

I. COURSE DESCRIPTION:

You will be introduced to the construction, operation, maintenance and adjustment of both highway truck and off road heavy machinery drive trains. The highway truck components will include pull release multi-disc clutches and transmission brakes, tandem differentials and inter-axle differentials. Off-road equipment drive trains encompass, steering clutches and brakes, final drives, torque converters, power shift transmissions and hydrostatic drives.

II. LEARNING OUTCOMES AND ELEMENTS OF THE PERFORMANCE:

Upon successful completion of this course, the CICE student, along with the assistance of a Learning Specialist, will demonstrate the basic ability to:

1. TORQUE CONVERTERS, FLUID COUPLINGS, HYDRAULIC RETARDERS

Explore the purpose and fundamentals of torque converters, fluid couplings, and hydraulic retarders.

Potential Elements of the Performance:

TORQUE CONVERTERS

- static and dynamic friction
- torque multiplication
- centripetal force
- vortex and rotary flow
- kinetic energy
- hydrodynamic drive
- hydrostatic drive
- multiplication phase
- coupling phase
- hydraulic retarders

1a. Explore the construction features of torque converters, fluid couplings, and hydraulic retarders.

Potential Elements of the Performance:

TORQUE CONVERTERS

- pumps
- impeller
- stator
 - fixed
 - rotating
- overrunning clutch
- flywheel
- lock-up device

FLUID COUPLINGS

- impeller
- turbine

- flywheel
- HYDRAULIC RETARDERS**
- rotor and housing
- control valve

1b. Explore the principles of operation of torque converters, fluid couplings, and hydraulic retarders.

Potential Elements of the Performance:

TORQUE CONVERTERS

- pump
- impeller
- stator
 - fixed
 - rotating
- overrunning clutch
- flywheel
- lock-up

FLYWHEEL

- impeller
- turbine
- flywheel

OIL FLOW ACTION

HYDRAULIC RETARDERS

- rotor and housing
- control valve

1c. Perform/assist with the inspection, testing, and diagnostic procedures following manufacturers' recommendations and perform/assist with performing assigned operations for torque converters, fluid couplings, and hydraulic retarders.

Potential Elements of the Performance:

- perform oil level condition check
- perform a demonstration of oil leak tests

PROVIDE A DEMONSTRATION OF CONVERTERS

- stall tests
- relief valve tests
- performance tests

2. HYDROSTATIC DRIVES

Explore the purpose and fundamentals of hydrostatic drives.

Potential Elements of the Performance:

APPLICATION:

- traction drives
- non-traction drives

TYPES:

- open loop circuits
- closed loop circuits

FUNDAMENTALS:

- lubricant types
- hydraulic pressures and output force
- coolers and circuits

2a. Explore the types and construction features of hydrostatic drives.

Potential Elements of the Performance:

HYDROSTATIC DRIVES:

- variable displacement pumps
- fixed displacement pumps
- variable displacement motors
- fixed displacement motors

CONTROLS:

- flow limiting
- flow dividing
- manual displacement control valves
- electronic displacement control valves
- hydraulic displacement control valves

CHARGE PUMP

CHARGE PUMP CIRCUITS

COOLERS AND CIRCUITS

2b. Explore the principles of operation of hydrostatic drives.

Potential Elements of the Performance:

HYDROSTATIC DRIVES:

- variable displacement pumps
- variable displacement motors
- fixed displacement pumps
- fixed displacement motors

OPERATION OF DRIVE SYSTEMS IN NEUTRAL , FORWARD AND REVERSE CONTROLS:

- flow limiting
- flow dividing
- manual displacement control valves
- electronic displacement control valves

- hydraulic displacement control valves

**CHARGE PUMP
CHARGE PUMP CIRCUITS
COOLERS AND CIRCUITS**

- 2c. Perform/assist with the inspection, testing, and diagnostic procedures following manufacturers' recommendations and perform assigned operations on hydrostatic drives.**

Potential Elements of the Performance:

PERFORM/ASSIST WITH TEST PRESSURES OF HYDROSTATIC DRIVE SYSTEMS

- 3. POWER SHIFT TRANSMISSIONS.
Explore the purpose and fundamentals of power shift transmissions.**

Control Systems:

- hydraulic
- pneumatic
- electronic

Planetary Gear Sets:

- simple
- sun gear
- planet pinions and carrier
- ring gear
- compound
- lubrication

- 3a. Perform/assist with the inspection, testing, and diagnostic procedures following manufacturers' recommendations and perform assigned operations for power shift transmission systems.**

Potential Elements of the Performance:

- Check and test fluid levels and condition.
- Perform a demonstration of recommended procedures to perform oil and filter changes.

- 4. PULL TYPES CLUTCHES AND FLYWHEEL ASSEMBLIES
Explore the purpose and fundamentals of pull type clutches and flywheel assemblies.**

Potential Elements of the Performance:

- Clamping force
- Mechanical advantage
- Laws of levers
- Hydraulics

- Static and sliding friction
- Coefficient of friction
- Friction and heat
- Centrifugal force

4a. Explore the functions, construction, composition, types, styles and application of pull type clutches and flywheel assemblies.

Potential Elements of the Performance:

- Clutch disengagement and engagement
- Flywheel
- Pressure plate(s)
- Clutch friction disc assemblies
- Hubs
- Input shaft
- Release bearing
- Clutch brake
- Mechanical release mechanisms
- Hydraulic release mechanisms
- Adjustment – Free
- Air cylinder / cables linkage
- Bus and coach controls
- Flywheel housings
- Bell / clutch housing

4b. Explore the principle(s) of operation of pull type clutches and flywheel assemblies.

Potential Elements of the Performance:

- Double disc clutches
- Clutch control systems
- Adjustment - Free
- Linkage geometry
- Release bearing assembly
- Clutch brake
- Flywheel
- Pilot bearing
- Clutch / input shaft
- Pressure plate(s)
- Heat dissipation
- Coefficient of friction
- Friction media effects
- Friction discs
- Dampening
- Hubs
- Clutch housing
- Clutch assembly alignment

- Power flow

4c. Perform/assist with the inspection, testing and diagnostic procedures on pull type clutches and flywheel assemblies.

Potential Elements of the Performance:

- Adjustment
- Visual inspection
- Test clutch and control operation
- Diagnose clutch condition
- Lubrication practices
- Hydraulics
- Fluid levels
- Clutch alignment
- Housing alignment
- Performance testing
- Sub-component inspection
- Identify causes of failure

4d. Recommend/assist with recommending reconditioning or repairs following manufacturers' procedures and perform/assist with performing assigned operations on pull type clutches and flywheel assemblies.

Potential Elements of the Performance:

- Familiarization with manufacturer's service literature and specifications.
- Perform clutch adjustment
- Remove and replace clutch assembly
- Remove and replace flywheel
- Machining practices
- Performance testing
- Identify causes of failure
- Measurement of components and assembly
- Clutch assemblies overhaul procedures
- Removal and replacement techniques

5 HEAVY DUTY DRIVELINES

Explore the purpose and fundamentals of drive shafts, power take-off shafts, and universal joints.

Potential Elements of the Performance:

- Angularity
- Articulation
- Telescoping
- theory of non-uniform velocity
- parallel drive line arrangements
- broken-back drive line arrangements

- parallelogram
- working angle calculations

5a. Explore the functions, construction features, composition, types, and application of drive shafts, power take-off shafts, and universal joints.

Potential Elements of the Performance:

- drive shaft classifications
- drive shaft load ratings
- drive shaft speed ratings
- hanger bearings
- slip splines

Cardan Joints

- trunnion
- bearings
- flanges and yokes

5b. Explore the principles of operation of drive shafts, power take-off shafts, and universal joints.

Potential Elements of the Performance:

- shafts and cardan joints
- angularity
- velocity
- phasing
- balancing
- run-out
- torsional loading
- vibration

5c. Perform/assist with the inspection, testing, and diagnostic procedures following manufacturers' recommendations and perform/assist with performing assigned operations of drive shafts, power take-off shafts, and universal joints.

Potential Elements of the Performance:

Perform a Demonstration of:

- visual inspection (wear/damage)
- noise analysis
- evaluating drive line vibration
- calculating universal joint working angles

Failure Analysis For:

- torsion vibration
- excessive angularity
- operational overloading
- seized slip-joint
- shock failures

- fatigue failures

5d. Recommend/assist with recommending reconditioning or repairs following manufacturers' procedures and perform/assist with performing assigned operations of drive shafts, power take-off shafts, and universal joints.

Potential Elements of the Performance:

Perform a Demonstration of:

- lubricating a universal joint and slip-spline assembly
- replacing a cardan joint
- replacing a centre hanger bearing assembly
- measuring slip-spline wear
- correcting component working angles

6 TANDEM AND INTERAXLE DIFFERENTIALS

Explore the purpose and fundamentals of multiple speed and double reduction drive axle assemblies.

Potential Elements of the Performance:

- Mechanical advantage
- Laws of levers
- Torque
- Input / output rotational speed
- Gear ratios
- Loading characteristics
- Differential action
- Thrust loads
- Power flow
- Bearing preloads
- Lubrication

6a. Explore the functions, construction, composition, types, styles and application of multiple speed and double reduction drive axle assemblies.

Potential Elements of the Performance:

- Drive axle assemblies
 - Planetary two-speed
 - Planetary double-reduction
 - Double-reduction helical
 - Two-speed double-reduction helical
- Housing
- Carriers
 - Removable
- Planetary gearing
- Planetary wheel end assemblies
 - Helical gearing

- Differential gearing
- Differential locks
- Axle shafts
- Full floating
- Pneumatic shift system
- Electric shift system
- Lubricants

6b. Explore the principle(s) of operation of multiple speed and double reduction drive axle assemblies.

Potential Elements of the Performance:

- Drive axle assemblies
 - Planetary two-speed
 - Planetary double-reduction
 - Double-reduction helical
 - Two-speed double-reduction helical
- Housing
- Carriers
 - Removable
- Planetary gearing
- Planetary wheel end assemblies
 - Helical gearing
 - Differential gearing
 - Differential locks
- Pneumatic shift system
- Electric shift system
- Lubricants

6c. Perform/assist with performing disassembly, inspection, testing, diagnostic and reassembly procedures on multiple speed and double reduction drive axle assemblies.

Potential Elements of the Performance:

- Disassemble
- Reassemble
 - pinion bearing preload
 - pinion depth
 - carrier bearing preload
 - backlash
- Noise analysis
- Temperature analysis
- Visual inspection
- Performance testing
- Lubricant level and condition
- Shift problems

- Shift control operation
- Failure analysis

6d. *Recommend/assist with recommending reconditioning or repairs following manufacturers' procedures and perform/assist with performing assigned operations on multiple speed and double reduction drive axle assemblies.*

Potential Elements of the Performance:

- Outline procedure for checking lubricant levels
- Outline recommended lubricant change levels
- Verify lubricant type and application
- Carrier removal, disassembly, reassembly and replacement procedure
- Failure analysis to identify
 - Shock failures
 - Fatigue failures
 - Torsional failures
 - Surface failures
 - Spinout failures
 - Operational overloading
 - Temperature effects
- Demonstrate procedure for setting
 - Pinion bearing preload
 - Pinion depth
 - Carrier bearing preload
 - Drive gear set backlash
- Procedure for checking
 - Drive gear set contact patterns
 - Drive gear set backlash
 - Thrust screw adjustment
- Shift unit and overhaul

7. **SERVICING TWIN COUNTERSHAFT TRANSMISSIONS**

Recommend/assist with recommending reconditioning or repairs following manufacturers' procedures and perform/assist with performing assigned operations on multiple countershaft manual transmission and auxiliary sections.

Potential Elements of the Performance:

- Outline procedure for checking lubricant levels
- Outline recommended lubricant change intervals and procedure
- Verify lubricant types and application
- Transmission removal, disassembly, reassembly, timing and replacement procedures
- Auxiliary section removal, disassembly, reassembly, timing and

replacement procedures

- Air pressure adjustment
- Pneumatic valve and cylinder replacement procedure
- O-ring replacement
- Air filter replacement
- System contaminant flushing
- Perform failure analysis
 - Shock failures
 - Fatigue failures
 - Torsional failures
 - Surface failures

8. STEERING CLUTCHES AND BRAKES

Explore the purpose and fundamentals of heavy duty steering clutches and brakes.

Potential Elements of the Performance:

- outline the features of all wheel steering, articulated steering, steering clutches, and differential steering

8a. Explore the types and construction features of steering system components.

Potential Elements of the Performance:

Hydraulic Assist

- pump and reservoir
- power cylinder
- gear assembly

Fully Hydraulic

- reservoir
- power cylinder
- directional steering pump
- steering arms and linkages
- pilot operated
- stick steer

Dual Steering Axles

Steering Clutches

- wet
- dry

Hydraulic Steering

Hydrostatic Steering

- skid steer (wheel/track)

9 FINAL DRIVES

Explore the purpose and fundamentals of final drives.

Potential Elements of the Performance:

Final Drives

- bevel gear

- spiral gear
- helical and hypoid gear
- planetary
- inboard and outboard

9a. Explore the principles of operation of final drives.

Potential Elements of the Performance:

Final Drives

- bevel gear
- spiral gear
- helical and hypoid gear
- planetary
- inboard and outboard

9b. Perform/assist with performing the inspection, testing, and diagnostic procedures following manufacturers' recommendations and perform/assist with performing assigned operations for final drives.

Potential Elements of the Performance:

Assist with inspecting final drives and check for:

- gear contact patterns
- gear backlash
- bearing pre-load

Assist in diagnosing component failures and determine potential causes for:

- noises
- wear
- malfunctions
- shift problems
- overheating
- lack of proper lubrication

9c. Recommend/assist with recommending reconditioning or repairs following manufacturers' recommendations and perform/assist with performing assigned operations for final drives.

Potential Elements of the Performance:

- perform a demonstration of:
 - lubricating oil level checks
 - seal replacement procedures
 - mechanical face-type seal
 - bearing service
 - adjustment procedures

III. TOPICS:

1. TORQUE CONVERTERS, FLUID COUPLINGS AND HYDRAULIC RETARDERS
2. HYDROSTATIC DRIVES
3. POWER SHIFT TRANSMISSIONS
4. PULL TYPE CLUTCHES
5. HEAVY DUTY DRIVELINES
6. TANDEM AND INTERAXLE DIFFERENTIALS
7. SERVICING TWIN COUNTERSHAFT TRANSMISSIONS
8. STEERING CLUTCHES AND BRAKES
9. FINAL DRIVES

IV. REQUIRED RESOURCES/TEXTS/MATERIALS:

Title: Heavy Duty Truck Systems

Edition: 4th ed., 12959#

Author: Bennett

Publisher: Thomson Nelson Learning Canada

Title: Automotive Technology: A Systems Approach/AST Test Prep

Edition: 06 ed., 17810#

Author: Erjavec

Publisher: Thomson Nelson Learning Canada

Various Handouts as supplied.

Pens, pencils, calculator, 3-ring binder

*shop coat or coveralls

*CSA approved steel toe boots (high top)

*CSA approved safety glasses

*these items mandatory for shop

V. EVALUATION PROCESS/GRADING SYSTEM:

The final grade for this course will be based on the results of classroom, assignments and shop evaluations weighed as indicated:

- Classroom – 50% of the final grade is comprised of term tests
- Assignments – 10% of the final grade is comprised of a number of technical reports
- Shop – 40% of the final grade is comprised of attendance, punctuality, preparedness, student ability, work organization and general attitude

(Student will be given notice of test and assignment dates in advance)

The following semester grades will be assigned to students:

Grade	<u>Definition</u>	<i>Grade Point Equivalent</i>
A+	90 – 100%	
A	80 – 89%	4.00
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.

Cell phones are not allowed to be on in the classrooms or shop areas.

VII. COURSE OUTLINE ADDENDUM:

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



**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.

- 4.6 Where damaged or unsafe equipment cannot be repaired or replaced, the Professor/Technologist will provide students alternate shop activity.
 - 4.7 Students must follow instructions and safe work practices in order to use or operate any shop equipment.
5. Repairs to your private vehicles in our facilities can be educational to you. We will accommodate you if the work is part of our program and schedules in. **No car should be parked in the shop compound or outside a shop door without staff permission and a temporary parking pass clearly displayed.**
6. **Attendance** – if late, don't bother coming until the next class, you will be marked absent. The student is to be continuously present and actively participating during all scheduled theory and shop classes (scheduled breaks excepted).
 - 6.1 A terminal objective of the Motive Power Department is the demonstration of satisfactory attendance and punctuality performance that the Motive Power Industry, itself, relies on, for efficiency, productivity and profitability.
 - 6.2 If you are marked absent, and no reasonable excuse is given your absence will be termed unexcused (See 1.4 below). There should **NOT** be a reason to **NOT** let us know nor related subject Professors, in writing why you're absent.
 - 6.3 Students will lose marks from their theory and shop mark grade for unexcused absences. Poor attendance can mean a repeat of both theory and shop courses if your employment skills are poor. This is based on what is considered: Employability Skills.
 - 6.4 At 10% of accumulated hours of unexcused absence you will be asked to a scheduled meeting with your Professor and will be asked to sign a contract enabling you to continue the course.
 - 6.5 If you are absent from class, the lesson material is your responsibility.
7. **BEHAVIOR/ATTITUDE**
 - 7.1 Students are required to:
 - a) Properly care for and maintain all shop and classroom equipment.
 - b) Properly clean the shop/classroom facility and equipment at the end of each class.

- 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.

CICE Modifications:**Preparation and Participation**

1. A Learning Specialist will attend class with the student(s) to assist with inclusion in the class and to take notes.
2. Students will receive support in and outside of the classroom (i.e. tutoring, assistance with homework and assignments, preparation for exams, tests and quizzes.)
3. Study notes will be geared to test content and style which will match with modified learning outcomes.
4. Although the Learning Specialist may not attend all classes with the student(s), support will always be available. When the Learning Specialist does attend classes he/she will remain as inconspicuous as possible.

A. Tests may be modified in the following ways:

1. Tests, which require essay answers, may be modified to short answers.
2. Short answer questions may be changed to multiple choice or the question may be simplified so the answer will reflect a basic understanding.
3. Tests, which use fill in the blank format, may be modified to include a few choices for each question, or a list of choices for all questions. This will allow the student to match or use visual clues.
4. Tests in the T/F or multiple choice format may be modified by rewording or clarifying statements into layman's or simplified terms. Multiple choice questions may have a reduced number of choices.

B. Tests will be written in CICE office with assistance from a Learning Specialist.***The Learning Specialist may:***

1. Read the test question to the student.
2. Paraphrase the test question without revealing any key words or definitions.
3. Transcribe the student's verbal answer.
4. Test length may be reduced and time allowed to complete test may be increased.

C. Assignments may be modified in the following ways:

1. Assignments may be modified by reducing the amount of information required while maintaining general concepts.
2. Some assignments may be eliminated depending on the number of assignments required in the particular course.

The Learning Specialist may:

1. Use a question/answer format instead of essay/research format
2. Propose a reduction in the number of references required for an assignment
3. Assist with groups to ensure that student comprehends his/her role within the group
4. Require an extension on due dates due to the fact that some students may require additional time to process information
5. Formally summarize articles and assigned readings to isolate main points for the student
6. Use questioning techniques and paraphrasing to assist in student comprehension of an assignment

D. Evaluation:

Is reflective of modified learning outcomes.