*Public and Catholic District School Board Writing Partnerships*

Technological Education

# Course Profile

## Transportation Technology

Grade 12
Workplace Preparation
TTJ4E

- *for teachers by teachers*

This sample course of study was prepared for teachers to use in meeting local classroom needs, as appropriate. This is not a mandated approach to the teaching of the course. It may be used in its entirety, in part, or adapted.

Course Profiles are professional development materials designed to help teachers implement the new Grade 12 secondary school curriculum. These materials were created by writing partnerships of school boards and subject associations. The development of these resources was funded by the Ontario Ministry of Education. This document reflects the views of the developers and not necessarily those of the Ministry. Permission is given to reproduce these materials for any purpose except profit. Teachers are also encouraged to amend, revise, edit, cut, paste, and otherwise adapt this material for educational purposes.

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# Course Overview
# Transportation Technology, TTJ4E, Grade 12, Workplace Preparation

**Policy Document:** *The Ontario Curriculum, Grades 11 and 12, Technological Education, 2000.*
**Prerequisite:** Transportation Technology, Grade 11, Workplace Preparation

## Course Description

This course examines the commonalities of land, air and marine vehicles, and transportation systems. Students will develop safe workplace habits and business management skills and effectively use diagnostic, hand and power tools to service and repair vehicles to meet industry standards and safety inspections. They will also research the entry requirements for apprenticeship training programs and develop the employability and technical skills required for entry into the workplace.

## How This Course Supports the Ontario Catholic School Graduate Expectations

The application of gospel values, the sense of community, and social consciousness factor as strong elements in the expectations for the transportation technology student. The activities in this course offer a broad awareness of social conscience and personal choice. The fact that the environment requires caring stewardship propels conservation and wisdom in choice throughout the curriculum. The importance of caring for the lives of individuals in the Catholic tradition is also infused throughout the course activities. Individual decision-making and collaborative processes are explored as students develop knowledge and skills that are applicable in their lives now, and as preparation for further studies or careers. Moral and ethical work practices are implemented and reinforced for lifelong learning and living.

## Course Notes

Workplace Preparation courses are designed to provide students with the knowledge and skills they need to meet the expectations of employers if they plan to enter the workplace directly after graduation, or the requirements for admission to certain apprenticeship or other training programs. The activities suggested in this profile provide students with opportunities to acquire and demonstrate general transferable skills in a technical context. These skills are of both immediate and long-term value to both the student and the employer.

The content of the course provides a varied set of themes to acquire and apply skills and knowledge. Transportation is addressed in a global perspective as well as in the transportation industry's specific technical procedures. The emphasis of this Course Profile is automobile servicing. However, teachers must include other land, air and marine vehicle system in the teaching/learning and assessment strategies. Where possible, students should have experience servicing a range of transportation system (e.g. all terrain vehicles, marine engines).

Students may be directed to Cooperative Education or School-Work Programs for further exploration of interest in the subject. Students interested in apprenticeship can participate in the Ontario Youth Apprenticeship Program (OYAP), which allows them to begin an apprenticeship while they are enrolled in secondary school. Students in Grades 11 and 12 can earn credits toward their secondary school diploma while accumulating hours toward the completion of an apprenticeship through the OYAP.

The activities in this course require access to a technical facility with appropriate working and storage space, tools, equipment, reference materials, and preferably a computerized automotive repair manual system. Substitutions for specific activities may be made depending on local facility situations, but the procedures should be addressed in a manner that serves the course expectations.

Special considerations are made in the course to incorporate specific health and safety guidelines, such as the Workplace Hazardous Materials Information System (WHMIS). The teacher must note safety considerations and regulations from such organizations as the Industrial Accident Prevention Association (IAPA) and the Workplace Safety Insurance Bureau (WSIB) that impact the transportation industry and in turn, the technical classroom. Safe practices in the workshop must be addressed and reinforced throughout the course to ensure students learn and practise safe operating procedures in the classroom.

The teacher must employ a tracking method to document student safety training in the shop, e.g., Appendix A – Safety Passport. This documentation can be used to determine if students have received the instruction needed to use safely and competently specific equipment prior to each activity.

### Units: Titles and Time

| | | |
|---|---|---|
| * Unit 1 | Electronic Engine Controls | 35 hours |
| Unit 2 | Emission Controls and Distributorless Ignition Systems | 20 hours |
| * Unit 3 | Braking Systems | 35 hours |
| Unit 4 | Pre-Certification Inspection of Vehicle | 20 hours |

* These units are fully developed in this Course Profile.

## Unit Overviews

### Unit 1: Electronic Engine Controls

**Time:** 35 hours

**Unit Description**

Students study the operating principles of devices that monitor and alter engine operation of land, marine and air vehicles. Students learn the names, operation and test procedures of key engine sensors and actuators, as well as their relationship to each other and to the vehicle's computer. Students also develop diagnostic strategies to be used in testing and servicing these devices and systems. Personal safety and safety regulations are reinforced throughout the unit activities. The activities and skills learned in this course reflect industry standards delivered with the honesty, values, and integrity of social teachings.

**Unit Overview Chart**

| Cluster | Learning Expectations | Assessment Categories | Focus |
|---|---|---|---|
| 1.1 | TFV.02, TFV.03, TF2.01, TF2.02, SPV.05, SP4.01, SP4.02, CGE3b | Knowledge/Understanding<br>Thinking/Inquiry<br>Communication<br>Application | System Theory and Operation |
| 1.2 | TFV.01, TF1.02, SPV.02, SP3.01, SP3.05, SP3.06, CGE1e, CGE5h | Knowledge/Understanding<br>Thinking/Inquiry<br>Communication<br>Application | System Diagnostics |
| 1.3 | SPV.03, SP2.01, SP2.03, SP3.05, CGE1e, CGE5h | Thinking/Inquiry<br>Application | System Service and Testing |

## Unit 2: Emission Controls and Distributorless Ignition Systems

**Time:** 20 hours

**Unit Description**

Students study the operating principles of devices that reduce the harmful effects of engine operation on the environment for land, marine and air vehicles. Students learn the types and sources of these emissions and study their effects of the environment. Students develop diagnostic strategies to be used in testing and servicing these devices and systems. Personal safety and safety regulations are reinforced throughout the unit activities. Students learn to develop their sense of personal choice and moral direction in the application of their skills and values in the workplace.

**Unit Overview Chart**

| Cluster | Learning Expectations | Assessment Categories | Focus |
|---|---|---|---|
| 2.1 | TFV.02, TFV.03, TF2.01, TF2.02, TF3.01, ICV.01, ICV.03, IC1.01, 1C1.04 CGE3b | Knowledge/Understanding | Vehicle Emissions and Their Effects on the Environment |
| 2.2 | SPV.02, SPV.03, SP2.01, SP2.03, SP3.05 CGE1e, CGE5h | Knowledge/Understanding Thinking/Inquiry Communication Application | Controlling Emissions Through the Ignition System |
| 2.3 | SPV.02, SPV.03, SP2.01, SP2.03, SP3.05 CGE1e, CGE5h | Knowledge/Understanding Thinking/Inquiry Communication Application | Controlling Emissions Through the Exhaust System |

## Unit 3: Braking Systems

**Time:** 35 hours

**Unit Description**

Students learn to explain the basic principles, components, and operation of hydraulic brakes, power brakes, and antilock braking systems for land and air vehicles. Emphasis is placed on preparing students to enter the workplace with the hands-on skills required to inspect, service, and repair braking systems to meet manufacturers' specifications and local industry standards. Students learn how to retrieve antilock braking systems trouble codes, test sensors, and analyse trouble shooting flow charts. The activities and skills learned in this activity reflect industry standards and are delivered with the honesty and integrity of our social teachings. Personal safety and safety standards are reinforced throughout the unit activities.

**Unit Overview Chart**

| Cluster | Learning Expectations | Assessment Categories | Focus |
|---|---|---|---|
| 3.1 | TFV.02, TF2.01, SPV.04, SPV.05, SP2.01, SP4.01, SP4.02 CGE3b, CGE2b | Knowledge/Understanding Communication | Braking System, Theory and Operation |
| 3.2 | TF1.01, SPV.02, SPV.03, SPV.05, SP2.01, SP2.03, SP3.02, SP3.05, IC2.02, IC2.03, IC2.03, IC2.04, ICV.05 CGE3c, CGE5h | Knowledge/Understanding Thinking/Inquiry Communication Application | Brake Service, Inspection, and Repair |

| Cluster | Learning Expectations | Assessment Categories | Focus |
|---|---|---|---|
| 3.3 | SPV.02, SPV.01, SPV.03, ICV.05, SP2.01, SP2.02, SP3.02, SP3.05, IC2.02, IC2.03, IC2.04, IC2.05 CGE5g, CGE3b | Knowledge/Understanding Thinking/Inquiry Communication Application | ABS Brake System Comparison and Service |
| 3.4 | TF1.02, SPV.01, SPV.02, SPV.03, SPV.04, SPV.05, SP1.02, SP2.01, SP2.03, SP3.05, SP3.06 CGE1e, CGE5h | Knowledge/Understanding Thinking/Inquiry Communication Application | Brake System Diagnostics, Troubleshooting, Service, and Testing |

### Unit 4: Pre-Certification Inspection of Vehicle

**Time:** 20 hours

**Unit Description**

Students learn the professional aspects of vehicle inspection and industry standards of practice for land, marine and air vehicles by researching and establishing a systematic procedure. Students also investigate the requirements for entry-level positions in transportation related businesses. Personal safety and safety regulations are reinforced throughout the unit activities. The development of caring attitudes towards others and the integrity of honest business practises are important components of this unit.

**Unit Overview Chart**

| Cluster | Learning Expectations | Assessment Categories | Focus |
|---|---|---|---|
| 4.1 | IC2.04, IC2.02, IC2.01, IC1.01, IC1.02, SPV.02 ICV.05, SP1.01, SP2.01, SP2.02, SP3.02, SP3.03, SP3.04 CGE5h, CGE4g | Knowledge/ Understanding Application | Basic Shop Skills |
| 4.2 | IC2.05, IC2.01, IC1.03, IC1.02, IC1.01, ICV.02, IC2.03, IC1.04, SPV.02, ICV.03, ICV.01, SP3.06 CGE7a, CGE3c | Knowledge/ Understanding Thinking/Inquiry | Shop and Workplace Health, Safety, Rights, Responsibility, and the Motor Vehicle Repair Act |
| 4.3 | IC3.03, IC3.02, IC3.01, IC2.02, ICV.04 CGE7a, CGE5h, CGE4g | Knowledge/ Understanding Thinking/Inquiry Communication | Apprenticeship Research to Job Placement |

## Teaching/Learning Strategies

Teaching and learning strategies in a Transportation Technology program include:

- *Group collaboration:* students work in teams or with partners to accomplish specific tasks. Individuals with differing strengths, skills, and knowledge work together to solve problems.
- *Individual work:* students work independently to accomplish specific tasks. This may include research, reporting, or completing individual tasks related to a group project, e.g., record keeping, tool management for the group, performing sub-procedures in repair, replacement, or diagnosis.
- *Class discussion:* students actively participate by discussing relevant topics. The teacher may direct discussions by posing initial questions, demonstrating specific procedures, e.g., a proper and safe tool operation, or by presenting a media topic related to the current activity, e.g., a video, service bulletin or recall.

- *Theoretical study:* students learn concepts and theory in application through the study of appropriate texts and manuals. Theoretical concepts are taught through lessons provided by the teacher or invited guests, or through assignments that involve research and study into technical procedures that apply to the current activities, e.g., retrieving trouble codes using a scanner.

Important issues such as safety must be reinforced throughout the course. Following initial discussions and testing, the teacher reintroduces specific topics as required. For example, before students lift a vehicle, the teacher reviews specific hoisting safety procedures.

A key component of this course is making students aware of career opportunities in the field of transportation. Strategies such as inviting guest speakers, conducting field trips or industry visits, participating in community based projects, encouraging and marketing job shadowing and participating in co-op or youth apprenticeship placements are highly recommended.

## Assessment & Evaluation of Student Achievement

| Assessment Category | Methods of Assessment | Weight |
|---|---|---|
| Knowledge/Understanding | Written, oral, and practical tests<br>Student/teacher conferencing<br>Class presentations<br>Formal projects<br>Teacher observation<br>Written assignments<br>Written reports on diagnostic tasks | 70% |
| Thinking/Inquiry | Sequenced procedural lists<br>Written reports on diagnostic tasks | |
| Communications | Report writing<br>Class presentations<br>Customer relations<br>Notebook | |
| Applications | Teacher observation of safe work habits<br>Student/teacher conferencing | |
| Final Assessment | Teacher observation of hands-on skills using checklists while students complete performance tasks.<br>Written testing<br>Problem-solving and/or design tasks | 30% |

## Accommodations

Various accommodations may be made throughout the program as required. They include one-to-one teaching/conferencing, adaptation of handouts, small group learning and peer tutoring. Activities are monitored and adapted to meet the needs of all learners by applying various accommodations, such as allowing increased time for activities and facilitating peer tutor assistance when possible. The teacher should consult Individual Education Plans (IEP) for specific direction on accommodation for individuals.

Specific accommodations in the transportation activities include:

- additional assistance for physical tasks;
- additional language resources (especially for technical terms);
- templates to assist in completing drawings or reports;

- peer tutoring or additional help in record-keeping, diagnosing, measuring, computing, or fabricating tasks;
- examples of completed assignments;
- one-on-one assistance in sequencing tasks;
- advanced service or research requirements for enrichment activities.

## Resources

Various resources are used throughout the course, including research software, transportation textbooks, websites, equipment and vehicle technical manuals, instructional videos and community industry experts. Special tools may be required for several procedures, e.g., scanning for codes. An electronic service manual system is a valuable asset as students locate and print specifications and procedures required for work to be performed. These copies may be inserted in the students' notebooks. Other resources, such as a teacher-developed worksheet of procedures and observations are completed by students at predetermined points in the activity.

Units in this Course Profile make reference to the use of specific texts, magazines, films videos and websites. The teacher must consult board policies regarding use of any copyrighted materials. Before reproducing materials for student use from printed publications, the teacher must ensure that the board has a Cancopy licence and that this licence covers the resources to be used. Before screening videos/films with students, the teacher must ensure that the board/school has obtained the appropriate public performance videocassette licence from an authorized distributor, e.g. Audio Cine Films Inc. The teacher is reminded that much of the material on the Internet is protected by copyright. The person or organization that created the work usually owns the copyright. Reproduction of any work or substantial part of any work on the Internet is not allowed without the permission of the owner.

### Print

Chapman, Norm. *Principles of Electricity and Electronics for the Automotive Technician.* South Puget Sound Community College: Delmar, 2000. ISBN 0-8273-8479-3

Crouse, W., D. Anglin, and W. Crouse. *Automotive Mechanics.* USA: Glencoe McGraw-Hill, 1993. ISBN 0028009436

Derato, Frank C. *Automotive Electrical and Electronics Systems*, 2nd ed. USA: Glencoe Division, Macmillian/McGraw-Hill, 1994. ISBN 0-02-800412-4

Duffy, James E. *Auto Electricity and Electronics Technology.* Illinois: Goodheart-Wilcox, 1995. ISBN 1-56637-053-1

Erjavec, Jack. *Automotive Technology: A Systems Approach,* 3rd ed. USA: Delmar Thomas Learning, 2000. ISBN 0-7668-0673-1

Hollembeak, Barry. *Automotive Electricity, Electronics and Computer Controls.* USA: Technical Training, Inc., Delmar, 1999. ISBN 0-8273-6566-7

Kabala, Thomas. *Electricity 1: Devices, Circuits and Materials.* USA: Delmar, 2001. ISBN 0-7668-1917-5

Schwaller, Anthony, E. *Motor Automotive Technology.* Cloud State University: Delmar, 1999. ISBN 0-8273-8354-1

Thiessen, Frank J. and Davis N. Dales. *Automotive Principles and Service,* 4th ed. New Jersey: Prentice Hall, 1994. ISBN 0-13-336561-1

Original Equipment Manufacturer (OEM) Reference and Repair Manuals/CD-ROMs, available from local dealerships.

## Videos

Several videos are available from The Learning Tree Mechanic (http://www.autovideo2000.com), or Thompson/Delmar Learning (AutoEd.com: http://www.autoed.com/)

*Understanding Auto Technology and Repair* Video Series – Tape 3: "Understanding Automotive Electricity." Delmar, 2000. ISBN 0-7668-0794-0

*Understanding Auto Technology and Repair* Video Series – Tape 4: "How to Diagnose Automotive Electrical Problems." Delmar, 2000. ISBN 0-7668-0795-9

*Understanding Auto Technology and Repair* Video Series – Tape 5: "Understanding Automotive Electronics." Delmar, 2000. ISBN 0-7668-0796-7

*Understanding Auto Technology and Repair* Video Series – Tape 6: "How to Diagnose Automotive Electronics Problems." Delmar, 2000. ISBN 0-7668-0797-5

## Websites

The URLs for the websites were verified by the writers prior to publication. Given the frequency with which these designations change, teachers should always verify the websites prior to assigning them for student use.

Air Quality Program - Pollution Probe – http://www.pollutionprobe.org
Pollution Probe is a Canadian environmental organization that deals with issues such as air quality.

C.A.R.S. (Canadian Automotive Repair and Service) Council – http://www.cars-council.ca/
Addresses the human resource training and development needs of the Canadian automotive repair and service industry

Catholic Conservation Centre – http://conservation.catholic.org
A collection of writings and documentation about ecology and environmental justice

How Stuff Works – http://www.howstuffworks.com/
A website containing descriptions of how various technical devices function

Industry Canada – http://strategis.ic.gc.ca/sc_indps/sectors/engdoc/tran_hpg.html
A description of various transportation sectors in the Canadian economy

Inner Auto – http://www.innerauto.com/
An exploration of inner functions of the automobile

Online Ethics Centre for Engineering and Science – http://onlineethics.org
Resources for understanding and addressing ethically significant problems in engineering

The Learning Tree Mechanic – www.autovideo2000.com
Help for the do-it yourself mechanic

## Software

Computerized service manuals
Tutorial Software
Databases

## OSS Considerations

Workplace Preparation courses are designed to equip students with the knowledge and skills they need for direct entry into the workplace or for admission to apprenticeship programs and other training programs offered in the community. The range and content of the courses offered allows students to prepare for a variety of jobs, training programs, and careers. Teaching and learning emphasizes workplace applications of the course content, but also explores the theoretical material that underlies these practical applications.

Cooperative education and work experience placements within the community can be important components of Workplace Preparation courses. Schools involve employers and site supervisors in the planning of cooperative education and work experience placements, and ensure that they have their cooperation and support in implementing these courses. Workplace Preparation courses are based on rigorous provincial curriculum expectations and emphasize the development of generic employment skills, as well as independent research and learning skills. Students are required to demonstrate that they have developed these skills. Workplace Preparation courses in particular should also promote and stress the importance of lifelong learning.

The Grade 12 Workplace Preparation Transportation Technology course is part of a technological education program. All courses offered in the technological education workplace stream are destination-related; they comprise a set of expectations that are appropriate for students who plan to begin apprenticeships or enter directly into the workforce upon graduation. (See *The Ontario Curriculum, Grades 9 to 12, Program Planning and Assessment, 2000* for a description of the different types of secondary school courses.) Students can use this course as a compulsory credit, (one additional credit from Science [Grade 11 or Grade 12] or Technological Education [Grade 9 –12]), or as an optional credit. This course is designed to provide students with a broad educational base that will prepare them for Cooperative Education or the OYAP, and to instil in them the need for lifelong learning in the workforce.

Students are involved in practical and theoretical aspects of Transportation Technology. The curriculum provides opportunities for students to undertake hands-on practical activities as well as to conduct research and analysis. There is a wide range of teaching/learning strategies and accommodations to meet the needs of all students at that level. Anti-discrimination education, equity/social justice issues, career goals/cooperative education, conflict resolution/violence prevention and community partnerships may be addressed in the day-to-day progression of the course. All of these support many of the Ontario Secondary School Policies.

Career exploration throughout all units shall be made available to students with specific reference to *Choices into Action: Guidance and Career Education Program Policy for Elementary and Secondary Schools, 1999.*

## Appendix A

### Safety Passport

This is a sample of a generic safety passport that may be adopted for use in a number of technology classrooms. The purpose of the safety passport is to ensure that students are fully aware of all safety features on each piece of equipment in the technical facility prior to using it independently. This process may be adapted to suit the needs of the teacher and students.

The general process is as follows:

1. When a new piece of equipment, e.g., lathe, is introduced, the teacher demonstrates techniques for the safe operation of the machine and the required personal protective procedures and equipment, e.g., wearing proper eye protection and protective clothing, securing loose hair, removing jewellery, etc. Students record the date of the safety demonstration on the safety passport (see sample below). Students take notes during the demonstration and record the information in a notebook along with the signed passport slip. If a student is absent on the day of a safety demonstration, a makeup opportunity must be provided.
2. Students must complete a written or verbal test on the safe operation of the machine tool, outlining all safety features that must be observed. Students must record the written tests in a notebook. These individual machine tests are designed to complement any general facility safety rules. When the test is completed satisfactorily students record the date in the "tested" column and the teacher initials this as complete.
3. Students must demonstrate to the teacher that he or she has a thorough knowledge of the safety rules for the equipment and is able to demonstrate competency on the equipment. Once the teacher has observed the required safe setup and operation of the equipment by a student, the teacher signs off that portion of the safety passport.
4. The teacher signs the final column of students' safety passport once students have completed steps 1, 2 and 3. Students are now able to use that piece of equipment.
5. Students must be able to provide the teacher with their signed passport for that equipment each time they wish to use it. A summary document of all the various permissions may be created by students and signed by the teacher (as permissions are earned). These summary safety passports may be protected with page protectors or laminated for protection.

**Sample Equipment Safety Passport**

| Student Name: _____<br>Equipment: _____<br>See notebook for the note on safe set-up and operation of the equipment. | | | | | | | |
|---|---|---|---|---|---|---|---|
| Attended Teacher Safety Instruction and Demonstration (and note recorded) | | Passed Written or Verbal Testing | | Demonstrated Safe Set-up and Operation of Equipment to Teacher | | Granted Permission to Use Equipment by Teacher | |
| Date of Lesson | Teacher Initial | Date Tested | Teacher Initial | Date of Demo | Teacher Initial | Date | Teacher Initial |
| | | | | | | | |

# Coded Expectations, Transportation Technology, Grade 12, Workplace Preparation, TTJ4E

## Theory and Foundation

### Overall Expectations

**TFV.01** · apply the design process to develop solutions, products, processes, or services in response to challenges or problems related to vehicles or vehicle systems;

**TFV.02** · analyse and describe a variety of system modifications and their effect on the interrelationship of vehicle systems;

**TFV.03** · identify the commonalities of systems in land, air, and marine vehicles;

**TFV.04** · describe and evaluate the types of energy and the conversion systems used in different vehicles.

### Specific Expectations

**The Design Process**

**TF1.01** – explain how human needs or wants related to transportation can be met through a new or improved vehicle or vehicle system;

**TF1.02** – apply the following steps of the design process to solve a variety of transportation technology challenges or problems, including problems involving lubrication, cooling, electrical/electronic, fuel intake and exhaust, emission control, suspension and steering, brake, and structural vehicle systems:

- identify what has to be accomplished (the problem);
- gather and record information, and establish a plan of procedures;
- brainstorm a list of as many solutions as possible;
- identify the resources required for each suggested solution, and compare each solution to the design criteria, refining and modifying it as required;
- evaluate the solutions (e.g., by testing, modelling, and documenting results) and choose the best one;
- produce presentation and working drawings, sketches, graphics, mathematical and physical models, or a prototype of the best solution;
- evaluate the prototype and determine the resources, including computer applications, required to produce it;
- communicate the solution, using one or more of the following: final drawings, graphs, charts, sketches, technical reports, electronic presentations, flow charts, mock-ups, models, prototypes, and so on;
- obtain feedback on the final solution and repeat the design process if necessary to refine or improve the solution.

**Vehicle Systems**

**TF2.01** – analyse and describe possible modifications to each of the following systems that are common to vehicles designed for the land, sea, or air: the chassis, frame, and body system; the engine system; the cooling system; the fuel system; the electrical/ electronics system; the gear and power train system; the steering system; the brake system; the suspension system;

**TF2.02** – explain the effects of modifications to any of a vehicle's components on the vehicle's other systems.

**Energy and Energy Conversion**

**TF3.01** – identify differences between the conversion of energy into power in gasoline and diesel engines;

**TF3.02** – identify and compare the different torque and power characteristics of gasoline and diesel engines.

## Skills and Processes

### Overall Expectations

**SPV.01** · work effectively as members of a team;
**SPV.02** · consult appropriate reference materials when servicing and repairing systems;
**SPV.03** · use current technology and a variety of troubleshooting techniques to service systems to meet manufacturers' performance specifications;
**SPV.04** · communicate ideas and transmit information about materials and specifications effectively when working with others;
**SPV.05** · demonstrate a working knowledge of fundamental mathematics and the scientific principles required to service, repair, and modify vehicles.

### Specific Expectations

**Organizational Skills**

**SP1.01** – demonstrate the following skills: the ability to accept responsibility, delegate tasks when appropriate, communicate effectively, resolve conflicts, manage time effectively, and set goals;
**SP1.02** – work effectively with team members to identify the optimum order of operations; determine the availability of tools, parts, and equipment; develop scheduling requirements; and obtain information needed to plan and prepare for the fabrication or repair process.

**Applied Work Practices and Procedures**

**SP2.01** – use correctly, store safely, and maintain in good working order the measurement, hand, power, machine, and pneumatic tools and equipment required for service, repair, and modification tasks;
**SP2.02** – safely operate a variety of heating, cutting, and welding equipment for service repair and modification tasks;
**SP2.03** – systematically troubleshoot problems arising from the service, repair, and modification of vehicles by organizing the variables into the following categories: input, process, and output.

**Communication Skills**

**SP3.01** – communicate project ideas effectively using scale drawings and sketches;
**SP3.02** – fill in work orders to communicate the materials used and the work practices and procedures related to the job;
**SP3.03** – communicate in a clear, concise, and accurate manner when working with colleagues and clients;
**SP3.04** – interpret detailed working drawings developed by computer-assisted drafting programs (CAD);
**SP3.05** – consult appropriate repair manuals for procedures, schematics, and specifications, and apply them in the repair, service, and modification of vehicle components and systems;
**SP3.06** – develop and present effective oral and written reports on service and repair methods, using technical language appropriately.

**Interdisciplinary Applications**

**SP4.01** – use mathematics to calculate electrical, mechanical, and fluid power;
**SP4.02** – apply scientific principles when determining states of matter and mechanical advantage, and when working with advanced electrical theory within the context of transportation technology.

## Impact and Consequences

### Overall Expectations

**ICV.01** · evaluate the environmental impacts of using specific products and processes, and recommend alternative methods and materials to reduce any negative impacts;

**ICV.02** · develop and conduct effective safety audits and inspections of the school transportation facility and implement a plan to address any deficiencies;

**ICV.03** · describe the role of legislation related to the transportation sector and identify its implications for the school transportation facility and for the transportation sector generally;

**ICV.04** · identify the career opportunities available through apprenticeships and other training programs related to transportation technology, and assess the aptitudes required for such opportunities;

**ICV.05** · demonstrate the employability skills required for success in the workplace.

## Specific Expectations

**Impacts**

**IC1.01** – evaluate any negative environmental impact of procedures used in the repair and service of vehicles, and suggest environmentally friendly alternatives;

**IC1.02** – recommend an effective process for collecting and recycling materials and fluids;

**IC1.03** – handle waste products safely and be able to implement an emergency action plan in the event of a minor spill;

**IC1.04** – identify the procedures required to eliminate the release of ozone-depleting substances by applying provincial or federal standards during the servicing of mobile air-conditioning units.

**Safety and Legislation**

**IC2.01** – demonstrate good housekeeping practices in the work environment by cleaning up spills and leaks, keeping areas clean and clear of obstruction, and storing tools and equipment so that the potential for injuries is minimized;

**IC2.02** – use safe work practices in the transportation technology program;

**IC2.03** – develop comprehensive safety checklists for applied work practices and procedures;

**IC2.04** – use all required protective clothing and gear (e.g., to protect the eyes, hands, head, feet, and respiratory system) when working in the transportation sector;

**IC2.05** – identify and adhere to the aspects of the Occupational Health and Safety Act (OHSA), the Workplace Hazardous Materials Information System (WHMIS), and the Motor Vehicle Repair Act that relate to procedures and operations used in the school transportation technology facility.

**Education, Training, and Career Opportunities**

**IC3.01** – describe the wide range of career opportunities available in the transportation sector;

**IC3.02** – identify the training required to enter apprenticeships for different careers in the transportation sector;

**IC3.03** – demonstrate the employability skills identified by the Conference Board of Canada.

## Ontario Catholic School Graduate Expectations

**The graduate is expected to be:**

**A Discerning Believer Formed in the Catholic Faith Community** who

**CGE1a** -illustrates a basic understanding of the **saving story** of our Christian faith;
**CGE1b** -participates in the **sacramental life** of the church and demonstrates an understanding of the centrality of the Eucharist to our Catholic story;
**CGE1c** -actively reflects on **God's Word** as communicated through the Hebrew and Christian scriptures;
**CGE1d** -develops attitudes and values founded on Catholic **social teaching** and acts to promote social responsibility, human solidarity and the common good;
**CGE1e** -speaks the **language of life**... "recognizing that life is an unearned gift and that a person entrusted with life does not own it but that one is called to protect and cherish it." (Witnesses to Faith)
**CGE1f** -seeks intimacy with God and celebrates **communion** with God, others and creation through prayer and worship;
**CGE1g** -understands that one's purpose or **call in life** comes from God and strives to discern and live out this call throughout life's journey;
**CGE1h** -respects the **faith traditions**, world religions and the life-journeys **of all people of good will**;
**CGE1i** -integrates faith with life;
**CGE1j** -recognizes that "sin, human weakness, conflict and forgiveness are part of the human journey" and that the cross, the ultimate sign of forgiveness is at the heart of **redemption**. (Witnesses to Faith)

**An Effective Communicator** who
**CGE2a** -listens actively and critically to understand and learn in light of gospel values;
**CGE2b** -reads, understands and uses written materials effectively;
**CGE2c** -presents information and ideas clearly and honestly and with sensitivity to others;
**CGE2d** -writes and speaks fluently one or both of Canada's official languages;
**CGE2e** -uses and integrates the Catholic faith tradition, in the critical analysis of the arts, media, technology and information systems to enhance the quality of life.

**A Reflective and Creative Thinker** who
**CGE3a** -recognizes there is more grace in our world than sin and that hope is essential in facing all challenges;
**CGE3b** -creates, adapts, evaluates new ideas in light of the common good;
**CGE3c** -thinks reflectively and creatively to evaluate situations and solve problems;
**CGE3d** -makes decisions in light of gospel values with an informed moral conscience;
**CGE3e** -adopts a holistic approach to life by integrating learning from various subject areas and experience;
**CGE3f** -examines, evaluates and applies knowledge of interdependent systems (physical, political, ethical, socio-economic and ecological) for the development of a just and compassionate society.

**A Self-Directed, Responsible, Life Long Learner** who

**CGE4a** -demonstrates a confident and positive sense of self and respect for the dignity and welfare of others;
**CGE4b** -demonstrates flexibility and adaptability;
**CGE4c** -takes initiative and demonstrates Christian leadership;
**CGE4d** -responds to, manages and constructively influences change in a discerning manner;
**CGE4e** -sets appropriate goals and priorities in school, work and personal life;
**CGE4f** -applies effective communication, decision-making, problem-solving, time and resource management skills;
**CGE4g** -examines and reflects on one's personal values, abilities and aspirations influencing life's choices and opportunities;
**CGE4h** -participates in leisure and fitness activities for a balanced and healthy lifestyle.

**A Collaborative Contributor** who

**CGE5a** -works effectively as an interdependent team member;
**CGE5b** -thinks critically about the meaning and purpose of work;
**CGE5c** -develops one's God-given potential and makes a meaningful contribution to society;
**CGE5d** -finds meaning, dignity, fulfillment and vocation in work which contributes to the common good;
**CGE5e** -respects the rights, responsibilities and contributions of self and others;
**CGE5f** -exercises Christian leadership in the achievement of individual and group goals;
**CGE5g** -achieves excellence, originality, and integrity in one's own work and supports these qualities in the work of others;
**CGE5h** -applies skills for employability, self-employment and entrepreneurship relative to Christian vocation.

**A Caring Family Member** who

**CGE6a** -relates to family members in a loving, compassionate and respectful manner;
**CGE6b** -recognizes human intimacy and sexuality as God given gifts, to be used as the creator intended;
**CGE6c** -values and honours the important role of the family in society;
**CGE6d** -values and nurtures opportunities for family prayer;
**CGE6e** -ministers to the family, school, parish, and wider community through service.

**A Responsible Citizen** who

**CGE7a** -acts morally and legally as a person formed in Catholic traditions;
**CGE7b** -accepts accountability for one's own actions;
**CGE7c** -seeks and grants forgiveness;
**CGE7d** -promotes the sacredness of life;
**CGE7e** -witnesses Catholic social teaching by promoting equality, democracy, and solidarity for a just, peaceful and compassionate society;
**CGE7f** -respects and affirms the diversity and interdependence of the world's peoples and cultures;
**CGE7g** -respects and understands the history, cultural heritage and pluralism of today's contemporary society;
**CGE7h** -exercises the rights and responsibilities of Canadian citizenship;
**CGE7i** -respects the environment and uses resources wisely;
**CGE7j** -contributes to the common good.

# Unit 1: Electronic Engine Controls

**Time:** 35 hours

## Unit Description

Students study the operating principles of devices that monitor and alter engine operation of land, marine and air vehicles. Students learn the names, operation and test procedures of key engine sensors and actuators, as well as their relationship to each other and to the vehicle's computer. Students also develop diagnostic strategies to be used in testing and servicing these devices and systems. Personal safety and safety regulations are reinforced throughout the unit activities. The activities and skills learned in this course reflect industry standards delivered with the honesty, values, and integrity of social teachings.

## Unit Synopsis Chart

| Activity | Time | Learning Expectations | Assessment Categories | Tasks |
|---|---|---|---|---|
| 1.1 System Theory and Operation | 6 hours | TFV.02, TFV.03, TF2.01, TF2.02, SPV.05, SP4.01, SP4.02 | Knowledge/ Understanding<br>Thinking/Inquiry<br>Communication<br>Application | • using teacher-supplied base engine sensors and actuators, use a Digital Volt/Ohm Meter (DVOM) to check for faults by measuring voltage and resistance and comparing them to manufacturers' specifications |
| 1.2 System Diagnostics | 8 hours | TFV.01, TF1.02, SPV.02, SP3.01, SP3.05, SP3.06 | Knowledge/ Understanding<br>Thinking/Inquiry<br>Communication<br>Application | • research and perform various code-retrieval techniques, then retrieve codes with and without the use of an automotive scanner<br>• use service manuals to prepare a Trouble Tree to diagnose faults |
| 1.3 System Service | 21 hours | SPV.03, SP2.01, SP2.03, SP3.05 | Thinking/Inquiry<br>Application | • use the corrected Trouble Tree designed in Activity 1.2 to service the system according to manufacturers' specifications |

## Activity 1.1: System Theory and Operation

**Time:** 6 hours

### Description

In this activity students identify and state the purpose of various teacher-supplied computer controlled sensors and actuators. Students measure the voltage and resistance in each of these base-engine sensors and diagnose them by comparing them to manufacturers' specifications. Students analyse and describe a variety of component functions and modifications and their effect on the interrelationship of the vehicle systems.

### Strand(s) & Learning Expectations

**Strand(s):** Theory and Foundation, Skills and Processes

**Overall Expectations**

TFV.02 - analyse and describe a variety of system modifications and their effect on the interrelationship of vehicle systems;
TFV.03 - identify the commonalities of systems in land, air, and marine vehicles;
SPV.05 - demonstrate a working knowledge of fundamental mathematics and the scientific principles required to service, repair, and modify vehicles.

**Specific Expectations**

TF2.01 - analyse and describe possible modifications to each of the following systems that are common to vehicles designed for the land, sea or air: the chassis, frame and body system; the engine system; the cooling system; the fuel system; the electrical/electronics system; the gear and power train system; the steering system; the brake system; the suspension system;
TF2.02 - explain the effects of modifications to any of a vehicle's components on the vehicle's other systems;
SP4.01 - use mathematics to calculate electrical, mechanical, and fluid power;
SP4.02 - apply scientific principles when determining states of matter and mechanical advantage, and when working with advanced electrical theory within the context of transportation technology.

### Prior Knowledge & Skills

- Basic understanding of electrical circuitry as well as an understanding of the three tenants of electricity: Current, Voltage, and Resistance.
- Awareness of basic hand tool safety in a transportation lab.
- Ability to use test lights and multi-meters appropriately.
- Awareness of the concerns regarding electrical safety.

### Planning Notes

- Students should have access to a variety of late model sensors, actuators, and electronic control modules. Used or recalled sensors of this type can usually be acquired from an automotive recycler, donation vehicle, or local dealership for little or no cost. The instructor must tag each component with the following information: part name, year, model, type of vehicle, and type/model of engine. This allows students to accurately obtain manufacturer's specifications from the appropriate shop manual.
- Ideally the students should have access to a complete vehicle (or least a functioning drive train) to remove, test, and replace components. This allows the students to monitor the sensors and their effect on the system when they receive reference voltages and operate normally.

- The use of an analog meter on modern fuel injected vehicles should be prohibited as it can damage the vehicle's computer system. Therefore, the students must have access to Meters (DVOM). As these are sensitive instruments, students must receive instruction on their use, care, and maintenance.
- When testing a vehicle's electronic fuel injection system, Electrostatic Discharge (ESD) can cause damage to some of the vehicle's more fragile components. To eliminate the risk of ESD damage to the vehicle's computer a grounding wrist strap should be worn. Wrist straps are available at a minimal cost from most automotive supply stores.
- A modern automotive textbook or software tutorials containing a detailed section on electronic engine control can be provided to assist students in understanding the theoretical aspects of this activity.

### Teaching/Learning Strategies

- To ensure that students are fully aware of all safety features on each piece of equipment in the technical facility prior to using it independently, the required safety instruction and performance is tracked using the Safety Passport (Appendix A – Safety Passport).
- The teacher and students discuss the theory and operation of electronic engine control and fuel metering systems. Students review the correct method for using a DVOM to test for Current, Voltage and Resistance as well as the care and maintenance of a DVOM. Students complete independent reading assignments from available text or computer-based resources.
- Students work in small groups to practise using the DVOM and to understand its various functions.
- The teacher demonstrates the correct use of a wrist strap or other means of neutralizing the dangers and effects of ESD and discusses the damage that can be caused by analog meters.
- The teacher introduces base engine sensors (a list of base engine sensors can be found in Appendix 1.1.1 – Base Engine Sensors) and students compare resistance readings to manufacturers' specifications using a DVOM.
- Using the information found on a tag attached to each sensor, the students consult a shop manual to identify the component specifications and testing procedure. The students use a DVOM to measure the resistance of the sensor and the voltage going into and out of the sensor (if it is still attached to a complete fuel injection system). Students note any discrepancies between the actual readings and reading found in the specifications portion of the manual.
- Students complete diagnosis of several sensors and record their findings in their notes (see Appendix 1.1.3 – Electronic Engine Control).

### Assessment & Evaluation of Student Achievement

| Task/Product | Tool | Purpose | Achievement Chart Categories |
|---|---|---|---|
| Skills Assessment | Safety passport | Diagnostic | Application<br>Knowledge/Understanding |
| Testing Sensors | Rubric<br>(Appendix 1.1.2) | Formative | Thinking/Inquiry<br>Application |
| Written/Verbal Report of Findings | Marking Scheme | Summative | Knowledge/Understanding<br>Thinking/Inquiry<br>Communication |

## Accommodations

The teacher consults individual student IEPs for specific direction on accommodation and adapts the activity and teaching strategies to meet the needs of individual students. Accommodation strategies may include:

- allowing those students who are excelling at the activity to assist those who are struggling;
- permitting verbal testing and oral assignments in lieu of written tests;
- allowing extra time to complete exercises and activities;
- including one-on-one teacher assistance;
- encouraging students to diagnose more complex sensors or prepare individual research projects relating to the topic, for enrichment.

## Resources

### Print

Chapman, Norm. *Principles of Electricity and Electronics for the Automotive Technician.* South Puget Sound Community College: Delmar, 2000. ISBN 0-8273-8479-3

Crouse, W., D. Anglin, and W. Crouse. *Automotive Mechanics.* USA: Glencoe McGraw-Hill, 1993. ISBN 0028009436

Derato, Frank C. *Automotive Electrical and Electronics Systems*, 2nd ed. USA: Glencoe Division Macmillian/McGraw-Hill, 1994. ISBN 0-02-800412-4

Duffy, James E. *Auto Electricity and Electronics Technology.* Illinois: Goodheart-Wilcox, 1995. ISBN 1-56637-053-1

Erjavec, Jack. *Automotive Technology: A Systems Approach,* 3rd ed. USA: Delmar Thomas Learning, 2000. ISBN 0-7668-0673-1

Hollembeak, Barry. *Automotive Electricity, Electronics and Computer Controls.* USA: Technical Training, Inc., Delmar, 1999. ISBN 0-8273-6566-7

Kabala, Thomas. *Electricity 1: Devices, Circuits and Materials.* USA: Delmar: 2001. ISBN 0-7668-1917-5

Schwaller, Anthony, E. *Motor Automotive Technology.* Cloud State University: Delmar, 1999. ISBN 0-8273-8354-1

Thiessen, Frank J. and Davis N. Dales. *Automotive Principles and Service,* 4th ed. New Jersey: Prentice Hall, 1994. ISBN 0-13-336561-1

OEM Reference and Repair Manuals/CD-ROMs, available from local dealerships

### Videos

*Understanding Auto Technology and Repair* Video Series – Tape 3: "Understanding Automotive Electricity." Delmar, 2000. ISBN 0-7668-0794-0

*Understanding Auto Technology and Repair* Video Series – Tape 4: "How to Diagnose Automotive Electrical Problems." Delmar, 2000. ISBN 0-7668-0795-9

*Understanding Auto Technology and Repair* Video Series – Tape 5: "Understanding Automotive Electronics." Delmar, 2000. ISBN 0-7668-0796-7

*Understanding Auto Technology and Repair* Video Series – Tape 6: "How to Diagnose Automotive Electronics Problems." Delmar, 2000. ISBN 0-7668-0797-5

**Websites**

How Stuff Works – http://www.howstuffworks.com/
A website containing descriptions of how various technical devices function

Inner Auto – http://www.innerauto.com/
An exploration of inner functions of the automobile

The Learning Tree Mechanic – www.autovideo2000.com
Help for the do-it yourself mechanic

**Software**

Computerized Service Manuals

## Appendix 1.1.1

### Basic Engine Sensors

| Component | Function |
|---|---|
| Oxygen Sensor | Sensor(s) located inside of the exhaust system – detects amount of oxygen content inside of exhaust gases and other functions |
| Coolant Temperature Sensor | Thermistor that is located within the water jacket – senses the general temperature of the engine by reading the temperature of the coolant and other functions |
| MAP Sensor/Barometric Pressure Sensor | Senses load on the engine by measuring the amount of vacuum inside the intake manifold and other functions |
| Throttle Position Sensor | Potentiometer that is attached to the throttle body – senses the amount the throttle plate is open |

## Appendix 1.1.2

### Sample Assessment Rubric for Unit 1 Activities – Electronic Engine Control

| Criteria | Level 1 (50-59%) | Level 2 (60-69%) | Level 3 (70-79%) | Level 4 (80-100%) |
|---|---|---|---|---|
| **Knowledge/ Understanding**<br>- describes the function of vehicle engine sensors and their effect on electronic engine control systems | - limited ability to identify and describe the functions of engine sensors | - some ability to identify and describe the functions of engine sensors | - considerable ability to identify and describe the functions of engine sensors | - high degree of ability to identify and describe the functions of engine sensors |
| **Thinking/Inquiry**<br>- locates the proper electrical specification for an electrical sensor and determines whether or not it is faulty | - locates the electrical specification of a few of the sensors provided | - locates the electrical specification of a few of the sensors provided and accurately diagnoses their condition | - locates the electrical specification of several of the sensors provided and accurately diagnoses their condition | - locates the electrical specification of the sensors provided and accurately diagnoses their condition |
| **Application**<br>- uses DVOM correctly | - uses DVOM to determine sensor specifications with limited accuracy | - uses DVOM to determine sensor specifications with some accuracy | - uses DVOM to determine sensor specifications with considerable accuracy | - uses DVOM to determine sensor specifications with a high degree of accuracy |

**Note:** A student whose achievement is below Level 1 (50%) has not met the expectations for this assignment or activity.

## Appendix 1.1.3

### Electronic Engine Control

**Worksheet 1** **Name: _____**

| General Information | | | DVOM Readings | | |
|---|---|---|---|---|---|
| Sensor | Function | Resistance | Voltage In | Voltage Out | Diagnosis |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

## Activity 1.2: System Diagnostics

**Time:** 8 hours

### Description

In this activity the students retrieve trouble codes utilizing the vehicle's computer-equipped self-diagnosis capability. Students also use a hand-held diagnostic scanner to acquire codes and data streams on on-board data diagnosis-equipped (OBD I and OBD II) vehicles. Students research the trouble codes using industry standard texts and computer programs and complete a trouble tree to diagnose the specific faulty system.

### Strand(s) & Learning Expectations

**Strand(s):** Theory and Foundation, Skills and Processes

**Overall Expectations**

TFV.01 - apply the design process to develop solutions, products, processes, or services in response to challenges or problems related to vehicles or vehicle systems;
SPV.02 - consult appropriate reference materials when servicing and repairing systems.

**Specific Expectations**

TF1.02 - apply the following steps of the design process to solve a variety of transportation technology challenges or problems, including problems involving lubrication, cooling, electrical/electronic, fuel intake and exhaust, emission control, suspension and steering, brake and structural vehicle systems:

- identify what has to be accomplished (the problem);
- gather and record information, and establish a plan of procedures;
- brainstorm a list of as many solutions as possible;
- identify the resources required for each suggested solution and compare each solution to the design criteria, refining and modifying it as required;
- evaluate the solutions (e.g., by testing, modelling and documenting results) and choose the best one;
- produce presentation and working drawings, sketches, graphics, mathematical and physical models, or a prototype of the best solution;
- evaluate the prototype and determine the resources, including computer applications, required to produce it;
- communicate the solution using one or more of the following: final drawings, graphs, charts, sketches, technical reports, electronic presentations, flow charts, mock-ups, models, prototypes and so on;
- obtain feedback on the final solution and repeat the design process if necessary to refine or improve the solution;

SP3.01 - communicate project ideas effectively using scale drawings and sketches;
SP3.05 - consult appropriate repair manuals for procedures, schematics and specifications, and apply them in the repair, service, and modification of vehicle components and systems;
SP3.06 - develop and present effective verbal and written reports on service and repair methods, using technical language appropriately.

### Prior Knowledge & Skills

- Knowledge of electrical circuitry and the possible damage caused by electro static discharge (ESD)
- Safe and competent use of basic hand tools from the prerequisite course

## Planning Notes

- Students who wish to read vehicle trouble codes must have access to a fully functioning OBD 1 chassis or complete vehicle. Vehicles that have been donated to the program are preferred due to the potential risk of damage to on-board control systems.
- The instructor may create fault codes within one of the systems, e.g., fuel injection system. Faults can be created in a variety of ways depending upon the type of system that is used by the particular vehicle, e.g., fuel metering control system. Most faults can be created by causing an open or ground in wiring, disconnecting a vacuum line or running the vehicle with a sensor disconnected. The teacher should first check a wiring schematic to find how a fault can be created without permanently damaging the vehicle.
- Students who wish to read codes on vehicles built from 1995 and later (OBD II) must use a scanner to read codes because no manual code-reading process exists. Though many expensive automotive scanners are available, less complex and inexpensive models are also available at many auto parts suppliers. These can also read trouble codes on most pre-1995 "On-Board Diagnostics (OBD) Generation One" electronic fuel injected vehicles.
- The teacher must also provide students with an example of a "Trouble Tree" and teach the students how to read them and eventually use them as a diagnostic tool. This can be accomplished by handing out several examples of trouble trees obtained from shop manuals.
- A modern automotive textbook that has a detailed chapter on electronic engine control can be provided to deliver background and supplement to the practical and theory position of this activity.

## Teaching/Learning Strategies

- The teacher and students discuss the fundamentals of electronic fuel injection and the capability of modern electronic fuel injection systems for self-diagnosis. A discussion on how the system works as well as why the computer has a self-diagnostic capability is addressed.
- An initial lesson on electronic engine control self-diagnosis is necessary to prepare students for the practical aspects of the activity. The teacher demonstrates accessing trouble codes with and without a scanner.
- The students manually read the teacher-generated codes within the vehicle computer (Appendix 1.2.1 – Obtaining Codes Manually). Students note which codes are present at this time.
- Students refer to the appropriate shop manual and research a detailed explanation of the problem to find a diagnostic procedure to correct the displayed fault code (Appendix 1.2.2 – Electronic Engine Control Worksheet 2).
- Students repeat this process researching an array of different codes on different vehicles.
- When students have mastered the manual code retrieval process, they use a scan tool to access codes. With teacher assistance, the students hook up an automotive scanner to an operating vehicle and complete the code-reading process. Students note the trouble codes that are present in this vehicle and refer to the appropriate shop manual for the required diagnostic procedure.
- Students design a computer-generated trouble tree from the information that they have obtained from the shop manual (Teacher should provide samples of trouble tree charts). This trouble tree is used to accurately diagnose the teacher-created fault that has occurred in the system. The chart is then submitted for marking.
- The teacher marks and corrects students' trouble tree charts and returns them to the students for use in Activity 1.3 – System Service.

### Assessment & Evaluation of Student Achievement

| Task/Product | Tool | Purpose | Achievement Chart Categories |
|---|---|---|---|
| Manual Code Retrieval Process | Observation | Formative | Knowledge/Understanding<br>Thinking/Inquiry<br>Application |
| Scan Tool/Usage | Observation | Formative | Application |
| Trouble Tree | Marking Scheme | Summative | Thinking/Inquiry<br>Communication<br>Application |

### Accommodations

- for enrichment, having students create the trouble tree using AutoCAD, diagnose more complex problems or work on more complex faults.

### Resources

**Print**

Chapman, Norm. *Principles of Electricity and Electronics for the Automotive Technician.* South Puget Sound Community College: Delmar, 2000. ISBN 0-8273-8479-3

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Inner Auto – http://www.innerauto.com/
An exploration of inner functions of the automobile

The Learning Tree Mechanic – www.autovideo2000.com
Help for the do-it yourself mechanic

**Software**

Computerized service manuals

## Appendix 1.2.1

### Obtaining Codes Manually

**Energizing Self-Diagnosis Without the Use of a Scanner**
All three major domestic auto manufacturers have self-energizing capabilities in the fuel injection systems of their OBD I automobiles. This enables the instructor and students to access trouble codes without the use of a scanner.

**These procedures are:**

*General Motors Trouble Codes:*
1. Locate diagnostic connector. It is usually located underneath the fuse panel or behind the glove box.
2. Use a jumper wire or paper clip to cross connections designated to start self-diagnosis (usually A and B terminals).
3. Watch the "Service Engine Soon" or "Check Engine" light flash in a Morse code fashion. One flash, a pause and then three flashes would indicate Code Thirteen.
4. Refer to trouble code chart in service manual for detailed explanation of fault.
5. Test circuit and compare to manufacturer's specifications.

*Daimler Chrysler Trouble Codes*
1. Though Chrysler does provide a diagnostic connector in the engine compartment of OBD I controlled vehicles, it is normally not needed unless a hand held scanner is available.
2. To access trouble codes, turn the key on and off three times within five seconds – Turn the key on, then off, then on, then off and then leave the key on.
3. As with General Motors trouble codes, count the number of times the service engine soon light flashes. One flash and then three flashes would indicate Trouble Code Thirteen.
4. Refer to trouble code chart in service manual for detailed explanation of fault.
5. Test circuit and compare to manufacturer's specifications.

*Ford Trouble Codes:*
1. Locate diagnostic connector. It can usually be found attached to the firewall, fender or near the engine intake manifold.
2. Connect an analog or needle type VOM to the designated terminals in the diagnostic connector.
3. Connect a jumper wire to between the designated terminal in the connector and the pigtail that is found near the connector.
4. Count the number of needle movements and record and read them in the same fashion as a flashing Service Engine Soon light in a Chrysler or General Motors vehicle.
5. Refer to trouble code chart in service manual for detailed explanation of fault.
6. Test circuit and compare to manufacturers' specifications.

## Appendix 1.2.2

### Electronic Engine Control Worksheet 2

**Fault Codes and Fault Code Reading**

Name: _____

| | **Fault Code Information** | **Diagnosis** |
|---|---|---|
| Code # | Code Description | Possible Causes |
| 33 | MAP Sensor Voltage High | Internal engine damage<br>Faulty ECM<br>Faulty MAP Sensor<br>Broken and/or shorted wiring or connections<br>Plugged or leaking vacuum hose |
| | | |
| | | |
| | | |
| | | |

## Activity 1.3: System Service

**Time:** 21 hours

### Description

Students use the teacher-checked trouble tree designed in Activity 1.2 System Diagnostics to diagnose and repair a fault in a specific circuit. Using troubleshooting tools such as a scanner, DVOM, and repair manuals, the students repair a teacher-created system fault according to manufacturers' specifications.

### Strand(s) & Learning Expectations

**Strand(s):** Skills and Processes

**Overall Expectations**

SPV.03 - use current technology and a variety of troubleshooting techniques to service systems to meet manufacturers' performance specifications.

**Specific Expectations**

SP2.01 - use correctly, store safely, and maintain in good working order the measurement, hand, power, machine and pneumatic tools, and equipment required for service, repair, and modification tasks;
SP2.03 - systematically troubleshoot problems arising from the service, repair, and modification of vehicles by organizing the variables into the following categories: input, process, and output;
SP3.05 - consult appropriate repair manuals for procedures, schematics and specifications, and apply them in the repair, service, and modification of vehicle components and systems.

### Prior Knowledge & Skills

- Knowledge of safety practices when working with electrical circuitry
- Hand tool safety
- Basic understanding of electrical circuitry as well as an understanding of the three tenants of electricity: Current, Voltage, and Resistance
- Ability to use test lights and multi-meters correctly
- Ability to repair wiring faults using a soldering iron, rosin-cored solder, and shrink tube
- Ability to splice and connect wiring correctly using a crimping tools and electrical connectors

### Planning Notes

- In preparation for this activity the students require electrical repair tools and supplies such as a soldering iron, wire stripper, rosin-core solder, electrical tape, and assorted lengths of automotive wire.
- Only rosin-core solder or rosin-flux solder may be used in the repair of automotive electrical wiring. Acid core and acid flux cause corrosion and deteriorate the wire resulting in a poor electrical connection.
- Disconnect the negative terminal of the battery before commencing with the repair procedure. Failure to disconnect the battery could lead to vehicle or system damage as well as injury to the student.
- Students must be provided with safety glasses, which must be worn when working with batteries.
- If the technical shop/classroom does not have the ventilation required for soldering, students must be provided with face masks to wear when soldering.

### Teaching/Learning Strategies

- Students observe a demonstration on the proper techniques for repairing a wiring fault, as well as the replacement of a base engine sensor. The teacher and students discuss the steps for properly repairing a wiring fault. The teacher emphasizes the safety aspects of this procedure.
- Using scrap lengths of wire and soldering or crimping tools, students perform proper repairing techniques. Students must be instructed to avoid breathing the fumes created while soldering. Students use a DVOM to ensure that there is minimal resistance in the repair that has been performed. Students shrink-wrap their repair to ensure that rust and corrosion does not occur.
- Students use the teacher-corrected trouble tree that they designed in Activity 1.2 System Diagnostics as well as a scanner, test light, and DVOM to repair the teacher-created fault in the Electronic Engine Control system. The faults that students encounter range from broken or disconnected wires, faulty sensors or actuators, grounded wires and disconnected vacuum lines.
- With approval of the instructor, students repair the system using manufacturers' recommendations, under teacher supervision. Once the repair has been checked for resistance, the battery is reconnected and vehicle is tested and checked for further trouble-codes.

### Assessment & Evaluation of Student Achievement

| Task/Product | Tool | Purpose | Achievement Chart Categories |
|---|---|---|---|
| Repair Demonstration | Observation<br>Conferencing | Formative | Thinking/Inquiry<br>Application |
| Repair | Marking Scheme | Summative | Thinking/Inquiry<br>Application |

### Accommodations

- having the student describe to the teacher how the repair should be performed in lieu of performing the actual repair process;
- for enrichment, having the student repair more complex faults, diagnose actual faults on vehicles, or assist the teacher in creating faults for other students to diagnose and repair.

### Resources

**Print**

Chapman, Norm. *Principles of Electricity and Electronics for the Automotive Technician.* South Puget Sound Community College: Delmar, 2000. ISBN 0-8273-8479-3

Crouse, W., D. Anglin, and W. Crouse. *Automotive Mechanics.* USA: Glencoe McGraw-Hill, 1993. ISBN 0028009436

Derato, Frank C. *Automotive Electrical and Electronics Systems,* 2nd ed. USA: Glencoe Division, Macmillian/McGraw-Hill, 1994. ISBN 0-02-800412-4

Duffy, James E. *Auto Electricity and Electronics Technology.* Illinois: Goodheart-Wilcox, 1995. ISBN 1-56637-053-1

Erjavec, Jack. *Automotive Technology: A Systems Approach,* 3rd ed. USA: Delmar Thomas Learning, 2000. ISBN 0-7668-0673-1

Hollembeak, Barry. *Automotive Electricity, Electronics and Computer Controls.* USA: Technical Training, Inc., Delmar, 1999. ISBN 0-8273-6566-7

Kabala, Thomas. *Electricity 1: Devices, Circuits and Materials.* USA: Delmar, 2001. ISBN 0-7668-1917-5

Schwaller, Anthony, E. *Motor Automotive Technology.* Cloud State University: Delmar, 1999. ISBN 0-8273-8354-1

Thiessen, Frank J. and Davis N. Dales. *Automotive Principles and Service,* 4th ed. New Jersey: Prentice Hall, 1994. ISBN 0-13-336561-1

OEM Reference and Repair Manuals/CD-ROMs, available from local dealerships

**Videos**

Several videos are available from The Learning Tree Mechanic (http://www.autovideo2000.com), or Thompson/Delmar Learning (AutoEd.com: http://www.autoed.com/)

Understanding Auto Technology and Repair Video Series – Tape 3: "Understanding Automotive Electricity." Delmar, 2000. ISBN 0-7668-0794-0

Understanding Auto Technology and Repair Video Series – Tape 4: "How to Diagnose Automotive Electrical Problems." Delmar, 2000. ISBN 0-7668-0795-9

Understanding Auto Technology and Repair Video Series – Tape 5: "Understanding Automotive Electronics." Delmar, 2000. ISBN 0-7668-0796-7

Understanding Auto Technology and Repair Video Series – Tape 6: "How to Diagnose Automotive Electronics Problems." Delmar, 2000. ISBN 0-7668-0797-5

**Websites**

How Stuff Works – http://www.howstuffworks.com/
A website containing descriptions of how various technical devices function

Inner Auto – http://www.innerauto.com/
An exploration of inner functions of the automobile

The Learning Tree Mechanic – www.autovideo2000.com
Help for the do-it yourself mechanic

**Software**

Computerized service manuals

# Unit 3: Braking Systems

**Time:** 35 hours

## Unit Description

Students learn to explain the basic principles, components, and operation of hydraulic brakes, power brakes, and antilock braking systems for land and air vehicles. Emphasis is placed on preparing students to enter the workplace with the hands-on skills required to inspect, service, and repair braking systems to meet manufacturers' specifications and local industry standards. Students learn how to retrieve antilock braking systems trouble codes, test sensors, and analyse trouble shooting flow charts. The activities and skills learned in this activity reflect industry standards and are delivered with the honesty and integrity of our social teachings. Personal safety and safety standards are reinforced throughout the unit activities.

## Unit Synopsis Chart

| Activity | Time | Learning Expectations | Assessment Categories | Tasks |
|---|---|---|---|---|
| 3.1<br>System Theory and Operation | 6 hours | TFV.02, TF2.01, SPV.04, SPV.05, SP2.01, SP4.01, SP4.02<br>CGE3b, CGE2b | Knowledge/ Understanding<br>Communication | • principles of hydraulics, static/kinetic and coefficients of friction<br>• identify brake components and describe their operation |
| 3.2<br>Service, Inspect and Repair front and rear disc/drum braking systems | 12 hours | TF1.01, SPV.02, SPV.03, SPV.05, SP2.01, SP2.03, SP3.02, SP3.05, IC2.02, IC2.03, IC2.03, IC2.04, ICV.05<br>CGE3c, CGE5h | Knowledge/ Understanding<br>Thinking/ Inquiry<br>Application | • disassemble, inspect, and re-assemble drum and/or disc brake components of a selected shop vehicles or workstations |
| 3.3<br>ABS System operation and comparison | 8 hours | SPV.02, SPV.01, SPV.03, ICV.05, SP2.01, SP2.02, SP3.02, SP3.05, IC2.02, IC2.03, IC2.04, IC2.05<br>CGE5g, CGE3b | Knowledge/ Understanding<br>Thinking/ Inquiry | • identify components and describe their operation<br>• identifying types of antilock systems |
| 3.4<br>System Diagnostics, Service and Testing | 9 hours | TF1.02, SPV.01, SPV.02, SPV.03, SPV.04, SPV.05, SP1.02, SP2.01, SP2.03, SP3.05, SP3.06<br>CGE1e, CGE5h | Thinking/ Inquiry<br>Communication<br>Application | • pre-diagnostic inspections<br>• warning light symptom troubleshooting<br>• wheel sensor testing<br>• trouble code retrieval<br>• trouble code diagnostics |

## Activity 3.1: Braking System Theory and Operation

**Time:** 6 hours

### Description

In this activity students develop an understanding of the basic braking system principles with the use of hydraulics, levers, and friction. Students identify and describe the operation of all the components in a front and rear disc and drum braking system. Students focus on the development of caring attitudes to create, adapt, and evaluate new ideas in light of the common good.

### Strand(s) & Learning Expectations

**Ontario Catholic School Graduate Expectations**

CGE2b - reads, understands, and uses written materials effectively;
CGE3b - creates, adapts, and evaluates new ideas in light of the common good.

**Strand(s):** Theory and Foundation, Skills and Processes

**Overall Expectations**

TFV.02 - analyse and describe a variety of system modifications and their effect on the interrelationship of vehicle systems;
SPV.04 - communicate ideas and transmit information about materials and specifications effectively when working with others;
SPV.05 - demonstrate a working knowledge of fundamental mathematics and the scientific principles required to service, repair, and modify vehicles.

**Specific Expectations**

TF2.01 - analyse and describe possible modifications to each of the following systems that are common to vehicles designed for the land, sea, or air: the chassis, frame, and body system; the engine system; the cooling system; the fuel system; the electrical/electronics system; the gear and power train system; the steering system; the brake system; the suspension system;
SP2.01 - use correctly, store safely, and maintain in good working order the measurement, hand, power, machine, and pneumatic tools and equipment required for service, repair, and modification tasks;
SP4.01 - use mathematics to calculate electrical, mechanical, and fluid power;
SP4.02 - apply scientific principles when determining states of matter and mechanical advantage, and when working with advanced electrical theory within the context of transportation technology.

### Prior Knowledge & Skills

- Awareness of basic hand tool safety
- Ability to use measurement tools accurately
- Computer skills to complete assignments and reports
- Math skills to convert metric equivalents to fractions

### Planning Notes

- The teacher must plan a lesson on the principles of hydraulics and how it used to obtain hydraulic force multiplication. Mechanical advantage must also be reviewed using the brake pedal as an example.
- The teacher plans a lesson on kinetic, static, and the coefficient of friction between brake parts, tires, and the road surface.
- Computers may be required for research and development of assignments.
- The teacher describes, using overheads, videos or computer software, the hydraulic brake system components and their operation.

- The teacher emphasises to students the importance of professionalism and skill competence to ensure the safety of people whose lives depend on proper brake operation.
- Required basic tools include brake spring tools, micrometers, and dial indicators. Other materials required for this activity include:
  - drum and disc brake assemblies (may be workstations or donated vehicles, or from actual customer vehicles). A key exercise of this activity is to compare the operations of both drum and disc type brake systems and explain their operation;
  - service manuals or other means of researching procedures and specifications;
  - brake service vacuums or catch pans with brake-parts cleaning solutions should be available. **Note:** brake dust may contain asbestos, a known health hazard. Special care must be taken to minimize exposure.

### Teaching/Learning Strategies

1. The teacher encourages students to create, adapt, and evaluate social and economic values and ideas in light of the common good. Students are asked to list the reasons it is important for taking particular care in working on brake systems, i.e., safety of citizens, protection of the public, and what steps a mechanic could take to ensure customer and public safety. This is recorded by the teacher during the discussion, as well as in each student's notebook for later use.
2. The teacher presents an initial lesson on the theory of hydraulic principles, levers, friction, and the basic braking system integrated warning devices and hydraulic safety. Students complete independent reading assignments, review questions and tests on the topic.
3. The teacher discusses brake components common to vehicles designed for the land, sea, and air.
4. The teacher demonstrates the correct use of the hand tools used for service and inspection.
5. Students demonstrate to the teacher the safe and competent use of hand tools for this activity.
6. Students work in small groups on drum and disc brake assemblies.
7. The teacher opens for discussion factors that limit braking ability. Topics include pressure, coefficient of friction, contact surface, heat dissipation, and materials of the brake lining.
8. Student-developed worksheet on hydraulic brake system components and an explanation of their operation.

### Assessment & Evaluation of Student Achievement

Students' knowledge of braking system theory and operation may be assessed in the following ways:

- written tests that allow students to demonstrate an understanding of hydraulic principles and friction;
- assignments explaining the operation of select braking components (including safety protocol). (See Appendix 3.1.1 – Evaluation Rubric for Unit 3 Activity 1 – Braking System Theory and Operation);
- verbally report on their findings.

### Accommodations

The teacher provides accommodation for those who find the assignment difficult. These accommodations may include some or all of the following:

- peer assistance to allow those students who are excelling at the activity to assist those who are finding it difficult;
- oral testing and assignments instead of written;
- allowing extra time and help to those who need more one on one assistance;
- reducing the volume of work to assist those who find the tasks difficult;
- for enrichment, students may present calculations on fluid pressures throughout the braking system components and/or prepare an individual research project relating to the topic.

## Resources

### Print

Crouse, W., D. Anglin, and W. Crouse. *Automotive Mechanics.* Glencoe McGraw-Hill, 1993. ISBN 0028009436

Erjavec, Jack. *Automotive Technology: A Systems Approach,* 3rd ed. United States: Delmar Thomas Learning, 2000. ISBN 0-7668-0673-1

Schwaller, Anthony, E. *Motor Automotive Technology*. Cloud State University: Delmar, 1999. ISBN 0-8273-8354-1

Thiessen, Frank J. and Davis N. Dales. *Automotive Principles and Service,* 4th ed. New Jersey: Prentice Hall, 1994. ISBN 0-13-336561-1

OEM Reference and Repair Manuals/CD-ROMs, available from local dealerships

### Videos

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(http://www.autovideo2000.com) or Thompson/Delmar Learning (AutoEd.com: http://www.autoed.com/)

### Websites

How Stuff Works – http://www.howstuffworks.com/
A website containing descriptions of how various technical devices function

Inner Auto – http://www.innerauto.com/
An exploration of inner functions of the automobile

The Learning Tree Mechanic – www.autovideo2000.com
Help for the do-it yourself mechanic

### Software

Computerized service manuals

## Appendix 3.1.1

### Evaluation Rubric for Unit 3 Activity 1 – Braking System Theory and Operation

| Criteria | Level 1 (50-59%) | Level 2 (60-69%) | Level 3 (70-79%) | Level 4 (80-100%) |
|---|---|---|---|---|
| **Knowledge/ Understanding**<br>- students explain the hydraulic principles of the basic braking system<br>SP4.02, TF2.01 | - demonstrates limited understanding of the hydraulic principles of the braking system | - demonstrates some understanding of the hydraulic principles of the braking system | - demonstrates considerable understanding of the hydraulic principles of the braking system | - demonstrates exceptional understanding of the hydraulic principles of the braking system |
| - students explain the function of kinetic, static, and coefficient of friction on the braking system<br>SPV.05, SP4.01 | - demonstrates limited understanding of the function of kinetic, static, and coefficient of friction | - demonstrates some understanding of the function of kinetic, static, and coefficient of friction | - demonstrates considerable understanding of the function of kinetic, static, and coefficient of friction | - demonstrates exceptional understanding of the function of kinetic, static, and coefficient of friction |
| - students identify and describe the operation of all the components of the braking system<br>SPV.04, SP2.01, TFV.02 | - demonstrates limited knowledge of the components and operation of the braking system | - demonstrates some understanding of the components and operation of the braking system | - demonstrates considerable knowledge of the components and operation of the braking system | - demonstrates high degree of knowledge of the components and operation of the braking system |
| **Communication**<br>- students can develop a worksheet on hydraulic brake system components and prepare an explanation of their operation<br>SPV.04, SPV.05 | - describes in written form the hydraulic brake system and its operation with limited effectiveness | - describes in written form the hydraulic brake system and its operation with some effectiveness | - describes in written form the hydraulic brake system and its operation with considerable effectiveness | - describes in written form the hydraulic brake system and its operation with a high degree of effectiveness |

**Note:** A student whose achievement is below Level 1 (50%) has not met the expectations for this assignment or activity.

## Activity 3.2: Brake Service

**Time:** 12 hours

### Description

Students remove and install friction material and hydraulic components. They fabricate and install new brake lines on a shop vehicle or workstation. In this activity students disassemble, inspect, and re-assemble drum and disc brake components of selected shop vehicles or workstations. The emphasis in this activity is to develop the hands-on skill required to remove, inspect, and replace brake components and brake lines to industry standards. Students apply skills for employability, self-employment, and entrepreneurship relative to Christian vocation.

### Strand(s) & Learning Expectations

**Ontario Catholic School Graduate Expectations**

CGE3f - examines, evaluates, and applies knowledge of interdependent systems for the development of a just and passionate society;
CGE5h - applies skills for employability, self-employment, and entrepreneurship relative to Christian vocation.

**Strand(s):** Theory and Foundation, Skills and Processes, Impact and Consequences

**Overall Expectations**

TFV.01 - apply the design process to develop solutions, products, processes, or services in response to challenges or problems related to vehicles or vehicle systems;
SPV.02 - consult appropriate reference materials when servicing and repairing systems;
SPV.03 - use current technology and a variety of troubleshooting techniques to service systems to meet manufacturers' performance specifications;
SPV.05 - demonstrate a working knowledge of fundamental mathematics and the scientific principles required to service, repair, and modify vehicles;
ICV.05 - demonstrate the employability skills required for success in the workplace.

**Specific Expectations**

SP2.01 - use correctly, store safely, and maintain in good working order the measurement, hand, power, machine, and pneumatic tools and equipment required for service, repair, and modification tasks;
SP2.03 - systematically troubleshoot problems arising from the service, repair, and modification of vehicles by organizing the variables into the following categories: input, process, and output;
SP3.02 - fill in work orders to communicate the materials used and the work practices and procedures related to the job;
SP3.05 - consult appropriate repair manuals for procedures, schematics, and specifications, and apply them in the repair, service, and modification of vehicle components and systems;
SP3.06 - develop and present effective oral and written reports on service and repair methods, using technical language appropriately;
IC2.02 - use safe work practices in the transportation technology program;
IC2.03 - develop comprehensive safety checklists for applied work practices and procedures;
IC2.04 - use all required protective clothing and gear (e.g., to protect the eyes, hands, head, feet, and respiratory system) when working in the transportation sector.

### Prior Knowledge & Skills

- Ability to use hand tools competently and safely
- Ability to use measurement tools accurately
- Knowledge of hydraulic safety and safe handling of asbestos products

- Ability to use shop or electronic manuals to acquire brake specification, procedures and diagrams
- Awareness of acceptable personal conduct standards
- Knowledge of vehicle jacking/hoisting procedures and proper placement of axle stands
- Knowledge of wheel bearing servicing procedures

## Planning Notes

- **Note:** (*A licensed Automotive Service Technician must inspect brake system work that is performed on a vehicle that will be returning to service before assembly is complete)*. If the teacher does not possess these qualifications this activity should be restricted to models or vehicles that will not be returned to service.
- The teacher prepares workstations or vehicles set up for disassembly, inspection, service and reassembly. The workstation or vehicles should consist of drum brake assemblies, front and rear disc brake assemblies, and a brake line cutting, flaring and bending workstation.
- Students rotate through the stations performing the brake service and inspection.
- The teacher demonstrates the proper procedure on each workstation prior to students beginning the rotation. Safety glasses must be worn by students for all activities.
- Depending on class size, having a few different vehicles on-hand may be necessary to allow all students to have a chance to work on a few of the many different braking configurations.
- It may be necessary for the instructor to create a workstation for brake line cutting, flaring, bending and installation of brake lines. This station is usually made out of plywood with a traced location for the brake line to be installed, a wheel cylinder at each end, and a few obstacles to go around. Students must use the brake line-bending tool to shape the brake line maintaining acceptable tolerances and equal amounts of brake line at both ends. The teacher evaluates students to assess brake–line tolerances to other obstacles, the flare to make sure it is even 360 degrees and check for kinks or partial kinks and the loop to the wheel cylinder is equal on both sides.

## Teaching/Learning Strategies

- Students are asked to identify the important role that a service technician plays in society and the types of skills a technician can bring to their local community. Students make notes based on the discussion.
- An initial demonstration is given on each workstations or vehicles with emphasis on safety.
- The teacher reviews measurements tools for brake drums; rotor thickness and rotor lateral run out measurements.
- Extra time should be given to cutting and flaring brake lines and several demonstration of brake line bending tool operation. Students mark out the brake line first before attempting to bend with marker on the opposite side of the bend, so that the black mark always faces out during the bending of the brake line.
- Students work with a single partner, each taking a turn to develop the hands-on skills at the workstation, while the other student completes the brake component inspection sheet (Appendices 3.2.1 and 3.2.2).
- Students produce brake diagrams and procedures through textbooks, electronic manuals, digital cameras, or student-created drawings before beginning workstations.
- The teacher prepares a lesson on brake lining material inspection guidelines according to manufacturer standards.
- Students refer to the procedure and inspection checklist to complete each station.
- Students are generally finished the front disc assemblies more quickly than the other stations and may wish to trade with another student doing the same. Students are required to have their work inspected before going to the next station.

## Assessment & Evaluation of Student Achievement

Students' performance of disassemble, inspection, service, and re-assemble of the brake work stations may be assessed in the following ways:

- observation of students' practice and performance during practical activities in the shop;
- utilizing inspection checklists for each workstation or vehicle to check for completion and accuracy (see Appendix 3.2.1 – Drum Brake Component Inspection and Appendix 3.2.2 – Front/Rear Disc Brake Component Inspection);
- written or verbal report on student findings.

## Resources

**Print**

Crouse, W., D. Anglin, and W. Crouse. *Automotive Mechanics.* Glencoe McGraw-Hill, 1993. ISBN 0028009436

Erjavec, Jack. *Automotive Technology: A Systems Approach,* 3rd ed. United States: Delmar Thomas Learning, 2000. ISBN 0-7668-0673-1

Schwaller, Anthony, E. *Motor Automotive Technology.* Cloud State University: Delmar, 1999. ISBN 0-8273-8354-1

Thiessen, Frank J. and Davis N. Dales. *Automotive Principles and Service,* 4th ed. New Jersey: Prentice Hall, 1994. ISBN 0-13-336561-1

OEM Reference and Repair Manuals/CD-ROMs, available from local dealerships

**Videos**

Several videos are available from The Learning Tree Mechanic (http://www.autovideo2000.com) or Thompson/Delmar Learning (AutoEd.com: http://www.autoed.com/)

**Websites**

How Stuff Works – http://www.howstuffworks.com/
A website containing descriptions of how various technical devices function

Inner Auto – http://www.innerauto.com/
An exploration of inner functions of the automobile

**Software**

Computerized service manuals

## Appendix 3.2.1

### Drum Brake Component Inspection

| **Braking Component** | **General Condition** | **AC** – acceptable condition<br>**NAC** – not acceptable condition<br>**RS** – requires servicing<br>**PR** – parts require replacement<br>**N/A** – not applicable |
|---|---|---|
| Shoe Lining | | |
| Return springs | | |
| Shoe hold-downs | | |
| Adjuster cables/springs/levers | | |
| Automatic adjusters/ cam (star wheel) | | |
| Drum Inspection<br>Specifications<br>Actual Measurement | | |
| Wheel cylinder<br>Left<br>Right | | |
| Brake lines:<br>Steel<br>Flex line | | |
| Wheel Bearings<br>Grease seals<br>Axle seals | | |
| Parking brake cables<br>Front<br>Right rear<br>Left rear | | |
| Backing plate<br>Right side<br>Left side | | |

## Appendix 3.2.2

### Front/Rear Disc Brake Component Inspection

| **Braking Component** | **General Condition** | **AC** – acceptable condition<br>**NAC** – not acceptable condition<br>**RS** – requires servicing<br>**PR** – parts require replacement<br>**N/A** – not applicable |
|---|---|---|
| Rotor Inspection<br>Specifications<br>Actual Measurement | | |
| Caliper<br>Piston dust boot | | |
| Alignment pins<br>Dust boot | | |
| Brake lines:<br>Flex line<br>Steel | | |
| Splash shield<br>Right side<br>Left side | | |
| Brake pad condition | | |
| Wheel Bearings<br>Grease seals | | |
| Rear Disc Systems | | |
| Caliper<br>Parking brake lever/ mechanism | | |
| Rear parking brake linings | | |
| Parking brake cables<br>Front<br>Right rear<br>Left rear | | |
| Rotor Inspection<br>Specifications<br>Actual Measurement | | |
| Caliper<br>Piston dust boot | | |
| Alignment pins<br>Dust boot | | |
| Brake lines:<br>Flex line<br>Steel | | |
| Splash shield<br>Right side<br>Left side | | |
| Brake pad condition | | |

## Activity 3.3: ABS Theory and Operation

**Time:** 8 hours

### Description

Students learn to identify and describe the operation of the major antilock brake components and how the braking system works to bring a vehicle to a controlled stop. Students compare the different systems and list the precautions to be taken when serving antilock braking systems. Students work in groups to achieve excellence, originality, and integrity in one's own work and supports these qualities in the work of others.

### Strand(s) & Learning Expectations

**Ontario Catholic School Graduate Expectations**

CGE5g - achieves excellence, originality, and integrity in one's own work and support these qualities in the work of others;
CGE3c - thinks reflectively and creatively to evaluate situations and solve problems.

**Strand(s):** Theory and Foundation, Skills and Processes, Impact and Consequences

**Overall Expectations**

SPV.01 - work effectively as members of a team;
SPV.02 - consult appropriate reference materials when servicing and repairing systems;
SPV.03 - use current technology and a variety of troubleshooting techniques to service systems to meet manufacturers' performance specifications;
ICV.05 - demonstrate the employability skills required for success in the workplace facility and implement a plan to address any deficiencies.

**Specific Expectations**

SP2.01 - use correctly, store safely, and maintain in good working order the measurement, hand, power, machine, and pneumatic tools and equipment required for service, repair, and modification tasks;
SP2.03 - systematically troubleshoot problems arising from the service, repair, and modification of vehicles by organizing the variables into the following categories: input, process, and output;
SP3.02 - fill in work orders to communicate the materials used and the work practices and procedures related to the job;
SP3.05 - consult appropriate repair manuals for procedures, schematics, and specifications, and apply them in the repair, service, and modification of vehicle components and systems;
IC2.02 - use safe work practices in the transportation technology program;
IC2.03 - develop comprehensive safety checklists for applied work practices and procedures;
IC2.04 - use all required protective clothing and gear (e.g., to protect the eyes, hands, head, feet, and respiratory system) when working in the transportation sector;
IC2.05 - identify and adhere to the aspects of the Occupational Health and Safety Act (OHSA), the Workplace Hazardous Materials Information System (WHMIS), and the Motor Vehicle Repair Act that relate to procedures and operations used in the school transportation technology facility.

### Prior Knowledge and Skills

- Knowledge of hand tool safety
- Ability to use measurement tools accurately
- Knowledge of hydraulic safety and safe handling of asbestos products
- Ability to use shop or electronic manuals to acquire brake components, procedures, and diagrams
- Knowledge of vehicle jacking/hoisting procedures and proper placement of axle stands

## Planning Notes

- The teacher requires late model ABS sensors, hydraulic control units, and ABS control modules. The teacher can generally receive used or recalled components of this type from an automotive recycler, donation vehicle, or local dealership for little or no cost.
- Whenever possible, it would be best to have a complete vehicle or functioning ABS system to allow students to identify and test components.
- Split the class in half during vehicle testing.
- Students require access to electronic manuals if available, shop manuals, and component locator guides.
- Students are required to identify all the major components on the vehicle or workstation.
- The teacher plans lessons around the types of ABS systems (1-, 2-, 3-, 4-channel) available and provides overviews on the other types.

## Teaching/Learning Strategies

- Students are asked to list the ways they can display leadership in the context of a shop environment in their notebooks. Students are asked to keep these values in mind as they play supportive roles in a teamwork environment.
- The teacher begins with a class discussion on how ABS works, i.e., during ABS braking, the control module receives signals from electronic sensors monitoring wheel rotation. If a wheel's rate of rotation suddenly decreases, the ABS control module orders a hydraulic control unit to reduce line pressure to that wheel's brake. Once the wheel resumes normal rotation, the hydraulic control unit restores pressure to the brake to maximize tire and road surface friction.
- The teacher plans a lesson on the types of ABS braking systems; 2-wheel systems 1-, 2-channel and 4-wheel systems 3-, 4-channel.
- The teacher reviews the theory and operation of the electronic components: control modules, brake pedal sensors, data link connectors, trouble code retrieval, switches, and wheel sensors.
- The teacher reviews the theory and operation of the hydraulic components: accumulators, hydraulic control valve assemblies or units, booster pump, solenoids, and master cylinder.
- Splitting the class in half at this point is important, half of the class will complete independent reading assignments and review questions on ABS hydraulic and electrical component theory and operation. The other half of the class will perform component identification and road testing procedures for future reference.
- The teacher relieves accumulator pressure and disconnects battery when electrical connectors are being disconnected and reconnected on a vehicle.
- Students compare the different types of systems in a students developed comparison chart.
- Students develop a checklist of safe working habits and practices.

## Assessment & Evaluation of Student Achievement

Students' knowledge of the repair procedures of Electronic Engine Control systems as well as the reading of Trouble Tree charts may be assessed in the following ways:

- written tests that allow students to demonstrate an understanding of the function and repair of self-diagnostic electronic engine control systems;
- diagnostic observation of students' practice and performance during practical activities in the shop;
- written or verbal report.

## Accommodations

- For enrichment, students may present an oral or written presentation on the cycling process of hydraulic pressure during wheel lock up.

## Resources

**Print**

Erjavec, Jack. *Automotive Technology: A Systems Approach,* 3rd ed. United States: Delmar Thomas Learning, 2000. ISBN 0-7668-0673-1

Schwaller, Anthony, E. *Motor Automotive Technology*. Cloud State University: Delmar, 1999. ISBN 0-8273-8354-1

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**Videos**

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(http://www.autovideo2000.com) or Thompson/Delmar Learning (AutoEd.com: http://www.autoed.com/)

**Website**

Inner Auto – http://www.innerauto.com/
An exploration of inner functions of the automobile

**Software**

Computerized service manuals

## Activity 3.4: System Diagnostics, Service and Testing

**Time:** 9 hours

### Description

In this activity, students perform pre-diagnostic inspections, wheel sensor tests, and retrieve trouble codes. Students research the trouble codes using industry standard texts and computer programs and construct a trouble tree to diagnose problems. Students also use the brake warning light for symptom trouble shooting. Students learn to appreciate that they are entrusted with the lives of others and it is their Christian duty to protect others through their service.

### Strand(s) & Learning Expectations

**Ontario Catholic School Graduate Expectations**

CGE1e - speaks the language of life... "recognizing that life is an unearned gift and that a person entrusted with life does not own it but that one is called to protect and cherish it." (Witnesses to Faith);
CGE5h - applies skills for employability, self-employment, and entrepreneurship relative to Christian vocation.

**Strand(s):** Theory and Foundation, Skills and Processes

**Overall Expectations**

TFV.01 - apply the design process to develop solutions, products, processes, or services in response to challenges or problems related to vehicles or vehicle systems;
SPV.01 - work effectively as members of a team;
SPV.02 - consult appropriate reference materials when servicing and repairing systems;
SPV.03 - use current technology and a variety of troubleshooting techniques to service systems to meet manufacturers' performance specifications;
SPV.04 - communicate ideas and transmit information about materials and specifications effectively when working with others.

**Specific Expectations**

SP1.02 - work effectively with team members to identify the optimum order of operations; determine the availability of tools, parts, and equipment; develop scheduling requirements; and obtain information needed to plan and prepare for the fabrication or repair process;
SP2.01 - use correctly, store safely, and maintain in good working order the measurement, hand, power, machine, and pneumatic tools and equipment required for service, repair, and modification tasks;
SP2.03 - systematically troubleshoot problems arising from the service, repair, and modification of vehicles by organizing the variables into the following categories: input, process, and output;
SP3.05 - consult appropriate repair manuals for procedures, schematics, and specifications, and apply them in the repair, service, and modification of vehicle components and systems;
SP3.06 - develop and present effective oral and written reports on service and repair methods using technical language appropriately.

### Prior Knowledge & Skills

- Knowledge of electrical and hydraulic safety
- Knowledge of hand tool safety
- Basic understanding of electrical circuitry
- Ability to use test lights and multi-meters correctly
- Knowledge of vehicle jacking/hoisting procedures and proper placement of axle stands
- Knowledge of hydraulic safety and safe handling of asbestos products

## Planning Notes

- The teacher requires late model vehicles or workstations suitable for testing.
- Students require access to the Internet, electronic manuals, shop manuals and component locator guides.
- Students are required to identify all the major components on the vehicle or workstation.
- The teacher may be required to arrange for an oscilloscope demonstration from a company that sells oscilloscope equipment if the shop does not have access to one.
- When testing a vehicle's electronic components, Electrostatic Discharge (ESD) can cause damage to some of the vehicle's more fragile components. To eliminate the risk of ESD damage to the vehicle's computer a grounding wrist strap should be worn.
- The teacher should review the steps for proper pre-diagnostic inspections, wheel sensor tests, and code retrieval.

## Teaching/Learning Strategies

- The teacher first discusses the importance of careful diligence of all service work as it is their duty as Christians and since people's lives depend on their vigilance. Using lists developed in earlier exercises, students develop their own personal Code of Ethics. These lists are to be word processed and presented to the teacher for approval.
- The teacher begins with lessons on preliminary checks, e.g., identify which light comes on with the key and should quickly go off, master cylinder level, inspecting components for hydraulic leaks, checking mechanical components for problems, wheel bearings that may produce a wobble, correct tire size, inspecting all electrical connections for problems and inspecting all wheel speed sensors for proper air gap and ring condition.
- The teacher demonstrates the preliminary checks and retrieve trouble codes using scan tools or self-diagnostics.
- Depending on class size, having a few different vehicles on-hand may be necessary to allow all students to have a chance to read codes with or without a scan tool. It may also be necessary for the instructor to create fault codes within the ABS system.
- Most faults can be created by causing an open or ground in wiring or running the vehicle with a sensor disconnected. The instructor should first check a wiring schematic to find how a fault could be created without permanently damaging the vehicle and safely allow the vehicle to be tested with no brake fluid pressure in the accumulator.
- Diagnostic charts can be designed by sketching placement of textboxes and connecting arrows and then laying out using a word processor drawing feature such as found in many word processing programs.
- Once students believe that they have isolated the fault, they check with the instructor before beginning the repair.
- With approval of the instructor, students disconnect the battery and then repair the system using manufacturers' recommendations and teacher supervision. Once the repair has been checked for resistance, the battery is reconnected and vehicle is tested and checked for further trouble-codes.
- Students present their findings individually in trouble tree format addressing problems that may arise in the future.
- The teacher and students discuss employability skills learned in this course that reflect industry standards and how our social teachings will affect their decisions for employability, self-employment, and entrepreneurship.

## Assessment & Evaluation of Student Achievement

Students' knowledge of the repair procedures of ABS braking systems as well as the reading of diagnostic flow charts may be assessed in the following ways:

- written tests that allow students to demonstrate an understanding of the function and repair of self-diagnostic electronic engine control systems;
- observations of students' practice and performance during practical activities in the shop (see Appendix 3.4.1 – Evaluation Rubric for System Diagnosis Service and Testing below);
- a written or verbal report of work performed and procedures followed.

## Accommodations

Depending on the performance of any individual, the teacher may wish to eliminate or modify various aspects of the activity. For example, students may only need to complete the repair once the fault has been pointed out to them; the fault may be simplified (unplugged sensor) to allow for student success and feeling of accomplishment. For enrichment, students may repair more complex faults, diagnose actual faults on customer vehicles, or assist the teacher in creating faults for other students to diagnose and repair.

## Resources

### Print

Erjavec, Jack. *Automotive Technology: A Systems Approach,* 3rd ed. United States: Delmar Thomas Learning, 2000. ISBN 0-7668-0673-1

Schwaller, Anthony, E. *Motor Automotive Technology*. Cloud State University: Delmar, 1999. ISBN 0-8273-8354-1

OEM Reference and Repair Manuals/CD-ROMs, available from local dealerships

### Websites

How Stuff Works – http://www.howstuffworks.com/
A website containing descriptions of how various technical devices function

Inner Auto – http://www.innerauto.com/
An exploration of inner functions of the automobile

### Software

Computerized service manuals

## Appendix 3.4.1

### Evaluation Rubric for System Diagnosis, Service and Testing

| Criteria | Level 1 (50-59%) | Level 2 (60-69%) | Level 3 (70-79%) | Level 4 (80-100%) |
|---|---|---|---|---|
| **Knowledge/ Understanding**<br>- describes and identifies proper procedures through consults reference materials<br>SPV.02, SP3.05 | - demonstrates limited knowledge of repair procedures and information gathering | - demonstrates adequate knowledge of repair procedures and information gathering | - demonstrates considerable knowledge of repair procedures and information gathering | - demonstrates exceptional knowledge of repair procedures and information gathering |
| **Thinking/Inquiry**<br>- students follow a systematic troubleshooting procedure<br>TFV.01, SPV.03, SP2.03 | - demonstrates a troubleshooting procedure with limited effectiveness | - demonstrates a troubleshooting procedure with some effectiveness | - demonstrates a troubleshooting procedure with considerable effectiveness | - demonstrates a troubleshooting procedure with a high degree of effectiveness |
| **Communications**<br>- completes proper forms and reports and communicates troubleshooting results effectively<br>SPV.04, SP3.06 | - completes forms and reports to a limited degree<br><br>- demonstrates limited ability to communicate technical information | - completes forms and reports to some degree<br><br>- demonstrates some ability to communicate technical information | - completes forms and reports to a considerable degree<br><br>- demonstrates considerable ability to communicate technical information effectively | - completes forms and reports with a high degree of effectiveness<br><br>- demonstrates ability to communicate technical information at high degree |

**Note:** A student whose achievement is below Level 1 (50%) has not met the expectations for this assignment or activity.