Skilled Trades Ontario | Métiers spécialisés Ontario

Apprenticeship Curriculum Standard

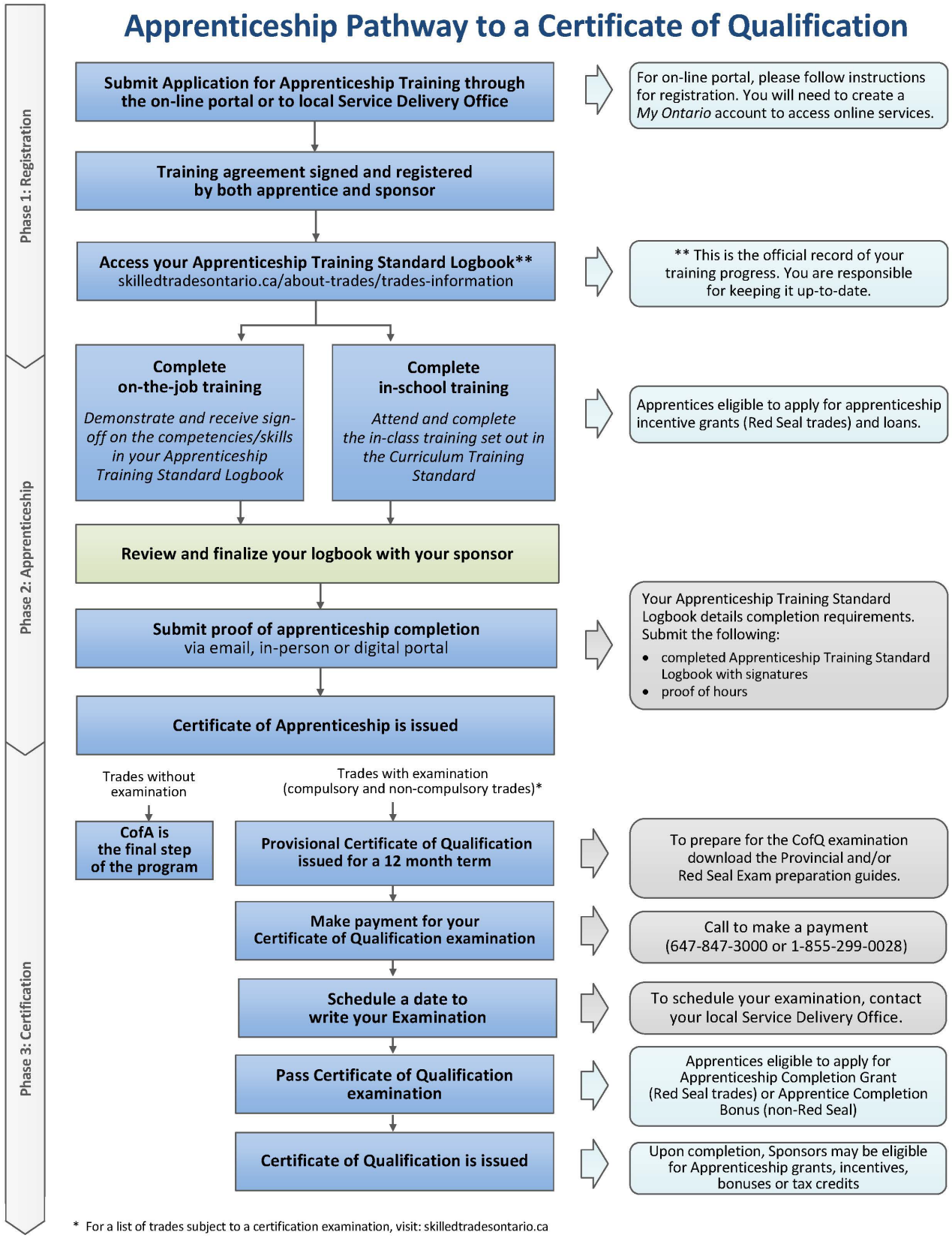
Precision Machining and Tooling

Level 1 Common Core

General Machinist – 429A
Tool and Die Maker – 430A
Mould Maker – 431A
Pattern Maker – 443A
Machine-Tool Builder and Integrator – 430M
Tool/Tooling Maker – 630T

2008

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.

Maintained with transfer to Skilled Trades Ontario 2008 (V100)

Preface

This curriculum standard for the Level 1 – Common Core for the Machining and Tooling trades program is based upon the on-the-job performance objectives, located in the industry-approved training standard.

The curriculum is organized into 11 reportable subjects. The Reportable Subjects Summary chart (located on page 2) 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)

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.

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

Reportable Subject Summary – Level 1

Number	Reportable Subjects	Hours Total	Hours Theory	Hours Practical
S0601.0	Applied Trade Safety Practices	6	6	0
S0602.0	Applied Trade Calculations, Charts, and Tables	42	42	0
S0603.0	Engineering drawings/CAD Data/Layout Processes	42	32	10
S0604.0	Metallurgy	12	12	0
S0605.0	Metrology (Measuring and Checking)	24	12	12
S0606.0	Benchworking Techniques	12	6	6
S0607.0	Metal Cutting Saw Technology	6	2	4
S0608.0	Drilling Technology	12	4	8
S0609.0	Turning Technology	36	11	25
S0610.0	Vertical Milling Technology	36	11	25
S0611.0	Surface Grinding Technology	12	6	6
	Total	**240**	**144**	**96**

This level is common core between the following trades/occupations
General Machinist – 429A
Tool and Die Maker – 430A
Mould Maker – 431A
Pattern Maker – 443A
Machine-Tool Builder and Integrator – 430M
Tool/Tooling Maker – 630T

Number:	S0601		
Title:	**Applied Trade Safety Practices**		
Duration:	Total Hours: 6	Theory: 6	Practical: 0
Prerequisites:	Grade 12		
Content:	S0601.1	Identify regulations as applicable to OHSA and WHMIS. (2 hrs)	
	S0601.2	Describe safe procedures and practices when setting up and using machines, equipment, tools, coolants/lubricants, and cleaning agents. (2 hrs)	
	S0601.3	Demonstrate use of all required protective clothing and gear. (2 hrs)	
Evaluation & Testing:	Assignments related to theory and application skills Minimum of one mid-term test during the term Final test at end of term Periodic quizzes		

Instructional and Delivery Strategies:	Lecture Video Paper based material CBT Internet On-Line
Reference Materials:	Technology of Machine Tools OHSA Safety Legislation Shop Text Books Safety Text Books

Number:	S0601.0		
Title:	**Applied Trade Safety Practices**		
Duration:	Total Hours: 6	Theory: 6	Practical: 0

General Learning Outcomes

Upon successful completion the apprentice is able to describe appropriate safety trade practices.

Learning Outcomes and Content

1.1 Identify regulations as applicable to the *Occupational Health and Safety Act (OHSA)* and Workplace Hazardous Materials Information System (WHMIS). (2 hrs)

Identify pertinent safety legislation including:
- Occupational Health and Safety Act
- Workplace Hazardous Materials Information System

1.2 Describe safe procedures and practices required when setting up and using machines, equipment, tools, coolants/lubricants, and cleaning agents. (2 hrs)

Describe safe work procedures including:
- lifting techniques
- handling of tools and equipment
- working conditions
- machine tool/tooling operating procedures
- good housekeeping
- start up and shut off procedures
- securing and stabilizing of workpiece
- installation of barricades and guards
- lock out procedures
- (HSM) High Speed Machining

Describe the handling and storage of required coolants and lubricants.

1.3 Demonstrate use of all required protective clothing and gear. (2 hrs)

Wear all required protective clothing and gear including:

- eye
- ear
- hand
- head
- foot
- respiratory protectors

Identify fire emergency procedures including:

- types of fires
- types of fire extinguishers
- reporting
- fire alarms
- evacuation

Describe personal hygiene in a shop environment.

Describe the procedures for reporting safety issues.

Evaluation Structure		
Theory Testing	Practical Application Testing	Final Assessment
100%	0%	100%

Number:	S0602		
Title:	**Applied Trade Calculations, Charts, and Tables**		
Duration:	Total Hours: 42	Theory: 42	Practical: 0
Prerequisites:	Grade 12		
Content:	S0602.1	Perform drawing dimension conversions. (5 hrs)	
	S0602.2	Solve trade-specific problems using ratios and proportions. (5 hrs)	
	S0602.3	Perform trade-specific plane geometric calculations and functions. (7 hrs)	
	S0602.4	Solve trade-specific algebraic equations. (7 hrs)	
	S0602.5	Calculate trade-specific perimeters, areas, and volumes (Mensuration). (5 hrs)	
	S0602.6	Demonstrate use of trade-specific charts, tables, and reference materials. (5 hrs)	
	S0602.7	Calculate part features and machining parameters using formulae. (8 hrs)	
Evaluation & Testing:	Assignments related to theory and application skills Minimum of one mid-term test during the term Final test at end of term Periodic quizzes		

Instructional and Delivery Strategies:	Lecture Video Paper based material CBT Internet On-Line
Reference Materials:	Technology of Machine Tools Shop Text Books Mathematics for Machine Technology Interpreting Engineering Drawings

Number:	S0602.0		
Title:	**Applied Trade Calculations, Charts, and Tables**		
Duration:	Total Hours: 42	Theory: 42	Practical: 0

General Learning Outcomes

Upon successful completion the apprentice is able to apply mathematical principles to trade-specific applications.

Learning Outcomes and Content

2.1 Perform drawing dimension conversions from SI to Imperial, Imperial to SI, and from fractions to decimals. (5 hrs)

Round off decimals to the closest one thousandth of an inch.

Change common fractions to decimal fractions and decimal fractions to common fractions.

Add, subtract, multiply, and divide fractions:
- definitions
- reduction
- least common denominator
- addition
- cancellation
- reciprocals

Add, subtract, multiply, and divide decimal fractions.

Identify and calculate percentages.

Demonstrate conversions between SI and Imperial systems of measurements:
- linear units
- mass units
- charts
- tables

2.2 Solve trade-specific problems using ratios and proportions. (5 hrs)

Solve trade-specific problems using direct and inverse ratios and proportions.

2.3 Perform trade-specific plane geometric calculations and functions. (7 hrs)

Perform plane geometric calculations using geometric principles, ratios, and proportions:

- plane geometry
- definitions
- types of angles
- unknown angles in geometric figures
- unknown angles and/or index of triangles
- types and parts of triangles
- unknown angles and sides of triangle
- interior angles of polygons
- axioms

Add, subtract, multiply, and divide angles in terms of degrees, minutes, and seconds.

Convert decimals to degrees, minutes, and seconds.

Calculate complements and supplements of angles.

2.4 Solve trade-specific algebraic equations. (7 hrs)

Perform trade-specific algebraic calculations and functions to solve:

- positive and negative numbers
- addition and subtraction of positive and negative numbers
- multiplication of positive and negative numbers
- division of positive and negative numbers
- parentheses and grouping symbols
- algebraic symbols and simple equations
- solution of simple equations
- percentages
- taper per foot
- square root
- formulae

2.5 Calculate trade-specific perimeters, areas, and volumes (Mensuration). (5 hrs)

Calculate areas, volume, and perimeters of geometric figures.

Calculate area of a circle.

Calculate the circumference of a circle.

Calculate the volume of solid figures including:
- cube
- square prism
- cylinder

2.6 Demonstrate use of trade-specific charts, tables, and reference materials. (5 hrs)

Demonstrate use of trade-specific conversion tables/charts by determining:
- application
- type
- format
- magnitudes
- dimensions
- graduations
- limitations
- accuracy
- abbreviations
- terminology

Demonstrate use of trade-specific material and product-related specification and value tables and charts by determining:
- application
- type
- format
- magnitudes
- dimensions
- standards
- abbreviations
- terminology
- graduations
- accuracy
- imitations

Interpret trade-specific charts and tables to determine:

- drill sizes
- thread information
- mathematical formulae
- cutting speeds
- tapping drill sizes
- feed rate
- taper calculations

2.7 Calculate part features and machining parameters using formulae. (8 hrs)

Calculate part features and machining parameters using formulae to determine:

- drill sizes
- thread size
- cutting speeds
- feed rate
- tapers
- angles
- depths of cut
- cutter locations

Evaluation Structure		
Theory Testing	Practical Application Testing	Final Assessment
100%	0%	100%

Number:	S0603		
Title:	**Engineering Drawings/Cad Data/Layout Processes**		
Duration:	Total Hours: 42	Theory: 32	Practical: 10
Prerequisites:	Grade 12		
Content:	S0603.1	Identify types and formats of engineering drawings/CAD data. (1 hr)	
	S0603.2	Describe graphic language and symbols of engineering drawings/CAD data. (4 hrs)	
	S0603.3	Describe dimensional terminology and practices. (4 hrs)	
	S0603.4	Describe the principle views of orthographic projection to identify component features. (6 hrs)	
	S0603.5	Demonstrate sketch to scale procedures for an isometric/pictorial view from a fully dimensioned orthographic drawing. (6 hrs)	
	S0603.6	Demonstrate sketch to scale for sectional views. (7 hrs)	
	S0603.7	Develop an operational plan for machining methods and operational sequences. (7 hrs)	
	S0603.8	Describe layout procedures, techniques, and equipment. (7 hrs)	
Evaluation & Testing:	Assignments related to theory and application skills Minimum of one mid-term test during the term Final test at end of term Periodic quizzes		

Instructional and Delivery Strategies:
Lecture
Video
Paper based material
CBT
Internet On-Line

Reference Materials:
Technology of Machine Tools
Shop Text Books
Mathematics for Machine Technology
Interpreting Engineering Drawings

Number:	S0603.0		
Title:	**Engineering Drawings/CAD Data/Layout Processes**		
Duration:	Total Hours: 42	Theory: 32	Practical: 10

General Learning Outcomes

Upon successful completion the apprentice is able to interpret engineered documentation and demonstrate sketching techniques.

Learning Outcomes and Content

3.1 Identify types and formats of engineering drawings/CAD data. (1 hr)

Identify types of engineering /CAD data including:
- detail
- sub-assembly
- working assembly
- assembly
- ANSI (American National Standards Institute)
- CSA (Canadian Standards Association)
- IS0 (International Standards Association)
- MIL (Military Specifications)

3.2 Describe graphic language and symbols of engineering drawings/CAD data. (4 hrs)

Interpret the language and symbols in engineering drawings/CAD data to determine:
- shape
- terminology
- symbols
- sizes
- scales
- title blocks
- zoning system
- engineering change notice (ECN)
- lettering on drawings
- bill of material

- notes and specifications
- revisions
- line types
- machined surfaces
- surface finish

Identify drawing lines to graphically illustrate and dimension components and assemblies:

- object
- hidden
- leader
- break
- section
- cutting plane
- phantom
- centre
- extension
- dimension

3.3 Describe dimensional terminology and practices. (4 hrs)

Describe dimensional terms:

- overall dimensions
- detail dimensions
- linear
- angular
- circumferential
- rounds
- fillets
- reference dimensions
- thread representation
- thread standards
- not to scale dimensions

Identify metric/inch dimensions.

Describe thread representations and designations to determine:

- thread forms
- screw thread designations
- thread representations

3.4 Describe the principle views of orthographic projection to identify component features. (6 hrs)

Describe orthographic projections:
- angle projections
- IS0 orthographic projection symbol

Demonstrate sketching to scale procedures using the orthographic principal views from a fully dimensioned pictorial view:
- top view
- front view
- right side view
- cylindrical views

3.5 Demonstrate sketch to scale procedures for an isometric/pictorial view from a fully dimensioned orthographic drawing. (6 hrs)

Demonstrate sketch to scale procedures using third angle projection for a pictorial view from a three view orthographic drawing which includes:
- 90E features
- angular features
- circular features

3.6 Demonstrate sketch to scale procedures for sectional views. (7 hrs)

Describe elements and functions of sectional views:
- cutting plane
- exposed features
- viewing direction
- section view location
- section view position

Demonstrate sketch to scale procedures for sectional views:
- full
- half

3.7 Develop an operational plan for machining methods and operational sequences. (7 hrs)

Interpret engineering drawings and job documentation to develop a plan for machining methods.

Interpret engineering drawings to develop operational sequences.

3.8 Describe layout procedures, techniques, and equipment. (7 hrs)

Describe layout procedures, techniques, and equipment:
- dyes/chalks
- marking punches
- scribing tools
- precision straight edges
- steel rules
- precision squares
- vernier height gauges
- universal vernier bevel protractors
- radius/fillet gauge sets
- contour templates
- combination sets
- workpiece holding/clamping devices

Describe layout methods and sequence of operations by determining:
- surface preparation
- layout sequences
- optimum position of workpiece
- reference and layout planes
- datum location
- accuracy and clarity of appearance
- prick punch markings
- centre punch markings
- tools
- instruments
- accessories
- holding characteristics

Identify layout tools:
- dividers
- trammels
- hermaphrodite calipers
- prick punches
- centre punch

Identify layout instruments:
- surface gauge
- combination set

Identify layout accessories:

- surface table
- angle plate
- adjustable angle plate
- precision cube
- parallels
- Vee-blocks
- jacks
- rule clamp
- key seat clamp

Describe the application of layout tools, instruments, and accessories by determining:

- workholding characteristics
- checking accuracy
- accessibility to location
- geometric construction
- point angle of tools
- checking ranges
- dimensional ranges
- scribing and marking

Evaluation Structure		
Theory Testing	Practical Application Testing	Final Assessment
70%	30%	100%

Number:	S0604		
Title:	**Metallurgy**		
Duration:	Total Hours: 12	Theory: 12	Practical: 0
Prerequisites:	Grade 12		
Content:	S0604.1	Describe characteristics of metals. (2 hrs)	
	S0604.2	Describe the manufacturing processes to produce steel and cast iron. (3 hrs)	
	S0604.3	Describe the physical and mechanical properties of steels and cast iron. (3 hrs)	
	S0604.4	Describe identification systems for steels and cast iron. (2 hrs)	
	S0604.5	Describe shapes and surface appearance of standard stock materials. (2 hrs)	
Evaluation & Testing:	Assignments related to theory and application skills Minimum of one mid-term test during the term Final test at end of term Periodic quizzes		

Instructional and Delivery Strategies:
Lecture
Video
Paper based material
CBT
Internet On-Line

Reference Materials:
Technology of Machine Tools
Shop Text Books
Interpreting Engineering Drawings

Number:	S0604.0		
Title:	**Metallurgy**		
Duration:	Total Hours: 12	Theory: 12	Practical: 0

General Learning Outcomes

Upon successful completion the apprentice is able to describe metal characteristics and properties, metal manufacturing processes, and systems of classification and identification.

Learning Outcomes and Content

4.1 Describe characteristics of metals. (2 hrs)

Describe categories and basic chemistry of ferrous metals:
- tensile strength
- size, shape, and surface condition
- applications
- machinability
- smelting and shaping processes
- tolerances
- manufacturers' code classification
- alloying elements
- malleability
- ductility
- hardness
- corrosion resistance
- wear resistance
- material colour recognition

Identify ferrous metals by type and application:
- plain carbon steel
- free machining steel
- alloy steel
- tool steel
- cast iron
- grey
- white
- ductile
- malleable
- high alloy cast iron

4.2 Describe the manufacturing processes to produce steel and cast iron. (3 hrs)

Describe the manufacturing processes to produce steel and cast iron:
- primary metalworking processes
- casting
- hot and cold rolling
- cold drawing
- centrifugal casting process

4.3 Describe the physical and mechanical properties of steels and cast iron. (3 hrs)

Describe the physical and mechanical properties of steels and cast iron:
- strength
- elasticity
- ductility
- hardness
- brittleness
- toughness
- malleability
- machinability

4.4 Describe identification systems for steels and cast iron. (2 hrs)

Describe identification systems for steels and cast iron:
- UNS (Unified Numbering System)
- AISI (American Iron and Steel Institute)
- SAE (Society of Automotive Engineers)
- ASTM (American Society for Testing and Materials)
- IS0 (International Standards Organization)
- MIL (Military specifications)
- CSA (Canadian Standards Association)

Describe methods of workpiece traceability:
- colour coding
- letter number stamps
- tagging
- bar codes

4.5 Describe shapes and surface appearance of standard stock materials. (2 hrs)

Describe the surface appearance of rolled and/or drawn stock materials:
- hot rolled/drawn
- cold rolled/drawn

Describe common shapes of rolled steel stock materials:
- structural shapes
- beams
- channels
- tubes
- angles
- tubes/welded
- hollow sections/welded
- T sections
- bar stock
- round
- square
- flat
- hexagon
- plate
- sheet
- strip
- gauge stock

Describe common shapes of drawn stock materials:
- round wire
- round
- square
- flat
- hexagon
- tubing
- hollow sections

Evaluation Structure		
Theory Testing	Practical Application Testing	Final Assessment
100%	0%	100%

Number:	S0605		
Title:	**Metrology (Measuring and Checking)**		
Duration:	Total Hours: 24	Theory: 12	Practical: 12
Prerequisites:	Grade 12		
Content:	S0605.1	Describe fundamentals of dimensional metrology. (7 hrs)	
	S0605.2	Describe the operational principles of measuring, checking, and gauging equipment. (7 hrs)	
	S0605.3	Demonstrate measuring techniques using direct/indirect linear measuring equipment. (10 hrs)	
Evaluation & Testing:	Assignments related to theory and application skills Minimum of one mid-term test during the term Final test at end of term Periodic quizzes		

Instructional and Delivery Strategies:	Lecture Video Paper based material CBT Internet On-Line
Reference Materials:	Technology of Machine Tools Shop Text Books Interpreting Engineering Drawings

Number:	S0605.0		
Title:	**Metrology (Measuring and Checking)**		
Duration:	Total Hours: 24	Theory: 12	Practical: 12

General Learning Outcomes

Upon successful completion the apprentice is able to using direct/indirect reading linear measuring instruments.

Learning Outcomes and Content

5.1 Describe fundamentals of dimensional metrology. (7 hrs)

Identify the primary standards of length:
- Imperial
- Metric - SI

Describe industrial standards of length:
- reference grade gauge blocks
- calibration grade gauge blocks
- inspection grade gauge blocks
- workshop grade gauge blocks

Describe terms and features used in measurement techniques:
- accuracy
- precision
- tolerances
- reliability
- limits
- fits
- datum
- discrimination
- length/width
- angular
- straight
- flat
- square
- round
- perpendicular
- parallel
- surface texture

5.2 Describe the operational principles of measuring, checking, and gauging equipment. (7 hrs)

Identify measuring, checking, and gauging equipment:
- direct/indirect linear measuring instruments
- direct/indirect angular measuring instruments
- inspection checking gauges
- indicating gauges and comparators

Describe direct reading linear measuring instruments:
- steel rules
- vernier caliper
- digital caliper
- dial caliper
- vernier height gauge
- dial height gauge
- height micrometer
- electronic height gauge
- outside micrometer caliper
- inside micrometer
- depth micrometer

Describe indirect reading (transfer type) linear measuring equipment:
- telescoping gauges
- small hole gauges
- outside/inside caliper
- adjustable parallel
- bevel protractor
- vernier bevel protractor

Describe inspection and checking gauges:
- thickness
- radius
- screw pitch
- centre

Describe indicating gauges and comparators:
- squares
- dial test indicators

5.3 Demonstrate measuring techniques using direct/indirect reading linear measuring equipment. (10 hrs)

Describe linear features to be measured and the specified accuracies of the workpiece.

Select direct/indirect reading linear measuring equipment by determining:

- type and components
- working principles
- adjusting mechanisms
- lengths and widths
- values of graduations
- accessibility to locations
- applications
- measuring accuracy
- temperature variations
- readings
- manipulative error bias
- predetermined values of checking, setting, and locking

Demonstrate measurement of linear features.

Demonstrate inspection and recording techniques.

Evaluation Structure		
Theory Testing	Practical Application Testing	Final Assessment
50%	50%	100%

Number:	S0606		
Title:	**Benchworking Techniques**		
Duration:	Total Hours: 12	Theory: 6	Practical: 6
Prerequisites:	Grade 12		
Content:	S0606.1	Select bench or hand tools for benchworking operations. (3 hrs)	
	S0606.2	Set up bench workholding devices and support accessories. (3 hrs)	
	S0606.3	Perform benchwork metal removal procedures. (3 hrs)	
	S0606.4	Select mechanical fasteners. (3 hrs)	
Evaluation & Testing:	Assignments related to theory and application skills Minimum of one mid-term test during the term Final test at end of term Periodic quizzes		

Instructional and Delivery Strategies:	Lecture Video Paper based material CBT Internet On-Line
Reference Materials:	Technology of Machine Tools Shop Text Books Fasteners Catalogues

Number:	S0606.0		
Title:	**Benchworking Techniques**		
Duration:	Total Hours: 12	Theory: 6	Practical: 6

General Learning Outcomes

Upon successful completion the apprentice is able to use benchworking techniques, tools, and equipment to fit and assemble components.

Learning Outcomes and Content

6.1 Select bench or hand tools for benchworking operations. (3 hrs)

Describe application of bench or hand tools:

- screw drivers
- wrenches
- pliers
- lever jaw locking pliers
- hammers
- punches
- tap extractors
- screw extractors
- nut splitter
- gear puller
- reamers
- taps
- threading dies
- hand hacksaw
- hand files
- hand chisels
- abrasive cloth
- saw blades
- drills

Select bench or hand tools for applications by determining:
- type of metal
- cutting characteristics
- required fit
- location accessibility
- speed of operation
- handling techniques
- gripping pressure
- removal procedures

Describe application of bench or hand tools by checking for:
- point angles
- sharpness
- functional defects
- chips and cracks
- cutting edge angle
- type
- suitability
- size of tool
- adjustments
- grit size

6.2 Set up bench workholding devices and support accessories. (3 hrs)

Describe bench or hand tools workholding devices and support accessories:
- clamps
- vise
- tap/reamer wrench
- threading die stock
- arbor press
- T-slot clamps
- magnetic devices
- angle plates
- Vee-blocks

Set up bench workholding devices and support accessories by determining:
- type of clamping
- type and size of tool to be mounted
- operations to be performed
- location accessibility

- capacity
- workpiece size, shape and characteristics
- pressure requirements
- handling, storage, and maintenance procedures Demonstrate contact surface cleaning and protection procedures. Select mounting, positioning, aligning, and securing procedures.

6.3 Perform benchworking metal removal procedures. (3 hrs)

Identify benchworking metal removal procedures:
- reaming
- threading
  - taps
  - dies
- sawing
- filing
- grinding
- drilling

Describe geometry/nomenclature of cutting tools.

Demonstrate contact surface cleaning and protection procedures.

Demonstrate benchworking metal removal procedures:
- reaming
- filing
- grinding
- tapping
- type of hole (thru or blind)
- thread cutting
- classification of fit
- sawing pressure
- blade characteristics
- shape characteristics
- characteristics of cutting tool
- surface finish
- workpiece characteristics
- cutting fluid application
- mounting and securing of workpiece
- handling, storage, and maintenance procedures

6.4 Select mechanical fasteners. (3 hrs)

Describe mechanical fasteners:

- threaded fasteners
- nuts
- washers
- keys
- pins
- retaining rings
- springs
- rivets
- adhesives

Select mechanical fasteners by determining:

- design and grade characteristics
- types, sizes, and head characteristics
- types and sizes of washers
- hole clearance and tolerance
- principles and limitations of assembling components
- types and sizes of tools/equipment
- locations and relative positions
- assembly/disassembly sequence
- torque requirements

Evaluation Structure		
Theory Testing	Practical Application Testing	Final Assessment
50%	50%	100%

Number:	S0607		
Title:	**Metal Cutting Saw Technology**		
Duration:	Total Hours: 6	Theory: 2	Practical: 4
Prerequisites:	Grade 12		
Content:	S0607.1	Demonstrate safe working procedures when setting up and operating metal cutting saws.	
	S0607.2	Describe functions and operating principles of vertical and horizontal bandsaws. (0.5 hrs)	
	S0607.3	Select saw workholding devices and set-up accessories. (0.5 hrs)	
	S0607.4	Describe vertical and horizontal band saws. (0.5 hrs)	
	S0607.5	Describe preparation of a metal cutting saw blade. (0.5 hrs)	
	S0607.6	Develop a plan for sawing. (0.5 hrs)	
	S0607.7	Describe installation and testing procedures for vertical and horizontal bandsaws. (1 hr)	
	S0607.8	Perform sawing. (2 hrs)	
	S0607.9	Perform routine maintenance. (0.5 hrs)	
Evaluation & Testing:	Assignments related to theory and application skills Minimum of one mid-term test during the term Final test at end of term Periodic quizzes		

Instructional and Delivery Strategies:
Lecture
Video
Paper based material
CBT
Internet On-Line

Reference Materials:
Technology of Machine Tools
Shop Text Books
Interpreting Engineering Drawings

Number:	S0607.0		
Title:	**Metal Cutting Saw Technology**		
Duration:	Total Hours: 6	Theory: 2	Practical: 4

General Learning Outcomes

Upon successful completion the apprentice is able to use metal cutting saws to cut and shape workpieces.

Learning Outcomes and Content

7.1 Demonstrate safe working procedures when setting up and operating metal cutting saws.

Identify potential safety hazards which may occur during saw set-up and operating procedures.

Demonstrate safe working habits including:

- protective clothing
- protective equipment and gear
- good housekeeping
- start up procedures
- shut off procedures
- securing workpiece
- stabilizing workpiece
- saw blade testing procedures
- saw blade fusing/welding
- saw blade installation procedures
- guards
- lock-out procedures
- tagging procedures

7.2 Describe functions and operating principles of vertical and horizontal bandsaws. (0.5 hrs)

Describe components of saw:
- frame
- table
- vise
- work supports
- band wheels
- blade holders
- blade guides
- feed mechanisms
- stops

Select metal cutting saw switches and controls:
- power
- start up controls
- shut down controls
- feed
- speed

Identify saw accessories and attachments:
- bands saw blade welding unit
- blade grinding unit
- blade shear
- mitre

Select metal cutting saw coolant and lubricating fluids.

7.3 Describe vertical and horizontal bandsaws. (0.5 hrs)

Describe metal saw cutting blades:
- high carbon
- high speed
- bi-metallic
- diamond edge
- carbide tip

Select metal saw cutting tools by determining:
- type
- width
- pitch
- gauge
- tooth form
- set

7.4 Select saw workholding devices and set-up accessories. (0.5 hrs)

Describe saw workholding devices and set-up accessories:
- manual vises
- power operated vises
- support stand

Select saw workholding devices and set-up accessories by determining:
- type
- size
- function
- alignments
- holding characteristics
- mounting characteristics
- type of blade
- handling
- storing
- maintenance procedures

Demonstrate contact surface cleaning procedures.

7.5 Describe preparation of a metal cutting saw blade. (0.5 hrs)

Describe blade preparation procedures:
- selection of blade
- cutting to length
- squaring of ends
- teeth removal

Describe blade fusion procedures:
- locating and clamping blade ends into weld unit
- setting band width controls
- operation of weld unit controls
- annealing procedures
- tempering procedures
- grinding of flash

7.6 Develop a plan for sawing. (0.5 hrs)

Interpret engineering drawings, CAD data, or process sheets to determine:
- workpiece material
- number of workpieces
- form of workpiece
- shape of workpiece
- machining operations
- tolerances

Select tooling, workholding, and tool holding devices/accessories by determining:
- application
- type
- running clearances
- size and throat capacity
- tolerances
- cutting capacity
- cutting parameters
- machining operations and sequence
- cutting fluid requirements
- operating principles
- tool holding and support requirements
- speed and feed values
- band saw blade preparation procedures
- tension adjustment
- side guide position
- workpiece characteristics
- handling
- storing
- maintenance procedures

Select metal cutting saw procedures:
- straight cut-off sawing
- angular cut-off sawing
- straight sawing
- angular sawing
- contour sawing

7.7 Describe installation and testing procedures for vertical/horizontal bandsaws. (1 hr)

Describe band saw blades.

Demonstrate mounting and alignment of wheels and cutting blades by determining:
- installation process
- saw blade size and stability
- type
- tooth type, pitch, and set
- nominal length
- overall length
- width
- thickness gauge
- centre to centre of pulleys
- pulley diameter
- initial workpiece material contact
- mounting, positioning, and securing of wheel/blade
- coolant requirements
- workpiece characteristics
- test run

7.8 Perform sawing. (2 hrs)

Demonstrate straight metal sawing.

Demonstrate angular metal sawing.

Demonstrate contour metal sawing.

7.9 Perform routine maintenance. (0.5 hrs)

Demonstrate routine cleaning and maintenance procedures.

Demonstrate lubrication procedures.

Demonstrate dismantling, handling and storage of tools and tooling.

Evaluation Structure		
Theory Testing	Practical Application Testing	Final Assessment
40%	60%	100%

Number:	S0608		
Title:	**Drilling Technology**		
Duration:	Total Hours: 12	Theory: 4	Practical: 8
Prerequisites:	Grade 12		
Content:	S0608.1	Demonstrate safe working procedures when setting up and operating drill presses/ machines.	
	S0608.2	Set up drill press/machine controls, coolant requirements, and attachments/accessories. (1 hr)	
	S0608.3	Set up drill press/machine workholding devices and set-up accessories. (1 hr)	
	S0608.4	Select drill press/machine cutting tools and tool holders. (1 hr)	
	S0608.5	Develop a plan for drilling. (3 hrs)	
	S0608.6	Perform drilling. (4 hrs)	
	S0608.7	Sharpen drills by hand and/or machine. (1.5 hrs)	
	S0608.8	Perform routine maintenance. (0.5 hrs)	
Evaluation & Testing:	Assignments related to theory and application skills Minimum of one mid-term test during the term Final test at end of term Periodic quizzes		

Instructional and Delivery Strategies:
Lecture
Video
Paper based material
CBT
Internet On-Line

Reference Materials:
Technology of Machine Tools
Shop Text Books

Number:	S0608.0		
Title:	**Drilling Technology**		
Duration:	Total Hours: 12	Theory: 4	Practical: 8

General Learning Outcomes

Upon successful completion the apprentice is able to use drill presses/machines to: drill, counterbore, countersink, spotface, deburr, ream, and tap workpieces.

Learning Outcomes and Content

8.1 Demonstrate safe working procedures when setting up and operating drill presses/machines.

Identify potential safety hazards which may occur during drill set-up and operating procedures.

Demonstrate safe work habits including:
- protective clothing
- protective equipment and gear
- good housekeeping
- start-up
- shut-down
- securing workpiece/cutting tool
- stabilizing workpiece/cutting tool
- lubricants
- lock-out procedures
- tagging procedures

8.2 Set up drill press/machine controls, coolant requirements, and attachments or accessories. (1 hr)

Describe parts of drill presses/machines:
- spindle speed change levers
- base
- table
- column
- head
- arm
- spindle
- quill
- motors
- clamps
- stops

Set up drill press/machine controls by determining:
- feed
- rpm
- head location
- table location
- arm location
- positioning clamps
- stop, start, and reverse
- depth stops Select cutting fluids.

8.3 Set up drill press/machine workholding devices and set-up accessories. (1 hr)

Describe drilling workholding devices and set-up accessories:
- swivel vises
- angular vises
- angle plate
- Vee-block
- jig
- clamping kits
- parallels
- c-clamps
- toolmakers clamps

Demonstrate contact surface cleaning procedures.

Demonstrate mounting, positioning, aligning, and securing procedures.

8.4 Select drill press/machine cutting tools and tool holders. (1 hr)

Describe cutting tool geometry (nomenclature) for:
- tool holding devices
- centre drills
- twist drills
- tapping heads and taps
- countersinks
- reamers
- spot-facing tools
- counterbore
- countersinks

Describe tool holders:
- sleeves
- chucks
- adaptors
- sockets
- tapping heads

Describe the condition of cutting tools and tool holders by checking:
- concentricity
- surface cleanliness
- burrs
- application
- size of tool
- functional defects
- angles
- chips and cracks
- adjustments

Describe corrective action to repair or replace cutting tools and tool holders.

8.5 Develop a plan for drilling. (3 hrs)

Interpret engineering drawings, CAD data, specifications, reference material and process sheets to determine:
- type of hole
- size and depth of hole
- tolerances
- surface finish

- cutting parameters
- thread type and size
- machining sequences
- workpiece material characteristics

Describe drilling procedures:

- drilling
- counterboring/countersinking
- deburring
- spot facing
- reaming
- tapping
- centre drilling

Select drill press/machine by determining:

- type, size and depth of hole
- machining sequences
- manual or auto spindle feed increments
- speeds and feeds
- coolant requirements
- tooling accessories
- machining operations
- depth stops
- cutting parameters
- workpiece characteristics

Select workholding and tool holding devices/accessories by determining:

- application
- type
- operating principles
- clamp positions
- attachment function
- workholding and tool holding characteristics

Describe methods of deburring using hand and power tools.

8.6 Perform drilling. (4 hrs)

Demonstrate drilling of holes.

Demonstrate counterboring of holes.

Demonstrate spotfacing of holes.

Demonstrate countersinking or deburring of holes.

Demonstrate reaming of holes.

Demonstrate tapping holes.

8.7 Sharpen drills by hand and/or machine. (1.5 hrs)

Identify required angles/cutting edge (tool point geometry).

Demonstrate drill sharpening techniques.

Perform final inspection.

8.8 Perform routine maintenance. (0.5 hrs)

Demonstrate routine cleaning and maintenance procedures.

Demonstrate lubrication procedures.

Demonstrate dismantling, handling, and storage of tools, tooling, workholding devices, and measuring equipment.

Perform required maintenance and/or replace:

- drills
- cutting tools
- workholding devices
- tool holding devices

Evaluation Structure		
Theory Testing	Practical Application Testing	Final Assessment
40%	60%	100%

Number:	S0609		
Title:	**Turning Technology**		
Duration:	Total Hours: 36	Theory: 11	Practical: 25
Prerequisites:	Grade 12		
Content:	S0609.1	Demonstrate safe working procedures when setting up and operating a lathe.	
	S0609.2	Set up lathe machine components, controls, and coolant requirements. (1.5 hrs)	
	S0609.3	Set up lathe workholding devices. (5 hrs)	
	S0609.4	Set up lathe cutting tools and tool holders. (8 hrs)	
	S0609.5	Develop a plan for turning operations. (8 hrs)	
	S0609.6	Perform turning. (13 hrs)	
	S0609.7	Perform routine maintenance. (0.5 hrs)	
Evaluation & Testing:	Assignments related to theory and application skills Minimum of one mid-term test during the term Final test at end of term Periodic quizzes		

Instructional and Delivery Strategies:	Lecture Video Paper based material CBT Internet On-Line
Reference Materials:	Technology of Machine Tools Shop Text Books

Number:	S0609.0		
Title:	**Turning Technology**		
Duration:	Total Hours: 36	Theory: 11	Practical: 25

General Learning Outcomes

Upon successful completion the apprentice is able to use a lathe to: parallel turn and face; centre drill; parallel turn to a shoulder; turn external tapers or angles; cut chamfers and external screw threads; drill and ream.

Learning Outcomes and Content

9.1 Demonstrate safe working procedures when setting up and operating a lathe.

Identify potential safety hazards which may occur during lathe set-up and operating procedures.

Demonstrate safe working habits including:
- protective clothing
- protective equipment and gear
- good housekeeping
- start-up procedures
- shut-down procedures
- securing workpiece/cutting tool
- stabilizing of workpiece/cutting tool
- lubricants
- lock-out procedures
- tagging procedures

9.2 Set up lathe machine components, controls, and coolant requirements. (1.5 hrs)

Describe components of a lathe:
- quick change gear box
- bed / bedways
- apron
- saddle
- tailstock
- cross slide

- compound rest
- lead screw
- feed rod
- head stock
- taper attachment

Set up lathe controls:
- spindle speeds
- feeds

Select cutting fluids.

9.3 Set up lathe workholding devices. (5 hrs)

Describe lathe workholding devices:
- three-jaw chucks
- self-centering universal chucks
- four-jaw chucks
- magnetic chucks
- collet chucks
- lathe centres
- mandrels and split bushings
- faceplates
- steady rest
- fixtures
- drive plates
- follower rests
- drive dogs
- soft jaws

Select lathe workholding devices by determining:
- type
- size
- shape
- angles
- holding/mounting characteristics
- type of tool
- capacity
- function
- handling, storing, and maintenance procedures
- workpiece characteristics

Demonstrate contact surface cleaning procedures.

Demonstrate mounting, positioning, aligning, and securing procedures for workholding devices:

- three-jaw chucks
- self-centering universal chucks
- four-jaw chucks
- collet chucks
- centres
- drive plates
- drive dogs

9.4 Set up lathe cutting tools and tool holders. (8 hrs)

Identify tool geometry for lathe cutting tools:

- solid tool bits
- brazed tipped
- inserted carbide
- right hand
- left hand
- facing
- grooving/recessing
- threading
- cut-off
- form
- centre drills
- drills
- reamers
- boring
- knurling

Select lathe cutting tools and tool holders by determining:

- type
- shape
- size
- angle
- cutting tool geometry
- cutting capacity
- holding/mounting characteristics
- cutting and shaping characteristics
- alignment

- tolerances
- surface finish requirements
- chip development and flow

Demonstrate mounting, positioning, alignment and securing procedures.

Demonstrate sharpening of cutting tool edges and angles.

Demonstrate repair and maintenance of tooling.

9.5 Develop a plan for turning operations. (8 hrs)

Interpret engineering drawings, CAD data, or process sheets to determine:
- workpiece material
- number of workpieces
- form and shape of workpiece
- machining operations
- tolerances
- surface finish
- machining sequence
- workholding method

Select turning procedures:
- facing
- parallel turning
- taper turning
- drilling
- reaming
- external threading
- grooving

Select lathe by determining:
- application
- type
- swing
- cutting capacity and parameters
- spindle speed and feed
- micrometer collars graduations
- compound rest
- tailstock spindle

- automatic tool motions
- carriage stops
- tool post indexing
- tailstock offset range
- thread pitch control
- workpiece characteristics
- taper turning attachment
- centre-to-centre distance

Select measuring and checking tools and instruments.

9.6 Perform turning. (13 hrs)

Demonstrate parallel turning and facing operations using a chuck.

Demonstrate centre drilling of workpiece.

Demonstrate drilling and reaming.

Demonstrate parallel turning to shoulder and facing between centres.

Demonstrate turning external tapers/angles.

Demonstrate cutting external screw threads. Demonstrate cutting of chamfers.

9.7 Perform routine maintenance. (0.5 hrs)

Demonstrate routine cleaning and maintenance procedures.

Demonstrate lubrication procedures.

Demonstrate dismantling, handling, and storage:
- tools
- tooling
- workholding devices
- measuring instruments.

Evaluation Structure		
Theory Testing	Practical Application Testing	Final Assessment
35%	65%	100%

Number:	S0610		
Title:	**Vertical Milling Technology**		
Duration:	Total Hours: 36	Theory: 11	Practical: 25
Prerequisites:	Grade 12		
Content:	S0610.1	Demonstrate safe working procedures when setting up and operating vertical milling machines.	
	S0610.2	Set up vertical milling machine controls, coolant requirements, and milling attachments. (2.5 hrs)	
	S0610.3	Set up vertical milling workholding devices and accessories. (5 hrs)	
	S0610.4	Demonstrate procedures for mounting vertical mill cutting tools and tool holders. (8 hrs)	
	S0610.5	Develop a plan for vertical milling machine operations. (8 hrs)	
	S0610.6	Perform vertical milling. (12 hrs)	
	S0610.7	Perform routine maintenance. (0.5 hrs)	
Evaluation & Testing:	Assignments related to theory and application skills Minimum of one mid-term test during the term Final test at end of term Periodic quizzes		

Instructional and Delivery Strategies:	Lecture Video Paper based material CBT Internet On-Line
Reference Materials:	Technology of Machine Tools Shop Text Books

Number:	S0610.0		
Title:	**Vertical Milling Technology**		
Duration:	Total Hours: 36	Theory: 11	Practical: 25

General Learning Outcomes

Upon successful completion the apprentice is able to: vertical mill surfaces, shapes, and forms; counter bore/spot face holes; and drill holes.

Learning Outcomes and Content

10.1 Demonstrate safe working procedures when setting up and operating vertical milling machines.

Identify potential safety hazards which may occur during milling set-up and operating procedures.

Demonstrate safe working habits including:
- protective clothing
- protective equipment and gear
- good housekeeping
- start-up
- shut-off
- securing workpiece/cutting tools
- stabilizing of workpiece/cutting tools
- lubricants
- lock-out procedures
- tagging procedures

10.2 Set up vertical milling machine controls, coolant requirements, and milling attachments. (2.5 hrs)

Describe parts of vertical milling machine:
- base
- column
- knee
- saddle
- table
- head
- ram
- bed
- cross slide

Select vertical milling machine switches, selectors, and controls:
- spindle feed
- table feed
- vertical feed
- slide locks
- power switch
- spindle switch
- feed selector
- coolant
- reverse switch

Select cutting fluids.

Describe milling machine digital read-outs.

10.3 Set up vertical milling workholding devices and accessories. (5 hrs)

Describe vertical milling workholding devices:
- plain vise
- swivel base vise
- universal vise
- angle plates
- Vee-blocks
- adjustable stops
- screw jacks
- parallels
- fixtures
- clamping accessories

Select workholding devices by determining:
- application
- operating principles
- type
- size
- function
- holding/mounting characteristics
- location accessibility
- workpiece characteristics
- handling
- storing
- maintenance procedures

Demonstrate contact surface cleaning procedures.

Demonstrate mounting, positioning, aligning, and securing procedures.

10.4 Demonstrate procedures for mounting vertical mill cutting tools and tool holders. (8 hrs)

Identify vertical mill cutting tools and tool holders:
- indexable inserts
- end milling cutters
- slot drills
- stub arbors
- shell end mills
- face milling cutters
- drills
- reamers
- taps
- spot face
- countersinks
- counterbore
- collets
- quick change holders
- end mill holders
- boring heads
- drill chucks
- boring bars

Select cutting tools and tool holders by determining:
- type
- size
- cutting tool material
- shape
- application
- operating principles
- holding/mounting characteristics
- cutting and shaping characteristics

Mount cutting tools and tool holders.

10.5 Develop a plan for vertical milling. (8 hrs)

Interpret engineering drawings, CAD data, and process sheets to determine:
- workpiece material
- number of workpieces
- form and shape of workpiece
- dimensions
- surface finish
- machining operations and sequence

Select vertical milling procedures:
- milling surfaces
- counterboring/spot facing holes
- drilling and reaming holes
- slotting
- face milling

Select vertical milling machine by determining:
- size and cutting capacity
- operating principles and clearances
- type and depth of cut
- micrometer collars graduations
- swivel head
- cutting fluid requirements
- table and saddle locking components
- workpiece characteristics
- set-up rigidity

Select vertical milling machine workholding devices by determining:
- application and operating principles
- workpiece characteristics
- positioning, mounting, and securing procedures

Select vertical mill cutting tools and tool holding devices or accessories by determining:
- type and application
- clearances and tolerances
- surface finish
- tool holding and support requirements
- speed and feed values
- workpiece characteristics
- handling, storing, and maintenance

Select measuring and checking tools and instruments.

10.6 Perform vertical milling. (12 hrs)

Demonstrate milling of surfaces.

Demonstrate milling of forms and shapes.

Demonstrate drilling holes.

Demonstrate counter boring, counter sinking, and spot facing of holes.

10.7 Perform routine maintenance. (0.5 hrs)

Demonstrate routine cleaning and maintenance procedures.

Demonstrate lubrication procedures.

Demonstrate dismantling, handling and storage of tools, tooling, workholding devices, and measuring equipment.

Evaluation Structure		
Theory Testing	Practical Application Testing	Final Assessment
35%	65%	100%

Number:	S0611		
Title:	**Surface Grinding Technology**		
Duration:	Total Hours: 12	Theory: 6	Practical: 6
Prerequisites:	Grade 12		
Content:	S0611.1	Demonstrate safe working procedures when setting up and operating surface grinders. (2 hrs)	
	S0611.2	Set up surface grinder machine controls and coolant requirements. (1.5 hrs)	
	S0611.3	Set up surface grinder workholding devices, attachments, and/or accessories. (1 hr)	
	S0611.4	Set up surface machine grinding wheels. (1.5 hrs)	
	S0611.5	Develop a plan for surface grinding. (1.5 hrs)	
	S0611.6	Perform surface grinding. (4 hrs)	
	S0611.7	Describe routine maintenance. (0.5 hrs)	
Evaluation & Testing:	Assignments related to theory and application skills Minimum of one mid-term test during the term Final test at end of term Periodic quizzes		

Instructional and Delivery Strategies:
Lecture
Video
Paper based material
CBT
Internet On-Line

Reference Materials:
Technology of Machine Tools
Shop Text Books

Number:	S0611.0		
Title:	**Surface Grinding Technology**		
Duration:	Total Hours: 12	Theory: 6	Practical: 6

General Learning Outcomes

Upon successful completion the apprentice is able to: surface grind horizontal, vertical, and angular flat surfaces; and surface grind parallel surfaces.

Learning Outcomes and Content

11.1 Demonstrate safe working procedures when setting up and operating surface grinders. (2 hrs)

Identify potential safety hazards which may occur during surface grinder set-up and operating procedures.

Describe safe working habits including:
- protective clothing and gear
- good house keeping
- start-up
- shut-off
- securing workpiece
- stabilizing workpiece
- guards and dust extraction system
- dressing grinding wheel
- inspection of grinding wheel
- lock-out procedures
- tagging procedures
- maximum rpm
- ring test of wheel

11.2 Set up surface grinder machine controls and coolant requirements. (1.5 hrs)

Describe components of a surface grinder:
- table
- bed ways
- base
- wheel head
- table traverse mechanism
- trip dogs
- saddle
- feed mechanisms

Identify surface grinder controls:
- power switch
- stop switch
- start switch
- table traverse
- cross feed
- wheel feed
- cutting fluid Select cutting fluids.

11.3 Set up surface grinder workholding devices, attachments, and/or accessories. (1 hr)

Describe grinder workholding devices, accessories, and attachments:
- wheel dressing attachment
- magnetic chucks
- magnetic chuck blocks
- magna-vise clamps
- double faced tape
- grinding vises
- adjustable angle vises
- angle plates
- Vee-blocks
- Fixtures

Select workholding devices and accessories or attachments by determining:
- type, function, and size
- holding/mounting characteristics
- handling, storing, and maintenance procedures
- workpiece characteristics

Demonstrate contact surface cleaning procedures.

Demonstrate grinder chuck magnetizing procedures.

Demonstrate procedures for demagnetizing the workpiece.

Demonstrate mounting, positioning, aligning, and securing procedures.

11.4 Set up surface grinding wheels. (1.5 hrs)

Identify grinding wheel using marking system to determine:
- grain
- bond
- grade
- structure
- abrasive

Identify wheel mounting and dressing procedures by determining:
- type and shape of wheel
- workpiece characteristics
- rough and finish grinding
- mounting of wheel
- coolant requirements
- maximum wheel rpm
- balancing and dressing of wheel
- truing wheel
- diamond positioning
- diamond wheel dresser
- cutting feeds

Demonstrate mounting of wheel on surface grinder.

Demonstrate truing and dressing of wheel.

Describe wheel balancing.

11.5 Develop a plan for surface grinding. (1.5 hrs)

Interpret engineering drawings, CAD data, or process sheets to determine:
- workpiece material characteristics
- form and shape of workpiece
- surface finish
- tolerance
- machining operations and sequences

Select surface grinding procedures.

Select surface grinder workholding devices and accessories by determining:
- application
- type
- set-up clearances
- tolerances
- surface finish
- machining operations and sequences
- grinding area accessibility
- workpiece characteristics
- handling, storing, and maintenance procedures

Select surface grinder by determining:
- grinding capacity
- type
- operating principles
- rough and finish grinding
- surface finish
- tolerances
- workpiece characteristics
- coolant requirements
- dust extraction system
- mounting of workpiece
- aligning of workpiece
- securing of workpiece

Select measuring and checking tools and instruments.

11.6 Perform surface grinding. (4 hrs)

Demonstrate grinding of horizontal flat surfaces.

Demonstrate grinding of vertical flat surfaces

Demonstrate grinding of angular flat surfaces.

Demonstrate grinding of parallel surfaces.

11.7 Describe routine maintenance. (0.5 hrs)

Describe routine cleaning and maintenance procedures.

Describe lubrication procedures.

Describe the dismantling, handling and storage of tools, tooling, and measuring equipment.

Evaluation Structure		
Theory Testing	Practical Application Testing	Final Assessment
50%	50%	100%

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Machinist
Tool and Die Maker