



El Camino College
COURSE OUTLINE OF RECORD – Official

Course Acronym:	ATEC
Course Number:	25
Descriptive Title:	Automotive Electrical Systems
Division:	Industry and Technology
Department:	Automotive Technology
Course Disciplines:	Automotive Technology
Catalog Description:	<p>This course covers the theory and operation of automotive electricity, electronic components, and systems. Laboratory activities stress the proper use of test equipment utilized in the automotive field.</p> <p><i>Note: The two-course sequence Automotive Technology 25 and 26 is the same as Automotive Technology 22B.</i></p>
Prerequisite:	
Co-requisite:	
Recommended Preparation:	Automotive Technology 21 or Automotive Technology 23 or equivalent
Enrollment Limitation:	
Hours Lecture (per week):	3
Hours Laboratory (per week):	3
Outside Study Hours:	6
Total Course Hours:	108
Course Units:	4
Grading Method:	Letter Grade only
Credit Status:	Credit, degree applicable
Transfer CSU:	Yes
Effective Date:	Prior to July, 1992
Transfer UC:	Yes
Effective Date:	
General Education:	
ECC	
Term:	
Other:	
CSU GE:	
Term:	

Other:	
IGETC:	
Term:	
Other:	
Student Learning Outcomes:	<p>SLO #1 Safety Exam</p> <p>Given an in class exam, based on readings, classroom discussions and demonstrations, the student will be able to work in the Automotive Shop safely and pass the Automotive Safety Exam with 100% accuracy.</p> <p>SLO #2 Battery System Test</p> <p>The student will be able to test the performance of the automotive battery charging and starting systems using the Automotive Battery/ Charging/ Starting Systems Testing lab worksheet and manufacturer specifications.</p> <p>SLO #3 Engine Condition & Performance</p> <p>The student will test and evaluate engine condition and performance using an Engine Analyzer / Scanner lab worksheet to manufacturer specifications.</p>
Course Objectives:	<ol style="list-style-type: none"> 1. Complete a safety test with 100% accuracy. 2. Service, test and diagnose a lead-acid battery. 3. Evaluate, service and repair charging systems. 4. Service, test, evaluate and repair cranking systems. 5. Diagnose and repair electrical circuits. 6. Examine electrical components. 7. Diagnose electrical circuits. 8. Evaluate an engine using engine analyzers. 9. Diagnose and repair ignition systems. 10. Diagnose and repair computer controlled systems. 11. Evaluate computer controlled components. 12. Analyze electrical testing data and recommend needed repairs. 13. Analyze computer controlled engine data and recommend needed repairs.
Major Topics:	<p>I. Course Overview and Safety (3 hours, lecture)</p> <ol style="list-style-type: none"> 1. <ol style="list-style-type: none"> A. Personal Protective Equipment (PPE) B. Shop and environmental hazards <ol style="list-style-type: none"> 1. Commonly used shop chemicals 2. Safety Data Sheets (SDS) 3. Tool and shop equipment hazards C. Proper hand/power tool and shop equipment identification and usage D. Vehicle hoist operation E. Service information accessing procedures <ol style="list-style-type: none"> 1. Published repair procedures and specifications F. Repair orders <ol style="list-style-type: none"> 1. Proper procedures and legal guidelines 2. California Department of Consumer Affairs, Bureau of Automotive Repair (BAR) - "Write It Right" 3. Purpose and workflow process

G. Technician training and certifications

II. Tools and Safety (3 hours, lab)

1.
 - A. PPE usage
 - B. Shop safety rules demonstration
 1. Proper hand tool identification and usage
 2. Shop equipment identification and usage
 - C. Safe work area maintenance
 1. In-shop vehicle handling
 2. Proper in-shop engine emissions venting
 3. Safe vehicle hoisting
 4. Clean up procedures
 - D. Automotive Service Excellence (ASE) technician certification process A-1 through A-8 lab sheet
 - E. Properly complete vehicle repair work order

III. Automotive Service Industry Terms and Conventions (1.5 hours, lecture)

1.
 - A. Key terms - speaking the language of a technician
 - B. Employee obligations
 - C. Accessing and usage of correct service and repair procedures
 1. Workshop manuals
 2. Electronic service information sources
 3. Other references
 4. Published repair, service procedures and specifications.
 - D. Legal rights and responsibilities under repair orders
 - E. Technician training and certifications.
 - F. ASE automotive technician testing and certification process
 1. G-1, A-1 through A-8, L-1

IV. Automotive Service Industry Terms and Conventions (1.5 hours, lab)

1.
 - A. Complete vehicle repair work order
 - B. Access online service information

V. Electrical Fundamentals (6 hours, lecture)

1.
 - A. Atomic structure and components
 1. Positive and negative charges
 2. Electron shells
 3. Free and bound electrons
 - B. Conductors, insulators and semiconductors
 - C. Units of electricity
 1. Volts, amperes and resistance
 2. Watts
 - D. Current flow
 1. Conventional theory vs. electron theory

- E. Sources of electricity
- F. Conductors and resistance
 - 1. Fixed and variable resistors
- G. Electrical circuit components and operation
 - 1. Circuit fault types
- H. Ohm's Law
 - 1. Definition, formulas and application
 - 2. Watt's Law
- I. Series circuits
 - 1. Ohm's Law applications
 - 2. Kirchhoff's Voltage Law applications and usage
 - 3. Series circuit laws
- J. Parallel circuits
 - 1. Kirchhoff's Current Law
 - 2. Parallel circuit laws
 - 3. Determining total resistance - 5 methods
- K. Series-parallel circuits
 - 1. Circuit faults and problem solving

VI. Electrical Fundamentals (6 hours, lab)

- 1.
 - A. Units of electricity
 - 1. Volts, amperes and resistance
 - 2. Watts
 - B. Sources of electricity
 - C. Conductors and resistance
 - 1. Fixed and variable resistor identification
 - D. Circuit component labeling
 - 1. Circuit fault type descriptions
 - E. Ohm's Law
 - 1. Problem solving
 - F. Series circuits
 - 1. Ohm's Law applications and problem solving
 - 2. Kirchhoff's Voltage Law applications and usage
 - 3. Voltage drops
 - 4. Circuit board usage and building of operational series circuits
 - G. Parallel circuits
 - 1. Kirchhoff's Current Law applications
 - 2. Determining total resistance
 - 3. Circuit board usage and building of operational parallel circuits
 - H. Series-parallel circuits
 - 1. Circuit faults and problem solving
 - 2. Circuit board usage and building of operational series-parallel circuits
 - I. Conductors, insulators and semiconductors

VII. Circuit Testing Procedures and Equipment (1.5 hours, lecture)

- A. Jumper wires and test lights
 - 1. Logic probes
- B. Digital Multimeters (DMM)
 - 1. Usage and interpretation of meter readings

- 2. Inductive ammeters
- 3. Electrical unit prefixes
- C. Oscilloscopes and graphing multimeters
 - 1. Terminology and setup
 - 2. Usage and interpretation of readings

VIII. Circuit Testing Procedures and Equipment (1.5 hours, lab)

- A. Jumper wire and test light usage
- B. Logic probe usage
- C. Digital multimeter (DMM), Digital Storage Oscilloscope (DSO) usage
 - 1. Reading source voltage and voltage drops
 - 2. Reading amperage
 - 3. Reading resistance
 - 4. Circuit and wire continuity testing

IX. Wiring and Wire Repair (3 hours, lecture)

- A. Metal conductivity
- B. Wire gauge sizing
 - 1. American Wire Gauge (AWG) system
 - 2. Metric wire gauge sizes
- C. Ground wires, battery cables and jumper cables
 - 1. Aluminum wire
 - 2. Twisted/shielded wire
- D. Fuses and circuit protection devices
 - 1. Fuse types and ratings
 - 2. Circuit breakers and protectors
 - 3. Fusible links and mega fuses
- E. Terminals and connectors
 - 1. Removal
 - 2. Crimping
- F. Wiring harness repair
 - 1. Solderless connections and splices
 - 2. Solder splices
 - 3. Crimp-and-seal connectors
 - 4. Heat shrink tubing
- G. Electrical conduit color interpretation

X. Wiring Repair (3 hours, lab)

- A. Solderless wire splicing
 - 1. Crimp-and-seal
 - 2. Square knot method
 - 3. Heat shrink application
- B. Solder splices
- C. Aluminum wire repair
- D. Twisted/shielded wire repair
- E. Identify, test and replace fuses and fusible links
- F. Hard-shell connector terminal repair/replacement
- G. Weather-pack and metri-pack connector terminal repair/replacement

XI. Wiring Schematics and Circuit Testing (4.5 hours, lecture)

- A. Wiring schematic interpretation and symbols
 - 1. Terminology and circuit information
 - 2. Wire size, color and circuit identification
 - 3. Electrical component identification
- B. Single-stranded or multi-stranded wire usage
- C. Resistive wire usage
- D. Purpose of wiring diagrams
- E. Fuse and relay terminal identification
- F. Connector end views, legends and terminal identification
- G. Component locators
- H. Circuit troubleshooting procedures
 - 1. Locating opens and shorts
 - 2. Common power or ground
 - 3. Locating intermittent problems
 - 4. Methods of fault location

XII. Wiring Schematics and Circuit Testing (4.5 hours, lab)

- A. Wiring schematic acquisition, interpretation and circuit diagnostic application
- B. Circuit specific testing procedures
 - 1. Wiper motor circuit
 - 2. Brake and tail light circuit
 - 3. Horn circuit
 - 4. Blower motor circuit
- C. Electrical fault diagnosis
 - 1. Visual inspection and circuit testing
 - 2. Circuit fault location and identification
 - 3. Relay testing and inspection

XIII. Automotive Batteries (3 hours, lecture)

- A. Purpose and construction
 - 1. Main components
 - 2. Chemical reaction process
 - 3. Safety concerns
- B. Battery types, differences and advantages/disadvantages
- C. Types of battery terminals
- D. Specific gravity and state-of-charge indicators
- E. Battery ratings and applications
- F. Temperature and load effects on battery performance
- G. Causes and types of battery failure
- H. Battery related terminology
- I. Battery sizes
- J. Battery trays, hold downs, clamps and cables

XIV. Battery Testing, Diagnosis and Service (3 hours, lab)

- A. Safe battery servicing
 - 1. Proper charging and jump starting procedure
 - 2. Safe battery disconnect and reconnect procedure
- B. Battery, cable and terminal visual inspection
- C. Open circuit battery voltage test and results evaluation
 - 1. DMM battery case voltage reading
 - 2. Battery removal, cleaning and reinstallation
- D. Specific gravity test
- E. Battery capacity test and analysis
 - 1. Battery rating identification
 - 2. Volt Amp Tester (VAT) usage
 - 3. Starter cranking test
- F. 3-minute charge test
- G. Battery conductance test
- H. Parasitic draw test and fault location procedure

XV. Capacitance and Capacitors (1.5 hours, lecture)

- A. Definition, history and working principles of capacitance
- B. Capacitor construction and operation
- C. Factors of capacitance
 - 1. Units of measurement
 - 2. Plate surface area, plate distance and dielectric material
- D. Capacitor uses
 - 1. Series circuits
 - 2. Parallel circuits
 - 3. Suppression

XVI. Capacitance and Capacitors (1.5 hours, lab)

- A. Radio noise in a blower motor circuit diagnosis
- B. Capacitor testing in a blower motor circuit
- C. Capacitor test on a vehicle sound system power circuit

XVII. Magnetism and Electromagnetism (3 hours, lecture)

- A. Fundamentals of magnetism
- B. Electromagnetism
 - 1. Definition and operating principles
 - 2. Uses of electromagnetism
- C. Principles of electromagnetic induction
 - 1. Lenz's Law
 - 2. Self-induction and mutual induction
- D. Ignition coil windings, construction and operation
- E. Electromagnetic interference

XVIII. Magnetism and Electromagnetism (3 hours, lab)

- A. Alternator rotor electromagnetism demonstration
- B. Circuit and relay identification
- C. Relay inspection and testing

- D. Relay pin identification with an ohmmeter

XIX. Starting Systems (4.5 hours, lecture)

- A. Starting system purpose and components
- B. Starter motor principles of operation
 - 1. Parts identification
 - 2. Types of starter motor construction
 - 3. Permanent magnet starters
 - 4. Starter drive mechanisms
 - 5. Positive engagement and solenoid operated starters
- C. Three-phase AC motor principles of operation
- D. Inverter modules
- E. Integrated Starter-Generator (IGS) systems operating principles

XX. Starting System Diagnosis and Service (4.5 hours, lab)

- A. Starting system diagnosis
 - 1. Slow crank condition
 - 2. No crank condition
 - 3. Starting system quick check test
- B. Starter control circuit inspection and testing
- C. Starter current draw test
 - 1. Starter circuit voltage drop test
- D. Starter relay and solenoid testing
- E. Starter motor free speed testing
- F. Starter motor removal and reinstallation
- G. Starter motor disassembly, cleaning, inspection, repair, and reassembly

XXI. Charging Systems (4.5 hours, lecture)

- A. Purpose and major components
- B. Alternator construction and operating principles
 - 1. Overrunning pulleys
 - 2. Components and operation
 - 3. Current induction and rectification
 - 4. Voltage regulation
- C. Types of charge indicators
- D. Computer controlled charging systems
 - 1. Types and modes of operation
 - 2. Pulse Width Modulation (PWM) and duty cycle
- E. Introduction to Hybrid Electric Vehicle (HEV) charging systems and applications
 - 1. Integrated Starter Generator (ISG) and Alternating Current (AC) motors
 - 2. Regenerative braking in High Voltage (HV) battery charging
 - 3. Purpose of direct current DC/DC converter

XXII. Charging System Testing and Service (4.5 hours, lab)

- A. Diagnose charging system problems
 - 1. Undercharge, no charge and overcharge
- B. Inspect, adjust, and replace generator drive belts and pulleys

- C. Charging system output test and circuit voltage drop test
- D. Voltage regulator test
- E. Test and replace AC generator diodes and/or rectifier bridge.
- F. AC generator removal and reinstallation
- G. AC generator component disassembly, inspection, testing and replacement
 - 1. AC generator brushes and brush holder
 - 2. AC generator diodes and/or rectifier bridge
 - 3. Rotor and stator
- H. Low Voltage (LV) and (HV) inverter/converter module circuit inspection

XXIII. Lighting and Signaling Circuits (3 hours, lecture)

- A. Automotive lamp construction and operation
- B. Exterior lighting
 - 1. Conventional sealed beam, halogen, and composite headlight lamps
 - 2. Bulb numbering and testing
 - 3. Brake lights and turn signals
 - a. Switches and flasher units
 - 4. High-intensity discharge (HID) headlights
 - a. System voltage identification and safety precautions
 - 5. Light emitting diode (LED) headlights
 - 6. Daytime running lights
 - 7. Dimmer switches
- C. Interior lighting systems
 - 1. Courtesy lights
 - 2. Instrument panel lights
 - 3. Illuminated entry
 - 4. Fiber optics
 - 5. Automatic dimming mirrors
- D. Lighting circuit diagnosis

XXIV. Lighting Circuits Diagnosis and Repair (3 hours, lab)

- A. Lighting system troubleshooting and circuit fault finding
 - 1. Brighter than-normal operation
 - 2. Intermittent
 - 3. Dim
 - 4. No light operation
- B. Exterior lamps and socket inspection and replacement
- C. Interior lamps and socket inspection and replacement
- D. HID headlight system voltage and safety precaution identification

XXV. Driver Information Systems, Gauges and Warning Devices (3 hours, lecture)

- A. Dash warning symbols purpose and function
 - 1. Warning lamp recognition and interpretation
 - 2. Driver information system
- B. Level, voltage, pressure and temperature gauges
 - 1. Analog and digital instruments
 - 2. Head Up Display (HUD)
- C. Gauge sending units
- D. Tachometer, speedometer, and odometer description
 - 1. Operating principles

- 2. Digital vs. analog
- 3. Integrated Circuit (IC) chip and stepper motor odometers
- E. Digital electronic displays
- F. Audible warning systems
- G. Instrument panel illumination light dimming
 - 1. Body Control Module (BCM) control protocols and operation
- H. OnStar, navigation systems and Global Positioning Satellite (GPS) systems
- I. Backup cameras and sensors
- J. Lane Departure Warning System (LDWS)

XXVI. Driver Information Systems, Gauges and Warning Devices Diagnosis and Repair (3 hours, lab)

- A. Instrument Panel (IP) gauge(s) testing and inspection
 - 1. Component failure root-cause diagnosis and identification
- B. IP gauge sending unit(s) testing and inspection
 - 1. Component failure root-cause diagnosis and identification
- C. Instrument cluster printed circuit board removal and replacement
- D. IP warning device(s) incorrect operation troubleshooting
 - 1. Component failure root-cause diagnosis and identification
- E. Driver information systems diagnosis
- F. Electronic dash instrument diagnosis and troubleshooting

XXVII. Horn, Wiper and Blower Motor Circuits (3 hours, lecture)

- A. Horn circuit purpose and function
 - 1. Horn operation and system diagnosis
 - 2. Horn service and replacement
- B. Windshield wiper and washer system purpose and function
 - 1. Computer control
 - 2. Wiper and washer components
 - 3. Windshield wiper operation, testing, diagnosis and service
 - 4. Windshield washer operation, testing, diagnosis and service
- C. Blower motor purpose and function
 - 1. Components, circuit description and operation
 - 2. Testing, diagnosis and service

XXVIII. Horn, Wiper/Washer and Blower Motor Diagnosis and Repair (3 hours, lab)

- A. Incorrect horn operation diagnosis and causal identification
 - 1. No operation, intermittent operation and/or constant horn operation
 - 2. Poor sound quality
- B. Incorrect windshield wiper operation diagnosis and causal identification
 - 1. No windshield wiper operation and/or one-speed only operation
 - 2. Slower-than-normal wiper operation
 - 3. Improper park operation
 - 4. Continuous wiper operation
- C. Windshield wiper blade replacement and operation verification
- D. Incorrect blower motor operation diagnosis and causal identification
 - 1. No operation, one-speed operation and/or constant blower motor

- operation
- 2. Blower motor circuit schematic interpretation and testing

XXIX. Accessory Circuits (3 hours, lecture)

- A. Cruise control components and operation
 - 1. Electronic throttle cruise control
- B. Heated mirrors and rear window defoggers
- C. Power window components and operation
 - 1. Motors, switches and controls
- D. Power seat components and operation
 - 1. Electrically heated and cooled seats
- E. Power door locks
 - 1. Components and operation
- F. Keyless entry/remote start systems
- G. Anti-theft systems
 - 1. Components and operation
- H. Door panel removal

XXX. Vehicle Accessories Diagnosis and Repair (3 hours, lab)

- A. Incorrect cruise control operation diagnosis and repair
 - 1. Electronic throttle cruise control
- B. Heated mirrors and rear window defogger diagnosis
- C. Incorrect power window operation diagnosis and repair
 - 1. Motors, switches and controls
- D. Power seat components and operation description
 - 1. Electrically heated and cooled seats
- E. Power door lock diagnosis
 - 1. Components and operation description
- F. Keyless entry/remote start systems description
- G. Anti-theft system diagnosis
- H. Door panel removal

XXXI. Passive Restraint Systems (3 hours, lecture)

- A. Purpose and components
- B. Passive seat belt systems basic operation
- C. Air bag module components and function
- D. Air bag system diagnostic modules
- E. Air bag system sensors
- F. Hybrid inflator modules
- G. Multi-stage air bags and side-impact air bags
- H. Seat belt pre-tensioners
- I. Occupant classification systems (OCS)
- J. Airbag disarming procedures

XXXII. Servicing Passive Restraint Systems (3 hours, lab)

- A. Seat belt inspection

	<ul style="list-style-type: none"> B. Airbag removal and reinstallation <ul style="list-style-type: none"> 1. Airbag disarming procedure 2. Indicator lamp verification C. Supplemental restraint system problem diagnosis D. Occupant classification system validation <p>XXXIII. Audio System Operation and Diagnosis (3 hours, lecture)</p> <ul style="list-style-type: none"> A. Audio fundamentals <ul style="list-style-type: none"> 1. Radio waves 2. Antennas 3. Receivers B. Antenna and radio interference diagnosis C. Speaker types and operating characteristics D. Audio and entertainment system configurations <ul style="list-style-type: none"> 1. Sound levels 2. Crossovers 3. Aftermarket system upgrades E. Voice recognition and Bluetooth F. Satellite radio <p>XXXIV. Audio System Operation and Diagnosis (3 hours, lab)</p> <ul style="list-style-type: none"> A. Radio static diagnosis B. Audio system noise concern diagnosis <ul style="list-style-type: none"> 1. Weak or intermittent signal 2. No radio reception C. Speaker servicing and impedance matching
Total Lecture Hours:	54
Total Laboratory Hours:	54
Total Hours:	108
Primary Method of Evaluation:	3) Skills demonstration
Typical Assignment Using Primary Method of Evaluation:	Sketch the lighting system for a contemporary automobile, including turn and hazard signals. Submit sketch to the instructor.
Critical Thinking Assignment 1:	Perform a charging system test and record data on a charging system lab sheet. Analyze data using manufacturer's specifications to determine recommended service and/or repairs and parts required. Submit charging system test lab sheet to the instructor.
Critical Thinking Assignment 2:	Perform a battery load test and record data on a battery performance lab sheet. Analyze data using industry standards to determine serviceability of the battery. Submit battery performance lab sheet and supporting data to the instructor.
Other Evaluation Methods:	Performance Exams Other Exams Quizzes Laboratory Reports Class Performance

	Multiple Choice Completion Matching Items True/False Other (specify): PERFORMANCE OF MANUFACTURER'S SERVICE PROCEDURES
Instructional Methods:	Demonstration Discussion Field Trips Group Activities Guest Speakers Laboratory Lecture Multimedia Presentations
If other:	COMPONENT MODELS
Work Outside of Class:	Study Answer questions Required reading Problem solving activities Written work
If Other:	
Up-To-Date Representative Textbooks:	James D. Halderman, <u>AUTOMOTIVE ELECTRICITY AND ELECTRONICS</u> , 5th edition, Prentice Hall, 2017. Discipline Standard
Alternative Textbooks:	
Required Supplementary Readings:	Lab sheets Procedure sheet Shop manuals
Other Required Materials:	Three ring binder notebook and paper Pen and pencil Digital Volt Ohm Meter (optional) Safety glasses Shop safe clothing Tools (optional) Tape recorder (optional) Calculator (portable)
Requisite:	
Category:	

Requisite course(s): List both prerequisites and corequisites in this box.	
Requisite and Matching skill(s): Bold the requisite skill. List the corresponding course objective under each skill(s).	
Requisite Skill:	
Requisite Skill and Matching Skill(s): Bold the requisite skill(s). If applicable	
Requisite course:	Automotive Technology 21 or Automotive Technology 23
Requisite and Matching skill(s): Bold the requisite skill. List the corresponding course objective under each skill(s).	Understanding of a good and faulty battery. ATEC 21-Evaluate, test, and service a lead-acid battery. ATEC 23- Service, test and evaluate ignition systems. Evaluate the starting system and evaluate if it is good, marginal or bad. ATEC 21-Evaluate, test, and service starting systems. ATEC 23-Service, test and evaluate ignition systems. Evaluate proper idle speed and operation of the engine. ATEC 21-Perform an analysis of an engine condition by conducting compression, cylinder leakage, and vacuum tests. ATEC 23-Inspect, test and evaluate fuel systems. Inspect and test ignition system to see if is working properly. ATEC 21-Evaluate, test, and service an ignition system. ATEC 23-Identify ignition components. ATEC 23-Service, test and evaluate ignition systems. ATEC 23-Analyze ignition scope patterns. ATEC 23-Diagnose and repair ignition systems. Determine if charging system is working properly. ATEC 21-Evaluate, test, and service charging systems.

	ATEC 23-Test and evaluate engine condition and performance using engine analyzer.
Requisite Skill:	or equivalent
Requisite Skill and Matching skill(s): Bold the requisite skill. List the corresponding course objective under each skill(s). If applicable	If a student has taken Auto Technology 21 or Auto Technology 23 at another college or has automotive experience, the student will be prepared to enroll in this course. It is highly recommended that students have experience in the proper use of automotive tools and knowledge of the operational concepts that pertain to automotive diagnosis and repair procedures to enhance their success in this course.
Enrollment Limitations and Category:	
Enrollment Limitations Impact:	
Course Created by:	George Barber
Date:	10/25/1985
Original Board Approval Date:	
Last Reviewed and/or Revised by:	Michael Anderson
Date:	05/10/2020
Last Board Approval Date:	12/19/2022