

**SAULT COLLEGE OF APPLIED ARTS AND TECHNOLOGY**

**SAULT STE. MARIE, ONTARIO**



**COURSE OUTLINE**

**COURSE TITLE:** ELECTRICAL/ELECTRONIC AND EMISSION SYSTEMS

**CODE NO. :** AST613 **LEVEL:** ONE

**PROGRAM:** AUTOMOTIVE SERVICE TECHNICIAN  
APPRENTICESHIP – LEVEL 1

**AUTHOR:** JAMIE SCHMIDT

**DATE:** Dec 2016 **PREVIOUS OUTLINE DATED:** September 2015

**APPROVED:** *“Corey Meunier”*

**CHAIR**

**DATE**

**TOTAL CREDITS:** TWELVE

**PREREQUISITE(S):** NIL

**HOURS/WEEK:** TWELVE

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***For additional information, please contact Corey Meunier, Chair***  
**School of Technology & Skilled Trades**  
**(705) 759-2554, Ext. 2610**

**I. COURSE DESCRIPTION:**

Multiple topic areas will be covered in Electrical/Electronic and emission systems.

You will gain the ability to explain the terminology, and the principles of operation of electricity. Practical use of various types of electrical test equipment will be taught as well as electrical circuit calculations.

Electromagnetic devices and basic electronics will be studied. The purpose, construction and principles of operation of batteries will be studied and you will perform inspection, maintenance and testing of batteries.

You will demonstrate knowledge of wiring schematics, basic electrical diagnosis and circuit repair.

Conventional and alternate fuels, intake, exhaust and fuel delivery systems will be studied as well as the principles of combustion and exhaust emissions.

Basic hybrid theory will be discussed with an emphasis on hybrid safety precautions.

**II. LEARNING OUTCOMES AND ELEMENTS OF THE PERFORMANCE:**

Upon successful completion of this course, the student will demonstrate the ability to:

**1. *Electrical Fundamentals*****Potential Elements of the Performance:**

Identify basic electrical terms.

- atomic structure
- conventional and electron theory
- A/C, D/C
- conductors, insulators & semi-conductors
- magnetism
- electromagnetism
- voltage
- resistance
- power
- current

Identify sources of electricity.

- heat
- pressure
- static
- chemical
- light
- magnetism

Explain the principles of Ohms' Law & Watts' Law.

Identify Systems International (S.I.) units of measurement.

- e.g. mega, kilo, milli, micro

Identify electrical circuit characteristics.

- series / parallel
- basic symbols

## **2. *Electrical/Electronic Diagnostic Test Equipment***

Potential Elements of the Performance:

Explain the types of electrical test equipment.

- Digital Multimeter (DMM)
- inductive clamp

Explain equipment setup, calibration and techniques used to measure.

- voltage
- resistance
- amperage

Perform the following measurements using electrical test equipment:

- voltage
- resistance
- amperage
- continuity
- impedance
- induction

### 3. ***Battery Fundamentals***

#### Potential Elements of the Performance:

Explain the purpose and principles of operations of batteries:

- battery chemical action during charging and discharging
- temperature effect on charging and internal resistance ratings

Explain the construction, types, styles and applications of batteries.

- lead acid
- low maintenance
- absorbed glass mat
- maintenance-free batteries

Explain battery ratings.

- hot cranking amps (HCA)
- amp-hour rating (AH)
- cranking amps (CA)
- reserve capacity (RC)
- cold cranking amps (CCA)

Describe precautions for servicing and charging.

- temperature adjustments
- conductance testing
- refractometer
- hydrometer

Perform inspect and testing on batteries.

- visually inspect
- test state-of-charge
- perform surface discharge
- perform load test
- perform parasitic draw

Perform assigned operations on batteries.

- clean battery and terminals
- charge
- activation
- removal and replacement

#### **4. *Electrical Circuit Calculations***

Potential Elements of the Performance:

Perform circuit calculations to verify Ohms' and Watts' Laws.

- series circuits
- parallel circuits

Perform assigned testing to determine voltage, current and resistance for the following circuits:

- circuit board exercises
- vehicle electrical circuits
- perform comparisons between measured and calculated circuit performances

#### **5. *Applied Electrical Schematics***

Potential Elements of the Performance:

Explain the purpose and fundamentals of electrical wiring schematics.

- electrical symbols
- circuit identification methods
- color codes
- circuit number codes gauge and metric wire sizes
- types of connectors

Explain the function, construction and styles of wiring diagrams.

- layout
- interpretation
- variations by different manufacturers

Locate electrical components and trace electrical circuits of vehicle systems.

- perform on-vehicle verification of wiring diagram circuits
- locate power sources and grounds

#### **6. *Circuit Repair and Protection Devices***

Potential Elements of the Performance:

Perform circuit analysis to identify.

- shorts
- opens
- grounds
- unintentional grounds
- high resistance
- dynamic circuit testing and voltage drops

Perform circuit repairs on the following components:

- wiring and connectors
- weather proofing
- circuit protection
- fuses
- circuit breakers
- fusible links
- repair wiring
- clean
- splice
- crimp
- solder
- corrosion protection

Perform tests to verify the correct operation of the following circuit protection devices.

- fuses
- circuit breakers
- fusible links

## **7. *Electromagnetic Devices Fundamentals***

Potential Elements of the Performance:

Explain the purpose and fundamentals of electromagnetic devices.

- magnetism
- electromagnetism
- current flow and magnetic fields applied to relays, solenoids and motors
- right and left-hand rules
- counter-electromotive force effect

Explain the construction, types and principles of operations of electromagnetic devices.

- voltage generation
  - alternators
  - generators
- electric motors
- solenoids
- relays
- coils
- stepper motors

Inspect, test and diagnose electromagnetic devices for proper performance.

- electric motors
- solenoids
- relays
- coils
- stepper motors

## **8. *Electronic Fundamentals***

Potential Elements of the Performance:

Explain the purpose, function, construction and application of electronic devices.

- power supplies
- voltage regulators
- voltage limiters
- resistors
  - fixed
  - variable
  - potentiometer
  - thermistors
  - capacitors
- semiconductor devices
- diodes
  - rectifying
  - zener
  - light emitting
  - photo

Specify the precautions necessary when working with electronic circuits and components.

- voltage spike
- static electricity buildup
- electrostatic discharge
- maintaining correct safe shielding and grounding

## **9. *Fuel System Fundamentals***

Potential Elements of the Performance:

Explain the purpose and fundamentals of fuels.

- engine theory
- thermodynamics
- combustion ratios
- fuels chemistry

Describe the function, composition and properties of fuels.

- gasoline fuel
  - volatility
  - octane rating
  - additives
  - hydrocarbons
  - atomization heat energy / calorific value
- diesel fuel
  - volatility
  - cetane number
  - viscosity
  - additives
  - sulfur content, etc.
- alternate fuels
  - Ethanol, E10, E85, biodiesel
  - propane, natural gas and alcohol
  - boiling points
  - volatility
  - pressure requirements

Explain the combustion principles of fuels.

- oxidation reactions
- products of combustion
  - HC
  - CO
  - CO<sub>2</sub>
  - NO<sub>x</sub>
- air fuel ratios
- atomization / vaporization
- detonation
- pre-ignition

Locate and identify fuel delivery system components.

- tanks
- filters
- lines
- pumps
- pressure regulators
- injectors



## **10. Intake and Exhaust Systems**

### Potential Elements of the Performance:

Explain the purpose and fundamentals of intake and exhaust systems.

- volumetric efficiency
- scavenging
- manifold vacuum and exhaust back pressure
- ported vacuum
- thermal expansion and contraction
- Boyle's Law, Charles Law, and Bernoulli's Theorem

Explain the construction, types, operation, styles and application of intake and exhaust systems.

- air cleaners
- intake and exhaust manifolds
- exhaust pipes
- resonators and mufflers
- intake manifold heating

Inspect and test intake and exhaust systems.

- visually inspect intake and exhaust systems
  - restrictions
  - noise
  - leaks
- perform:
  - test exhaust back pressure
  - test intake manifold vacuum

## **11. Emission Control Systems**

### Potential Elements of the Performance:

Explain the basics of emission control systems.

- combustion of fuels
- combustion bi-products
- Properties of carbon monoxide, hydrocarbons, oxides of nitrogen.
- photo-chemicals, smog, acid rain, greenhouse effect
- emission standards and model year compliance
- legal consequences of emission equipment tampering
- air / fuel ratio
- temperature of combustion
- thermal expansion and contraction

Explain the basic operation of the emission control components.

- evaporative emission systems
- exhaust gas re-circulation systems
- positive crankcase ventilation
- catalytic converters
- air injection systems

Locate and identify emission control system components.

- manifold heating devices
- evaporative emission systems
- exhaust gas re-circulation systems
- positive crankcase ventilation
- catalytic converters/air injection systems

## **12. Hybrid Systems**

Potential Elements of the Performance:

Explain the basic hybrid types.

- hybrid system types
  - Toyota - synergy system
  - Honda - Integrated Motor Assist (IMA)
  - General Motors / Saturn - Belt Alternator Starter (BAS)
  - General Motors / Chrysler / BMW - dual mode

Explanation and identification of hybrid systems.

- high voltage / intermediate voltage
- cooling
  - Internal Combustion Engine (I.C.E.)
  - Inverter
- braking
- accessory
- air conditioning

Explain safe hybrid working practices.

- high voltage / intermediate voltage
- personal safety
- area safety
- protective equipment
- meter requirements
- disconnect procedures
- driving the vehicle into or out of the shop
- lifting / hoisting
- pushing or moving a hybrid

**III. TOPICS:**

1. Electrical Fundamentals
2. Electrical/Electronic Diagnostic Test Equipment
3. Battery Fundamentals
4. Electrical Circuit Calculations
5. Applied Electrical Schematics
6. Circuit Repair and Protection Devices
7. Electromagnetic Devices Fundamentals
8. Electronic Fundamentals
9. Fuel System Fundamentals
10. Intake and Exhaust Systems
11. Emission Control Systems
12. Hybrid Systems

**IV. REQUIRED RESOURCES/TEXTS/MATERIALS:**

**Title:** Automotive Technology: A Systems Approach

**Edition:** 06 ed., 17810#

**Author:** Erjavec

**V. EVALUATION PROCESS/GRADING SYSTEM:**

Evaluation is broken down into two distinct areas; Theory Testing and Practical Application Exercises. The percentage between these two areas is directly related to the percentage of time that has been assigned for each Reportable subject.

Theory  
Testing  
70%

Practical  
Application Testing  
30%

The following semester grades will be assigned to students:

<b>Grade</b>	<b><u>Definition</u></b>	<i>Grade Point Equivalent</i>
A+	90 – 100%	4.00
A	80 – 89%	
B	70 - 79%	3.00
C	60 - 69%	2.00
D	50 – 59%	1.00
F (Fail)	49% and below	0.00
CR (Credit)	Credit for diploma requirements has been awarded.	
S	Satisfactory achievement in field /clinical placement or non-graded subject area.	
U	Unsatisfactory achievement in field/clinical placement or non-graded subject area.	
X	A temporary grade limited to situations with extenuating circumstances giving a student additional time to complete the requirements for a course.	
NR	Grade not reported to Registrar's office.	
W	Student has withdrawn from the course without academic penalty.	

If a faculty member determines that a student is at risk of not being successful in their academic pursuits and has exhausted all strategies available to faculty, student contact information may be confidentially provided to Student Services in an effort to offer even more assistance with options for success. Any student wishing to restrict the sharing of such information should make their wishes known to the coordinator or faculty member.

**VI. SPECIAL NOTES:****Attendance:**

Sault College is committed to student success. There is a direct correlation between academic performance and class attendance; therefore, for the benefit of all its constituents, all students are encouraged to attend all of their scheduled learning and evaluation sessions. This implies arriving on time and remaining for the duration of the scheduled session.

It is the departmental policy that once the classroom door has been closed, the learning process has begun. Late arrivers will not be granted admission to the room.

**Safety:****Eye, Face and Foot Personal Protection Equipment (PPE)**

Students are required to wear appropriate Personal Protection Equipment (PPE) in designated areas at all times. The designated areas for eye and foot protection in the Motive Power areas are: C1073 (Automotive), C1000, C1010, and C1040 (Truck/Coach and Heavy Equipment) and C1120 (Marine and Small Engines). Appropriate PPE must also be worn when facing hazards outside of these designated areas.

**Eye Protection:**

**All protective eye wear shall meet the requirements of:**

**C.S.A. - Z94.3 or A.N.S.I. - Z87.1 +.**

**Approved safety glasses (lens and frames) shall have side protection such as wrap around design or fixed side shields.**

The minimum acceptable eye protection is a spectacle (class 1A on chart Z94.3). Dark tinted spectacles will not be accepted for general indoor use. Additional eye and face protection is required for specific hazards. Chart Z94.3 outlines the appropriate PPE for specific hazards.

**Foot Protection:**

1. **Boot height- minimum 5 ½" uppers, measured from the top of the sole.**
2. **CSA Green Patch rating.**

Safety boots must be properly laced and not be worn or damaged as to impair their effectiveness.

Food and drink are not permitted in C1070

**VII. COURSE OUTLINE ADDENDUM:**

The provisions contained in the addendum located on the portal, form part of this course outline.