

I. COURSE DESCRIPTION:

The CICE student be introduced to the construction, operation, maintenance and adjustment of both highway truck and off road heavy machinery drive trains. Highway truck components will include: pull release multi-disc clutches and transmission brakes, tandem differentials, and inter-axle differentials. Off-road equipment drive trains will 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, with assistance from a Learning Specialist, will demonstrate the ability to:

1. TORQUE CONVERTERS, FLUID COUPLINGS, HYDRAULIC RETARDERS

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

Potential Elements of the Performance of:

TORQUE CONVERTERS

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

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

Potential Elements of the Performance of:

TORQUE CONVERTERS

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

FLUID COUPLINGS

- impeller
- turbine
- flywheel

HYDRAULIC RETARDERS

- rotor and housing
- control valve

- 1b. **Explain the principles of the operation of torque converters, fluid couplings, and hydraulic retarders.**

Potential Elements of the Performance of:

TORQUE CONVERTERS

- pump
- impeller
- stator (fixed and rotating)
- overrunning clutch
- flywheel
- lock-up

FLYWHEEL

- impeller
- turbine
- flywheel

HYDRAULIC RETARDERS

- rotor and housing
- control valve

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

Potential Elements of the Performance of:

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

PERFORM A DEMONSTRATION OF CONVERTER:

- stall tests
- relief valve tests
- performance tests

2. HYDROSTATIC DRIVES

Define the purpose and fundamentals of hydrostatic drives.

Potential Elements of the Performance of:

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. **Describe the types and construction features of hydrostatic drives.**

Potential Elements of the Performance of:

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

2b. **Explain the principles of the operation of hydrostatic drives.**

Potential Elements of the Performance of:

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

Potential Elements of the Performance of:

PERFORM TEST PRESSURES OF HYDROSTATIC DRIVE SYSTEMS**3. POWER SHIFT TRANSMISSIONS.**

Define 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 inspection, testing, and diagnostic procedures following manufacturers' recommendations, and perform the assigned operations for power shift transmission systems.**

Potential Elements of the Performance of:

- check and test fluid levels and conditions
- perform a demonstration of the recommended procedures to perform oil and filter changes

4. PULL TYPES CLUTCHES AND FLYWHEEL ASSEMBLIES

Define the purpose and fundamentals of pull type clutches and flywheel assemblies.

Potential Elements of the Performance of:

- clamping force
- mechanical advantage
- laws of levers
- hydraulics
- static and sliding friction
- the coefficient of friction
- friction and heat
- centrifugal force

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

Potential Elements of the Performance of:

- 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 and cables linkage
- bus and coach controls
- flywheel housings
- bell and clutch housings

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

Potential Elements of the Performance of:

- double disc clutches
- clutch control systems
- adjustment - free
- linkage geometry

- release bearing assemblies
- clutch brakes
- flywheels
- pilot bearings
- clutch and input shafts
- pressure plate(s)
- heat dissipation
- the coefficient of friction
- friction media effects
- friction discs
- dampening
- hubs
- clutch housings
- clutch assembly alignments
- power flow

4c. **Perform inspection, testing and diagnostic procedures on pull type clutches and flywheel assemblies.**

Potential Elements of the Performance of:

- adjustment
- visual inspection
- test clutch and control operation
- diagnose clutch conditions
- lubrication practices
- hydraulics
- fluid levels
- clutch alignment
- housing alignment
- performance testing
- sub-component inspection
- identify causes of failure

4d. **Recommend reconditioning or repairs following manufacturers' procedures, and perform the assigned operations on pull type clutches and flywheel assemblies.**

Potential Elements of the Performance of:

- familiarization with manufacturer's service literature and specifications
- perform a clutch adjustment
- remove and replace clutch assemblies
- remove and replace a flywheel
- proper machining practices

- performance testing
- identify causes of failure
- measurement of components and assemblies
- clutch assembly overhaul procedures
- removal and replacement techniques

5 **HEAVY DUTY DRIVELINES**

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

Potential Elements of the Performance of:

- angularity
- articulation
- telescoping
- theory of non-uniform velocity
- parallel drive line arrangements
- broken-back drive line arrangements
- parallelogram
- working angle calculations

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

Potential Elements of the Performance of:

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

cardan joints

- trunnions
- bearings
- flanges and yokes

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

Potential Elements of the Performance of:
shafts and cardan joints

- angularity
- velocity

- phasing
- balancing
- run-out
- torsional loading
- vibration

- 5c. **Perform inspection, testing, and diagnostic procedures following manufacturers' recommendations, and perform assigned operations on drive shafts, power take-off shafts, and universal joints.**

Potential Elements of the Performance of:

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 reconditioning or repairs following manufacturers' procedures, and the perform assigned operations of drive shafts, power take-off shafts, and universal joints.**

Potential Elements of the Performance of:

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**

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

Potential Elements of the Performance of:

- mechanical advantage
- laws of levers
- torque
- input / output rotational speed
- gear ratios
- loading characteristics
- differential action
- thrust loads
- power flow
- bearing preloads
- lubrication

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

Potential Elements of the Performance of:

Drive axle assemblies

- planetary two-speed
- planetary double-reduction
- double-reduction helical
- two-speed double-reduction helical

- housings
- carriers (removable)
- planetary gearing
- lubricants

Planetary wheel end assemblies

- helical gearing
- differential gearing
- differential locks
- axle shafts (full floating)
- pneumatic shift systems
- electric shift systems

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

Potential Elements of the Performance of:

Drive axle assemblies

- planetary two-speed
- planetary double-reduction
- double-reduction helical
- two-speed double-reduction helical

- housings
- carriers (removable)
- planetary gearing
- lubricants

Planetary wheel end assemblies

- helical gearing
- differential gearing
- differential locks
- pneumatic shift systems
- electric shift systems

- 6c. **Perform disassembly, inspection, testing, diagnostic and reassembly procedures on multiple speed and double reduction drive axle assemblies.**

Potential Elements of the Performance of:

Disassemble and reassemble

- pinion bearing preload
- pinion depth
- carrier bearing preload
- backlash

- noise analysis
- temperature analysis
- visual inspection
- performance testing
- lubricant level and conditions
- shift problems
- shift control operation
- failure analysis

- 6d. **Recommend reconditioning or repairs following manufacturers' procedures, and the perform assigned operations on multiple speed and double reduction drive axle assemblies.**

Potential Elements of the Performance of:

Outline the procedure for checking lubricant levels

- outline recommended lubricant change levels
- verify lubricant type and application
- carrier removal, disassembly, reassembly and replacement procedures

Failure analysis to identify

- shock failures
- fatigue failures
- torsional failures
- surface failures
- spinout failures
- operational overloading
- temperature effects

Demonstrate the procedures for setting

- pinion bearing preload
- pinion depth
- carrier bearing preload
- drive gear set backlash

Demonstrate the procedures for checking

- drive gear set contact patterns
- drive gear set backlash
- thrust screw adjustment
- shift unit and overhaul

7. SERVICING TWIN COUNTERSHAFT TRANSMISSIONS

Recommend reconditioning or repairs following manufacturers' procedures, and perform the assigned operations on multiple countershaft manual transmission and auxiliary sections.

Potential Elements of the Performance of:

- outline the 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

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

Potential Elements of the Performance of:

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

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

Potential Elements of the Performance of:

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 and dry)

hydrostatic steering

- skid steer (wheel and track)

9. FINAL DRIVES

Define the purpose and fundamentals of final drives.

Potential Elements of the Performance of:**Final drives**

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

- 9a. **Explain the principles of operation of final drives.**

Potential Elements of the Performance of:**Final drives**

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

- 9b. **Perform inspection, testing, and diagnostic procedures following manufacturers' recommendations, and perform the assigned operations for final drives.**

Potential Elements of the Performance:**inspect final drives and check for:**

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

diagnose component failures and determine potential causes for:

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

- 9c. **Recommend reconditioning or repairs following manufacturers' recommendations, and perform the assigned operations for final drives.**

Potential Elements of the Performance of:**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

IV. REQUIRED RESOURCES/TEXTS/MATERIALS:

Title: Heavy Duty Truck Systems

Edition: 6th Canadian Edition

Author: Bennett

Publisher: Thomson Nelson Learning Canada

Pens, pencils, calculator, 3-ring binder

The following items are mandatory for shop:

- CSA approved steel toe boots (high top)
 - CSA approved safety glasses
 - Approved coveralls
9. FINAL DRIVES

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 – 30% of the final grade is comprised of term tests
- Assignments – 30% of the final grade is comprised of technical reports
- Shop – 40% of the final grade is comprised of attendance, punctuality, preparedness, student ability, work organization and general attitude

All Assignments must be typed

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.**

Students 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%	4.00
A	80 – 89%	3.00
B	70 - 79%	2.00
C	60 - 69%	1.00
D	50 – 59%	0.00
F (Fail)	49% and below	
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.

Professor Parsons
Student Assessment Procedure
For
Motive Power
THEORY ASSIGNMENTS and REPORTS

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

The following grades will be assigned for **Theory Assignments and Reports:**

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

All Assignments MUST be typed

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.**

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.

A Department Attendance Policy will be discussed.

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 during class time.**

Addendum:

Further modifications may be required as needed as the semester progresses based on individual student(s) ability. All modifications to evaluation components and/or assessments must be discussed and agreed upon by the instructor and the learning specialist in advanced of assigned competition date

VII. COURSE OUTLINE ADDENDUM:

The faculty member reserves the right to change the information contained in this course outline depending on the needs of the learner and the availability of resources.

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.