able to:

1. Identify reasons for a battery to be dead in a vehicle.
2. Identify the various jumper cables sizes available.
3. Explain the jump starting procedure.
4. Perform a jump start procedure on a vehicle.

Materials and Equipment:
Jumper cable set, two vehicles, and a dead battery.

Evaluation:
Class participation, lab projects and participation, quizzes, and tests.

Comprehension:
Students will complete each lesson of this unit with 100% accuracy before proceeding to the next unit.
Unit Title: Starter Draw Test

Unit Outlines:
Instructional time: 4 hours
1. Electric Motor Operation
2. Starter Draw Test

IEMCS Standard- 370, 372
NATEF- C-1

Unit Objectives:
Upon completion of this unit the student will be able to:
1. Describe the operation of an engine starter motor.
2. Identify the parts of a starter motor.
3. Describe the starter draw test procedures.
4. Perform a starter draw test on a starter.

Materials and Equipment:
A voltage-amperage tester (VAT) and a vehicle.

Evaluation:
Class participation, lab projects and participation, quizzes, and tests.

Comprehension:
Students will complete each lesson of this unit with 100% accuracy before proceeding to the next unit.
Unit Title: Starter Voltage Drop Test

Unit Outlines:
Instructional time: 3 hours
1. Starter Circuit Resistance
2. Starter Voltage Drop Test

IEMCS Standard- 370,372
NATEF- C-2

Unit Objectives:
Upon completion of this unit the student will be able to:

1. Identify potential high resistance sources in a starter circuit.
2. Describe the correct test procedures for a voltage drop test.
3. Perform a voltage drop test using a voltmeter.

Materials and Equipment:
A voltmeter and a running vehicle.

Evaluation:
Class participation, lab projects and participation, quizzes, and tests.

Comprehension:
Students will complete each lesson of this unit with 100% accuracy before proceeding to the next unit.
Unit Title: Starter Relays and Solenoids

Unit Outlines:
Instructional time: 3 hours
1. Starter Relay Operation
2. Starter Solenoid Operation

IEMCS Standard- 370, 372
NATEF- C-3

Unit Objectives:
Upon completion of this unit the student will be able to:

1. Describe the operation of a starter relay.
2. Identify the parts of a starter relay.
3. Describe the operation of a starter solenoid.
4. Identify the two purpose of a starter solenoid.
5. Perform a functional test on a starter relay.
6. Perform a functional test on a starter solenoid.

Materials and Equipment:
A vehicle, starter unit with solenoid, a starter relay, and a voltmeter.

Evaluation:
Class participation, lab projects and participation, quizzes, and tests.

Comprehension:
Students will complete each lesson of this unit with 100% accuracy before proceeding to the next unit.
**Unit Title:** Starter Removal and Installation

**Unit Outlines:**
Instructional time: 4 hours
1. Starter Removal
2. Starter Installation

IEMCS Standard- 370,372
NATEF- C-4

**Unit Objectives:**
Upon completion of this unit the student will be able to:

1. Explain the procedures to remove and replace a starter.
2. Perform a task of removing a starter from a vehicle.
3. Perform a task of installing a starter in a vehicle.

**Materials and Equipment:**
A running vehicle.

**Evaluation:**
Class participation, lab projects and participation, quizzes, and tests.

**Comprehension:**
Students will complete each lesson of this unit with 100% accuracy before proceeding to the next unit.
**Unit Title:** Starter Bench Tests

**Unit Outlines:**
Instructional time: 5 hours
1. Starter Disassembly
2. Starter Bench Tests
3. Starter Reassemble

IEMCS Standard- 370, 372
NATEF- C-5

**Unit Objectives:**
Upon completion of this unit the student will be able to:

1. Describe the procedures to disassemble a starter.
2. Disassemble a starter unit.
3. Perform an inspection and tests on the internal parts of a starter:
   A. Brushes.
   B. Bearings or bushings.
   C. Starter drive.
   D. Armature.
   E. Pole shoes.
4. Determine the condition of a starter based on inspection and tests.
5. Reassemble a starter unit.

**Materials and Equipment:**
A starter, ohmmeter, and a growler.

**Evaluation:**
Class participation, lab projects and participation, quizzes, and tests.

**Comprehension:**
Students will complete each lesson of this unit with 100% accuracy before proceeding to the next unit.
Unit Title: Starter Control Circuits

Unit Outlines:
Instructional time: 4 hours
1. Ignition Switches
2. Neutral Safety Switches
3. Starter/Clutch Interlock Switch

IEMCS Standard- 370,372
NATEF- C-6

Unit Objectives:

Upon completion of this unit the student will be able to:

1. Identify the various switches that control the starter.
2. Describe the operation of the ignition switch.
3. Describe the operation of the neutral safety switch.
4. Describe the operation of the starter/clutch interlock switch.
5. Perform a continuity test on an ignition switch.
6. Perform a continuity test on a neutral safety switch.
7. Perform a continuity test on a starter/clutch interlock switch.

Materials and Equipment:

An ignition switch, neutral safety switch, starter/clutch interlock switch, and an ohmmeter.

Evaluation:

Class participation, lab projects and participation, quizzes, and tests.

Comprehension:

Students will complete each lesson of this unit with 100% accuracy before proceeding to the next unit.
Unit Title: Starter Rebuilding and Testing

Unit Outlines:
Instructional time: 6 hours
1. Starter Rebuilding
2. Starter Service
3. Bench Test

IEMCS Standard- 370, 372
NATEF- C-7

Unit Objectives:
Upon completion of this unit the student will be able to:

1. Identify the components to replace when rebuilding a starter unit.
2. Disassemble a starter and replace worn components:
   A. Brushes.
   B. Bearings or Bushings.
   C. Starter drive.
   D. Solenoid.
   E. Lathe the armature.
3. Reassemble the starter with new parts.
4. Perform a bench starter test after assembling the rebuilt starter.

Materials and Equipment:
A starter, various starter parts, bench starter tester, and an armature lathe.

Evaluation:
Class participation, lab projects and participation, quizzes, and tests.

Comprehension:
Students will complete each lesson of this unit with 100% accuracy before proceeding to the next unit.
Unit Title: Alternator Output Tests

Unit Outlines:
Instructional time: 3 hours
1. Alternator Operation
2. Alternator Output Test

IEMCS Standard- 370, 373
NATEF- D-1

Unit Objectives:
Upon completion of this unit the student will be able to:

1. Explain the method to determine the maximum output of an alternator.
2. Describe the operation of an alternator.
3. Explain the procedure to perform an alternator output test.
4. Determine the condition of an alternator from an output test.

Materials and Equipment:
A running vehicle and a voltage-amperage tester (VAT).

Evaluation:
Class participation, lab projects and participation, quizzes, and tests.

Comprehension:
Students will complete each lesson of this unit with 100% accuracy before proceeding to the next unit.
Unit Title: Diagnosing Charging System Problems

Unit Outlines:
Instructional time: 3 hours
1. Diagnosing Charging System Problems
2. Voltage Regulator
3. Diodes
4. Noises

IEMCS Standard- 370,373
NATEF- D-2

Unit Objectives:
Upon completion of this unit the student will be able to:
1. Diagnose undercharge, no-charge, and overcharge conditions.
2. Describe voltage regulator operation and its effect on alternator output.
3. Explain the effect of faulty diodes on the output of an alternator.
4. Describe noise conditions that develop in an alternator:
   A. Bearings
   B. Diodes
   C. Pulleys

Materials and Equipment:
A bench alternator tester, various alternators, and alternator parts.

Evaluation:
Class participation, lab projects and participation, quizzes, and tests.

Comprehension:
Students will complete each lesson of this unit with 100% accuracy before proceeding to the next unit.
Unit Title: Alternator Belt Replacement

Unit Outlines:
Instructional time: 2 hours
1. Serpentine Belt
2. V-Ribbed Belt
3. Belt Tension

IEMCS Standard-370,372
NATEF- D-3

Unit Objectives:
Upon completion of this unit the student will be able to:

1. Identify the condition of an alternator belt:
   A. Cracks.
   B. Glazed.
   C. Tension.
2. Describe the procedure to replace a serpentine belt.
3. Describe the procedure to replace a v-ribbed belt.
4. Describe the procedure using a belt tension gauge to tighten a belt.

Materials and Equipment:
Two vehicle, various belts, tension gauge, hand tools, and a torque wrench.

Evaluation:
Class participation, lab projects and participation, quizzes, and tests.

Comprehension:
Students will complete each lesson of this unit with 100% accuracy before proceeding to the next unit.
# Unit Title: Voltage Regulators

## Unit Outlines:
Instructional time: 4 hours
1. Internal Regulator
2. External Regulator

IEMCS Standard- 370.373
NATEF= D-4

## Unit Objectives:
Upon completion of this unit the student will be able to:

1. Describe the operation of a voltage regulator.
2. Describe the differences between an electromechanical and electronic regulator.
3. Describe the operation of an internal regulator.
4. Describe the operation of an external regulator.
5. Identify the parts of a regulator.
6. Describe the computer-controlled alternator.

## Materials and Equipment:
Various regulators, alternators, and regulator parts.

## Evaluation:
Class participation, lab projects and participation, quizzes, and tests.

## Comprehension:
Students will complete each lesson of this unit with 100% accuracy before proceeding to the next unit.
**Unit Title:** Alternator Removal and Installation

**Unit Outlines:**
Instructional time: 3 hours
1. Removal Precautions
   - Disconnect negative battery cable first.
   - Label connectors.
   - Bolt order.
2. Installation Precautions

IEMCS Standard- 370, 373
NATEF- D-5

**Unit Objectives:**
Upon completion of this unit the student will be able to:
1. Describe the precautions to observe when removing an alternator.
   A. Disconnect negative battery cable first.
   B. Label connectors.
   C. Bolt order.
2. Describe the removal procedure for an alternator.
3. Describe the installation procedures for an alternator.

**Materials and Equipment:**
A vehicle, hand tools, an alternator, labels, and a belt tension tool.

**Evaluation:**
Class participation, lab projects and participation, quizzes, and tests.

**Comprehension:**
Students will complete each lesson of this unit with 100% accuracy before proceeding to the next unit.
Unit Title: Alternator Rebuilding and Testing

Unit Outlines:
Instructional time: 6 hours
1. Alternator Disassembly.
3. Alternator Assembly.

IEMCS Standard- 370,373
NATEF- D-6

Unit Objectives:
Upon completion of this unit the student will be able to:
1. Describe the procedures to disassemble an alternator.
2. Describe the inspection process and testing of internal alternator parts.
3. Describe the procedures to assemble an alternator with new parts.

Materials and Equipment:
An alternator, hand tools, ohmmeter, new alternator parts, and a soldering gun.

Evaluation:
Class participation, lab projects and participation, quizzes, and tests.

Comprehension:
Students will complete each lesson of this unit with 100% accuracy before proceeding to the next unit.
## Unit Title: Charging System Voltage Drop Tests

### Unit Outlines:
Instructional time: 3 hours  
1. System Resistance  
2. Voltage Drop Tests

IEMCS Standard- 370,373  
NATEF- D-7

### Unit Objectives:
Upon completion of this unit the student will be able to:

1. Identify sections of the charging system that usually have resistance.  
2. Describe the procedures to complete a voltage drop test on a charging system.  
3. Perform a voltage drop test.

### Materials and Equipment:
A vehicle, voltmeter, and a voltage-amperage tester (VAT).

### Evaluation:
Class participation, lab projects and participation, quizzes, and tests.

### Comprehension:
Students will complete each lesson of this unit with 100% accuracy before proceeding to the next unit.
### Unit Title: Light Operation

#### Unit Outlines:
Instructional time: 4 hours
1. Light Requirements
2. Wiring Requirements
3. Circuit Protection

IEMCS Standard- 370, 374
NATEF- E-1

#### Unit Objectives:
Upon completion of this unit the student will be able to:

1. Describe the difference between wire and cable.
2. Explain the lighting requirements of a vehicle.
3. Explain the wiring requirements for lighting on a vehicle.
4. Explain the operation of automotive lighting and wiring.
5. Describe the different types of circuit protection used on automotive lighting systems.
6. Perform a light inspection on a vehicle.

#### Materials and Equipment:
A vehicle, various lights, various wiring harnesses, and circuit protection devices.

#### Evaluation:
Class participation, lab projects and participation, quizzes, and tests.

#### Comprehension:
Students will complete each lesson of this unit with 100% accuracy before proceeding to the next unit.
Unit Title: Headlights

Unit Outlines:
Instructional time: 4 hours
1. Two-light System
2. Four-light System
3. Headlight Low Beams
4. Headlight High Beams

IEMCS Standard- 370, 374
NATEF- E-2

Unit Objectives:
Upon completion of this unit the student will be able to:

1. Describe the operation of a two-light system.
2. Describe the operation of a four-light system.
3. Describe the low beam system.
4. Describe the high beam system and function.
5. Explain the difference between a regular headlight and a halogen headlight.
6. Explain the advantages of a halogen headlight.
7. Perform a head light inspection.
8. Explain the need for aiming headlights.

Materials and Equipment:
A vehicle, various headlights, and a headlight aiming tool.

Evaluation:
Class participation, lab projects and participation, quizzes, and tests.

Comprehension:
Students will complete each lesson of this unit with 100% accuracy before proceeding to the next unit.
Unit Title: Turn Signal and Hazard Light Operation

Unit Outlines:
Instructional time: 3 hours
1. Turn Signal Light Operation
2. Hazard Light Operation

IEMCS Standard- 370, 374
NATEF- E-3

Unit Objectives:
Upon completion of this unit the student will be able to:
1. Identify the basic parts of the turn signal circuit.
2. Describe the operation of the turn signal circuit.
3. Describe the operation of the hazard light circuit.
4. Perform an inspection on the turn signal and hazard light circuits.
5. Troubleshoot problems on a turn signal and a hazard light system.

Materials and Equipment:
A vehicle, test light, flashers, and various turn signal bulbs.

Evaluation:
Class participation, lab projects and participation, quizzes, and tests.

Comprehension:
Students will complete each lesson of this unit with 100% accuracy before proceeding to the next unit.
Unit Title: Vehicle Gauges

Unit Outlines:
Instructional time: 5 hours
1. Vehicle Gauge Operation
2. Dash Gauges
3. Sending Units
4. Troubleshooting Gauges
5. Warning Devices

IEMCS Standard- 370, 375
NATEF- F-1

Unit Objectives:
Upon completion of this unit the student will be able to:

1. Describe the operation of gauges used in a vehicle.
2. Explain the procedures to remove gauges from a vehicle’s dash.
3. Describe the function of a sending unit used in gauge operation.
4. Explain the operation of warning lights on a vehicle.
5. Perform a test on a printed circuit.

Materials and Equipment:
A vehicle, dash instrument clusters, test light, voltmeter, ohmmeter, sending units, printed circuits, and gauges.

Evaluation:
Class participation, lab projects and participation, quizzes, and tests.

Comprehension:
Students will complete each lesson of this unit with 100% accuracy before proceeding to the next unit.
Unit Title: Brake Warning Devices and Driver Information

Unit Outlines:
Instructional time: 5 hours
1. Brake Warning Light
2. Anti-lock Brake Warning Light
3. Driver Information System

IEMCS Standard- 370, 375
NATEF- F-2

Unit Objectives:
Upon completion of this unit the student will be able to:

1. Describe the operation of the brake warning light system.
2. Describe the operation of the anti-lock brake warning light system.
3. Describe the operation of a driver information system.
   A. Trip odometer.
   B. Low fuel.
   C. Open door.
   D. Engine warning.
4. Diagnose driver information system malfunctions.
5. Diagnose anti-lock brake warning light system malfunctions.
6. Diagnose brake warning light system malfunctions.

Materials and Equipment:
A vehicle with anti-lock and driver information systems, test light, and a voltmeter.

Evaluation:
Class participation, lab projects and participation, quizzes, and tests.

Comprehension:
Students will complete each lesson of this unit with 100% accuracy before proceeding to the next unit.
Unit Title: Horn Operation

Unit Outlines:
Instructional time: 3 hours
1. Horn Operation
2. Horn System Components

IEMCS Standard- 370, 376
NATEF- G-1

Unit Objectives:
Upon completion of this unit the student will be able to:
1. Explain the operation of the horn system.
2. Identify the components of the horn system.
3. Diagnose horn system malfunctions.

Materials and Equipment:
A vehicle, test light, voltmeter, and an ohmmeter.

Evaluation:
Class participation, lab projects and participation, quizzes, and tests.

Comprehension:
Students will complete each lesson of this unit with 100% accuracy before proceeding to the next unit.
Unit Title: Wiper Operation

Unit Outlines:
Instructional time: 5 hours
1. Wiper Operation
2. Wiper System Components
3. Pulse Wiper Operation

IEMCS Standard- 370, 376
NATEF- G-2

Unit Objectives:
Upon completion of this unit the student will be able to:
1. Describe wiper system operation.
2. Identify wiper system components.
3. Describe pulse wiper operation.
4. Diagnose wiper system malfunctions.

Materials and Equipment:
A vehicle, voltmeter, test light, and an ohmmeter.

Evaluation:
Class participation, lab projects and participation, quizzes, and tests.

Comprehension:
Students will complete each lesson of this unit with 100% accuracy before proceeding to the next unit.
Unit Title: Motor-driven Accessory Circuits

Unit Outlines:
Instructional time: 5 hours
1. DC Motor Operation
2. Uses of DC Motors in the Automobile

IEMCS Standard- 370, 377
NATEF- H-1

Unit Objectives:
Upon completion of this unit the student will be able to:
1. Explain the principles of DC motor operation.
2. Describe the uses of DC motors in the automobile.
3. Explain the operation of power windows.
4. Identify the parts of a power window circuit.
5. Diagnose power window circuit malfunctions.

Materials and Equipment:
A vehicle, various DC motors, test light, voltmeter, and an ohmmeter.

Evaluation:
Class participation, lab projects and participation, quizzes, and tests.

Comprehension:
Students will complete each lesson of this unit with 100% accuracy before proceeding to the next unit.
Unit Title: Supplemental Restraint Systems

Unit Outlines:
Instructional time: 5 hours
1. Supplemental Restraint System Operation
2. Supplemental Restraint System Components

IEMCS Standard: 370, 378
NATEF - H-2

Unit Objectives:
Upon completion of this unit the student will be able to:
1. Identify the components on a supplemental restraint system.
2. Describe the operation of a supplemental restraint system.
3. Diagnose malfunctions in a supplemental restraint system.

Materials and Equipment:
A vehicle equipped with an air bag, digital voltmeter, and an ohmmeter.

Evaluation:
Class participation, lab projects and participation, quizzes, and tests.

Comprehension:
Students will complete each lesson of this unit with 100% accuracy before proceeding to the next unit.
Unit Title: Power Door Lock Systems

Unit Outlines:
Instructional time: 6 hours
1. Power Door Lock System Operation
2. Power Door Lock System Components
3. Power Seat Operation

IEMCS Standard-370, 377, 378
NATEF- H-3

Unit Objectives:
Upon completion of this unit the student will be able to:
1. Identify the components in a power door lock system.
2. Describe the operation of a power door lock system.
3. Diagnose circuit malfunctions in power door lock systems.
4. Describe power seat operation.

Materials and Equipment:
A vehicle with power door lock system, voltmeter, ohmmeter, and a test light.

Evaluation:
Class participation, lab projects and participation, quizzes, and tests.

Comprehension:
Students will complete each lesson of this unit with 100% accuracy before proceeding to the next unit.
Unit Title: Job Seeking Skills

Unit Outlines:
Instructional time: 5 hours
1. Job Sources
2. Job Application
3. Resume
4. Letter of Application
5. Interview Skills
6. Interview Follow Up

Unit Objectives:
Upon completion of this unit the student will be able to:

1. Identify sources to find a job in the automotive industry.
2. Correctly fill out a job application.
3. Assemble a resume.
4. Write a letter of application.
5. Identify skills needed to interview for a job.
6. Identify the correct method to follow up on an interview.

Materials and Equipment:
Overheads transparencies, sample resumes, and job applications.

Evaluation:
Class participation, lab projects and participation, quizzes, and tests.

Comprehension:
Students will complete each lesson of this unit with 100% accuracy before proceeding to the next unit.
APPENDIX E

REFERENCES FOR UNIT PLANS
REFERENCES FOR UNIT PLANS


REFERENCES


