

**SAULT COLLEGE OF APPLIED ARTS AND TECHNOLOGY**

**SAULT STE. MARIE, ONTARIO**



**SAULT  
COLLEGE**

**COURSE OUTLINE**

**COURSE TITLE:** HEAVY DUTY ENGINE SYSTEMS  
**CODE NO. :** HET703 **SEMESTER:** LEVEL 2  
**PROGRAM:** COMMERCIAL VEHICLE AND EQUIPMENT HED  
APPRENTICESHIP  
**AUTHOR:** GEORGE PARSONS  
**DATE:** JAN PREVIOUS OUTLINE JAN  
2011 DATED: 2010  
**APPROVED:**

*“Corey Meunier”*  
CHAIR

\_\_\_\_\_  
DATE

**TOTAL CREDITS:**

**PREREQUISITE(S):**

**HOURS/WEEK:** 27.5 HOURS OVER EIGHT WEEKS

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

**I. COURSE DESCRIPTION:**

The apprentice will be able to describe testing procedures for combustion chamber condition, define the fundamentals of applied calculations for compression pressure, cylinder balance, cylinder leakage and explain the procedures for assessing combustion chamber conditions, following manufacturers' recommendations and safe work practices.

The apprentice will be able to describe the testing and servicing procedures for cylinder heads, valve trains, and related components following manufacturers' recommendations and safe work practices.

The apprentice will be able to describe the testing and servicing procedures for cooling systems components and coolants following manufacturers' recommendations and safe work practices.

The apprentice will be able to describe the testing and servicing of lubricating system, components, and lubricants following manufacturers' recommendations and safe work practices.

The apprentice will be able to describe the testing and servicing procedures for air induction and exhaust systems following manufacturers' recommendations.

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

Upon successful completion of this course, the student will demonstrate the ability to describe testing procedures for combustion chamber condition following manufacturers' recommendations and safe work practices.

**1. Diesel Engine Fundamentals**

**Define the fundamentals of applied calculations for compression pressure, cylinder balance, and cylinder leakage.**

Potential Elements of the Performance:

- clearance volume vs. pressure
- mathematical formulas
- effects of cylinder sealing defects on balance and leakage

**1b. Demonstrate the procedures for assessing combustion chamber conditions.**

Potential Elements of the Performance:

**assess combustion chamber conditions using the following tests:**

- compression test
- cylinder leakage test
- cylinder balance test

**2. Cylinder Head, Valve Train Assemblies and Components**

**The apprentice is able to describe the testing and servicing procedures for cylinder heads, valve trains, and related components following manufacturers' recommendations and safe work practices.**

Potential Elements of the Performance:

**Define the fundamentals of cylinder heads, valve train assemblies, and components.**

**purpose and application of cylinder heads and valve train assemblies**

- interpret and draw valve timing diagrams including duration, overlap, lead, and lag
- cylinder head resurfacing
- cylinder head torquing procedures when hot, cold, wet or dry
- seat width, undercutting, fitting, and sealing
  - interference angle and multi-angle seats

**2a. Describe the construction features of cylinder heads, valve train assemblies, and related components.**

Potential Elements of the Performance:

- function and types of major components
- drive mechanisms
- combustion chambers
- gasket surfaces, gaskets and seals

**2b. Explain the principles of operation of cylinder heads, valve trains, and related components.**

Potential Elements of the Performance:

- explain combustion chamber operation
- explain valve timing diagrams, including duration, overlap, lead, and lag
- valve seats and guides
- valve seals
- valve springs, rocker arms and shafts
- valve pushrods, lifters, camshafts, and drive mechanisms
- cylinder head gaskets and seals

**2c. Perform inspection and testing procedures following manufacturers' recommendations and perform the assigned operations on cylinder heads and valve train components.**

Potential Elements of the Performance:

- outline removal and replacement procedures

perform inspection of all accessible components with head removed

- timing mark
- lobe wear
  - lifters

**perform inspection on cylinder heads for:**

- loose valve seats
  - valve guide wear
  - distortion
  - valve spring condition
  - valve protrusion
- valve leakage test

**2d. Recommend reconditioning or repairs following manufacturers' recommendations and perform assigned operations on cylinder heads and valve train components.**

Potential Elements of the Performance:

- **demonstrate the disassembly and assembly of a cylinder head**

**demonstrate machining operations on:**

- valve and seat cutting and grinding

**demonstrate installation and reaming of:**

- valve guides
- valve seal installation

**3. Cooling Systems**

**Define the fundamentals of inspecting and testing engine cooling systems, components, and coolants.**

Potential Elements of the Performance:

**explain the significance of the following with regards to inspection and testing results**

- heat transfer
- coolants
- cavitation
- air cooling concepts

**3a. Explain the process of testing and inspecting cooling systems.**

Potential Elements of the Performance:

- radiator shutters and controls
- control fans
- heat exchangers and coolers

- air cooling

**3b. Perform inspection and testing procedures following manufacturers' recommendations and perform the assigned operations for cooling systems.**

Potential Elements of the Performance:

**perform the inspection and testing procedures for:**

- radiator shutters and controls
- in/out temperatures using pyrometer
- heat exchangers and coolers
- fan controls
- operation cycle (stat, shutters, and fan)
- coolant filters
- pH levels of coolant
- coolant strengths and condition
- pressure test cooling system

**3c. Recommend reconditioning or repairs following manufacturers' recommendations and perform assigned operations for cooling systems.**

Potential Elements of the Performance:

**perform a demonstration of:**

- cooling system air-entrapment removal procedures
- coolant filter service procedures
- cooling system flushing procedures
- explain coolant additive packages and contamination checks
- explain coolant pump shaft sealing devices and packings

**4. Lubricating Systems**

**Define the fundamentals of testing and servicing lubricating system components and lubricants.**

Potential Elements of the Performance:

**purpose, function, types, styles, and application**

- crude oils
- synthetic oils
- significance of selecting correct lubricating oils for engine service
- viscosity ratings
- grades
- service ratings

**4a. Explain the principles of testing and servicing filters, heat**

**exchangers, and oil coolers.**

Potential Elements of the Performance:  
**filters**

- bypass
- full flow
- centrifugal
  
- heat exchangers
- oil coolers
- pressure regulator
- pressure relief valve
- filter bypass valve
- oil cooler bypass valve
- thermostatic control

**4b. Perform inspection and testing procedures following manufacturers' recommendations and perform assigned operations for lubricating system components and lubricants.**

Potential Elements of the Performance:

**perform the inspection and testing procedures of:**

- bearing leakdown test
- oil pressure tests
- oil cooler test
- vacuum test (coolers)
- pressure test (coolers)

**4c. Recommend reconditioning or repairs following manufacturers' recommendations and perform assigned operations for lubricating system components.**

Potential Elements of the Performance:

**perform a demonstration of service procedures for:**

- changing oil and oil filters
- centrifugal filters
- lubrifiner
- removing and installing oil pumps
  
- explain oil and oil filter change interval requirements
- describe requirements for priming oil pump and system

**5. Air Induction & Exhaust Systems**

**Define the fundamentals of commercial vehicle air induction and exhaust systems, turbochargers, and blowers.**

Potential Elements of the Performance:

**purpose, function, types, styles, and application**

- air cleaners
- turbochargers
- blowers

**fundamentals enhancement**

- volumetric efficiency
- air charge temperature
- cubic feet and cubic meters/minute air flow rate
- mean effective pressure
- exhaust system component overview

**5a. Describe the construction features of turbochargers, blowers, and air cleaners.**

Potential Elements of the Performance:

**turbochargers**

- housing, shafts, turbine wheels, seals, bearings
- **intercoolers and aftercoolers**

**controls**

- wastegate, boost

**lubrication**

- oils, passages, lines

**blowers**

- housings, drive mechanisms, shaft, rotors, bearings, seals

**air cleaners**

- oil bath
- dry type
- pre-cleaners
- two-stage

**manifolds**

- intake
- exhaust
- blowers

**mufflers**

- exhaust scrubbers
- catalytic converters
- water
- ceramic
- palladium

**5b. Explain the principles of operation of turbochargers, blowers, and air cleaners.**

Potential Elements of the Performance:

**turbochargers**

- boost control, tip turbines, air flow, exhaust thrust, wastegate, intercoolers, aftercoolers
- thermodynamics of turbine operation

**blowers**

- air flow, drive mechanisms
- **compare effectiveness of turbochargers and blowers**

**air cleaners**

- oil bath
- dry
- pre cleaners
- two-stage

**5c. Perform inspecting and testing procedures for air induction and exhaust systems, turbochargers, and blowers following manufacturers' recommendations.**

Potential Elements of the Performance:

**perform a demonstration of:**

- air induction system restrictions tests
- exhaust system restrictions
- air flow restriction indicators
- noise level tests
- turbocharger oil leak tests
- air intake temperature test

**perform a demonstration of inspecting and testing turbochargers for:**

- boost pressure, wastegate operations, axial and radial movement, and play, air and exhaust leaks
- recommended start-up/shutdown procedures

**perform a demonstration of inspecting and testing blowers for:**

- air box pressure
- bypass

- visual inspection
- rotor clearance

**5d. Recommend reconditioning or repairs following manufacturers' recommendations and perform assigned operations for air induction and exhaust systems, turbochargers, and blowers.**

Potential Elements of the Performance:

**perform a demonstration of turbocharger**

- pre-lubrication requirements
- lubrication requirements
- clean air flow passages
- mounting bolt torque

**perform a demonstration of blower**

- lubrication requirements
- clean air flow passages

- **servicing air filters**
- **servicing intercoolers and aftercoolers**
- **installation precautions for turbocharger pre-lubrication**

**III. TOPICS:**

1. DIESEL ENGINE FUNDAMENTALS
2. CYLINDER HEAD, VALVE TRAIN ASSEMBLIES & COMPONENTS
3. COOLING SYSTEMS
4. LUBRICATING SYSTEMS
5. AIR INDUCTION & EXHAUST SYSTEM

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

- Various handouts
- Heavy Duty Truck Systems Text Book

Sault College/SAE approved safety glasses and steel toe work boots required for shop activities. Coveralls or a shop coat.

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

- **70% of theory testing.**
- **10% shop assignments.**
- **20% Final Exam.**

The following semester grades will be assigned to students:

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

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

Sault College is committed to student success. There is a direct correlation between academic performance and class attendance; therefore, for the benefit of all its constituents, all students are encouraged to attend all of their scheduled learning and evaluation sessions. This implies arriving on time and remaining for the duration of the scheduled session. ***It is the departmental policy that once the classroom door has been closed, the learning process has begun. Late arrivers will not be granted admission to the room.***

**VII. COURSE OUTLINE ADDENDUM:**

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



**Professor Parsons  
Student Assessment Procedure  
For  
Motive Power  
THEORY ASSIGNMENTS**

Theory assessment is based on regularly scheduled tests and assignments and final exam. Attendance and home work checks are recorded and used as an aid for counseling.

The following grades will be assigned for Theory Assignments:

A+	90 to 100
A	85
A-	80
B +	79
B	75
B-	70
C +	69
C	65
C-	60
D	50
F (Fail)	49 or less.

**Assignments will be graded as follows:**

- a) One day after the original due date – 70% maximum.
- b) Two or more days after the original due date – 50% maximum.



**Professor Parsons'  
Motive Power Program  
Policies and Procedures**

1. During your program, you are considered to be a member of the Motive Power Department. As such, your actions and behavior, both in the college and the community reflect on this Department. We trust that your influence will be positive.
2. College policy prohibits the consumption of food and drink in the classrooms and shop. Smoking is allowed only outside of the building in designated smoking areas. **No smokeless tobacco is allowed in theory class or shop class.**
3. CSA approved Safety Glasses and Safety Boots must be worn in the Shop at all times. This means going to and from all of the classrooms located in the shop. It is the responsibility of the **STUDENT** to wear them. You will be marked absent if the aforementioned policy is not adhered to.

**Note; All safety glasses and boots must meet Sault College CSA approval rating.**

**NO GLASSES-NO BOOTS-NO ENTRY!!**

**4. SAFETY**

- 4.1 Students must not enter the shop area or commence work before their scheduled time.
- 4.2 Students must not work alone or in an unsupervised area.
- 4.3 Students must have lift truck training prior to operating those units.
- 4.4 Students must have equipment training and Technologist/Professor approval before operating any equipment.
- 4.5 Students must not use or operate equipment that is found to be unsafe or damaged. All such equipment must be reported to the Professor or Technologist who will replace and/or repair the said equipment.



- c) Remain in the class during clean-up and assist in the cleaning and shutting down of their shop/classroom.

**7.2** Students are expected to conduct themselves in a manner that does not interfere with or obstruct the overall learning environment.

**7.3** The following activities are not allowed in the shop/classrooms:

- a) Horseplay.
- b) Making unnecessary noise.
- c) Swearing.
- d) Abusive behavior.
- e) Smoking, chewing smokeless tobacco, beverages and eating.

## **8. ASSIGNMENTS AND THEORY TESTS**

**8.1** Students are required to hand in assignments or write theory tests on the day and at the time specified/scheduled. See item #16 in the aforementioned document.

**8.2** Assignments will be graded as follows:

- a) One day after the original due date – 70% maximum.
- b) Two or more days after the original due date – 50% maximum.

**NOTE:** The only exception of Policy # 8 shall be those arising from personal emergencies (i.e. car accident, family death, serious illness, employment reasons) and the student supplies a written statement to that effect. See item #16.

**9.** Please, coffee breaks only 10 to 12 minutes **MAXIMUM. NOTE: Individual Professors will address each class with their expectations. Some may only allow 10 minutes.**

**10.** Please refrain from loitering in “C” wing hallways, around shop hallway entry doors and outside entrance doorways/walkways.

**11.** Being under the influence of alcohol or drugs during any shop or theory class will not be tolerated and the student will be excused from class at the Professor’s discretion.

**12.** Please remember that you must attend all related subject areas and pass successfully to obtain a Certificate or Diploma.

**13.** If you miss a test with an “**unexcused absence**” (as deemed legitimate by your professor) you will **NOT** be allowed to write that test. Only if; a doctors note, airline ticket, etc., or circumstances

arising from a family emergency; and legitimate written proof can be presented to the professor. See item number 18 below for clarification.

- 14.** If a class is missed or going to be missed it is your responsibility to notify in writing (see item #16 below) your Professor and make arrangements for handouts and notes taken while you are away.
- 15.** **The use of Lap Tops, cell phones/PDA's, electronic information/image capturing, recording device for any form of communication or recording (voice, text, recording, image, etc...) during theory class or shop is strictly prohibited. Cell phones/PDA's must be silenced during regular class and shop times and must be turned off and kept out of sight during all classes and test sittings. Failure to follow the latter requirement during a test sitting will result in a grade of 0 (zero) being assigned and if not out of sight or being used during class, the unit WILL be confiscated for the duration of the class.**

**NO EXCEPTIONS**

- 16.** Students may not wear earphones/headphones of any kind (i.e. for playback of recorded music/voice) during theory classes, shop classes and test sittings. This does not include hearing aids as required by hearing impaired students.
- 17.** **NO Lap Top Computers** will be allowed in any class unless proper documentation is provided that the computer is required for learning assistance.
- 18.** **Any request to deviate from the aforementioned course outline requirements must be made to the Professor in writing or via Sault College email. If permission is granted it must also be granted in writing or via Sault College email. Verbal requests/permissions are not acceptable. It is the students responsibility to maintain a copy of all such requests and associated permissions.**

Student  
Signature: \_\_\_\_\_

Date: \_\_\_\_\_

**Students refusing to sign this form will not be allowed to register or continue in their course.**