



Machinist

Guide to Course Content

2022

Online: www.saskapprenticeship.ca

Recognition:

To promote transparency and consistency, this document has been adapted from the 2018 Machinist Red Seal Occupational Standard (Employment and Social Development Canada).

A complete version of the Occupational Standard can be found at www.red-seal.ca

STRUCTURE OF THE GUIDE TO COURSE CONTENT

To facilitate understanding of the occupation, this guide to course content contains the following sections:

Description of the Machinist trade: an overview of the trade's duties and training requirements.

Essential Skills Summary: an overview of how each of the nine essential skills is applied in this trade.

Task Matrix: a chart which outlines graphically the major work activities, tasks and sub-tasks of this standard detailing the essential skills and the level of training where the content is covered.

Major Work Activity (MWA): the largest division within the standard that is comprised of a distinct set of trade activities.

Task: distinct actions that describe the activities within a major work activity.

Sub-task: distinct actions that describe the activities within a task.

Training Profile Chart: a chart which outlines the model for Saskatchewan Apprenticeship and Trade Certification Commission (SATCC) technical training.

Technical Training Course Content for the Machinist trade: a chart which outlines the model for SATCC technical training sequencing.

DESCRIPTION OF THE MACHINIST TRADE

Machinists work with metals and other materials and operate lathes, milling machines and other tools to produce shapes to a required finish and size.

Fully qualified machinists possess the knowledge and abilities to set up and machine using conventional, portable and Computer Numerical Control (CNC) machines that cut or grind metal and other materials into products with precise dimensions. These machines include lathes, milling machines, saws, grinding machines, drilling machines, boring machines, electrical discharge machines (EDM), line borers and portable milling machines.

Machinists work from drawings, specifications, and their own measurements to calculate dimensions, tolerances and types of fit. Precise measurements are critical to machinists' work. They must be knowledgeable about the properties of metals and non-metallic materials.

Machinists may work in industries where machines are manufactured, repaired, or used. These may include industries that manufacture machinery equipment, motor vehicle or aerospace parts. Machinists produce precision parts that are used in all aspects of manufacturing. They may also work in shipyards, rail yards, refineries, pulp and paper mills, mines, smelters, metal fabricating and repair shops. Some sectors that employ machinists may include oil and gas, medical, research and development and forestry. Shiftwork is common in some companies. Machinists tend to work indoors.

Safety is always important. There are risks of injury working with moving machine parts, sharp edges, flying debris and extreme temperatures from heated or chilled materials. Precautions are required while working with manufacturing chemicals and airborne irritants.

Key attributes for people entering this trade are: communication skills, mechanical aptitude, hand-eye coordination, manual dexterity, an ability to work independently and knowledge of mathematics and physics. The work often requires considerable standing and the handling of heavy objects. This standard recognizes similarities or overlaps with the work of other tradespeople such as tool and die makers, mould makers, welders, and industrial mechanics (millwrights).

Experienced machinists may move into mentoring or supervisory positions. They may transfer their skills to related occupations such as tool and die maker, mould maker, industrial mechanic (millwright) or CNC programmer.

Training Requirements: To graduate from each level of the apprenticeship program, an apprentice must successfully complete the required technical training and compile enough on-the-job experience to total at least 1800 hours each year. Total trade time required is 7200 hours and at least 4 years in the trade.

There are four levels of technical training delivered by Saskatchewan Polytechnic in Saskatoon.

Level One:	8 weeks
Level Two:	8 weeks
Level Three:	8 weeks
Level Four:	6 weeks

The information contained in this guide to course content details the technical training delivered for each level of apprenticeship. An apprentice spends approximately 15% of their apprenticeship term in a technical training institute learning the technical and theoretical aspects of the trade. The hours and percentages of technical and practical training may vary according to class needs and progress.

The content of the technical training components is subject to change without notice.

Entrance Requirements for Apprenticeship Training

Your grade twelve transcripts (with no modified classes) or GED 12 is your guarantee that you meet the educational entrance requirements for apprenticeship in Saskatchewan. In fact, employers prefer and recommend apprentices who have completed high school. This ensures the individual has all of the necessary skills required to successfully complete the apprenticeship program and receive journeyman certification.

Individuals with “modified” or “general” classes in math or science do not meet our entry requirements. These individuals are required to take an entrance assessment prescribed by the SATCC.

English is the language of instruction in all apprenticeship programs and is the common language for business in Saskatchewan. Before admission, all apprentices and/or “upgraders” must be able to understand and communicate in the English language. Applicants whose first language is not English must have a minimum Canadian Language Benchmark Assessment of six (CLB6).

Note: A CLB assessment is valid for a one-year period from date of issue.

Designated Trade Name	Math Credit at the Indicated Grade Level ❶	Science Credit at Grade Level
Machinist	Grade 11	Grade 10
<p>❶ - (One of the following) WA – Workplace and Apprenticeship; or F – Foundations; or P – Precalculus, or a Math at the indicated grade level (Modified and General Math credits are not acceptable).</p> <p>*Applicants who have graduated in advance of 2015-2016, or who do not have access to the revised Science curricula will require a Science at the minimum grade level indicated by trade.</p> <p>For information about high school curriculum, including Math and Science course names, please see: - http://www.curriculum.gov.sk.ca/#</p> <p>Individuals not meeting the entrance requirements will be subject to an assessment and any required training</p>		

ESSENTIAL SKILLS SUMMARY

Essential skills are needed for work, learning and life. They provide the foundation for learning all other skills and enable people to evolve with their jobs and adapt to workplace change.

Through extensive research, the Government of Canada and other national and international agencies have identified and validated nine essential skills. These skills are used in nearly every occupation and throughout daily life in different ways.

A series of CCDA-endorsed tools have been developed to support apprentices in their training and to be better prepared for a career in the trades. The tools can be used independently or with the assistance of a tradesperson, trainer, employer, teacher, or mentor to:

- understand how essential skills are used in the trades;
- learn about individual essential skills strengths and areas for improvement; and
- improve essential skills and increase success in an apprenticeship program.

The tools are available online or for order at: www.esdc.gc.ca/eng/jobs/les/profiles/index.shtml

The application of these skills may be described throughout this document within the skills and knowledge which support each sub-task of the trade. The most important essential skills for each sub-task have also been identified. The following are summaries of the requirements in each of the essential skills, taken from the essential skills profile. A link to the complete essential skills profile can be found at www.red-seal.ca.

READING

Machinists require strong reading skills to gather information from forms and labels. They also need to read longer texts such as notes, letters, process sheets, manuals (Machinery's Handbook), specifications, regulations, reports, data collection, books, and charts.

DOCUMENT USE

Document use is a significant essential skill for this trade. Machinists need to be able to refer to and interpret several types of documents such as inspection reports, work orders, charts, sketches, drawings, set-up sheets and job travellers. They also need to be able to enter information or create these documents.

WRITING

Writing skills are used by machinists to record job procedures, write work-related requests, record tooling lists and setup sheets, and record work instructions and process sheets.

ORAL COMMUNICATION

Some tasks performed by machinists require oral communication skills, including exchanging technical information with co-workers in their trade and other trades, discussing work with supervisors, interacting with clients, and instructing less-experienced machinists and apprentices.

NUMERACY

Numeracy skills are very important in the everyday work of machinists. Machinists frequently calculate measurements and dimensions of raw materials and finished products to make sure they match specifications. They must calculate speeds and feeds for the machines that they operate. Layout of workpieces requires strong geometry and trigonometry skills.

THINKING

Machinists must plan, make allowances and corrections, and determine the best sequence of work processes. They use problem solving skills to assess and adjust machining processes according to unforeseen circumstances. Machinists must make decisions and use critical thinking about the materials, processes, or tools to use for specific jobs. They may initiate design changes. They may be responsible for scheduling and delegating tasks to apprentices or junior machinists.

WORKING WITH OTHERS

Much of machinists' work may be done independently such as interpreting, planning, producing, and repairing parts. Machinists may work with other machinists to carry out new or complex tasks or work on larger jobs. They may also work with engineering staff and computer programming staff.

DIGITAL TECHNOLOGY

Machinists may use computers and CAD software in their work. They may use computers to access database information, reference electronic manuals and resources, communicate with others or perform Internet research. Certain equipment such as CMM and CNC machines require digital technology skills.

CONTINUOUS LEARNING

Machinists are required to stay abreast of new technologies, products, and trends in the machining industry.

ELEMENTS OF HARMONIZATION FOR APPRENTICESHIP TRAINING

At the request of industry, the Harmonization Initiative was launched in 2013 to *substantively align* apprenticeship systems across Canada by making training requirements more consistent in the Red Seal trades. Harmonization aims to improve the mobility of apprentices, support an increase in their completion rates and enable employers to access a larger pool of apprentices.

As part of this work, the Canadian Council of the Directors of Apprenticeship (CCDA) identified four main harmonization priorities in consultation with industry and training stakeholders:

1. Trade name

The official Red Seal name for this trade is Machinist.

2. Number of Levels of Apprenticeship

The number of levels of technical training recommended for the Machinist trade is four.

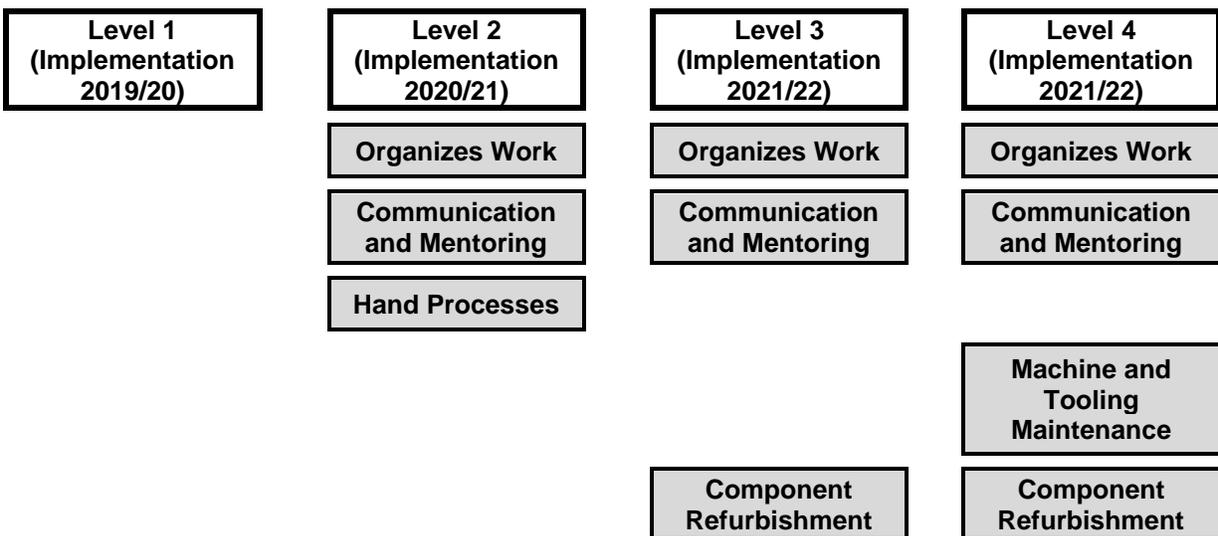
3. Total Training Hours during Apprenticeship Training

The total hours of training, including both on-the-job and in-school training for the Machinist trade is 7200.

4. Consistent sequencing of training content (at each level) using the most recent Occupational Standard

Implementation for harmonization has taken place progressively. Level one was implemented in 2019/2020, level two 2020/2021, level three and level four in 2021/2022. See Appendix A for the finalized curriculum comparisons.

White boxes are “Topics,” grey boxes are “In Context”. In context means learning that has already taken place and is being applied to the applicable task. Learning outcomes for in context topics are accomplished in other topics in that level



Level 1 (Implementation 2019/20)	Level 2 (Implementation 2020/21)	Level 3 (Implementation 2021/22)	Level 4 (Implementation 2021/22)
Safety-Related Tasks	Safety-Related Tasks	Safety-Related Tasks	Safety-Related Tasks
Organizes Work			
Communication and Mentoring			
Workpiece Material Processing	Workpiece Material Processing	Workpiece Material Processing	Workpiece Material Processing
Machine and Tooling Maintenance	Machine and Tooling Maintenance	Machine and Tooling Maintenance	
Hand Processes			
Components (Introduction)	Component Refurbishment		
Power Saw Setup			
Power Saw Operation			
Drill Press Setup			
Drill Press Operation			
Conventional Lathe Setup	Conventional Lathe Setup		
Conventional Lathe Operation	Conventional Lathe Operation		
Conventional Milling Machine (Introduction)	Conventional Milling Machine Setup	Conventional Milling Machine Setup	Conventional Milling Machine Setup
	Conventional Milling Machine Operation	Conventional Milling Machine Operation	Conventional Milling Machine Operation
	Precision Grinding Machine Setup	Precision Grinding Machine Setup	
	Precision Grinding Machine Operation	Precision Grinding Machine Operation	
	CNC Programming	CNC Programming	CNC Programming
	CNC Machine Setup	CNC Machine Setup	CNC Machine
	CNC Machine Operation	CNC Machine Operation	CNC Machine Operation

MACHINIST TASK MATRIX

This chart outlines the major work activities, tasks and sub-tasks from the 2018 Machinist Red Seal Occupational Standard (RSOS). Each sub-task details the corresponding essential skill and level of training where the content is covered. *

* Sub Tasks with numbers in the boxes is where the content will be delivered in training.

A – PERFORMS COMMON OCCUPATIONAL SKILLS

Task A-1 Performs safety-related tasks	1.01 Maintains safe work environment 1, 2, 3, 4	1.02 Uses personal protective equipment (PPE) and safety equipment 1		
Task A-2 Organizes work	2.01 Interprets documentation 1	2.02 Plans sequence of operations 1		
Task A-3 Uses communication and mentoring techniques	3.01 Uses communication techniques 1	3.02 Uses mentoring techniques 1		
Task A-4 Processes workpiece material	4.01 Selects workpiece material 1, 2	4.02 Uses hoisting, lifting and rigging equipment 1	4.03 Marks workpiece for identification 1	4.04 Performs heat treatment 2, 3
	4.05 Performs quality control of workpiece 1, 2, 3, 4	4.06 Deburs workpiece 1	4.07 Sketches parts 1, 2	
Task A-5 Maintains machines, tooling and inspection equipment	5.01 Cleans machines 1, 2	5.02 Lubricates machines 1	5.03 Sharpens tooling 1, 3	5.04 Applies cutting fluid and coolant 1

Task C-9 Operates power saws	9.01 Saws straight and angle cuts 1	9.02 Cuts irregular shapes 1
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D – MACHINES USING DRILL PRESS

Task D-10 Sets up drill presses	10.01 Selects drill press types 1	10.02 Plans operation of drill presses 1	10.03 Selects drill press speeds and feeds 1	10.04 Sets up jigs, fixtures and work holding devices for drill presses 1
	10.05 Sets up tooling for drill presses 1			
Task D-11 Operates drill presses	11.01 Drills holes using a drill press 1	11.02 Cuts countersinks, counterbores, chamfers and spot faces using a drill press 1	11.03 Performs tapping using a drill press 1	11.04 Finishes holes using a drill press 1

E – MACHINES USING CONVENTIONAL LATHES

Task E-12 Sets up conventional lathes	12.01 Selects conventional lathe types 1	12.02 Plans operation of conventional lathes 1, 2	12.03 Sets up work holding devices for conventional lathes 1, 2	12.04 Sets up tooling for conventional lathes 1, 2
	12.05 Sets up conventional lathe accessories 1, 2	12.06 Sets up workpiece on conventional lathe 1, 2	12.07 Selects conventional lathe speeds and feeds 1	
Task E-13 Operates conventional lathes	13.01 Faces surfaces using a conventional lathe 1,	13.02 Turns external surfaces using a conventional lathe 1, 2	13.03 Drills using a conventional lathe 1	13.04 Bores holes using a conventional lathe 1, 2

13.05 Reams holes using a conventional lathe 1	13.06 Turns tapers using a conventional lathe 1, 2	13.07 Knurls using a conventional lathe 1	13.08 Cuts grooves using a conventional lathe 1, 2
13.09 Cuts threads using a conventional lathe 1, 2	13.10 Parts off workpiece using a conventional lathe 1		

F – MACHINES USING CONVENTIONAL MILLING MACHINES

Task F-14 Sets up conventional milling machines	14.01 Selects conventional milling machine types 1, 2	14.02 Plans operation of milling machines 2, 3	14.03 Sets up work holding devices for conventional milling machines 2, 3	14.04 Sets up tooling for conventional milling machines 1, 2, 3
	14.05 Sets up milling accessories 2, 3, 4	14.06 Sets up workpiece on a conventional milling machine 2, 3	14.07 Selects conventional milling machine speeds and feeds 2, 3	
Task F-15 Operates conventional milling machines	15.01 Mills surfaces using a conventional milling machine 2, 3	15.02 Mills profiles and pockets using a conventional milling machine 2, 3	15.03 Mills slots, grooves and keyways using a conventional milling machine 2, 3	15.04 Cuts gears and splines using a conventional milling machine 2, 3, 4
	15.05 Drills holes using a conventional milling machine 2	15.06 Reams holes using a conventional milling machine 2	15.07 Cuts countersinks, counterbores, chamfers and spot faces using a conventional milling machine 2	15.08 Performs tapping using a conventional milling machine 2
	15.09 Bores holes using a conventional milling machine 2, 3			

G – MACHINES USING PRECISION GRINDING MACHINES

Task G-16 Sets up precision grinding machines	16.01 Selects precision grinding machine types 2, 3	16.02 Plans operation of grinding machines 2, 3	16.03 Sets up work holding devices for precision grinding machines 2, 3	16.04 Mounts grinding wheel 2, 3
	16.05 Sets up grinding accessories 2, 3	16.06 Sets up workpiece on precision grinding machines 2, 3	16.07 Selects precision grinding machine speeds and feeds 2, 3	
	Task G-17 Operates precision grinding machines	17.01 Grinds flat surfaces using a surface grinder 2	17.02 Grinds profiles 3	17.03 Grinds internal and external cylindrical and tapered surfaces 3
17.05 Finishes holes using a honing machine 3				

H – MACHINES USING COMPUTER NUMERICAL CONTROL (CNC) MACHINES

Task H-18 Performs CNC programming	18.01 Creates process documentation 2, 3	18.02 Creates manual input program 2, 3	18.03 Transfers program to and from control memory 2	18.04 Optimizes program 3, 4
	18.05 Creates 2D and 3D models 3, 4	18.06 Programs using computer-aided manufacturing (CAM) 3, 4		
Task H-19 Sets up CNC machines	19.01 Selects tooling and tool holders for CNC machines 2, 3	19.02 Sets up tooling and tool holders on CNC machines 2, 3	19.03 Sets up workpieces on CNC machines 2, 3, 4	19.04 Establishes work datum 2, 3

	19.05 Verifies program 2			
Task H-20 Operates CNC machines	20.01 Adjusts offsets 2, 3, 4	20.02 Monitors machining processes 2	20.03 Interrupts program cycle 2	20.04 Restarts program cycle 2

TRAINING PROFILE CHART

This Training Profile Chart represents Saskatchewan Apprenticeship and Trade Certification Commission (SATCC) technical training at the topic level.

Level One	Transcript Code	Hours
Benchwork	TOOL 173 - Theory	14
	TOOL 174 - Shop	34
Lathes	MACH 175 - Theory	12
	MACH 176 - Shop	54
Power Saws	MACH 177	6
Drilling	MACH 178 - Theory	6
	MACH 193 - Shop	8
Safety and Basic Shop Mechanics	ME 183	24
Technical Drawing and Blueprint Reading	DRFT 188	20
Milling	MACH 189	24
Materials and Measurement	MACH 192	8
Trade Mathematics	MATH 179	18
Technical Communication for Trades	COMM 388	12
		240

Level Two	Transcript Code	Hours
Mathematics	MATH 258	16
Technical Drawing and Blueprint Reading	DRFT 283	24
Computer Numerical Control Operation and Programming	MACH 283	24
Materials/Heat Treatment	MACH 285	15
Precision grinding	MACH 290 - Theory	12
	MACH 291 - Shop	14
Lathe Operations	MACH 292 - Theory	15
	MACH 293 - Shop	42
Milling	MACH 294 - Theory	20
	MACH 295 - Shop	52
Refurbishment	MACH 296	6
		240

Level Three	Transcript Code	Hours
Power Transmission	MACH 383	24
CNC Machining	MACH 386	56
Mathematics	MATH 386	16
Technical Drawings and Blueprint Reading	PRNT 385	16
Cutting Tool Technology	TOOL 381	20
Machine Tools	TOOL 383 - Theory	18
	TOOL 384 - Shop	90
		240

Level Four	Transcript Code	Hours
CNC Machining	MACH 483	56
Material Select / Heat Treatment	MATE 481	12
Advanced Machine Tools	TOOL 482 - Theory	35
	TOOL 484 - Shop	77
		180

TECHNICAL TRAINING COURSE CONTENT

This chart outlines the model for Saskatchewan Apprenticeship and Trade Certification Commission (SATCC) technical training sequencing.

Sub-tasks listed are the minimum to be covered in a topic. Related sub-tasks not listed may be used as a reference and taught “in context” in other topics.

Level One	8 weeks	240 hours
Benchwork (Theory)		14 hours
<ul style="list-style-type: none">• Identify layout tools• Identify hand tools• Identify cutting tools• Identify power tools• Identify layout techniques• Identify mechanical hardware		
Benchwork (Shop)		34 hours
<ul style="list-style-type: none">• Use semi precision layout tools• Use layout tools• Use hand tools• Operate presses and pullers• Use cutting tools• Use thread cutting tools• Use power tools		
RSOS topics covered in this section of training:		
A-4 Processes Workpiece Material		
A-4.06 Deburrs workpiece		
<ul style="list-style-type: none">• Identify hand and power tools for deburring and their applicable techniques• Identify features to be deburred		
<hr/>		
Lathes (Theory)		12 hours
<ul style="list-style-type: none">• Identify turning machine features• Identify cutting tools• Identify work holding devices• Identify speeds and feeds• Identify turning to size operations• Compare taper turning methods• Calculate thread dimensions• Prepare job plans		
Lathes (Shop)		54 hours
<ul style="list-style-type: none">• Grind lathe tools• Perform external turning• Perform internal turning• Perform grooving and parting• Perform knurling		

- Cut basic 60-degree screw threads
- Perform taper turning
- Demonstrate safe care and maintenance of equipment

RSOS topics covered in this section of training:

E-12 Sets Up Conventional Lathes

E-12.01 Selects conventional lathe types

- Describe terminology associated with conventional lathes
- Identify types of conventional lathes, and describe their operating principles and applications

E-12.02 Plans operation of conventional lathes

- Identify components and controls of conventional lathes
- Describe the purpose and operation of conventional lathes
- Identify conventional lathe tools and accessories, their maintenance and procedures for use

E-12.03 Sets up work holding devices for conventional lathes

- Identify work holding devices, their maintenance and procedures for use
- Describe the procedures used to set up work holding devices on a lathe
- Identify potential setup problems and describe their causes and solutions

E-12.04 Sets up tooling for conventional lathes

- Identify cutting tools, their maintenance and procedures for use
- Describe procedures used to set up cutting tools on lathes

E-12.05 Sets up conventional lathe accessories

- Identify conventional lathe accessories, their maintenance and procedures for use
- Describe the procedures used to inspect and clean conventional lathe accessories

E-12.06 Sets up workpiece on conventional lathe

- Identify types of work holding devices and their applications
- Describe procedure used to set up work holding devices on lathes
- Describe procedures used to ensure parts run true

E-12.07 Selects conventional lathe speeds and feeds

- Describe considerations to determine lathe speeds, feeds and depth of cut
- Identify calculations required to adjust machine controls

E-13 Operates Conventional Lathes

E-13.01 Faces surfaces using a conventional lathe

- Describe considerations to determine lathe speeds, feeds and depth of cut
- Identify cutting fluids and coolants used during conventional lathe operations
- Identify hazards and describe safe work practices pertaining to conventional lathes
- Identify types of facing tools and their applications and procedures for use
- Describe the procedures used for facing operations on a conventional lathe

E-13.02 Turns external surfaces using a conventional lathe

- Describe considerations to determine lathe speeds, feeds and depth of cut
- Identify cutting fluids and coolants used during conventional lathe operations
- Identify hazards and describe safe work practices pertaining to conventional lathes
- Identify types of facing tools and their applications and procedures for use
- Describe the procedures used for turning external surfaces on a conventional lathe

E-13.03 Drills using a conventional lathe

- Describe the procedures used for centre drilling and drilling on a conventional lathe
- Describe the procedure for installing a drill on a conventional lathe

E-13.04 Bores holes using a conventional lathe

- Describe considerations to determine speeds, feeds and depth of cut
- Identify types of boring tools and describe their applications and procedures for use
- Describe the procedures used for counterboring and chamfering work on a conventional lathe

- E-13.05 Reams holes using a conventional lathe
 - Describe the procedures used for reaming work on a conventional lathe
 - Describe the procedure for installing reamers
 - Identify potential problems and describe their causes and solutions
- E-13.07 Knurls using a conventional lathe
 - Describe considerations to determine speeds, feeds and depth of cut during knurling operations
 - Identify cutting fluids and coolants used during knurling operations
 - Identify hazards and describe safe work practices pertaining to knurling
- E-13.08 Cuts grooves using a conventional lathe
 - Describe considerations to determine speeds, feeds and depth of cut during grooving operations
 - Identify cutting fluids and coolants used during grooving operations
 - Identify hazards and describe safe work practices pertaining to grooving
- E-13.09 Cuts threads using a conventional lathe
 - Identify methods to cut threads and describe their associated procedures
 - Describe considerations to determine speeds, feeds and depth of cut during grooving operations
 - Identify cutting fluids and coolants used during threading operations
 - Identify hazards and describe safe work practices pertaining to threading
 - Describe the procedures used to deburr a workpiece
 - Describe procedures used to check and measure threads using inspection equipment
 - Identify types of threads, and describe their purpose, characteristics and applications
- E-13.10 Parts off workpiece using a conventional lathe
 - Describe considerations to determine speeds, feeds and depth of cut during Parting off operations
 - Identify cutting fluids and coolants used during parting off operations
 - Identify hazards and describe safe work practices pertaining to parting off operations

Power Saws

6 hours

- Demonstrate safe care and maintenance of equipment
- Identify sawing machines
- Use power saws

RSOS topics covered in this section of training:

C-8 Sets Up Power Saws

- C-8.01 Selects power saw types
 - Define terminology associated with power saws
 - Identify types of power saws and attachments and describe their applications
 - Identify size and capacity of power saw
 - Describe power saw maintenance and safe procedures for use
- C-8.02 Selects saw blades
 - Identify types of saw blades and describe their parameters, applications, and installation procedures
 - Describe procedures used to adjust a saw blade
- C-8.03 Installs saw blades
 - Identify types of saw blades, their parameters, applications, and installation procedures
 - Describe the procedure used to butt weld bandsaw blades
- C-8.04 Selects power saw speeds and feeds
 - Describe procedures used to calculate speed and feed requirements
 - Describe the procedures used to adjust speeds and feeds
- C-8.05 Makes power saw adjustments

- Describes procedures used to adjust power saws
- Define terminology associated with power saws

C-8.06 Sets up workpiece on power saw

- Describe the procedures used to secure workpiece on power saws
- Identify types of power saw accessories
- Describe procedures used to adjust table angle
- Describe procedures used to calculate and measure workpiece to be cut

C-9 Operates Power Saws

C-9.01 Saws straight and angle cuts

- Identify types of sawing operations and describe their associated procedures
- Identify potential problems during sawing operations and describe their causes and solutions
- Identify types of saws and accessories and describe their applications
- Identify safe work practices and procedures related to the use of power saws and saw blades

C-9.02 Cuts irregular shapes

- Identify types of sawing operations and describe their associated procedures
- Identify potential problems during sawing operations and describe their causes and solutions
- Identify types of saws and accessories and describe their applications
- Identify safe work practices and procedures related to the use of power saws and saw blades

Drilling (Theory)

6 hours

- Identify drilling machines
- Identify hole making tools
- Identify work holding devices and methods
- Identify speeds and feeds for drilling
- Describe cutting fluids

Drilling (Shop)

8 hours

- Perform drilling operations
- Use countersinking and counter boring tools
- Use reamers
- Identify power tapping and boring operations
- Sharpen twist drills
- Demonstrate safe care and maintenance of equipment

RSOS topics covered in this section of training:

D-10 Sets Up Drill Presses

D-10.01 Selects drills press types

- Define terminology associated with drill press tooling and drill presses
- Identify types of drill press tooling and describe their applications
- Identify types of drill presses and describe their components and applications

D-10.02 Plans operation of drill presses

- Define terminology associated with drill press tooling and drill presses
- Describe the procedures used to set up and perform drill press operations

D-10.03 Selects drill press speeds and feeds

- Describe the considerations to determine speed, feed and depth of cut for drill press operations

D-10.04 Sets up jigs, fixtures and work holding devices for drill presses

- Define terminology associated with jigs, fixtures and work holding devices
- Identify jigs, fixtures and work holding devices and describe their applications and procedures for use

D-10.05 Sets up tooling for drill presses

- Describe procedures used to inspect and maintain drill press tooling and drill presses
- Describe the applications, maintenance and procedures for use of drill press tooling and drill presses

D-11 Operates Drill Presses

D-11.01 Drills holes using a drill press

- Identify drill press tooling and drill presses, their applications, maintenance and procedures for use
- Describe drill press safe work practices and procedures
- Identify methods of measurement pertaining to drilling operations
- Identify calculations to verify depth, sizing and positions
- Identify jigs, fixtures and work holding devices and describe their applications and procedures for use

D-11.02 Cuts countersinks, counterbores, chamfers and spot faces using a drill press

- Identify drill press tooling, their applications, maintenance and procedures for use
- Describe the use of measurements pertaining to countersinks, counterbores, chamfers and spot faces
- Identify calculations pertaining to countersinks, counterbores, chamfers and spot faces

D-11.03 Performs tapping using a drill press

- Describe drill press tapping tooling, its applications, maintenance and procedures for use
- Identify types of drill press tapping tooling and describe their applications
- Identify thread type and class of fit

D-11.04 Finishes holes using a drill press

- Identify types of hole finishing tooling, their applications, maintenance and procedures for use
- Identify methods of measurements pertaining to hole finishing operations
- Identify calculations pertaining to hole finishing operation

Trade Mathematics

18 hours

- Use basic mathematics
- Convert between imperial and metric systems
- Use basic algebra
- Use basic geometry and trigonometry

This section of training exceeds the minimum sequencing as set out in the Machinist RSOS.

Safety and Basic Shop Mechanics

24 hours

- Describe WHMIS
- Describe Occupational Health and Safety
- Perform basic rigging and hoisting techniques
- Set up oxy-acetylene equipment
- Use oxy-acetylene equipment

RSOS topics covered in this section of training:

A-1 Performs Safety-Related Tasks

A-1.01 Maintains safe work environment

- Describe safe work practices
- Describe regulatory requirements pertaining to safety
- Identify and follow workplace safety and health regulations

A-1.02 Uses personal protective equipment (PPE) and safety equipment

- Identify types of PPE and safety equipment, their applications, maintenance and procedures for use

- Identify types of fire extinguishing equipment and describe their applications and procedures for use

A-4 Process Workpiece Material

A-4.02 Uses hoisting, lifting and rigging equipment

- Define terminology associated with hoisting, lifting and rigging
- Identify hazards and describe safe work practices pertaining to hoisting, lifting and rigging
- Identify codes and regulations pertaining to hoisting, lifting and rigging training requirements
- Identify types of hoisting, lifting and rigging equipment, their applications, limitations and procedures for use
- Identify and interpret hand signals used for hoisting and lifting
- Identify types of hoisting, lifting and rigging accessories, their applications, limitations and procedures for use
- Describe considerations when rigging material/equipment for lifting
- Describe the procedures used to inspect, maintain and store hoisting, lifting and rigging equipment

Technical Drawing and Blueprint Reading

20 hours

- Use manual drafting instruments
- Demonstrate orthographic drawing skills (third angle projection)
- Use dimensioning systems
- Apply tolerances, section and auxiliary views
- Demonstrate isometric sketching
- Locate surfaces, features and dimensions on engineering drawing

RSOS topics covered in this section of training:

A-2 Organizes Work

A-2.01 Interprets documentation

- Define terminology associated with drawings
- Identify types of drawings and sketches and describe their purpose
- Interpret and extract information from drawing features
- Identify types of reference materials and their use
- Identify information from reference materials and determine the calculations

A-4 Processes workpiece material

A-4.07 Sketches Parts

- Identify types of sketches and their purpose
- Describe basic sketching techniques and types of views
- Identify dimensions used in creating sketches
- Describe how to interpret and extract information from parts to create a sketch

Milling

24 hours

- Identify vertical milling machines cutting tools
- Identify vertical milling machine cutting tools
- Identify work holding devices and methods
- Perform vertical milling machine operations
- Demonstrate safe care and maintenance of equipment

RSOS topics covered in this section of training:

F-14 Sets Up Conventional Milling Machine Types

F-14.01 Selects conventional milling machine types

- Define terminology associated with conventional milling machines
- Identify types of conventional milling machines and describe their applications
- Identify the components and controls of conventional milling machines and describes their purpose and operation
- Identify hazards and describe safe work practices pertaining to conventional milling machines

Materials and Measurement

8 hours

- Recognize measurement systems
- Read steel rules
- Read vernier scale instruments
- Read micrometers
- Describe comparison measuring tools
- Describe gauge block use
- Read angular measuring tools
- Identify materials
- Identify surface finish
- Identify non-metals

RSOS topics covered in this section of training:

B-6 Performs Hand Processes

B-6.01 Performs layout

- Define terminology associated with layout
- Describe the procedures used to read and transfer sizes from a drawing
- Calculate layout dimensions and reference points
- Describe the procedures used to perform a basic layout
- Identify types of basic layout tools and describe their applications and procedures for use
- Identify types of layout media/solutions and describe their applications
- Describe the procedures used to inspect, maintain, and store layout tools and equipment
- Describe the procedures used to perform a precision layout
- Identify precision layout tools and describe their applications and procedures for use
- Calculate sine bar values
- Calculate angles, arcs and locations from reference point
- Describe the procedures used to inspect, maintain and store precision layout tools

Technical Communication for Trades

12 hours

- Solve common grammatical errors to meet technical writing requirements
- Write shop documentation
- Demonstrate knowledge of effective workplace communications

RSOS topics covered in this section of training:

A-3 Uses Communication and Mentoring Techniques

A-3.01 Uses communication techniques

- Define terminology used in trade
- Describe the importance of using effective verbal and non-verbal communication
- Identify sources of information to effectively communicate
- Identify communication and learning styles
- Describe effective listening and speaking skills
- Identify personal responsibilities and attitudes that contribute to on-the-job success
- Identify the value of diversity in the workplace
- Identify communication that constitutes harassment and discrimination

A-3.02 Uses mentoring techniques

- Describe strategies for learning skills in the workplace
- Identify strategies for teaching workplace skills
- Identify and utilize different learning styles
- Identify techniques for giving effective feedback

Level Two

8 weeks

240 hours

Mathematics

16 hours

- Use basic algebra
- Use basic geometry and trigonometry
- Perform trade calculations

This section of training exceeds the minimum sequencing as set out in the Machinist RSOS.

Technical Drawing and Blueprint Reading

24 hours

- Use manual drafting instruments
- Demonstrate orthographic drawing skills
- Use various drawing commands in CAD drafting
- Use various editing commands in CAD drafting
- Place dimensions on drawings
- Find dimensional data on technical drawings
- Apply tolerances to sectional and auxiliary views

RSOS topics covered in this section of training:

A-4 Processes workpiece material

A-4.07 Sketches part

- Identify types of sketches and describe their purpose
 - Describe basic sketching techniques and types of views
 - Identify dimensions used in creating sketches
 - Describe how to interpret and extract information from parts to create a sketch
-

Computer Numerical Control Operation and Programming

24 hours

- Demonstrate safe care and maintenance of equipment
- Describe movement principles
- Examine turning machine programming
- Perform turning machine set up and operation
- Examine machining centre programming
- Perform machining centre set up and operation
- Describe applications of CAD/CAM systems

RSOS topics covered in this section of training:

H-18 Performs CNC programming

H-18.01 Creates process documentation

- Define terminology associated with CNC machines
- Identify CNC control units and describe their purpose
- Interpret documentation pertaining to the machining of workpieces

H-18.02 Creates manual input program

- Identify types of programming codes and describe their applications
- Define the differences between centerline programming and cutter radius compensation (CRC) programming
- Identify reference points and their location
- Describe the procedures used to calculate speed, feed and depth of cuts
- Identify potential setup problems and describe their causes and solutions
- Identify the hazards and describe safe work practices pertaining to CNC machines

H-18.03 Transfers program to and from control memory

- Identify types and use of edit functions and their applications
- Describe the procedures used to transfer programs to and from CNC machines

H-19 Sets up CNC machines

H-19.01 Selects tooling and tool holders for CNC machines

- Define terminology associated with CNC machines and tooling
- Identify types of CNC machines and tooling, and describe their characteristics and applications
- Identify types of accessories and tool changers used with CNC machines and describe their applications
- Identify types of tool holders and work holding devices used with CNC machines and describe their applications
- Identify the hazards and describe safe work practices pertaining to CNC machines

H-19.02 Sets up tooling and tool holders for CNC machines

- Identify CNC axis and describe the relationship between them
- Identify CNC control units and describe their purpose
- Identify the hazards and describe safe work practices pertaining to CNC machines
- Describe the procedures used to set up tooling and tool holders on CNC machines
- Describe methods for determining tool offsets

H-19.03 Sets up workpiece on CNC machines

- Identify CNC control units and describe their purpose
- Describe the procedures used to set up workpieces in CNC machines
- Identify the hazards and describe safe work practices pertaining to CNC machines

H-19.04 Establishes work datum

- Describe the procedures used to touch off datum surfaces
- Describe the procedures used to input datum information
- Identify the hazards and describe safe work practices pertaining to CNC machines

H-19.05 Verifies program

- Procedures to download/save a program to CNC machines
- Describe the procedures used to perform dry run or graphic simulation of a program
- Define features for stepping through program
- Describe procedures used to perform CNC programming
- Describe the procedures for saving modified program into master file
- Identify hazards and describe safe work practices pertaining to CNC machines

H-20 Operates CNC machines

H-20.01 Adjusts offsets

- Describe the procedures used to operate CNC machines
- Describe the procedures used to adjust offsets
- Identify the hazards and describe safe work practices pertaining to CNC machines
- Calculate deviations from specifications

H-20.02 Monitors machining processes

- Describe the procedures used to operate CNC machines
- Describe the procedures used to inspect and maintain CNC machines
- Identify issues with operating conditions
- Identify the hazards and describe safe work practices pertaining to CNC machines

H-20.03 Interrupts program cycle

- Identify CNC reference points and their locations
- Describe the procedures used to operate CNC machines
- Identify levels of urgency requiring a type of stop
- Define control features
- Identify the hazards and describe safe work practices pertaining to CNC machines

H-20.04 Restarts program cycle

- Identify CNC related reference points and their location
 - Describe the procedures used to restart program
 - Describe the procedures used to program and operate CNC machines
 - Identify hazards and describe safe work practices pertaining to CNC machines
-

Materials/Heat Treatment

15 hours

- Perform hardness testing
- Perform hardening and tempering
- Describe annealing, normalizing, and stress relieving processes
- Identify properties of materials
- Demonstrate safe care and maintenance of equipment

RSOS topics covered in this section of training:

A-4 Processes workpiece material

A-4.01 Selects workpiece material

- Identify types of materials and describe their characteristics and applications
- Identify hazards and describe safe work practices pertaining to materials
- Describe the properties of materials and their chemical, physical and mechanical characteristics
- Identify and interpret markings and documentation relating to material identification systems
- Explain the processing characteristics of materials

A-4.04 Performs heat treatment

- Define terminology associated with heat treatment
- Identify hazards and describe safe work practices pertaining to heat treatment
- Identify methods used to determine the carbon content of steels
- Identify heat treatment processes and describe their applications
- Describe the procedures used to determine properties of metals
- Identify and interpret reference data used in heat treatment
- Identify methods used for quenching steel and describe the properties of the steel produced by each

A-4.05 Performs quality control of workpiece

- Define terminology related to material testing
- Identify hazards and describe safe work practices pertaining to material testing
- Describe the purpose and applications of material testing
- Identify types of tests performed on materials and describe their applications
- Identify the machines and scales used for hardness testing and describe their associated procedures
- Define terminology associated with quality inspection
- Describe the procedures used to inspect workpieces
- Identify types of precision gauges used in quality inspection and describe their applications and procedures for use
- Identify types of precision measuring tools used in quality inspection and describe their applications and procedures for use
- Identify types of comparators and describe their applications and procedures for use
- Identify types of CMMs and describe their components, applications and procedures for use

Precision Grinding (Theory)**12 hours**

- Identify grinding machines
- Identify grinding wheels
- Describe grinding wheel use
- Develop job plans for grinding projects.
- Describe cutting fluids

Precision Grinding (Shop)**14 hours**

- Perform grinding wheel service
- Operate precision grinders
- Demonstrate safe care and maintenance of equipment

RSOS topics covered in this section of training:**G-16 Machines using precision grinding machines****G-16.01 Selects precision grinding machine types**

- Define terminology associated with grinding machines
- Identify types of grinding machines and accessories and describe their applications
- Interpret documentation pertaining to the material to be ground
- Describe grinding operations to be performed

G-16.02 Plans operation of grinding machines

- Define terminology associated with grinding machines
- Identify types of grinding machines and accessories and describe their applications
- Interpret documentation pertaining to the material to be ground
- Identify types of work holding devices and describe their applications and maintenance
- Identify sequence of grinding operations

G-16.03 Sets up work holding devices for precision grinding machines

- Describe the procedures used to set up grinding machines and accessories
- Identify types of work holding devices and describe their applications and maintenance
- Describe the procedures used to align a workpiece and work holding devices
- Identify potential setup problems and describe their causes and solutions

G-16.04 Mounts grinding wheel

- Describe the procedures used to set up and mount wheels on grinding machines
- Identify types of wheel dressers and describe their applications
- Describe the procedures used to true and dress grinding wheels
- Describe the procedures used to inspect, maintain and store grinding wheels

G-16.05 Sets up grinding accessories

- Identify types of accessories used for grinding operations and describe their applications
- Describe the procedures used to set up grinding machines and accessories
- Describe the procedures used to inspect and maintain grinding machine accessories

G-16.06 Sets up workpiece on precision grinding machines

- Describe the procedures used to set up workpieces on grinders using accessories
- Describe the procedures used to check alignment of workpieces

G-16.07 Selects precision grinding machine speeds and feeds

- Describe the factors used to determine feed and depth of cut for grinding operations
- Describe the calculations used to determine speed

G-17 Operates precision grinding machines**G-17.01 Grinds flat surfaces using a surface grinder**

- Describe the procedures used to adjust and maintain surface grinding machines
- Describe the procedures used to perform surface grinding operations
- Identify potential problems and describe their causes and solutions
- Identify hazards and describe safe work practices pertaining to surface grinding operations

Lathe Operations (Theory)**15 hours**

- Identify carbide tooling
- Identify precision tapers
- Identify tapered threads
- Identify steady rests and follower rests

Lathe Operations (Shop)**42 hours**

- Demonstrate safe care and maintenance of equipment
- Cut precision tapers
- Cut a tapered thread
- Use a steady rest
- Use a follower rest
- Perform internal sleeving

RSOS topics covered in this section of training:**A-5 Maintains machines, tooling and inspection equipment**

A-5.05 Troubleshoots equipment

- Identify machine operating procedures
- Identify troubleshooting techniques

A-5.06 Maintains machine alignment

- Demonstrate procedures used to adjust and maintain machine alignment

E-12 Sets up conventional lathes

E-12.02 Plans operation of conventional lathes

- Identify controls and components of conventional lathes and describe their operation
- Identify types of work holding devices and describe their applications
- Identify types of tool holding devices and describe their application
- Identify conventional lathe tools and accessories and describe their applications
- Identify the considerations and requirements for selecting conventional lathe tools and accessories for specific operations

E-12.03 Sets up holding devices for conventional lathes

- Identify types of work holding devices and describe their applications
- Describe the procedures used to set up work holding devices on lathes
- Identify tools required to set up work holding devices on lathes
- Identify potential setup problems and describe their causes and solutions

E-12.04 Sets up tooling for conventional lathes

- Identify types of cutting tools and describe their applications
- Describe the procedures used to set up cutting tools on lathes
- Identify potential setup problems and describe their causes and solutions

E-12.05 Sets up conventional lathe accessories

- Identify conventional lathe accessories and their applications
- Describe procedures used to set up, inspect and clean accessories
- Identify potential setup problems and describe their causes and solutions

E-12.06 Sets up workpiece on conventional lathe

- Identify types of work holding devices and describe their applications
- Describe the procedures used to set up work holding devices on lathes
- Identify types of inspection equipment and describe their use
- Describe the procedures used to set up eccentrics on conventional lathes
- Describe the procedures used to ensure parts run true

E-13 Operates conventional lathes

E-13.02 Turns external surfaces using a conventional lathe

- Describe the procedures to determine speed, feed, and depth of cut
- Identify cutting fluids and coolants used
- Describe procedures used to set speeds and feeds
- Identify hazards and describe safe work practices pertaining to conventional lathes
- Identify potential problems and describe their causes and solutions

E-13.04 Bores holes using a conventional lathe

- Describe the procedures to determine speed, feed, and depth of cut
- Identify cutting fluids and coolants used
- Identify hazards and describe safe work practices pertaining to conventional lathes
- Identify types of boring tools and describe their applications and use
- Describe procedures used for boring work on a conventional lathe
- Describe procedures used for counter boring and chamfering work on a conventional lathe

E-13.06 Turns tapers using a conventional lathe

- Identify types of tapers and their applications
- Identify taper attachments and their procedures for use
- Identify calculations for tapers
- Identify methods and procedures to turn and check tapers
- Define terminology associated with taper turning
- Identify hazards and describe safe work practices pertaining to taper turning

E-13.08 Cuts grooves using a conventional lathe

- Describe the considerations to determine speed and feed for conventional lathe operation
- Identify cutting fluids and coolants used
- Describe the procedures used to set speeds and feeds
- Identify hazards and describe safe work practices pertaining to cutting grooves
- Identify potential problems and describe their causes and solutions

E-13.09 Cuts threads using a conventional lathe

- Identify methods used to cut threads and describe their associated procedures
- Describe the considerations to determine speed and feed
- Identify cutting fluids and coolants used
- Describe the procedures used to set speeds and feeds
- Identify methods used to cut multiple start threads
- Describe procedures to de-burr a workpiece
- Identify types of threads, purpose and characteristics
- Identify hazards and describe safe work practices pertaining to conventional lathes
- Identify potential problems and describe their causes and solutions

Milling (Theory)

20 hours

- Identify grinding machines
- Identify grinding wheels
- Describe grinding wheel use
- Develop job plans for grinding projects
- Describe cutting fluids

Milling (Shop)

52 hours

- Perform vertical milling operations
- Perform horizontal milling machine operations
- Use indexing devices
- Demonstrate safe care and maintenance of equipment

RSOS topics covered in this section of training:

A-5 Maintains machines, tooling and inspection equipment

A-5.05 Troubleshoots equipment

- Identify machine operating procedures
- Identify troubleshooting techniques

A-5.06 Maintains machine alignment

- Demonstrate procedures used to adjust and maintain machine alignment

F-14 Machines using conventional milling machines

F-14.01 Selects conventional milling machine types

- Define terminology associated with conventional milling machines
- Identify types of milling machines and their applications
- Identify components, controls of conventional milling machines and describe their operation
- Identify hazards and describe safe work practices pertaining to conventional milling machines

F-14.02 Plans operation of milling machines

- Identify types of conventional milling machines accessories and attachments and describe their purpose
- Identify types of tool holding devices and describe their applications
- Identify types of work holding devices and describe their applications
- Identify types of cutting tools and describe their applications
- Identify hazards and describe safe work practices pertaining to conventional milling machines
- Identify potential setup problems and describe their causes and solutions
- Identify considerations and requirements for selecting tools and accessories for milling operations
- Describe procedures used to set up conventional milling machines to perform basic milling operations
- Describe the procedures used to perform milling operations on conventional milling machines

F-14.03 Sets up work holding devices for conventional milling machines

- Identify hazards and describe safe work practices pertaining to conventional milling machines
- Describe the procedures used to align conventional milling machine heads and table
- Describe the procedures used to set up conventional milling machines to perform milling operations
- Describe the procedures used to align workpieces
- Identify types of work holding devices
- Describe the procedures used to secure and align work holding devices

F-14.04 Sets up tooling for conventional milling machines

- Identify the considerations and requirements used for selecting tooling and tool holding devices
- Describe the procedures used to install tooling and tool holding devices

F-14.05 Sets up milling accessories

- Identify the considerations and requirements used for selecting accessories for milling operations
- Identify types of rotary tables and describe their construction, applications and procedures for use
- Identify types of dividing heads and describe their characteristics and applications

F-14.06 Sets up workpiece on a conventional milling machine

- Describe considerations and procedures used to set up a workpiece
- Describe alignment procedures when setting up a workpiece
- Describe the procedures used to establish workpiece datums

F-14.07 selects conventional milling machine speeds and feeds

- Describe considerations used to determine speed, feed and depth of cut for milling machine operation
- Interpret tables and charts regarding speeds and feeds
- Calculate speed, feed and depth of cut

F-15 Operates conventional milling machines

F-15.01 Mills surfaces using a conventional milling machine

- Describe the procedures used to perform milling operations
- Describe considerations to determine speeds and feeds
- Identify cutting fluids and coolants and their uses
- Identify calculations required to determine amount of excess material
- Identify potential problems and describe their causes and solutions

F-15.02 Mills profiles and pockets using conventional milling machines

- Describe milling operations used to mill profiles and pockets
- Describe considerations to determine speeds and feeds
- Identify cutting fluids and coolants used
- Describe the procedures used to set speeds and feeds
- Identify calculations required to determine amount of excess material
- Identify potential problems and describe their causes and solutions

F-15.03 Mills slots, grooves and keyways using a conventional milling machine

- Describe milling operations used to cut slots, grooves and keyways
- Describe considerations to determine speeds and feeds
- Identify cutting fluids and coolants used
- Describe the procedures used to set speeds and feeds
- Identify calculations required to determine amount of excess material
- Identify potential problems and describe their causes and solutions

F-15.04 Cuts gears and splines using conventional milling machines (indexing calculations)

- Explain the principles of gears and splines and their types and uses
- Describe procedures to measure gear teeth and splines
- Identify tooling used to cut gears and splines
- Identify machines and accessories used for cutting gears and splines
- Define terminology associated with gears and splines
- Identify calculations required to determine ratios for simple and compound gear trains
- Identify calculations required to determine gear and spline cutting requirements

F-15.05 Drills holes using a conventional milling machine

- Describe operations used to drill holes using a conventional mill
- Describe considerations to determine speeds and feeds when drilling holes in a conventional mill
- Identify cutting fluids and coolants used
- Describe the procedures used to set speeds and feeds
- Identify calculations required to determine amount of excess material
- Identify potential problems and describe their causes and solutions

F-15.06 Reams holes using a conventional milling machine

- Describe operations used to ream holes using a conventional mill
- Identify considerations to determine speeds and feeds when reaming holes in a conventional mill
- Identify reaming allowance
- Identify cutting fluids and coolants used
- Describe the procedures used to set speeds and feeds
- Identify calculations required to determine amount of excess material
- Identify potential problems and describe their causes and solutions
- Identify process to measure reamed hole

F-15.07 Cuts countersinks, counterbores, chamfers and spot faces using conventional milling machines

- Describe operations used to cut countersinks, counterbores, chamfers and spot faces using a conventional mill
- Describe considerations to determine speeds and feeds used to cut countersinks, counterbores, chamfers and spot faces using a conventional mill
- Identify cutting fluids and coolants used
- Describe the procedures used to set speeds and feeds

- Identify potential problems and describe their causes and solutions
- F-15.08 Performs tapping using a conventional milling machine
- Describe procedures used to tap holes using a conventional mill
 - Describe considerations to determine speeds and feeds when tapping holes in a conventional mill
 - Identify cutting fluids and coolants used
 - Describe the procedures used to set speeds and feeds
 - Identify potential problems and describe their causes and solutions
 - Identify tools and accessories and their procedures for use when tapping
 - Identify thread classifications and inspection equipment
- F-15.09 Bores holes using a conventional milling machine
- Describe procedures used to bore holes using a conventional mill
 - Describe considerations to determine speeds and feeds when boring holes in a conventional mill
 - Identify cutting fluids and coolants used
 - Describe the procedures used to set speeds and feeds
 - Identify tools and their procedure for use when performing boring procedures
 - Identify potential problems and describe their causes and solutions

Refurbishment

6 hours

- Demonstrate safe care and maintenance of equipment
- Disassemble gear box
- Analyze components
- Assemble gear box

RSOS topics covered in this section of training:

B-7 Refurbishes components

B-7.02 Analyzes components

- Describe procedures used to clean components
- Identify inspection equipment
- Knowledge of calculations required to measure components
- Describe procedures used to visually inspect components for defects
- Describe the procedure used to analyze and document findings according to specifications

B-7.03 Assembles components

- Describe procedures used to repair or replace components
- Identify types of materials used to fit and assemble components and describe their applications and procedures for use
- Describe procedures used to fit and assemble components
- Describe order of operations used to assemble components
- Calculate and measure component features

Level Two topics that may be taught in context:

Organizes work

Communication and mentoring

Hand processes

For details regarding the in-context topics, see page 44

Level Three**8 weeks****240 hours**

Power Transmission**24 hours**

- Identify power transmitting threads
- Measure power transmitting threads
- Classify keyed drives
- Apply tolerances to keys and key seats
- Identify splines
- Identify common shaft coupling arrangements
- Identify common types of clutches
- Identify types of gears

RSOS topics covered in this section of training:**A-4 Processes workpiece material****A-4.05 Performs quality control**

- Define terminology related to material testing
- Identify hazards and describe safe work practices pertaining to material testing
- Describe the purpose and applications of material testing
- Identify types of tests performed on materials and describe their applications
- Identify the machines and scales used for hardness testing and describe their associated procedures
- Define terminology associated with quality inspection
- Describe the procedures used to inspect workpieces
- Identify types of precision gauges used in quality inspection and describe their applications and procedures for use
- Identify types of precision measuring tools used in quality inspection and describe their applications and procedures for use
- Identify types of comparators and describe their applications and procedures for use
- Identify types of CMMs and describe their components, applications and procedures for use

F-15 Operates conventional milling machines**F-15.03 Mills slots, grooves and keyways using a conventional milling machine**

- Describe milling operations used to cut slots, grooves and keyways
- Describe considerations to determine speeds and feeds
- Identify cutting fluids and coolants used
- Describe the procedures used to set speeds and feeds
- Identify calculations required to determine amount of excess material
- Identify potential problems and describe their causes and solutions

F-15.04 Cuts gears and splines using a conventional milling machine

- Explain the principles of gears and splines and their types and uses
- Describe procedures to measure gear teeth and splines
- Identify tooling used to cut gears and splines
- Identify machines and accessories used for cutting gears and splines
- Define terminology associated with gears and splines
- Identify calculations required to determine ratios for simple and compound gear trains
- Identify calculations required to determine gear and spline cutting requirements

CNC Machining

56 hours

- Describe the 2 axis coordinate grid
- Describe key tool positions
- Describe basic CNC codes
- Describe tool offsets
- Set tool offsets on the CNC lathe
- Make a point sketch from a part drawing
- Manually compensate for tool radius
- Describe complex g-codes
- Write a part program for the CNC lathe using multiple repetitive cycles for roughing, finishing, and threading
- Program using CAM
- Machine a part using CAM

RSOS topics covered in this section of training:

H-18 Machines using computer numerical control (CNC) machines

H-18.01 Creates process documentation

- Define terminology associated with CNC machines
- Identify CNC control units and describe their purpose
- Interpret documentation pertaining to the machining of workpieces

H-18.02 Creates manual input program

- Identify types of programming codes and describe their applications
- Define the differences between centerline programming and cutter radius compensation (CRC) programming
- Identify reference points and their location
- Describe the procedures used to calculate speed, feed and depth of cuts
- Identify potential setup problems and describe their causes and solutions
- Identify the hazards and describe safe work practices pertaining to CNC machines

H-18.04 Optimizes program

- Identify types of programming codes and their applications
- Describe the procedures used to perform CNC programming

H-18.05 Creates 2D and 3D models

- Describe process to create geometry using CAD software
- Identify dimensioning tools in CAD software
- Identify datum used to obtain reference point for machining

H-18.06 Programs using CAM

- Identify cutting tools in CAM software
- Define types of CAM operations and tool paths
- Identify machine post processors in CAM software
- Identify hazards and describe safe work practices pertaining to CNC machines

H-19 Sets up CNC machines

H-19.01 Selects tooling and tool holders for CNC machines

- Define terminology associated with CNC machines and tooling
- Identify types of CNC machines and tooling, and describe their characteristics and applications
- Identify types of accessories and tool changers used with CNC machines and describe their applications
- Identify types of tool holders and work holding devices used with CNC machines and describe their applications
- Identify the hazards and describe safe work practices pertaining to CNC machines

H-19.02 Sets up tooling and tool holders on CNC machines

- Identify CNC axis and describe the relationship between them
- Identify CNC control units and describe their purpose
- Identify the hazards and describe safe work practices pertaining to CNC machines
- Describe the procedures used to set up tooling and tool holders on CNC machines
- Describe methods for determining tool offsets

H-19.03 Sets up workpiece on CNC machines

- Identify CNC control units and describe their purpose
- Describe the procedures used to set up workpieces in CNC machines
- Identify the hazards and describe safe work practices pertaining to CNC machines

H-19.04 Establishes work datum

- Describe the procedures used to touch off datum surfaces
- Describe the procedures used to input datum information
- Identify the hazards and describe safe work practices pertaining to CNC machines

H-20 Operates CNC machines

H-20.01 Adjusts offsets

- Describe the procedures used to operate CNC machines
- Describe the procedures used to adjust offsets
- Identify the hazards and describe safe work practices pertaining to CNC machines
- Calculate deviations from specifications

Trade Mathematics

16 hours

- Use mathematics in machine shop applications
- Use machine shop formulae
- Use trigonometric principles in a variety of machine shop formulae

This section of training exceeds the minimum sequencing as set out in the Machinist RSOS.

Technical Drawings and Blueprint Reading

16 hours

- Find data for machining of parts on engineering drawings
- Locate surfaces, features, and dimensions on combined sectional engineering drawings
- Identify surfaces, features and machining dimensions from auxiliary sectional engineering drawings
- Find machining data on detail sections and assembly drawings on engineering drawings
- Use various drawing commands in CAD drafting
- Use various editing commands in CAD drafting
- Create 2D and 3D models

RSOS topics covered in this section of training:

A-4 Processes workpiece material

A-4.07 Sketches part

- Identify types of sketches and their purpose
- Describe basic sketching techniques and types of views
- Identify dimensions used in creating sketches
- Describe how to interpret and extract information from parts to create a sketch

H-18 Machines using computer numerical control (CNC) machines

H-18.05 Creates 2D and 3D models

- Identify datum used to obtain reference point for machining
- Describe process to create geometry using CAD software
- Identify dimensioning tools in CAD software

Cutting Tool Technology

20 hours

- Discuss cutting tool materials
- Select cutting tool geometries
- Identify common causes of tool failure
- Discuss hole making tools
- Discuss surface texture
- Optimize metal removal rates

RSOS topics covered in this section of training:

A-5 Maintains machines, tooling and inspection equipment

A-5.05 Troubleshoots equipment

- Identify machine operating procedures
- Identify troubleshooting techniques

Machine Tools (Theory)

18 hours

- Explain conventional lathe setups and operations
- Explain conventional milling machine setups and operations
- Explain horizontal boring mill (HBM) setups and operations
- Explain precision grinder setups and operations

Machine Tools (Shop)

90 hours

- Demonstrate safe care and maintenance of equipment
- Perform conventional lathe setups and operations
- Perform conventional milling machine setups and operations
- Perform horizontal boring mill (HBM) setups and operations
- Perform precision grinder setups and operations
- Perform materials testing
- Record quality assurance measurements

RSOS topics covered in this section of training:

F-14 Machines using conventional milling machines

F-14.02 Plans operation of milling machines

- Identify types of conventional milling machines accessories and attachments and describe their purpose
- Identify types of tool holding devices and describe their applications
- Identify types of work holding devices and describe their applications
- Identify types of cutting tools and describe their applications
- Identify hazards and describe safe work practices pertaining to conventional milling machines
- Identify potential setup problems and describe their causes and solutions

- Identify considerations and requirements for selecting tools and accessories for milling operations
- Describe procedures used to set up conventional milling machines to perform basic milling operations
- Describe the procedures used to perform milling operations on conventional milling machines
- F-14.03 Sets up work holding devices for conventional milling machines
 - Identify hazards and describe safe work practices pertaining to conventional milling machines
 - Describe the procedures used to align conventional milling machine heads and table
 - Describe the procedures used to set up conventional milling machines to perform milling operations
 - Describe the procedures used to align workpieces
 - Identify types of work holding devices
 - Describe the procedures used to secure and align work holding devices
- F-14.04 Sets up tooling for conventional milling machines
 - Describe procedures used to install tooling and tool holding devices
 - Identify considerations and requirements used for selecting tooling and tool holding devices
- F-14.05 Sets up milling accessories
 - Identify considerations and requirements used for selecting accessories
 - Identify types of rotary tables and describe their construction, applications and procedures for use
 - Identify types of dividing heads and their characteristics
- F-14.06 Sets up workpiece on a conventional milling machine
 - Describe workpiece setup procedures
 - Describe procedures used to align a workpiece
 - Describe procedures used to establish workpiece datums
- F-14.07 Selects conventional milling machine speeds and feeds
 - Describe considerations used to determine speed, feed and depth of cut
 - Interpret table and charts of speeds and feeds
 - Calculate speed, feed, and depth of cut

F-15 Operates conventional milling machines

- F-15.01 Mills surfaces using a conventional milling machine
 - Describe the procedures used to perform milling operations
 - Describe considerations to determine speeds and feeds
 - Identify cutting fluids and coolants and their uses
 - Identify calculations required to determine amount of excess material
 - Identify potential problems and describe their causes and solutions
- F-15.02 Mills profiles and pockets using a conventional milling machine
 - Describe milling operations used to mill profiles and pockets
 - Describe considerations to determine speeds and feeds
 - Identify cutting fluids and coolants used
 - Describe the procedures used to set speeds and feeds
 - Identify calculations required to determine amount of excess material
 - Identify potential problems and describe their causes and solutions
- F-15.03 Mills slots, grooves and keyways using a conventional milling machine
 - Describe milling operations used to cut slots, grooves and keyways
 - Describe considerations to determine speeds and feeds
 - Identify cutting fluids and coolants used
 - Describe the procedures used to set speeds and feeds
 - Identify calculations required to determine amount of excess material
 - Identify potential problems and describe their causes and solutions

- F-15.04 Cuts gears and splines using a conventional milling machine
 - Explain the principles of gears and splines and their types and uses
 - Describe procedures to measure gear teeth and splines
 - Identify tooling used to cut gears and splines
 - Identify machines and accessories used for cutting gears and splines
 - Define terminology associated with gears and splines
 - Identify calculations required to determine ratios for simple and compound gear trains
 - Identify calculations required to determine gear and spline cutting requirements
- F-15.09 Bore holes using a conventional milling machine
 - Describe procedures used to bore holes using a conventional mill
 - Describe considerations to determine speeds and feeds when boring holes in a conventional mill
 - Identify cutting fluids and coolants used
 - Describe the procedures used to set speeds and feeds
 - Identify tools and their procedure for use when performing boring procedures
 - Identify potential problems and describe their causes and solutions

G-16 Machines using precision grinding machines

- G-16.01 Selects precision grinding machine types
 - Define terminology associated with grinding machines
 - Identify types of grinding machines and accessories and describe their applications
 - Interpret documentation pertaining to the material to be ground
 - Describe grinding operations to be performed
- G-16.02 Plans operation of grinding machines
 - Define terminology associated with grinding machines
 - Identify types of grinding machines and accessories and describe their applications
 - Interpret documentation pertaining to the material to be ground
 - Identify types of work holding devices and describe their applications and maintenance
 - Identify sequence of grinding operations
- G-16.03 Sets up work holding devices for precision grinding machines
 - Describe procedures used to set up grinding machines and accessories
 - Identify types of work holding devices and describe their applications and maintenance
 - Describe workpiece alignment procedures
 - Identify potential setup problems, their cause and solutions
- G-16.04 Mounts grinding wheel
 - Describe procedures used to set up and mount wheels on grinding machines
 - Identify types of wheel dressers and their applications
 - Describe procedures used to true and dress grinding wheels
 - Describe procedure to balance grinding wheels
- G-16.05 Sets up grinding accessories
 - Identify types of accessories used for grinding operations
 - Describe procedures used to set up grinding machines and accessories
 - Describe inspection procedures used when using grinding machines
- G-16.06 Sets up workpiece on precision grinding machines
 - Describe procedures used to set up workpieces on grinders using accessories
 - Describe procedures used to verify alignment of workpieces
- G-16.07 Selects precision grinding machines speeds and feeds
 - Describe the factors used to determine feed and depth of cut for grinding operations
 - Describe calculations used to determine speed

G-17 Operates precision grinding machines

G-17.02 Grinds profiles

- Describe the procedures used to calculate the amount of excess material
- Identify types of grinding wheels and describe their characteristics and applications
- Identify types of wheel dressers and describe their applications and procedures for use
- Identify considerations and requirements for selecting a grinding wheel for profile grinding
- Describe procedures used to grind profiles
- Identify troubleshooting techniques for profile grinding operations

G-17.03 Grinds internal and external cylindrical and tapered surfaces

- Describe procedures used to align workpieces
- Describe procedures used to perform calculations to determine amount of excess material
- Describe the procedures used to perform cylindrical grinding operations
- Describe the procedures used to calculate feed and depth of cut
- Identify techniques used to troubleshoot cylindrical grinding operations and their associated procedures
- Describe procedures used to inspect, maintain and store cylindrical grinding wheels
- Identify hazards and describe safe work practices pertaining to cylindrical grinding
- Identify types of cylindrical grinding wheels and describe their characteristics and applications
- Identify types of wheel dressers and describe their applications
- Describe the procedures used to true and dress grinding wheels
- Identify the considerations and requirements for selecting a grinding wheel for cylindrical grinding operations
- Describe the procedures used to mount and balance cylindrical grinding wheels

G-17.04 Grinds tools and cutters

- Identify types of cutting tools and cutter grinding wheels and describe their applications
- Describe procedures used to align cutting tools
- Identify requirements when selecting a grinding wheel for tool and cutter grinding
- Identify types of wheel dressers and describe their applications
- Describe the procedures used to true and dress grinding wheels
- Describe procedures used to inspect, maintain and store tool and cutter wheels

G-17.05 Finishes holes using a honing machine

- Identify types of honing machines, their setup and maintenance
- Identify types of tooling required for honing
- Identify honing techniques and describe their procedures
- Identify potential problems and describe their causes and solutions

Level Three topics that may be taught in context:

Organizes work

Communication and mentoring

Component refurbishment

For details regarding the in-context topics, see page 44

Level Four**6 weeks****180 hours**

CNC Machining**56 hours**

- Set tool offsets
- Calculate coordinates
- Construct a CNC program
- Run CNC program
- Demonstrate mill programming
- Program a 3-axis mill using CAM
- Machine a part using CAM

RSOS topics covered in this section of training:**H-18 Machines using computer numerical control (CNC) machines****H-18.04 Optimizes program**

- Identify types of programming codes and their applications
- Describe the procedures used to perform CNC programming

H-18.05 Creates 2D and 3D models

- Describe process to create geometry using CAD software
- Identify dimensioning tools in CAD software
- Identify datum used to obtain reference point for machining

H-18.06 Programs using CAM

- Identify cutting tools in CAM software
- Define types of CAM operations and tool paths
- Identify machine post processors in CAM software
- Identify hazards and describe safe work practices pertaining to CNC machines

H-19 Sets up CNC machines**H-19.03 Sets up workpiece on CNC machines**

- Identify CNC control units and describe their purpose
- Describe the procedures used to set up workpieces in CNC machines
- Identify the hazards and describe safe work practices pertaining to CNC machines

H-20 Operates CNC machines**H-20.01 Adjusts offsets**

- Describe the procedures used to operate CNC machines
- Describe the procedures used to adjust offsets
- Identify the hazards and describe safe work practices pertaining to CNC machines
- Calculate deviations from specifications

Material Select / Heat Treatment**12 hours**

- Discuss properties of materials
- Discuss materials testing
- Discuss properties of tool steels
- Discuss heat treatment of steel

RSOS topics covered in this section of training:**A-4 Processes workpiece material****A-4.04 Performs heat treatment**

- Define terminology associated with heat treatment
- Identify hazards and describe safe work practices pertaining to heat treatment
- Identify methods used to determine the carbon content of steels
- Identify heat treatment processes and describe their applications

- Describe the procedures used to determine properties of metals
- Identify and interpret reference data used in heat treatment
- Identify methods used for quenching steel and describe the properties of the steel produced by each

A-4.05 Performs quality control of workpiece

- Define terminology related to material testing
- Identify hazards and describe safe work practices pertaining to material testing
- Describe the purpose and applications of material testing
- Identify types of tests performed on materials and describe their applications
- Identify the machines and scales used for hardness testing and describe their associated procedures
- Define terminology associated with quality inspection
- Describe the procedures used to inspect workpieces
- Identify types of precision gauges used in quality inspection and describe their applications and procedures for use
- Identify types of precision measuring tools used in quality inspection and describe their applications and procedures for use
- Identify types of comparators and describe their applications and procedures for use
- Identify types of CMMs and describe their components, applications and procedures for use

Advanced Machine Tool (Theory)

35 hours

- Discuss dividing head operations
- Explain bevel gear milling
- Identify common cam terminology
- Discuss interference fits
- Interpret standard fits
- Explain helical milling

Advanced Machine Tool (Shop)

77 hours

- Perform heat treatment operations on tool steel
- Inspect hardened tool steel
- Plan jobs
- Perform precision grinding operations
- Perform lathe operations
- Perform milling and indexing operations

RSOS topics covered in this section of training:

F-14 Machines using conventional milling machines

F-14.05 Sets up milling accessories

- Identify considerations and requirements used for selecting accessories
- Identify types of rotary tables and describe their construction, applications and procedures for use
- Identify types of dividing heads and their characteristics

F-15 Operates conventional milling machines

F-15.04 Cuts gears and splines using a conventional milling machine

- Explain the principles of gears and splines and their types and uses
- Describe procedures to measure gear teeth and splines
- Identify tooling used to cut gears and splines
- Identify machines and accessories used for cutting gears and splines
- Define terminology associated with gears and splines
- Identify calculations required to determine ratios for simple and compound gear trains
- Identify calculations required to determine gear and spline cutting requirements

H-18 Performs CNC programming

H-18.04 Optimizes program

- Identify types of programming codes and their applications
- Describe the procedures used to perform CNC programming

H-18.05 Creates 2D and 3D models

- Describe process to create geometry using CAD software
- Identify dimensioning tools in CAD software
- Identify datum used to obtain reference point for machining

H-18.06 Programs using CAM

- Identify cutting tools in CAM software
- Define types of CAM operations and tool paths
- Identify machine post processors in CAM software
- Identify hazards and describe safe work practices pertaining to CNC machines

H-19 Sets up CNC machines

H-19.03 sets up workpiece on CNC machines

- Identify CNC control units and describe their purpose
- Describe the procedures used to set up workpieces in CNC machines
- Identify the hazards and describe safe work practices pertaining to CNC machines

H-20 Operates CNC machines

H-20.01 adjusts offsets

- Describe the procedures used to operate CNC machines
- Describe the procedures used to adjust offsets
- Identify the hazards and describe safe work practices pertaining to CNC machines
- Calculate deviations from specifications

Level Four topics that may be taught in context:

Organizes work

Communication and mentoring

Machine and tool maintenance

Component refurbishment

For details regarding the in-context topics, see page 44

In Context Topics

In context means learning that has already taken place and is being applied to the applicable task. Learning outcomes for in context topics are accomplished in other topics in that level.

Organizes work

A-2 Organizes work

A-2.01 Interprets documentation

- Define terminology associated with drawings
- Identify types of drawings and sketches and describe their purpose
- Interpret and extract information from drawing features
- Identify types of reference materials and their use
- Identify information from reference materials and determine the calculations

A-2.02 Plans sequence of operations

- Identify sources of information relevant to job planning
- Identify the considerations and requirements for selecting equipment and tooling to complete specified jobs
- Determine amount of materials required to complete specified jobs

Communication and mentoring

A-3 Use communication and mentoring techniques

A-3.01 Uses communication techniques

- Define terminology used in the trade
- Describe the importance of using effective verbal and non-verbal communication
- Identify sources of information to effectively communicate
- Identify learning styles and describe effective listening and speaking skills
- Identify personal responsibilities and attitudes that contribute to success on the job
- Identify the value of diversity in the workplace
- Identify communication that constitutes harassment and discrimination

A-3.02 Uses mentoring techniques

- Describe the importance of individual experience
- Describe the shared responsibilities for workplace learning
- Describe how a person's learning preference can relate to learning new skills
- Identify the importance of different types of skills within the workplace
- Identify essential skills and describe their importance in the workplace
- Identify strategies to assist in learning a new skill
- Describe teaching skills
- Identify how to choose a good time to present a lesson
- Explain the importance of providing feedback
- Identify methods of assessing progress

Machine and tooling maintenance

A-5 Maintains Machines, Tooling and Inspection Equipment

A-5.01 Cleans machines

- Identify cleaning agents, their applications, and procedures for use

A-5.02 Lubricates machines

- Describe the procedure used to select, apply and maintain lubricants
- Describe the procedures used to handle, store and dispose of lubricants

A-5.03 Sharpens tooling

- Identify types of cutting tools and describe their applications
- Demonstrate knowledge of tool geometry
- Identify hazards and describe safe work practices

A-5.04 Applies cutting fluid and coolant

- Define terminology associated with cutting fluids and coolants
- Identify hazards and describe safe work practices pertaining to cutting fluids and coolants
- Describe regulations pertaining to the use of cutting fluids and coolants

A-5.05 Troubleshoots Equipment

- Identify machine operating procedures
- Identify troubleshooting techniques

A-5.06 Maintains machine alignment

- Describe maintenance and alignment of machines

A-5.07 Maintains inspection equipment

- Describe procedures used to inspect, maintain and store precision measuring equipment
- Identify types of precision measuring equipment used in quality inspection and describe their applications and procedures for use

Hand processes

B-6 Performs Hand Processes

B-6.01 Performs layout

- Describe basic layout and its application
- Identify basic layout tools, their applications, maintenance, and procedures for use
- Describe the procedures used for precision layout and its applications
- Identify precision layout tools, their applications, maintenance, and procedures for use

B-6.02 Saws workpiece

- Describe safe work practices and procedures used to saw a workpiece
- Identify hand saws, their applications, maintenance and procedures for use
- Identify types of sawing operations and their procedures
- Identify types of saw blades, their parameters applications and installation procedures

B-6.03 Files workpiece

- Describe safe work practices and procedures for filing a workpiece
- Identify filing tools, their applications, maintenance and procedures for use

B-6.04 Performs hole making operations

- Identify drilling, reaming and countersink operations
- Describe procedures used for spotting and drilling work
- Identify types of drills and hand reamers and procedures for use

B-6.05 Performs threading operations

- Describe safe work practices and procedures used when performing threading operations
- Identify types of threads and their applications
- Describe procedures used to measure and gauge threads

B-6.06 Installs thread inserts

- Describe safe work practices and procedures used when installing threaded inserts
- Describe procedures used to measure and gauge threads
- Identify types of thread inserts and describe their applications and installation procedures
- Identify types of thread failures and their causes
- Describe procedure to remove a broken tap

B-6.07 Broaches workpiece

- Describe safe work practices and procedures to broach a workpiece
- Identify broaches and broaching equipment, their applications, set up and procedures for use
- Describe the procedure to hand broach a keyway

B-6.08 Performs pressing operations

- Describe safe work practices and procedures when performing pressing operations
- Describe the procedures used to set up and operate press equipment
- Describe press equipment applications, maintenance and procedures for use

B-6.09 Forms workpiece

- Describes safe work practices and procedures when forming a workpiece
- Identify heating processes used in machining operations and their applications
- Describe bending processes used in machining operations and their applications
- Identify types of bending equipment and describe their applications

Component refurbishment

B-7 Refurbishes Components

B-7.01 Disassembles components

- Identify procedures used for refurbishing components
- Identify types of fits, clearances, tolerances and serviceable limits
- Interpret documentation pertaining to refurbishing components

B-7.02 Analyzes components

- Identify procedures used to analyze components
- Describe the calculations required to measure components
- Describe procedures used to prepare documentation

B-7.03 Assembles components

- Describe the procedures used to repair or replace mechanical components
- Describe procedures used to fit and assemble components
- Identify calculations required to measure components
- Describe order of operations used to assemble components

APPENDIX A: POST HARMONIZATION TRAINING PROFILE CHART

This chart which outlines the finalized model for SATCC technical training sequencing with a cross reference to the Harmonized apprenticeship technical training sequencing, at the topic level.

Implementation for harmonization took place progressively. Level one was implemented in 2019/20, level two 2020/2021, level three and four in 2021/2022.

SATCC Level One	Transcript Code	Hours	Pan-Canadian Harmonized Level One
Technical Drawing and Blueprint	DRFT 188	20	Organizes Work
Power Saws	MACH 177	6	Power Saw Setup
			Power Saw Operation
Lathes	MACH 175 (Theory)	12	Conventional Lathe Setup
	MACH 176 (Shop)	54	Conventional Lathe Operation
Milling	MACH 189	24	Conventional Milling Machine (Introduction) Machine and Tooling Maintenance
Materials and Measurement	MACH 192	8	Workpiece Material Processing
Drilling	MACH 178 (Theory)	6	Drill Press Setup
	MACH 193 (Shop)	8	Drill Press Operation
Safety and Basic Shop Mechanics	ME 183	24	Safety-Related Tasks
Technical Communication for Trades	TCOM 109	12	Communication and Mentoring Techniques
Benchwork	TOOL 173 (Theory)	14	Processes Workpiece Material
	TOOL 174 (Shop)	34	Hand Processes Components (Introduction)
Trade Mathematics (Exceed)	MATH 179	18	Trade math (In-Context)
		240	

SATCC Level Two	Transcript Code	Hours	Pan-Canadian Harmonized Level Two
			Organizes Work (In-Context)
			Communication and Mentoring (In-Context)
			Hand Processes (In-Context)
Technical Drawing and Blueprint Reading	DRFT 283	24	CNC Programming
Computer Numerical Control Operation and Programming	MACH 283	24	CNC Machine Setup
			CNC Machine Operation
Materials/Heat Treatment	MACH 285	15	Workpiece Material Processing
Precision Grinding	MACH 290 (Theory)	12	Precision Grinding Machine Setup
	MACH 291 (Shop)	14	Precision Grinding Machine Operation Safety-Related Tasks
Lathe	MACH 292 (Theory)	15	Conventional Lathe Setup
	MACH 293 (Shop)	42	Conventional Lather Operation Machine and Tooling Maintenance
Milling	MACH 294 (Theory)	20	Conventional Milling Machine Setup
	MACH 295 (Shop)	52	Conventional Milling Machine Operation Machine and Tooling Maintenance
Refurbishment	MACH 296	6	Component Refurbishment
Mathematics (Exceed)	MATH 258	16	Trade math (In-Context)
		240	

SATCC Level Three	Transcript Code	Hours	Pan-Canadian Harmonized Level Three
			Organizes Work (In-Context)
			Communication and Mentoring (In-Context)
			Component Refurbishment (In-Context)
Power Transmission	MACH 383	24	Conventional Milling Machine Operation
CNC Machining	MACH 386	56	CNC Machine Setup
			CNC Machine Operation
Technical Drawing and Blueprint Reading	PRNT 385	16	CNC Programming
Cutting Tool Technology	TOOL 381	20	Machine and Tooling Maintenance
Machine Tools	TOOL 383 (Theory)	18	Precision Grinding Machine Setup
	TOOL 384 (Shop)	90	Precision Grinding Machine Operation Safety-Related Tasks
Mathematics (Exceed)	MATH 258	16	Trade math (In-Context)
		240	

SATCC Level Four	Transcript Code	Hours	Pan-Canadian Harmonized Level Four
			Organizes Work (In-Context)
			Communication and Mentoring (In-Context)
			Machine and Tooling Maintenance (In-context)
			Component Refurbishment (In-Context)
CNC Machining	MACH 483	56	CNC Programming
			CNC Machine Shop
			CNC Machine Operation
Material Select/Heat Treatment	MATH 481	12	Workpiece Material Processing
Advanced Machine Tool (Theory)	TOOL 482	35	Conventional Milling Machine Setup
Advanced Machine Tool (Shop)	TOOL 484	77	Conventional Milling Machine Operation Safety-Related Tasks
		180	

Exceed Topics

Throughout this guide to course content there are topics which exceed the minimum scope of work as set out in the Machinist RSOS. Industry in Saskatchewan has deemed certain topics to fall within the scope of work of the Machinist trade in Saskatchewan and therefore require technical training to cover these topics.