



**Skilled
Trades**
Ontario

**Métiers
spécialisés**
Ontario

Apprenticeship
Curriculum Standard

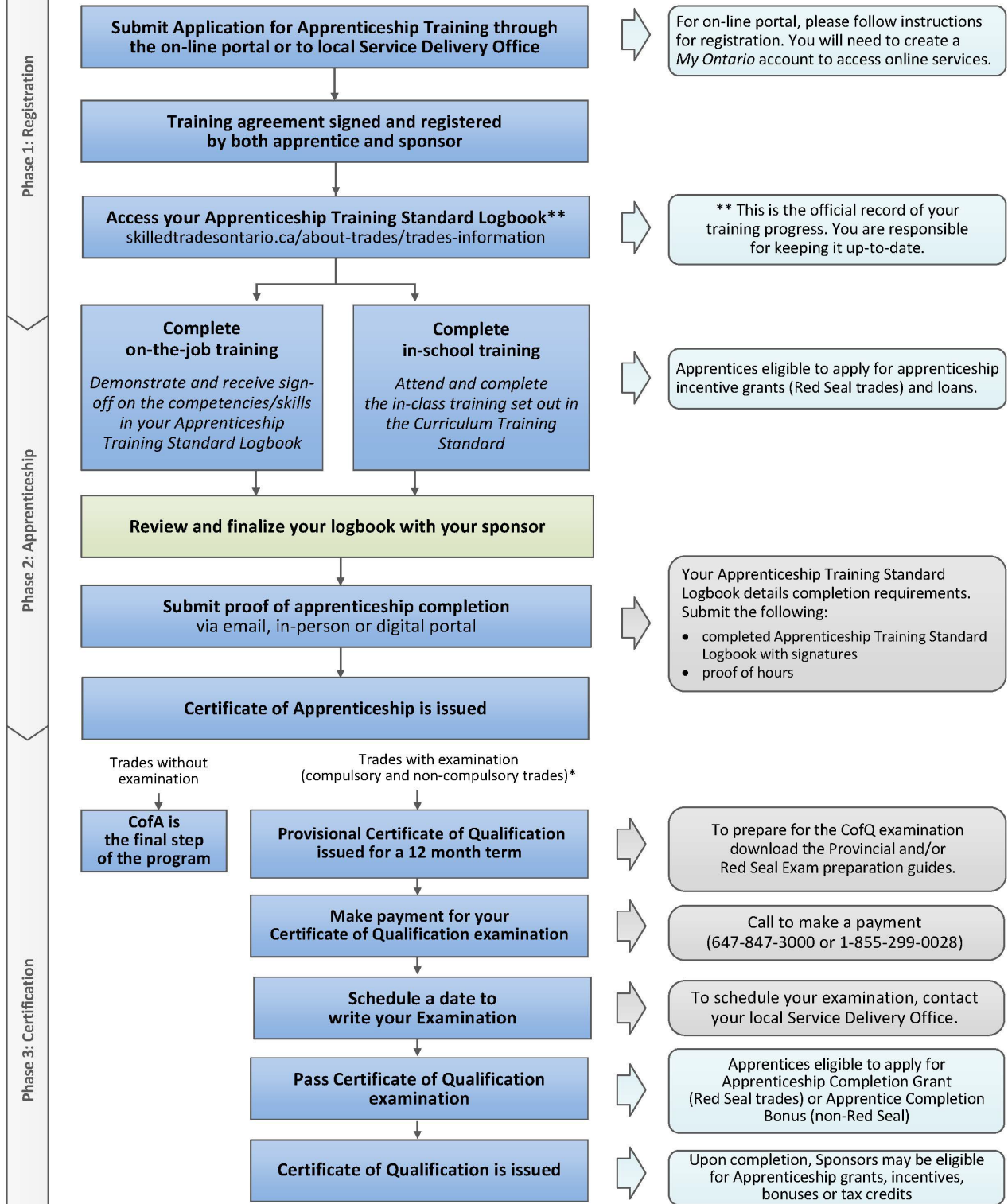
Small Engine Technician,
Marine Engine Technician &
Turf Equipment Technician

Level 1

435A, 435B & 421C

2014

Apprenticeship Pathway to a Certificate of Qualification



* For a list of trades subject to a certification examination, visit: skilledtradesontario.ca

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Please Note: This Standard has been revised to reflect the visual identity of Skilled Trades Ontario (STO) which replaced the Ontario College of Trades on January 1, 2022. The content of this Standard may refer to the former organization; however, all trade specific information or content remains relevant and accurate based on the original date of publishing.

Please refer to STO's website: skilledtradesontario.ca for the most accurate and up to date information. For information about BOSTA and its regulations, please visit [Building Opportunities in the Skilled Trades Act, 2021 \(BOSTA\)](#).

Any updates to this publication are available on-line; to download this document in PDF format, please follow the link: Skilled Trades Ontario.ca.

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Maintained with transfer to Skilled Trades Ontario 2014 (V100)

Preface

This curriculum standard for the Small Engine Technician, Marine Engine Technician & Turf Equipment Technician trade programs is based upon the on-the-job performance objectives, located in the industry-approved training standard.

The curriculum is organized into 3 levels of training. The Reportable Subjects Summary chart (located on page 4) summarizes the training hours for each reportable subject.

The curriculum identifies the learning that takes place in-school. The in-school program focuses primarily on the theoretical knowledge and the essential skills required to support the performance objectives of the Apprenticeship Training Standards.

Employers/Sponsors are expected to extend the apprentice's knowledge and skills through practical training on a work site. Regular evaluations of the apprentice's knowledge and skills are conducted throughout training to verify that all apprentices have achieved the learning outcomes identified in the curriculum standard.

It is not the intent of the in-school curriculum to perfect on-the-job skills. The practical portion of the in-school program is used to reinforce theoretical knowledge. Skill training is provided on the job.

Please refer to Skilled Trades Ontario website (www.skilledtradesontario.ca) for the most accurate and up-to-date information about Skilled Trades Ontario. For information on *Building Opportunities in the Skilled Trades Act, 2021 (BOSTA)* and its regulations, please visit [Building Opportunities in the Skilled Trades Act, 2021, S.O. 2021, c. 28 - Bill 288 \(ontario.ca\)](http://www.skilledtradesontario.ca/building-opportunities-in-the-skilled-trades-act-2021-s.o.-2021-c.-28-bill-288)

Pre-requisites

In order to advance to Level 2 of the apprenticeship program, an individual must have completed all of the units outlined in Level 1. Similarly, in order to advance to Level 3 of the program, an individual must have completed all of the units outlined in Level 1 and 2.

Hours Disclaimer (if applicable)

It is agreed that Training Delivery Agents (TDAs) may need to make slight adjustments (with cause) according to particular apprentice needs and may deviate from the unit sequencing and the prescribed practical and theoretical hours shown within the standard. However, all TDAs will comply with the hours at the reportable subject level.

Suggested Equipment for Training Delivery Agencies

Personal and Safety Equipment: Personal protective equipment is at the discretion of the TDA who must conform to Ontario Provincial Health and Safety Regulations.

Introduction

This curriculum standard for the Small Engine Technician & Marine Engine Technician trades is designed down from the learning outcomes, which were in turn developed from the industry-approved training standard.

The curriculum is organized into three levels of training, each including reportable subjects containing like or similar learning outcomes to reflect the units of the training standard. The hours charts indicates how the curriculum can be delivered in the current block release format and summarizes the hours of training for each reportable by level.

The reportable subjects are cross-referenced to the training standard for ease of comparison.

Each reportable subject and learning outcome identifies a recommended number of training hours. This hour allotment is broken into hours for instruction in theory and practical application. The division of the curriculum into reportable subjects that follow a natural progression of learning through the levels and branches of training will allow training centres and apprentices, flexibility in program delivery while still observing the importance of sequencing learning in a logical progression.

The curriculum is framed by and includes specific references to performance objectives in the Apprenticeship Training Standards for Small Engine Technician and Marine Engine Technician. However, it identifies only the learning that takes place off the job, in a training centre. The in-school program focuses primarily on the theoretical knowledge required to master the performance objectives of the Training Standards.

Employers are expected to extend the apprentice's knowledge and skills through appropriate practical training on the work site. Regular evaluations of the apprentice's knowledge and skills is conducted throughout training to assure that all apprentices have achieved the learning outcomes identified in the curriculum standard. The balance between theoretical and practical evaluation is identified for each unit of learning outcomes.

Level 1

Program Summary of Reportable Subjects

Number	Reportable Subjects	Hours Total	Hours Theory	Hours Practical
S1431	Safe Working Practices and Techniques	18	13	5
S1432	Work Practices and Procedures	60	33	27
S1433	Electrical and Electronic Systems	45	24	21
S1434	Fuel Systems	24	16	8
S1435	Engine Systems	54	30	24
S1436	Braking, Transmission and Auxiliary Drive Systems	39	20	19
	Total	240	136	104

Number:	S1431		
Title:	Safe Working Practices and Techniques		
Duration:	Total Hours: 18	Theory: 13	Practical: 5
Prerequisites:	None		
Content:	1.1 Workplace Safety Requirements (13/5)		

Evaluation & Testing:

Assignments

Tests

Reference Materials:

Workplace Safety and Insurance Act, 1997

Occupational Health and Safety Act, 1990

Employment Standards Act, 2000

Labour Relations Act, 1995

Employment Insurance Act, 1996

Ontario College of Trades and Apprenticeship Act, 2009

Apprenticeship and Certification Act, 1998

Canadian Standards Association (CSA)

Workplace Hazardous Materials Information System (WHMIS)

Canadian Coast Guard

Recommended Equipment List:

Approved storage and disposal containers

WHMIS materials

Approved fire extinguishers

Appropriate first aid supplies

Adequate safety shields

Equipment safety guards

Appropriate hand and power tools

Appropriate lifting, rigging and blocking equipment

Number:	S1431.1		
Title:	Workplace Safety Requirements		
Duration:	Total Hours: 18	Theory: 13	Practical: 5
Prerequisites:	None		
Cross Reference to Training Standard:	6400.01 to 6400.07; 6380.01 to 6380.07		

General Learning Outcomes

Upon successful completion, the apprentice is able to interpret workplace safety requirements in accordance with government safety regulations and approved industry standards.

Learning Outcomes and Content

1.1.1 Identify the fundamentals of safe work practices, equipment and cleaning agents. (2/0)

Personal attire:

- glasses
- shields
- guards
- ventilation
- gloves
- clothing
- shoes
- masks
- breathing filters

Cleaning agents:

- handling
- storage
- disposal
- safety hazards

Physical activities:

- lifting techniques
- safe handling of equipment and tools
- safe working conditions
- organization of work areas
- application of force on wrenches and levers

- 1.1.2 Identify legal responsibilities in Workplace Hazardous Materials Information Systems (WHMIS), the *Occupational Health and Safety Act, 1990* and other provincial and federal government legislation. (4/0)

Workplace Hazardous Materials Information Systems (WHMIS):

- regulatory requirements
- information delivery
- occupational health
- control of hazardous material/safety data sheets
- fluid disposal

Occupational Health and Safety Act, 1990:

- principles pertaining to industry
- responsibilities of employer and employee
- right of refusal/unsafe working conditions
- accident and hazard reporting

Purpose and principles of:

- Workplace Safety and Insurance Act, 1997
- Occupational Health and Safety Act, 1990
- Employment Standards Act, 2000
- Labour Relations Act, 1995
- Employment Insurance Act, 2010
- Trades Qualification and Apprenticeship Act, 1990
- Technical Standards and Safety Act, 2000
- Canadian Standards Association (CSA)
- Canadian Coast Guard

- 1.1.3 Describe the operating procedures for emergency safety equipment, such as fire extinguishers and other extinguishing media, in a safe, efficient manner in accordance with the *Occupational Health and Safety Act, 1990* and *Employment Standards Act, 2000*, as they apply to workplace health and safety policies and procedures. (4/1)

Types of fire:

- Class “A”
- Class “B”
- Class “C”
- Class “D”

Emergency safety equipment:

- fire extinguishers/codes
- fire blankets
- alarms
- standard first aid kit

Basic methods of extinguishing fires:

- removal of oxygen
- removal of fuel
- lowering temperature of fuel
- interruption of flame chemistry

Identification of available extinguishing agents:

- HALON 1211
- HALON 1301
- dry chemical
- carbon dioxide
- foam
- water

Fire extinguishers selection and recharging:

- code
- when you recharge
- fire class and extinguishing agents

- 1.1.4 Identify the government regulations and safety requirements for handling, storing, and disposal of hazardous materials in a safe manner using specified handling and storage equipment. (1/1)

Technical Standards and Safety Act, 2000:

- gasoline, O.Reg. 217/01
- diesel fuel, O.Reg. 217/01
- propane, O.Reg. 211/01
- alcohol, O.Reg. 217/01

1.1.5 Perform safe working practices in the workplace. (1/1)

Observe safety rules and identify the correct behaviour to avoid safety and health hazards caused by:

- horseplay and practical jokes
- loose clothing and improper footwear
- rings, pendants and other jewellery
- long hair
- poor housekeeping
- lifting and carrying heavy objects
- contact with toxic chemicals
- improper handling/storage of hazardous material
- improper operation of hydraulic/pneumatic equipment
- improper use of compressed air
- improper start-up of equipment
- non use of safety attire and equipment

1.1.6 Describe the requirements of rigging and lifting of powered equipment and unit vehicle systems and components. (1/0)

State the safe use of rigging equipment used with lifting, hoisting of materials and/or products:

- slings
- care and safe use of hoisting equipment
- crate handling and unpacking procedures

1.1.7 Perform safe moving of powered equipment and unit vehicle systems and components such as: (0/2)

- Personal lifting techniques
- Lifting and blocking techniques
- Transportation techniques
- Crate handling and unpacking procedures

Evaluation Structure		
Theory Testing	Practical Application Testing	Final Assessment
55%	15%	30%

Number:	S1432		
Title:	Work Practices and Procedures		
Duration:	Total Hours: 60	Theory: 33	Practical: 27
Prerequisites:	Level 1, Reportable Subject Number 1		
Content:	2.1 Information, Parts and Warranty Control Systems (4/0)		
	2.2 Customer Relations and Communication Techniques (4/0)		
	2.3 Tools and Equipment (8/5)		
	2.4 Fastening and Sealing Techniques (3/3)		
	2.5 Trade Calculations (5/0)		
	2.6 Heating, Cutting and Welding (8/16)		
	2.7 Seasonal Storage of Marine and Small Powered Equipment (1/3)		

Evaluation & Testing:

Minimum of one mid-term test during the 8-week term

Final exam at end of term

Periodic quizzes

Instructional and Delivery Strategies:

Assignments related to theory and appropriate application skills

Reference Materials:

Workplace Safety and Insurance Act, 1997

Occupational Health and Safety Act, 1990

Employment Standards Act, 2000

Labour Relations Act, 1995

Employment Insurance Act, 1996

Ontario College of Trades and Apprenticeship Act, 2009

Apprenticeship and Certification Act, 1998

Canadian Standards Association (CSA)

Workplace Hazardous Materials Information System (WHMIS)

Canadian Coast Guard

Recommended Equipment List:

Approved storage and disposal containers

WHMIS materials

Approved fire extinguishers

Oxyacetylene heating, cutting and welding equipment

Shielded metal arc welding equipment

Appropriate welding supplies

Appropriate hand and power tools

Appropriate lifting, rigging and blocking equipment

Number:	S1432.1		
Title:	Information, Parts and Warranty Control Systems		
Duration:	Total Hours: 4	Theory: 4	Practical: 0
Prerequisites:	None		
Cross Reference to Training Standard:	6401.01; 6381.01		

General Learning Outcomes

Upon successful completion, the apprentice is able to identify the fundamentals of accessing workplace information for parts and warranty control systems, in accordance with government safety regulations and approved industry standards.

Learning Outcomes and Content

2.1.1 Identify the fundamentals of parts inventory control systems. (2/0)

Parts inventory systems:

- parts manual interpretation
- microfiche systems
- system updates and implementation

Stockroom practices:

- shop supplies
- year-end inventory
- computerized inventory systems
- computerized parts/service information systems

2.1.2 Identify the essential basic information and fundamentals of industry warranty claims. (2/0)

Manufacturers' warranty coverage:

- duration
- parts
- service
- product use
- customer responsibility
- warranty administration

Number:	S1432.2		
Title:	Customer Relations and Communication Techniques		
Duration:	Total Hours: 4	Theory: 4	Practical: 0
Prerequisites:	None		
Cross Reference to Training Standard:	6401.02, 6401.03; 6381.02, 6381.03		

General Learning Outcomes

Upon successful completion, the apprentice is able to demonstrate effective communication and customer relation techniques in accordance with government safety regulations and approved industry standards.

Learning Outcomes and Content

- 2.2.1 Employ communication techniques in gathering relevant data to provide for diagnostic procedures and work descriptions. (.5/0)
- Evaluate a customer's attitude and opinion
 - Interpret oral instructions
 - Identify and avoid poor listening habits
 - Listen to the customer's description of the trouble
 - Ask questions to determine the scope of the problems
- 2.2.2 Process messages accurately to ensure customer satisfaction with work orders and service calls. (.5/0)
- Recognize and clearly record customer's main points
- Determine contents of messages:
- respond effectively
 - respond accurately
 - respond quickly
- 2.2.3 Develop skills in customer relations and promote the business in areas of product, service and facilities. (1/0)
- Develop constructive attitudes towards customers
- Recognize that a profit-oriented organization must be responsive to customer needs

Avoid criticism of:

- other personnel
- customer
- product you sell

Express a sense of urgency and interest in the customer problems:

- avoid arguments with the customer
- treat the customer with courtesy and convey positive attitude about your product and service

Handle complaints by:

- showing interest
- giving prompt attention
- implementing a solution
- following through with customer

2.2.4 Explain to customer the malfunction, nature of repair and recommendations for future avoidance. (1/0)

Explain in terms the customer can understand:

- cause of malfunction
- nature of repairs
- points enabling avoidance of future problems
- recommended operating and maintenance of equipment

Recommend alternative repairs to allow customer to make an informed decision about proceeding with suggested repairs

2.2.5 Accurately complete the work order and discuss with the customer. (1/0)

Clearly and accurately complete work order:

- customer's name, address and telephone number
- repair required
- date received
- unit identification

List the required needs of the repair as they relate to:

- replacement parts
- service parts
- routine maintenance
- shop supplies
- labour
 - in-house
 - sublet

Estimate the cause of the malfunction or damage for:

- insurance claims
- warranty claims
- shop guarantee

Calculate the estimated cost from:

- parts books
- flat rate manuals
- shop labour rates

Obtain supervisor's guidance in determining cost of:

- parts
- sublet procedure
- all taxes
- in-house service
- shop supplies

Calculate total costs and discuss with customer

Number:	S1432.3		
Title:	Tools and Equipment		
Duration:	Total Hours: 13	Theory: 8	Practical: 5
Prerequisites:	None		
Cross Reference to Training Standard: 6400.05, 6401.06, 6401.09, 6401.12, 6403.03; 6380.05, 6381.06, 6381.09, 6381.12, 6384.03			

General Learning Outcomes

Upon successful completion, the apprentice is able to use and perform maintenance procedures for tools and equipment in accordance with government safety regulations, approved industry standards and equipment manufacturers' recommendations and specifications.

Learning Outcomes and Content

2.3.1 Define the fundamentals of precision and non-precision tools. (4/0)

Purpose, function, types, styles and applications

Fundamentals:

- metric and imperial measurements and conversions
- hammers (ball peen and soft faced)
- pliers (diagonal cutters, Adjustable pliers, and needle nose)
- locking Pliers
- wrenches, imperial and metric
- wrenches, open end, box end, combination and flare nut
- screwdrivers
- chisels
- drills
- reamers
- taps and dies (imperial and metric)
- thread chasers (imperial and metric)
- stud removers
- inserts
- cutting fluids

2.3.2 Describe the basic function and construction of precision and non-precision tools. (2/0)

Micrometers:

- inside, outside, depth

Small-hole gauges

Callipers

Precision, Vernier, non-precision

Telescoping gauges

Straight edges

Dial indicators

Cylinder/bore gauge

Plug gauges

2.3.3 Explain the basic principles of operations of precision and non-precision tools. (2/0)

Micrometers:

- inside, outside, depth

Small hole gauges

Callipers:

- precision, Vernier, non-precision

Telescoping gauges

Straight edges

Dial indicators

Cylinder/bore gauge

Plug gauges

2.3.4 Describe the manufacturers' system maintenance and calibration procedures of precision and non-precision measuring tools and power tools and perform assigned operations. (0/5)

Describe and perform basic precision tool maintenance procedures:

- storage
- lubrication
- methods of restoring critical surfaces
- adjustments, calibrations

Perform precision measuring activities as applied to various components and clearance checks

Describe and perform power tool maintenance procedures:

- electrical connections
- air lines and connectors
- hydraulic lines and connectors
- moisture contamination
- impact wrenches
- portable drills
- drill press
- hydraulic press
- grinders

Number:	S1432.4		
Title:	Fastening and Sealing Techniques		
Duration:	Total Hours: 6	Theory: 3	Practical: 3
Prerequisites:	None		
Cross Reference to Training Standard: 6402.05, 6403.05, 6403.08, 6403.11, 6403.14, 6404.03, 6405.01, 6405.02; 6406.03, 6406.07, 6406.11, 6411.01 to 6411.04, 6412.01 to 6412.04; 6383.03, 6384.05, 6384.09, 6384.11, 6384.14, 6385.03, 6386.01, 6386.02, 6387.03, 6387.07, 6387.11, 6389.01 to 6389.04			

General Learning Outcomes

Upon successful completion, the apprentice is able to describe the application of fastening and sealing techniques in accordance with government safety regulations, approved industry standards and equipment manufacturers' recommendations and specifications.

Learning Outcomes and Content

2.4.1 Define the essential basic information and fundamentals of fastening and sealing techniques. (1/0)

History, purpose and types

Fundamentals:

- thread terminology, fastener grade, fastener application
- SAE standards, international standards
- tensile strength, sheer strength, grade, pitch, threads per inch, diameter
- dynamic and static seals applications
- thread locking agents
- anti-seize
- sealant applications

2.4.2 Describe the construction features and applications of fastening and locking devices, thread repair devices, seals, sealants and gaskets, including; (1/0)

- Threaded fasteners, cap screws, nuts, screws, rivets
- Thread repair devices
- Locking devices
- Self-locking nuts, pal nuts, washers, plates, keys, splines, snap rings
- Seals, sealants, and gaskets
- Thread locking agents
- Anti-seize

2.4.3 Explain the basic principles of operation of fastening and locking devices, thread repair devices, seals, sealants and gaskets, including; (1/0)

- Torque to yield bolts and cap screws
- Torque effects of wet, dry and clean threads
- Thread repair principles

2.4.4 Describe the installation and removal procedures for various fastening, locking and sealing applications and perform drilling, tapping, hack sawing and filing procedures using the prescribed service tools and equipment. (0/3)

Verify fastener thread strengths and torque requirements for wet and dry applications.

Perform thread repair:

- freeing of seized threads, removal of broken studs or cap screws
- installation of thread inserts, locking devices

Describe the characteristics and performance of metal working practices:

- drilling, tapping, hack sawing and filing

Describe seal, sealant, and gasket selection, removal and installation practices.

Number:	S1432.5		
Title:	Trade Calculations		
Duration:	Total Hours: 5	Theory: 5	Practical: 0
Prerequisites:	None		
Cross Reference to Training Standard:	6401.01 to 6401.03; 6381.01 to 6381.03		

General Learning Outcomes

Upon successful completion, the apprentice is able to perform applied trade calculations in accordance with the requirements of applied trade related problems.

Learning Outcomes and Content

2.5.1 Perform arithmetic operations related to fractions, decimals, and percentages. (2/0)

Review rules for adding, subtracting, multiplying, and dividing whole numbers, fractions and decimals

Review fractions and decimals and their applications

Review the rules of percentages and percentage calculations

Apply rules to simple mathematical calculations:

- stock taking
- invoices
- estimates
- work orders
- discounts
- profit
- taxes
- interest
- depreciation
- grades

2.5.2 Perform conversions between the metric and imperial systems. (1/0)

Review the differences between the metric and imperial system of measurement

Review use of conversion tables and charts

Apply tables and charts to calculate and convert imperial to metric and metric to imperial

2.5.3 Perform operations in order to calculate linear and angular measurements. (2/0)

Linear measurement:

- length
- width
- height
- holes/slots

Angular measurements:

- principles pertaining to industry

Purpose and principles of:

- rotation
- minutes
- degrees
- seconds

Number:	S1432.6		
Title:	Heating, Cutting and Welding		
Duration:	Total Hours: 24	Theory: 8	Practical: 16
Prerequisites:	None		
Cross Reference to Training Standard:	6401.05 to 6401.13; 6381.05 to 6381.13		

General Learning Outcomes

Upon successful completion, the apprentice is able to perform basic heating, cutting and welding techniques in accordance with government safety regulations, approved industry standards and equipment manufacturers' recommendations and specifications.

Learning Outcomes and Content

- 2.6.1 Define the essential basic information and fundamental set up and safety procedures for the oxyacetylene and ARC welding equipment. (3/0)

History, purpose, types and applications

Fundamentals

- metallurgy, heat treating metals

- 2.6.2 Describe the construction features of oxyacetylene and ARC welding equipment. (3/0)

Oxyacetylene welding

- tanks, valves, hoses

ARC welding

- transformer, cables, and rod selection

- 2.6.3 Explain the safe principles of operation of oxyacetylene and ARC welding equipment. (2/0)

Oxyacetylene

- oxygen dangers, acetylene dangers
- ignition procedures, pressure settings
- eye protection, welding helmet, face shield
- gloves, boots, leather aprons, protective screens
- fire extinguisher availability
- set up and shut down sequence

ARC welding

- electrical shock, radiation burns

2.6.4 Describe the manufacturers' system maintenance procedures of oxyacetylene and ARC welding equipment and perform assigned operations. (0/3)

Oxyacetylene equipment

- condition of lines, valves, tanks, and tips

ARC welding

- condition of cables, rod holders, clamps and transformer

2.6.5 Perform basic heating, cutting and welding procedures. (0/13)

Oxygen and acetylene pressure settings

Cutting tips and procedures:

- observance of tip angle
- temperature of metals
- awareness of potential heating or cutting damage
- perform cutting of seized fasteners
- perform cutting of common metals

Heating tips and procedures:

- torch pressure settings
- flame adjustment
- perform heating to loosen seized fasteners

Welding and brazing tips:

- temperature control
- speed and angle of tip
- oxygen and acetylene pressure settings

Perform welding and brazing procedures:

- weld lap and tee joints
- metal fracture repairs
- metal fill in repairs

Number:	S1432.7		
Title:	Seasonal Storage of Marine and Small Powered Equipment		
Duration:	Total Hours: 4	Theory: 1	Practical: 3
Prerequisites:	None		
Cross Reference to Training Standard:	6401.04, 6381.04		

General Learning Outcomes

Upon successful completion, the apprentice is able to describe seasonal storage techniques of marine and small powered equipment in accordance with government safety regulations, approved industry standards and equipment manufacturers' recommendations and specifications.

Learning Outcomes and Content

2.7.1 Describe the seasonal storage procedures for engine systems and components. (1/3)

2 stroke cycle procedures

- fogging

4 stroke cycle procedures

- fogging
- oil cylinder walls
- need for pre-storage oil change

Fuel storage techniques

Evaluation Structure		
Theory Testing	Practical Application Testing	Final Assessment
40%	30%	30%

Number:	S1433		
Title:	Electrical and Electronic Systems		
Duration:	Total Hours: 45	Theory: 24	Practical: 21
Prerequisites:	None		
Content:	3.1 Electrical and Electronic System Fundamentals (17/17)		
	3.2 Lead Acid Batteries (4/1)		
	3.3 Electrical Wiring Diagrams (3/3)		

Evaluation & Testing:

Minimum of one mid-term test during the 8-week term
Final exam at end of term
Periodic quizzes

Instructional and Delivery Strategies:

Assignments related to theory and appropriate application skills

Reference Materials:

Workplace Safety and Insurance Act, 1997
Occupational Health and Safety Act, 1990
Employment Standards Act, 2000
Labour Relations Act, 1995
Employment Insurance Act, 1996
Ontario College of Trades and Apprenticeship Act, 2009
Apprenticeship and Certification Act, 1998
Canadian Standards Association (CSA)
Workplace Hazardous Materials Information System (WHMIS)
Canadian Coast Guard

Recommended Equipment List:

Approved storage and disposal containers
WHMIS materials
Approved fire extinguishers
Appropriate lifting, rigging and blocking equipment
Appropriate equipment and unit vehicles
Appropriate hand and power tools
Precision measuring tools
Digital volt ohmmeters/multi-meters
Battery load testers
Service information systems

Number:	S1433.1		
Title:	Electrical and Electronic System Fundamentals		
Duration:	Total Hours: 34	Theory: 17	Practical: 17
Prerequisites:	None		
Cross Reference to Training Standard:	6403.01 to 6403.15; 6384.01 to 6384.15		

General Learning Outcomes

Upon successful completion, the apprentice is able to identify and describe electrical and electronic systems in accordance with government safety regulations, manufacturers' recommendations and specifications and approved industry standards.

Learning Outcomes and Content

3.1.1 Define the fundamentals of electrical and electronic systems. (11/7)

History, purpose, function, types, styles and application

3.1.2 Apply the fundamentals of electrical and electronic systems

Fundamentals:

- atomic structure
- electron and conventional theories
- source of electricity
- heat
- pressure
- friction
- chemical
- light
- magnetism
- conductors and insulators
- mega, kilo, milli, micro
- voltage, amperage, resistance, wattage
- Kirchhoff's Law
- magnetism
- induction
- circuits

Circuit protection devices:

- fuses, circuit breakers, fusible links

Circuit controls:

- switches, diodes, transistors, resistors, sensors, relays, modules

Conductors and insulators:

- gauge size
- temperature effects and weather proofing

Definition of:

- opens, shorts, grounds, high resistance connections

Introduction to semi-conductors:

- diodes, transistors, Silicon Controlled Rectifier

Meters:

- multi-meters
- analog, digital
- scope
- peak
- testing equipment
- diagnostic equipment
- spark testers

Introduction to series and parallel circuits:

- Ohm's Law
- voltage drops

Perform circuit wiring repair:

- cleaning, splicing, crimping, soldering, corrosion protection, circuit termination guidelines

- 3.1.3 Describe the construction features and basic principles of operation of mechanical breaker ignition (MBI), capacitor discharge ignition (CDI) and transistor controlled ignition (TCI) systems. (6/0)

Ignition systems:

- coils
- spark plugs
- high tension leads
- resistor plug caps
- switches
- capacitor, condenser
- spark voltages
 - required voltage
 - available, reserve voltage
- ignition Index marks

Point ignition systems:

- battery
- magneto

CDI ignition:

- battery
- magneto
- Introduction to transistor controlled ignition

3.1.4 Identify, test and diagnose ignition systems and components. (0/10)

Ignition coil testing:

- resistance tests

Spark testing

Check timing

Magneto ignition

CDI:

- trigger/pulser coil tests
- charge coil/exciter coil tests

TCI

- output tests

Battery ignition:

- breaker points
- transistorized

Energy transfer ignition

Advance mechanisms:

- manual
- centrifugal
- electronic

Applied tools and equipment:

- test light
- multi-meter (analog, digital)
- peak reading voltmeter (DVA)
- spark gap tester
- timing light

Number:	S1433.2		
Title:	Lead Acid Batteries		
Duration:	Total Hours: 5	Theory: 4	Practical: 1
Prerequisites:	None		
Cross Reference to Training Standard:	6403.01 to 6403.04; 6384.01 to 6384.04		

General Learning Outcomes

Upon successful completion, the apprentice is able to test and diagnose lead acid batteries in accordance with government safety regulations, manufacturers' recommendations and specifications and approved industry standards.

Learning Outcomes and Content

- 3.2.1 Define the fundamentals of lead acid batteries. (2/0)
 - History, purpose, function, types and application
 - Reserve capacity
 - Cold cranking rating
 - Temperature effects
 - Internal resistance factors
 - Specific gravity and temperature compensation for electrolyte
 - Ampere-hour ratings (amp-hour)
- 3.2.2 Describe the basic function, composition, and construction of lead acid battery components. (1/0)
 - Deep cycle
 - Lead acid low maintenance and maintenance-free batteries
 - Absorbed glass mat (AGM)
 - Gel batteries
 - Lithium type batteries

3.2.3 Explain the basic principles of operation of lead acid battery components, charging, temperature resistance and ratings effects. (1/0)

Battery chemical action during charging and discharging

Temperature effect on charging, internal resistance ratings

3.2.4 Inspect and test batteries with the prescribed service tools and equipment. (0/1)

Demonstrate:

- maintenance, state of charge, storage, activation, charging procedures
- cleaning precautions
- removal and replacement procedures

Number:	S1433.3		
Title:	Electrical Wiring Diagrams		
Duration:	Total Hours: 5	Theory: 3	Practical: 2
Prerequisites:	None		
Cross Reference to Training Standard:	6403.01, 6403.04 to 6403.15, 6404.01 to 6404.07;6384.01, 6384.04 to 6384.15, 6385.01 to 6385.07		

General Learning Outcomes

Upon successful completion, the apprentice is able to interpret electrical wiring diagrams in accordance with government safety regulations, manufacturers' recommendations and specifications and approved industry standards.

Learning Outcomes and Content

- 3.3.1 Define the fundamentals of electrical wiring diagrams. (1.5/0)
- Purpose, function, types and applications
 - Electrical symbols
 - Circuit identification methods
 - Colour codes, number codes
- 3.3.2 Explain the basic design, layout and interpretation techniques of manufacturers' wiring diagrams. (1.5/0)
- Electrical wiring diagrams
 - Schematic wiring diagrams
 - Block wiring diagrams
 - Pictorial wiring diagrams
 - Component location diagrams

3.3.3 Locate electrical components and trace circuits of systems with the prescribed manufacturers' wiring diagram. (0/3)

Demonstrate and perform:

- verification of wiring diagram and trace circuits on the unit
 - - colour codes, connectors, gauge sizes, number codes

Applied safety precautions:

- eye protection
- accidental grounds
- test lamp precautions on electronic circuits

Evaluation Structure		
Theory Testing	Practical Application Testing	Final Assessment
30%	40%	30%

Number:	S1434		
Title:	Fuel Systems		
Duration:	Total Hours: 24	Theory: 16	Practical: 8
Prerequisites:	None		
Content:	4.1 Fuel Systems (8/4)		
	4.2 Governors and Control Systems (2/1)		
	4.3 Intake and Exhaust Systems (2/3)		
	4.4 Emission Control Systems (4/0)		

Evaluation & Testing:

Minimum of one mid-term test during the 8 week term

Final exam at end of term

Periodic quizzes

Instructional and Delivery Systems:

Assignments related to theory and appropriate application skills

Reference Materials:

Workplace Safety and Insurance Act, 1997

Occupational Health and Safety Act, 1990

Employment Standards Act, 2000

Labour Relations Act, 1995

Employment Insurance Act, 1996

Ontario College of Trades and Apprenticeship Act, 2009

Apprenticeship and Certification Act, 1998

Canadian Standards Association (CSA)

Workplace Hazardous Materials Information System (WHMIS)

Canadian Coast Guard

Recommended Equipment List:

Approved storage and disposal containers

WHMIS materials

Approved fire extinguishers

Appropriate lifting, rigging and blocking equipment

Appropriate equipment and unit vehicles

Appropriate hand and power tools

Appropriate emission testing equipment

Digital volt ohmmeters/ multi-meters

Service information systems

Pressure gauges

Flow gauges

Vacuum gauges

Number:	S1434.1		
Title:	Fuel Systems		
Duration:	Total Hours: 12	Theory: 8	Practical: 4
Prerequisites:	None		
Cross Reference to Training Standard: 6404.01 to 6404.04, 6405.01, 6405.03; 6385.01 to 6385.04, 6386.01, 6386.03			

General Learning Outcomes

Upon successful completion, the apprentice is able to service gasoline engine fuel systems in accordance with government safety regulations, manufacturers' recommendations and specifications and approved industry standards.

Learning Outcomes and Content

4.1.1 Explain the essential properties of fuels. (2/0)

Seasonal blending

Ethanol content

Ethanol testing

Additive packages

Octane rating/levels

Shelf life

Blended fuels

Phase separation

Research octane method (ROM)

Research octane number (RON)

Boiling point

Propane

Natural gas

Diesel:

- flash points
- cloud points
- algae growth
- cetane
- water content
- sulphur content
- 1D/2D
- biodiesel

4.1.2 Define the fundamentals of gasoline fuel systems. (1/0)

History, purpose, function, types, styles and applications

Combustion of fuels

Air/fuel ratios

Bernoulli's theorem

Fuel consumption, units of measure

Effects of altitude on:

- atmospheric pressure
- vacuum

Vapour lock

4.1.3 Describe and explain the basic function, composition, construction and basic operating principles of gasoline and alternate fuel systems. (3/0)

Carburetor fuel supply system:

- tanks, pumps, lines, fittings
- filters
- single and dual line
- vented and pressurized tanks
- gravity and pump supplied

Carburetors:

- diaphragm (internal/external pulse)
- float
- suction
- circuits
- pulse-jet

Introduction to alternate fuels systems:

- propane
- natural gas

4.1.4 Inspect, test, maintain and adjust carbureted fuel systems. (2/4)

Carbureted systems

Visual inspection of lines, filters

Demonstrate and perform fuel pump tests:

- capacity, pressure, vacuum

Applied safety precautions:

- spontaneous combustion/storage of wipes
- Canadian Standards Association (CSA) approved equipment for emptying tanks and storing fuels
- hazards of solvents
- high pressure fuel lines
- alternate fuel safety concerns
- carburetor flashback
- legal aspects of emission control equipment
- carburetor cleaning products

Number:	S1434.2		
Title:	Governors and Control Systems		
Duration:	Total Hours: 3	Theory: 2	Practical: 1
Prerequisites:	None		
Cross Reference to Training Standard:	6403.10 to 6403.12; 6384.10 to 6384.12		

General Learning Outcomes

Upon successful completion, the apprentice is able to identify and describe governors and control systems in accordance with government safety regulations, manufacturers' recommendations and specifications and approved industry standards

Learning Outcomes and Content

4.2.1 Define the fundamentals of governors and control systems. (1/0)

Pneumatic

Mechanical

Electrical

4.2.2 Describe the basic function, composition, construction and operating principles of governors and control systems. (1/1)

Airvane

Centrifugal

Electrical

Number:	S1434.3		
Title:	Intake and Exhaust Systems		
Duration:	Total Hours: 5	Theory: 2	Practical: 3
Prerequisites:	None		
Cross Reference to Training Standard:	6402.01 to 6402.03, 6404.01 to 6404.04, 6405.01, 6405.03; 6383.01 to 6383.03, 6385.01 to 6385.04, 6386.01, 6386.03		

General Learning Outcomes

Upon successful completion, the apprentice is able to service intake and exhaust systems in accordance with government safety regulations, manufacturers' recommendations and specifications and approved industry standards.

Learning Outcomes and Content

4.3.1 Define the fundamentals of intake and exhaust systems. (1/0)

History, purpose, function, types, styles and application

Volumetric efficiency

Scavenging

Fundamentals:

- manifold vacuum and exhaust back pressure
- ported vacuum
- volumetric efficiency
- thermal expansion and contraction

4.3.2 Describe the basic function, composition, construction and operating principles of intake and exhaust systems. (1/0)

Intake systems:

- filter assemblies
- manifolds
- gaskets

Exhaust systems:

- manifolds
- gaskets
- flanges
- pipes

4.3.3 Inspect and test intake exhaust systems and components. (0/2.5)

Visual inspection of intake and exhaust systems:

- restrictions
- noise
- leaks

Demonstration of:

- exhaust back pressure testing
- intake manifold vacuum testing

4.3.4 Describe manufacturers' system maintenance procedures of air filters and perform assigned operations. (0/.5)

Perform maintenance procedures for air filter systems

Number:	S1434.4		
Title:	Emission Control Systems		
Duration:	Total Hours: 4	Theory: 4	Practical: 0
Prerequisites:	None		
Cross Reference to Training Standard:	6404.01 to 6404.04, 6405.01, 6405.03; 6385.01 to 6385.04, 6386.01, 6386.03		

General Learning Outcomes

Upon successful completion, the apprentice is able to describe the fundamentals and construction features of emission control systems in accordance with government safety regulations, manufacturers' recommendations and specifications and approved industry standards.

Learning Outcomes and Content

4.4.1 Define the fundamentals of emission control systems. (2/0)

History, purpose, function, types, styles, and application

Fundamentals

Properties of carbon monoxide, hydrocarbons, oxides of nitrogen and particulates

Thermal expansion and contraction

Air/fuel ratios

Combustion of fuels:

- photochemical, smog, acid rain, greenhouse effect
- legal consequences of emission equipment tampering
- temperature of combustion
- legal requirements of exhaust emissions

4.4.2 Describe the basic function, composition and construction of emission control systems. (2/0)

Positive crankcase ventilation

Evaporative emission systems

Exhaust gas recirculation systems

Catalytic converter

Manifold heating devices

Evaluation Structure		
Theory Testing	Practical Application Testing	Final Assessment
40%	30%	30%

Number:	S1435		
Title:	Engine Systems		
Duration:	Total Hours: 54	Theory: 30	Practical: 24
Prerequisites:	None		
Content:	5.1 Engine Assemblies (20/18)		
	5.2 Lubrication Systems (6/2)		
	5.3 Cooling systems (4/4)		

Evaluation & Testing:

Minimum of one mid-term test during the 8 week term
Final exam at end of term
Periodic quizzes

Instructional and Delivery Strategies:

Assignments related to theory and appropriate application skills

Reference Materials:

Workplace Safety and Insurance Act, 1997
Occupational Health and Safety Act, 1990
Employment Standards Act, 2000
Labour Relations Act, 1995
Employment Insurance Act, 1996
Ontario College of Trades and Apprenticeship Act, 2009
Apprenticeship and Certification Act, 1998
Canadian Standards Association (CSA)
Workplace Hazardous Materials Information System (WHMIS)
Canadian Coast Guard

Recommended Equipment List:

Approved storage and disposal containers
WHMIS materials
Approved fire extinguishers
Appropriate lifting, rigging and blocking equipment
Appropriate equipment and unit vehicles
Appropriate hand and power tools
Appropriate emission testing equipment
Digital volt ohmmeters/ multi-meters
Service information systems
Pressure gauges
Flow gauges
Vacuum gauges

Number:	S1435.1		
Title:	Engine Assemblies		
Duration:	Total Hours: 38	Theory: 20	Practical: 18
Prerequisites:	None		
Cross Reference to Training Standard:	6406.01 to 6406.15; 6387.01 to 6387.15		

General Learning Outcomes

Upon successful completion, the apprentice is able to test, service and maintain engine assemblies in accordance with government safety regulations, manufacturers' recommendations and specifications and approved industry standards.

Learning Outcomes and Content

- 5.1.1 Define the fundamentals of engine systems and components. (6/0)
- Two and four-stroke cycle
 - Bore, stroke, displacement, horsepower and torque
 - Engine formulae application for compression ratio and measurement of area and volume
 - Heat transfer and expansion
 - Means of heat transfer, heat measurement
 - Spark and compression ignition engines
 - Types of starting systems

5.1.2 Describe the basic function, composition, construction and principles of operation of two-stroke cycle engines. (4/0)

Cylinder blocks

Crankshafts

Piston and connecting rod assemblies

Bearings

Cylinder heads

Balance shafts and gears

Air, fuel and oil induction systems

Scavenging systems

5.1.3 Describe the basic function, composition, construction and principles of operation of four-stroke cycle engines. (6/0)

Spark and compression ignition engines

Cylinder blocks

Crankshafts

Piston and connecting rod assemblies

Bearings

Valve trains and cam shafts:

- drive mechanisms
 - gear drive
 - belt drive
 - chain drive
- interference and non-interference engines
- single overhead cam (SOHC) and dual overhead cam (DOHC)
- valve timing
 - lead
 - lag
 - overlap
- camshaft timing

Cylinder heads

Balance shafts and gears

5.1.4 Dismantle, inspect and test basic two-and-four-stroke cycle engine assemblies with the prescribed service tools and equipment. (1/10)

Perform cylinder compression test

Perform combustion chamber leak-down test

Perform crankcase vacuum test

Check valve lash adjustment

Perform cylinder block dismantling procedures

General cleaning:

- solvents, equipment, procedures

Perform inspection and measuring of engine short block component assemblies checking for:

- measuring to spec
- service limits
- warpage
- wear
- distortion
- out of round
- scuffing and scoring
- specified size
- alignment

Bearings:

- main, connecting rod, camshaft
- piston pins
- thrust

Crankshaft (maintain end play)

Camshaft:

- lobes
- journals

Crankshaft and camshaft timing

Static seals

Dynamic seals

Pistons with rings

Cylinder heads:

- check machine surfaces for distortion
- valve guide reconditioning
- valve machining
- seat machining

Torque all fasteners to specified sequence

Flywheels

Lubricant pumps

Connecting rods

Induction system components

5.1.5 Reassemble, adjust and maintain engine components using appropriate tools as established by the manufacturer maintaining all clearance limitations and specifications. (1/8)

Bearings

Crankshaft

Camshaft

Pistons

Cylinder heads

Valves

Seals and gaskets

Flywheels

Manual starters

Use of appropriate tools:

- piston ring compressors
- connecting rod guide tools
- engine support devices
- seal installers
- pullers
- press
- torque wrench

5.1.6 Select the appropriate replacement engine by interpreting the manufacturers' design and specifications. (2/0)

Engine type:

- two-or-four-stroke cycle
- gasoline or diesel
- number and arrangement of cylinders
- valve arrangement (four-stroke cycle)
- cylinder head design
- scavenging design (two-stroke cycle)
- rebuilt
- short block
- long block
- complete

Cylinder block:

- design
- material, die cast
- aluminum or cast iron

Crankshaft:

- vertical or horizontal
- PTO length and diameter

Bearing type:

- friction, ball or tapered roller

Ignition type:

- magneto types
 - MBI
 - CDI
 - transistorized ignition
- battery types
 - MBI
 - CDI
 - transistorized ignition

Carburetor type

Fuel system (gravity or fuel pump)

Model

Horsepower

Manufacturer

Starter type:

- automatic rewind
- manual rewind
- electric

Governor (if required)

Engine speed range

Direction of crankshaft rotation

Base mount design

Number:	S1435.2		
Title:	Lubrication Systems		
Duration:	Total Hours: 8	Theory: 6	Practical: 2
Prerequisites:	None		
Cross Reference to Training Standard:	6406.05 to 6406.08; 6387.06 to 6387.08		

General Learning Outcomes

Upon successful completion, the apprentice is able to test and describe maintenance procedures for engine lubrication systems in accordance with government safety regulations, manufacturers' recommendations and specifications and approved industry standards.

Learning Outcomes and Content

- 5.2.1 Define the fundamentals of two-stroke and four-stroke cycle engine lubrication systems. (2/0)
- Oil characteristics, properties, additives, and classifications of two-stroke and four-stroke cycle engine lubricants
 - Engine lubrication equipment
 - Lubrication system cooling
 - Significance of selecting correct lubricating oils
 - Significance of selecting correct oil filters
- 5.2.2 Describe the construction features of two-stroke and four-stroke cycle engine lubrication systems and components. (2/0)
- Gear, piston and rotor type oil pumps
 - Oil coolers and heat exchangers
 - Piston cooling
 - By-pass, full flow
 - Oil filters

5.2.3 Explain the basic principles of operation of two-stroke and four-stroke cycle engine lubrication systems. (2/0)

Lubricating system operation:

- oil pumps
- oil filtering methods and characteristics
- splash lubrication
- pressurized system
- heat exchangers
- oil-fuel mixtures
- oil injection

5.2.4 Inspect and test engine oil pressure and oil condition with the prescribed service tools and equipment. (0/1)

Demonstrate and perform engine oil pump testing for pressure and output, engine oil conditions and oil levels

5.2.5 Describe manufacturers' system maintenance procedures for lubrication systems. (0/1)

Demonstrate and perform engine oil and filter replacement procedures

Perform a visual inspection of the lubrication system

Perform oil circuit bleeding procedures

Perform oil and pump adjustments

Number:	S1435.3		
Title:	Cooling Systems		
Duration:	Total Hours: 8	Theory: 4	Practical: 4
Prerequisites:	None		
Cross Reference to Training Standard:	6406.01 to 6406.04; 6387.01 to 6387.04		

General Learning Outcomes

Upon successful completion, the apprentice is able to test and describe maintenance procedures for engine cooling systems in accordance with government safety regulations, manufacturers' recommendations and specifications and approved industry standards.

Learning Outcomes and Content

- 5.3.1 Define the fundamentals of engine cooling. (2/0)
- Convection, conduction, radiation
 - Temperature effects on expansion and contraction
 - Air-cooled engine principles
 - Raw water cooling systems
 - The effects of pressure on boiling points
 - Anti-freeze characteristics:
 - specific gravity
 - ratio

5.3.2 Describe the basic construction features and principles of operation of engine cooling systems and components. (1/0)

Thermostats

Water pumps

Radiators

Heat exchangers

Circulating pumps

Fans, shrouds

Pressure caps

Hoses

Expansion tanks

Fins

5.3.3 Inspect and test engine cooling systems and replace components as necessary. (1/4)

Demonstration and performance of:

- visual inspection procedures
- cleaning of air cooled systems
- liquid cooling system pressure testing
- coolant mixture protection ratio, condition and compatibility

Perform water pump replacement

Inspect all cooling system components

Correct mixture procedures:

- water purity
- ratio
- antifreeze type

Evaluation Structure		
Theory Testing	Practical Application Testing	Final Assessment
40%	30%	30%

Number:	S1436		
Title:	Braking, Transmission and Auxiliary Drive Systems		
Duration:	Total Hours: 39	Theory: 20	Practical: 19
Prerequisites:	None		
Content:	6.1 Clutch Systems (3/4)		
	6.2 Gear Theory (4/0)		
	6.3 Manual Shift Gear Boxes (4/7)		
	6.4 Final Drive Units and Attachments (5/5)		
	6.5 Mechanical Braking Systems (4/3)		

Evaluation & Testing:

Minimum of one mid-term test during the 8 week term
Final exam at end of term
Periodic quizzes

Instructional and Delivery Systems:

Assignments related to theory and appropriate application skills

Reference Materials:

Workplace Safety and Insurance Act, 1997
Occupational Health and Safety Act, 1990
Employment Standards Act, 2000
Labour Relations Act, 1995
Employment Insurance Act, 1996
Ontario College of Trades and Apprenticeship Act, 2009
Apprenticeship and Certification Act, 1998
Canadian Standards Association (CSA)
Workplace Hazardous Materials Information System (WHMIS)
Canadian Coast Guard

Recommended Equipment List:

Approved storage and disposal containers
WHMIS materials
Approved fire extinguishers
Appropriate lifting, rigging and blocking equipment
Appropriate equipment and unit vehicles
Appropriate hand and power tools
Precision measuring tools
Digital volt ohmmeters/multi-meters
Service information systems
Pressure gauges
Vacuum gauges
Brake bleeding equipment

Number:	S1436.1		
Title:	Clutch Systems		
Duration:	Total Hours: 7	Theory: 3	Practical: 4
Prerequisites:	None		
Cross Reference to Training Standard:	6408.01 to 6408.04		

General Learning Outcomes

Upon successful completion, the apprentice is able to define the fundamentals of clutch systems and components in accordance with government safety regulations, manufacturers' recommendations and specifications and approved industry standards.

Learning Outcomes and Content

6.1.1 Define the history, purpose, types and application of clutch systems. (1/0)

Fundamentals:

- friction
- coefficient of friction
- leverage
- centrifugal force type

6.1.2 Describe the construction features and operating principles of clutch system components. (2/0)

Single – plate type

Centrifugal force

Electromagnetic type

Manual type

6.1.3 Test, dismantle, inspect, reassemble, and maintain clutch systems and components. (0/4)

Shoe type centrifugal clutch:

- inspect condition and measure shoes
- measure and inspect drum
- inspect springs

Electromagnetic type:

- inspect wiring
- adjust air gap

Clutch dog assemblies:

- inspect for wear
- inspect for damage
- installation procedures

Diagnose clutch problems:

- slippage
- drag
- chatter
- improper release
- incorrect release RPM (centrifugal type)

Adjust clutches as required

Number:	S1436.2		
Title:	Gear Theory		
Duration:	Total Hours: 4	Theory: 4	Practical: 0
Prerequisites:	None		
Cross Reference to Training Standard:	6408.01, 6408.05 to 6408.07		

General Learning Outcomes

Upon successful completion, the apprentice is able to define the fundamentals of gear theory in accordance with government safety regulations, and approved industry standards.

Learning Outcomes and Content

6.2.1 Define the fundamentals of gears. (3/0)

Materials

Ratios

Torque vs. speed

Calculate fit and tolerance values:

- sizes
 - nominal size
 - basic size
- definition of fit
 - running
 - force
 - sliding
- tolerances
 - bilateral
 - unilateral

6.2.2 Describe the construction features, types and applications of gears. (1/0)

Types:

- helical
- spur
- bevel
- spiral bevel

Number:	S1436.3		
Title:	Manual Shift Gear Boxes		
Duration:	Total Hours: 11	Theory: 4	Practical: 7
Prerequisites:	None		
Cross Reference to Training Standard:	6408.01, 6408.05, 6408.06		

General Learning Outcomes

Upon successful completion, the apprentice is able to repair manual shift gear boxes in accordance with government safety regulations, manufacturers' recommendations and specifications and approved industry standards.

Learning Outcomes and Content

- 6.3.1 Describe the fundamentals of manual shift gear boxes. (1/0)
- Power flow characteristics of gear box
 - Torque multiplication
- 6.3.2 Describe the construction features and operating principles of manual shift gear box components. (3/0)
- Shift mechanism:
 - designs
 - operations
 - Gear styles – drive:
 - driven
 - Bushings/ bearings:
 - radial
 - axial
 - composition
 - Lubrication principles

6.3.3 Dismantle, inspect, test, and reassemble manual shift gear boxes. (0/7)

Dismantle gear box components:

- shafts
- bushings and bearings
- fasteners and clips
- linkages
- gear assemblies
- shift mechanisms

Inspect shaft endplay and gear alignment

Reassemble gear box components and lubricate

Check gear backlash

Check gear tooth contact

Number:	S1436.4		
Title:	Final Drive Units and Attachments		
Duration:	Total Hours: 10	Theory: 5	Practical: 5
Prerequisites:	None		
Cross Reference to Training Standard:	6408.01		

General Learning Outcomes

Upon successful completion, the apprentice is able to describe the maintenance procedures for final drive units and attachments in accordance with government safety regulations, manufacturers' recommendations and specifications and approved industry standard.

Learning Outcomes and Content

6.4.1 Describe the construction features and operating principles of final drive unit and attachment components. (5/0)

Chain drives:

- sizing
- master links
- sprockets
- sprocket dampening systems

Belt drive:

- belt types
- materials
- tooth style/pitch
- design
- size
- toothed pulleys

Shaft drive:

- drive shafts
- universal joint
- constant velocity joint
- shafts
- dampeners
- spline joints

Final gear assemblies:

- case
- bearings
- bevelled gear assembly
- spline joints
- bearing positioning
- gear positioning
- shim selection
- spiral gear assemblies
- hypoid gear assemblies

6.4.2 Dismantle, inspect, test and reassemble final drive units and attachments.
(0/3)

Attachments:

- chains and bars
- trimmer heads
- construction equipment
- decks and blades
- generators

Chain drive:

- inspect for chain and sprocket wear/damage
- check alignment
- adjust chain tension

Belt drives:

- inspect for belt and pulley wear
- check alignment
- adjust belt tension
- belt routing
- inspect seals and bearings

Shaft drives:

- inspect and replace universal joint
- inspect splines for wear

6.4.3 Perform manufacturers' maintenance procedures for final drive units and attachments. (0/2)

Backlash

Gear tooth contact

Bearing pre-load adjustments

Lubrication:

- gear lubes
- greases
- extreme pressure lubes
- application

Sharpening

Number:	S1436.5		
Title:	Mechanical Braking Systems		
Duration:	Total Hours: 7	Theory: 4	Practical: 3
Prerequisites:	None		
Cross Reference to Training Standard:	6409.01 to 6409.04		

General Learning Outcomes

Upon successful completion, the apprentice is able to explain mechanical braking system fundamentals in accordance with government safety regulations, manufacturers' recommendations and specifications and approved industry standards.

Learning Outcomes and Content

6.5.1 Define the fundamentals of mechanical braking systems. (1/0)

Fundamentals:

- mechanical leverage
- first, second and third class levers
- pivot points
- actuating arm
- pivoting mechanisms
- backing plates and stays

Friction:

- characteristics
- co-efficient of friction
- temperature effects
- heat transfer
- static energy
- kinetic energy
- friction face materials
- lead transfer on braking

Safety precautions:

- brake dust
- asbestos

6.5.2 Describe the construction features, applications and operating systems of mechanical braking systems. (3/0)

Drum brakes

Disc brakes

Band brakes

6.5.3 Inspect, test and maintain mechanical braking systems. (0/3)

Drum

Disc

Band

Evaluation Structure		
Theory Testing	Practical Application Testing	Final Assessment
40%	30%	30%



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