Saskatchewan Apprenticeship and Trade Certification Commission

Machinist

On-the-Job Training Guide

2019

Online: www.saskapprenticeship.ca

Recognition:
To promote transparency and consistency, portions of 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 ON-THE-JOB TRAINING GUIDE

To facilitate understanding of the occupation, this on-the-job training guide 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.

Harmonization: a brief description on the pan-Canadian Harmonization Initiative for the Machinist 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.

On-the-Job and In-school Training Content for the Machinist Trade: a chart which outlines on-the-job examples for apprentices to achieve relevant work experience to prepare for topics of technical training.

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 important at all times. 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

It is the employer's or journeyperson's responsibility to supervise an apprentice's practical skills development until a satisfactory level of proficiency has been reached.

EMPLOYER TRAINING RESPONSIBILITY

- introduce the apprentice to daily practice in approved safety procedures
- provide guided, hands-on, practical experience in the operation of machine tools and equipment
- where possible, expose the apprentice to new technology in the Machinist trade.

Employers should make every effort to expose their apprentices to work experience in as many areas of the trade as possible.

In the On-the-Job Training Guide, in-school instruction is listed first; on-the-job suggestions to help employers assist the apprentice to prepare for in-school training are listed next.

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

Entrance Requirements for Apprenticeship Training

Your grade twelve transcript (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 journeyperson 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 Level❶	**Science Credit** at Grade Level
Machinist	Grade 11	Grade 10

❶ - (One of the following) WA – Workplace and Apprenticeship; or F – Foundations; or P – Pre-calculus, or a Math at the indicated grade level (Modified and General Math credits are not acceptable).

*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.

For information about high school curriculum, including Math and Science course names, please see: http://www.curriculum.gov.sk.ca/#

Individuals not meeting the entrance requirements will be subject to an assessment and any required training

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.

HARMONIZATION

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 will take place progressively. Level one to be implemented in 2019/2020, level two 2020/2021, level three 2021/2022, and level four in 2022/2023.

MACHINIST TASK MATRIX CHART

This chart outlines the major work activities, tasks and sub-tasks from the 2018 Machinist Red Seal Occupational Standard. 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. The Task Matrix Chart will be updated every year until Harmonization implementation is complete. Implementation for harmonization will take place progressively. Level one to be implemented in 2019/2020, level two 2020/2021, level three 2021/2022, and level four in 2022/2023.

A - PERFORMS COMMON OCCUPATIONAL SKILLS

Task A-1 **Performs safety-related tasks**	**1.01 Maintains safe work environment** **1**	**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**	**4.02 Uses hoisting, lifting and rigging equipment** **1**	**4.03 Marks workpiece for identification** **1**
	4.04 Performs heat treatment	**4.05 Performs quality control of workpiece** **1**	**4.06 Deburrs workpiece** **1**
	4.07 Sketches parts **1**		

Task A-5 **Maintains machines, tooling and inspection equipment**	**5.01 Cleans machines** **1**	**5.02 Lubricates machines** **1**	**5.03 Sharpens tooling** **1**
	5.04 Applies cutting fluid and coolant **1**	**5.05 Troubleshoots equipment** **1**	**5.06 Maintains machine alignment** **1**
	5.07 Maintains inspection equipment **1**		

B - PERFORMS BENCHWORK

Task B-6 **Performs hand processes**	**6.01 Performs layout** **1**	**6.02 Saws workpiece** **1**	**6.03 Files workpiece** **1**
	6.04 Performs hole making operations **1**	**6.05 Performs threading operations** **1**	**6.06 Installs thread inserts** **1**
	6.07 Broaches workpiece **1**	**6.08 Performs pressing operations** **1**	**6.09 Forms workpiece** **1**
	6.10 Finishes workpiece **1**		
Task B-7 Refurbishes components	**7.01 Disassembles components** **1**	**7.02 Analyzes components** **1**	**7.03 Assembles components**

C – MACHINES USING POWER SAWS

Task C-8 **Sets up power saws**	**8.01 Selects power saw types** 1	**8.02 Selects saw blades** 1	**8.03 Installs saw blades** 1
	8.04 Selects power saw speeds and feeds 1	**8.05 Makes power saw adjustments** 1	**8.06 Sets up workpiece on power saw** 1
Task C-9 **Operates power saws**	**9.01 Saws straight and angle cuts** 1	**9.02 Cuts irregular shapes** 1	

D – MACHINES USING DRILL PRESSES

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**	**12.03 Sets up work holding devices for conventional lathes** **1**
	12.04 Sets up tooling for conventional lathes **1**	**12.05 Sets up conventional lathe accessories** **1**	**12.06 Sets up workpiece on conventional lathe** **1**
	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**	**13.03 Drills using a conventional lathe** **1**
	13.04 Bores holes using a conventional lathe **1**	**13.05 Reams holes using a conventional lathe** **1**	**13.06 Turns tapers using a conventional lathe** **1**
	13.07 Knurls using a conventional lathe **1**	**13.08 Cuts grooves using a conventional lathe** **1**	**13.09 Cuts threads using a conventional lathe** **1**
	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**	**14.02 Plans operation of milling machines**	**14.03 Sets up work holding devices for conventional milling machines**
	14.04 Sets up tooling for conventional milling machines **1**	**14.05 Sets up milling accessories**	**14.06 Sets up workpiece on a conventional milling machine**
	14.07 Selects conventional milling machine speeds and feeds		
Task F-15 **Operates conventional milling machines**	**15.01 Mills surfaces using a conventional milling machine**	**15.02 Mills profiles and pockets using a conventional milling machine**	**15.03 Mills slots, grooves and keyways using a conventional milling machine**
	15.04 Cuts gears and splines using a conventional milling machine	**15.05 Drills holes using a conventional milling machine**	**15.06 Reams holes using a conventional milling machine**
	15.07 Cuts countersinks, counterbores, chamfers and spot faces using a conventional milling machine	**15.08 Performs tapping using a conventional milling machine**	**15.09 Bores holes using a conventional milling machine**

G – MACHINES USING PRECISION GRINDING MACHINES

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

ON-THE-JOB AND IN-SCHOOL TRAINING CONTENT FOR THE MACHINIST TRADE

This chart outlines on-the-job examples for apprentices to achieve relevant work experience to prepare for the topics of technical training. Topics of technical training are provided with the associated learning outcomes.

Level One — 8 weeks — 240 hours

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

Mentors can assist the apprentice to prepare for this section of technical training by:

- *assisting in drawing interpretation*

Power Saws — 6 hours

- demonstrate safe care and maintenance of equipment
- identify sawing machines
- use power saws

Mentors can assist the apprentice to prepare for this section of technical training by:

- *introducing the apprentice to blade selection and usage, changing blades, speeds and feeds when using cutoff machines*

Drilling Machine – Theory — 6 hours

- demonstrate safe care and maintenance of equipment
- identify drilling machines
- identify drilling tools
- identify work holding devices and methods
- identify speeds and feeds for drilling

Drilling Machine– Shop — 8 hours

- identify drilling machines
- identify drilling tools
- operate drilling machines
- use countersinking and counterboring tools
- use reamers
- identify power tapping and boring operations
- sharpen twist drills
- describe cutting fluids

Mentors can assist the apprentice to prepare for this section of technical training by:

- *explaining how the machine works*
- *providing information on speeds, work-holding practices and machine safety*

Lathes – Theory — 12 hours

- identify types of turning machines
- identify cutting tools
- identify work holding devices
- identify steady rests and follower rests
- calculate taper information
- identify taper cutting processes
- calculate thread dimensions
- prepare job plans

Lathes – Shop — 54 hours

- grind lathe tools
- perform external turning
- perform internal turning
- perform grooving and parting
- use steady rest and follow rest
- perform knurling
- cut basic 60-degree screw threads
- perform taper turning
- demonstrate safe care and maintenance of equipment
- perform drilling and reaming

Mentors can assist the apprentice to prepare for this section of technical training by:

- *ensuring familiarization with the safe and proper operation of the lathe*
- *providing a hands-on opportunity to use the lathe, with exposure to jobs that introduce basic lathe operation, including some or all of the operations listed above*

Milling — 24 hours

- identify vertical milling machines
- identify basic vertical milling machine cutting tools
- identify work holding devices and methods
- perform basic vertical milling machine operations
- demonstrate safe care and maintenance of equipment

Mentors can assist the apprentice to prepare for this section of technical training by:

- *ensuring that the apprentice has a basic familiarization with the machines*

Measure, Materials and Cutting Fluid — 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

Mentors can assist the apprentice to prepare for this section of technical training by:

- *providing training in the safe and efficient use of pedestal grinders, including wheel identification and wheel selection for material to be ground*
- *assisting the apprentice in the identification of cutting fluids, mixing procedures, and safety practice*
- *introducing the apprentice to blade selection and usage, changing blades and speeds and feeds when using cutoff machines*

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

Mentors can assist the apprentice to prepare for this section of technical training by:

- *ensuring the proper use of WHMIS and Safety Data Sheets*
- *identifying hazardous materials in the shop*
- *providing instruction in basic rigging and load lifting including chains, hooks and knots*
- *providing instruction in ladder safety*

Technical Communication for Trades — 12 hours

- solve common grammatical errors to meet technical writing requirements
- write shop documentation
- demonstrate knowledge of effective workplace communications

Mentors can assist the apprentice to prepare for this section of technical training by:

- *explain safety hazards found in the workplace*
- *provide necessary PPE and explain how to use it properly*
- *offer training such as fall arrest and mobile equipment training as per OH&S requirements*
- *involve apprentice in hazard assessments*

Benchwork (Theory) — 14 hours

- identify mechanical hardware
- calculate hole spacing
- calculate tap drill size
- select grinding wheels

Benchwork (Shop) — 34 hours

- use semi precision layout tools
- use precision layout tools
- use non-cutting hand tools
- operate presses and pullers
- use metal cutting hand tools
- use thread cutting tools
- use power tools

Mentors can assist the apprentice to prepare for this section of technical training by:

- *introducing the use of calipers, micrometers, and other shop precision measuring tools*
- *ensuring familiarization with basic layout tools such as the centre punch, scribers and combination square*
- *demonstrating the physical properties of metals, such as weight and magnetism*

Trade Mathematics **18 hours**

- use basic mathematics
- convert between imperial and metric systems
- use basic algebra
- use basic geometry and trigonometry

Mentors can assist the apprentice to prepare for this section of technical training by:

- *ensuring that the metric and imperial graduations on measuring tools and instruments are fully understood*
- *requiring the repetitive use of the math required to interpret blueprints and calculate quantities using fractions, decimals, percentages, ratios, perimeters, volumes and areas by hand and using calculators*
- *teaching the 3-4-5 method of squaring and relating this to the Pythagorean theorem*

Level Two 8 weeks 240 hours

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

Mentors can assist the apprentice to prepare for this section of technical training by:

- *exposing the apprentice to more complex drawings, including tolerance*
- *exposure to Auto CAD drafting where possible*

Computer Numerical Control Operation and Programming **24 hours**

- describe principles of CNC lathe programming
- operate a CNC lathe manually
- plan a job for the CNC lathe
- write CNC Code for roughing toolpath
- write CNC Code for finishing toolpath
- write CNC Code for threading toolpath
- operate simulated CNC control
- operate CNC machine

Mentors can assist the apprentice to prepare for this section of technical training by:

- *explaining the basic operation of CNC machines, as opposed to manual machines (when and where CNC machines are available)*

Materials/Heat Treatment **17 hours**

- perform hardness testing
- perform hardening and tempering
- describe annealing, normalizing, and stress relieving processes
- identify properties of materials

Mentors can assist the apprentice to prepare for this section of technical training by:

- *explaining oven operation and safety, quenching mediums and oxidation colours, (when and where possible)*
- *ensuring awareness of the properties that can be achieved by heat treatment of various steels*

Precision Grinding Machine (Theory) **12 hours**

- identify grinding machines
- identify grinding wheels
- select grinding wheels
- develop job plans for grinding projects

Precision Grinding Machine (Shop) **15 hours**

- perform grinding wheel service
- service precision grinder
- operate precision grinders
- apply grinding wheels

Mentors can assist the apprentice to prepare for this section of technical training by:

- *ensuring the apprentice has an understanding of safety issues*
- *introducing the operation of cylindrical and horizontal grinders (when and where available)*
- *explaining wheel selection, mounting, work holding devices, feeds and speeds, measurement and safety*

Lathes Operations (Theory) **15 hours**

- determine appropriate carbide tool selection
- calculate machining time
- calculate required taper information
- calculate required thread information

Lathes Operation (Shop) **42 hours**

- use work holding devices
- use lathe tooling
- perform basic lathe operations
- perform internal taper turning
- cut screw threads
- use lathe accessories
- services lathes

Mentors can assist the apprentice to prepare for this section of technical training by:

- *continuing to familiarize the apprentice with lathe operation*

Milling (Theory) **21 hours**

- identify milling machines applications
- identify vertical milling machine cutting tools
- select speeds and feeds for vertical milling machines
- select cutting tools holders for horizontal milling machines
- select speeds and feeds for horizontal milling machines
- determine machining time

Milling (Shop) **54 hours**

- perform set-ups on vertical milling machines
- perform vertical milling machine operations
- use an offset boring head
- perform set-ups on horizontal milling machines
- service horizontal milling machines
- perform horizontal milling machine operations
- operate indexing devices

Mentors can assist the apprentice to prepare for this section of technical training by:

- *introducing machine safety and the selection of tools, work holding devices, speeds and feeds*
- *illustrating the operation of attachments*

Mathematics **16 Hours**

- use basic algebra
- use basic geometry and trigonometry
- perform trade calculations

Mentors can assist the apprentice to prepare for this section of technical training by:

- *encouraging the repetitive use of math required for gear cutting equations, calculating proportions, trigonometric functions to solve triangles, to determine gear ratios indexing problems, co-ordinate locations and to determine thread measurements*

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 keyseats
- identify splines
- identify common shaft coupling arrangements
- identify common types of clutches
- identify types of gears

Mentors can assist the apprentice to prepare for this section of technical training by:

- *exposing apprentices to different gear types such as helical, spur, worm, crown and pinion, etc.*
- *discussing applications of these gears and the types of machines used to manufacture different gears*

CNC Machining **42 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

Mentors can assist the apprentice to prepare for this section of technical training by:

- *allowing the apprentice to develop programs and perform dry runs when and where possible*

Mathematics **16 hours**

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

Mentors can assist the apprentice to prepare for this section of technical training by:

- *encouraging the repetitive use of math required for use with fractions, decimals, formulae for cutting speed and spur gears, trigonometric functions, Pythagorean Theorem, chordal length, internal and external dovetail requirements and V-groove requirements*

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

Mentors can assist the apprentice to prepare for this section of technical training by:

- *exposing the apprentice to more complex drawings, including tolerance*
- *exposure to Auto CAD drafting where possible*

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

Mentors can assist the apprentice to prepare for this section of technical training by:

- *making available to the apprentice carbide suppliers catalogues*

Machine Tools (Theory) — 18 hours

- apply knowledge of milling cutter technology
- explain the construction of the horizontal boring mill
- explain horizontal boring mill operations
- plan horizontal boring mill (HDM) work
- explain abrasive technology

Machine Tools (Shop) — 90 hours

- operate engine lathe
- operate milling machine
- operate surface grinder
- operate horizontal boring mill

Mentors can assist the apprentice to prepare for this section of technical training by:

- *introducing information sources and manuals for advanced machine settings*
- *introducing advanced operations such as relief angles for cutters, and setting crowning on CNC roll grinder*
- *introducing macro programming on the CNC lathe, and spiral milling on the milling machine*

Level Four — 6 weeks — 180 hours

CNC Machining — 44 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

Mentors can assist the apprentice to prepare for this section of technical training by:

- *allowing the apprentice to develop programs and practice a dry run*
- *providing access to reference materials for CNC milling operations*

Material Select / Heat Treatment — 12 hours

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

Mentors can assist the apprentice to prepare for this section of technical training by:

- *explaining the selection of appropriate steels*
- *allowing observation and practice in heat treatment of steels*
- *explaining sources for information and assistance with heat treating processes when necessary*

Blueprint Reading — 12 hours

- find part shape and dimensional data on working assembly drawings
- use pictorial assembly drawings
- identify special features and adjacent parts on a drawing
- use print reading techniques on complex part drawings
- apply tolerance and finishes to technical drawings

Mentors can assist the apprentice to prepare for this section of technical training by:

- *continuing to expose the apprentice to blueprint reading and sketching*

Advanced Machine Tool (Theory) — 35 hours

- discuss dividing head operations
- explain bevel gear milling
- identify common cam nomenclature
- 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

Mentors can assist the apprentice to prepare for this section of technical training by:

- *continuing supervision and mentoring of apprentice's activity in precision part production*

Consider apprenticeship training as an investment in the future of your company and in the future of your workforce. Ultimately, skilled and certified workers increase your bottom line.

Get involved in the apprenticeship training system. Your commitment to training helps to maintain the integrity of the trade.

Do you have employees who have been working in the trade for a number of years but don't have trade certification? Contact your local apprenticeship office for details on how they might obtain the certification they need.

Saskatchewan Apprenticeship & Trade Certification Commission
2140 Hamilton St. Regina, SK S4P 2E3
Tel: (306) 787-2444
Fax: (306) 787-5105
Toll Free: 1-877-363-0536
Website: www.saskapprenticeship.ca

District Offices
Estevan (306) 637-4930
La Ronge (306) 425-4385
Moose Jaw (306) 694-3735
North Battleford (306) 446-7409
Prince Albert (306) 953-2632
Saskatoon (306) 933-8476
Swift Current (306) 778-8945
Yorkton (306) 786-1394