Atlantic Workforce Partnership

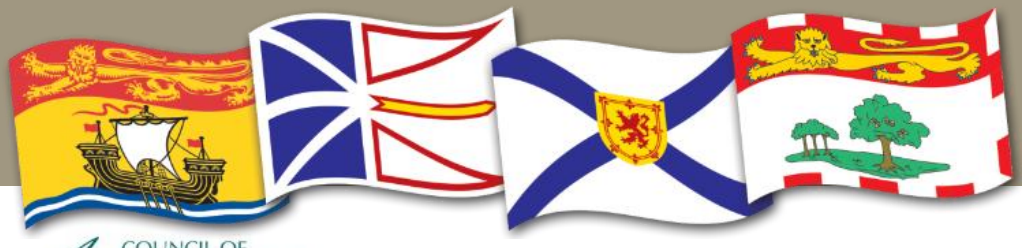
Curriculum Standard

MACHINIST

Version: 2023

Revised: N/A

Atlantic Apprenticeship



COUNCIL OF ATLANTIC PREMIERS
CONSEIL DES PREMIERS MINISTRES DE L'ATLANTIQUE

Employment and Social Development Canada
Emploi et Développement social Canada

Atlantic Apprenticeship Curriculum Standard

Machinist

Preface

This Atlantic Apprenticeship Curriculum Standard is intended to assist instructional staff in the design and delivery of technical, in-class training in support of the Machinist program.

This document contains all the technical training elements required to complete the Machinist apprenticeship program and has been developed based on the Red Seal Occupational Standard (RSOS). The RSOS can be found on the Red Seal website (www.red-seal.ca).

Implementation of this AACS for Apprenticeship training is outlined in the following table.

Level	Implementation Effective
Level 1	2023-2024
Level 2	2024-2025
Level 3	2025-2026
Level 4	2026-2027

**** The above implementation schedule was current at time of printing. Please confirm with Apprenticeship Staff prior to commencing training.**

Granting of credit or permission to challenge level examinations for pre-employment or pre-apprenticeship training for the Machinist trade will be based on the content outlined in this standard. Training providers must contact their provincial apprenticeship authority for more information on the process and requirements for determining eligibility for credit towards an apprenticeship program. Programs which have been deemed acceptable by the jurisdictional apprenticeship authority will be identified in a transfer credit matrix developed through the Atlantic Apprenticeship Harmonization Project.

Acknowledgements

The development of the Atlantic Apprenticeship Curriculum Standard (AACS) is an initiative of the Atlantic Apprenticeship Council's Atlantic Apprenticeship Harmonization Project (AAHP) through the Atlantic Workforce Partnership and Employment and Social Development Canada.

The Atlantic Apprenticeship Council wishes to acknowledge the contributions of the following industry and instructional representatives on the Atlantic Trade Advisory Committee (ATAC) who participated in the development of this document in September 2021.

Bob Doucet	New Brunswick
Andre Goguen	New Brunswick
Ron Justason	New Brunswick
Bert Sonier	New Brunswick
Adam Kerrivan	Newfoundland and Labrador
Darrell Evely	Newfoundland and Labrador
Tyler Russell	Newfoundland and Labrador
Wes Roma	Nova Scotia
Kelsey Gallant	Nova Scotia
Andrew Morash	Nova Scotia
Brett MacKay	Prince Edward Island
Ken Muirhead	Prince Edward Island

Advisory committees, industry representatives, instructors and apprenticeship staff provided valuable input to the development of this document. Without their dedication to quality apprenticeship training, this document could not have been produced.

Table of Contents

Preface 2

Acknowledgements 3

User Guide 5

Glossary of Terms 7

Essential Skills / Skills for Success 9

Level Structure 10

2018 RSOS Sub-Task to AACS Unit Comparison 12

Program Content

- Level 1 19
- Level 2 67
- Level 3 93
- Level 4 109

Feedback and Revisions 123

User Guide

Atlantic Apprenticeship Curriculum Standards (AACS) are developed based on Red Seal Occupational Standards (RSOS), National Occupational Analyses (NOA), Interprovincial Program Guides (IPG), if available, and extensive industry consultation. This document represents the minimum content to be delivered as part of the harmonized Atlantic program for the Machinist trade.

The AACSs are deliberately constructed for ease of use and flexibility of structure in order to adapt to all delivery requirements. They detail units of training, unit outcomes and objectives. They do not impose a delivery model or teaching format.

Jurisdictions and/or training providers will select and develop delivery materials and techniques that accommodate a variety of learning styles and delivery patterns. The AACS does not dictate study materials, textbooks or learning activities to be used in delivery.

The document includes a Level Structure to facilitate mobility for apprentices moving from one jurisdiction to another.

Structure

The content of the AACS is divided into units. Unit codes are used as a means of identification and are not intended to convey the order of delivery. It is at the discretion of the training provider to deliver the content in the required logical sequence of delivery within the level. Jurisdictions are free to deliver units one at a time or concurrently within a level, provided all outcomes are met.

The Learning Outcomes describe what the apprentice should know or be able to do at the end of training. Wording of the Learning Outcomes, “Demonstrate knowledge of…” acknowledges the broad spectrum of ways in which knowledge can be assessed, (i.e. practical projects, multiple choice testing, presentations, etc.) by instructional staff within the training.

Summative evaluation will be through a multiple-choice Level Examination administered through the jurisdictional Apprenticeship Authority.

User Guide (continued)

The 2018 Red Seal Occupational Standard (RSOS) to AACS comparison chart outlines the relation between each RSOS sub-task and the AACS units. RSOS references have also been detailed in each unit to highlight the direct link between the unit and relevant sub-tasks in the RSOS.

In the Level Structure section, the document identifies suggested hours in order to provide an indication of the time it should take to cover the material in the unit and is provided as a guide only. Adjustments to the suggested hours for each unit may be required to account for rate of apprentice learning, statutory holidays, storm days, registration and examinations. These suggested hours detailed for each unit will represent both theory and practical training (if relevant) and for consistency will be based on a standard of 30 hours per week of training. The true length of time required to deliver an outcome successfully will depend upon the learning activities and teaching methods used.

There are two types of objectives found in the AACS document: theoretical and practical.

The theoretical objectives represent the material that is to be covered during the technical training in order to convey the required knowledge to the apprentice.

The practical objectives represent the tasks or skills that have been deemed by the Atlantic Trade Advisory Committee as critical for the apprentices to receive exposure to while attending technical training. For example, exposure could be done through instructor demonstration or individual or group performance of the skill or task. Training providers are encouraged to use practical demonstration and opportunities for hands-on learning whenever possible. Practical objectives are not intended to replace the on-the-job training component of the apprentice's program or to mirror or replace the logbook skills that are to be taught and evaluated in the workplace.

Detailed content for each objective has not been developed. Where detail is required for clarity, content has been provided.

Glossary of Terms

These definitions are intended as a guide to how language is used in the document.

Adjust	To put in good working order; regulate; bring to a proper state or position.
Application	The use to which something is put and/or the circumstance in which an individual would use it.
Characteristic	A feature that helps to identify, tell apart or describe recognizably; a distinguishing mark or trait.
Component	A part that can be separated from or attached to a system; a segment or unit.
Define	To state the meaning of (a word, phrase, etc.).
Describe	To give a verbal account of; tell about in detail.
Explain	To make plain or clear; illustrate; rationalize.
Identify	To point out or name objectives or types.
Interpret	To translate information from observation, charts, tables, graphs and written material.
Maintain	To keep in a condition of good repair or efficiency.
Method	A means or manner of doing something that has procedures attached to it.
Operate	How an object works; to control or direct the functioning of.
Procedure	A prescribed series of steps taken to accomplish an end.
Purpose	The reason for which something exists or is done, made or used.

Glossary of Terms (continued)

Service	Routine inspection and replacement of worn or deteriorating parts. An act or business function provided to a customer in the course of an individual's profession (e.g., haircut).
Technique	Within a procedure, the manner in which technical skills are applied.
Test	v. To subject to a procedure that ascertains effectiveness, value, proper function or other quality. n. A way of examining something to determine its characteristics or properties, or to determine whether or not it is working correctly.

Essential Skills / Skills for Success

Through extensive research, the Government of Canada and other national and international agencies have identified and validated key essential skills for the workplace. These skills are used in nearly every job and at different levels of complexity. They provide the foundation for learning all other skills and enable people to evolve with their jobs and adapt to workplace change. In response to the evolving labour market and changing skill needs, in 2021 the Government of Canada launched a new **Skills for Success** model: QR code #1 or the web link below.
https://www.canada.ca/en/services/jobs/training/initiatives/skills-success/new-model.html

The Employment and Social Development Canada (ESDC) website provides information about the Skills for Success, including:

- a brief description of the skill;
- why the skill is important;
- tools to help you improve on each of the skills, and
- videos to help you improve on each of the skills.

This information can be found at: QR code #2 or web link below.
https://www.jobbank.gc.ca/essentialskills

Skills for Success training tools can be found at: QR code #3 or web link below.
https://www.canada.ca/en/services/jobs/training/initiatives/skills-success/tools.html

The development and improvement of these Skills for Success is inherent throughout the apprenticeship training program as apprentices work towards achieving journeyperson status.

#1 The new Skills for Success model – Canada.ca

#2 Explore careers by essential skills – Job Bank

#3 Assessment and training tools – Canada.ca

Level Structure

Level 1 – 8 Weeks

Unit Code	Unit Title	Sugg Hrs*	Pg #	Practical Objectives*
MCH-100	Safety	6	20	N/A
MENT-700	Mentoring I	6	22	N/A
MCH-110	Hoisting, Lifting and Rigging	6	24	N/A
MCH-115	Drawings	18	26	N/A
MCH-120	Precision Measurement I	12	28	N/A
MCH-125	Hand and Power Tools	12	30	N/A
MCH-130	Introduction to Grinding Machines	9	33	Change a wheel on a bench grinder.
MCH-135	Hand Threading	9	34	Install a threaded insert.
MCH-140	Power Saws	9	36	Remove, select and install a bandsaw blade.
MCH-145	Fluids and Coolants	3	38	Check coolant concentration with a refractometer.
MCH-150	Introduction to Layout	9	40	N/A
MCH-155	Drills and Drill Presses	12	42	N/A
MCH-160	Intro to Conventional Lathes Set Up	18	46	N/A
MCH-165	Basic Lathe Operation	48	49	Perform basic turning operations.
MCH-170	Introduction to Milling Machines	18	53	N/A
MCH-175	Machinable Material	9	55	N/A
MCH-180	Material Testing	6	57	N/A
MCH-185	Abrasive Finishing	6	58	N/A
MCH-190	Intro to Mechanical Components	12	60	N/A
MCH-195	Heating and Bending Processes	12	63	1. Start up and shut down an oxy-fuel torch. 2. Perform a free-hand cut and bend with oxy-fuel.

***Suggested Hours:** The time it should take to cover the unit (a guide only).

***Practical Objectives:** The tasks/skills apprentices must be exposed to during technical training. An individual or group performance of the task/skill is recommended; if not possible, an instructor demonstration is acceptable. Training Providers should use practical, hands-on learning whenever possible, whether identified in the curriculum as a practical objective or not.

Level Structure (continued)

Level 2 – 8 Weeks

Unit Code	Unit Title	Sugg Hrs*	Pg #	Practical Objectives*
MCH-200	Heat Treatment	15	68	Perform a hardness test.
MCH-205	Reconditioning/Refurbishment	12	70	N/A
MCH-210	Surface Grinders	15	72	N/A
MCH-215	Precision Measurement II	6	75	N/A
MCH-220	Advanced Lathe Operation	57	76	1. Machine a multi start acme thread. 2. Machine an eccentric shaft. 3. Perform an operation with a steady rest.
MCH-225	Vertical Milling Machine Operation	60	79	1. Machine a dovetail. 2. Machine a t-slot. 3. Machine a key seat. 4. Machine a bolt hole pattern.
MCH-230	Taper Turning	15	84	N/A
MCH-235	Intro to CNC Programming	15	86	N/A
MCH-240	Intro to CNC Machine Set Up	15	88	N/A
MCH-245	Intro to CNC Machine Operation	30	91	Operate CNC mill & lathe to produce a part.

Level 3 – 6 Weeks

Unit Code	Unit Title	Sugg Hrs*	Pg #	Practical Objectives*
MCH-300	Cutting Tools	15	94	N/A
MCH-305	Advanced Grinding	30	96	N/A
MCH-310	Horizontal/Universal Conventional Milling Machine Set Up	18	99	N/A
MCH-315	Horizontal/Universal Conventional Milling Machine Operation	24	102	N/A
MCH-320	CNC Programming II	48	104	1. Create basic program for milling & turning. 2. Create basic 2-dimension CAD/CAM drawing.
MCH-325	CNC Set Up/Operation II	45	106	1. Set up a workpiece on a CNC lathe and milling machine. 2. Perform a tool and work offset.

Level 4 – 7 Weeks

Unit Code	Unit Title	Sugg Hrs*	Pg #	Practical Objectives*
MCH-400	Gears and Gear Cutting	45	110	Machine a gear.
MCH-405	Quality Inspection	15	112	N/A
MCH-410	CNC Programming III	45	114	1. Create a 3-dimention model. 2. Create a basic CAM program.
MCH-415	CNC Set Up/Operation III	39	116	Produce a basic part on a mill & lathe machine.
MCH-420	Job Planning	30	117	N/A
MENT-701	Mentoring II	6	119	N/A
MCH-430	Program Review	30	120	N/A

2018 RSOS Sub-Task to AACS Unit Comparison

RSOS Sub-Task		AACS Unit	
Task A-1 – Performs safety-related functions.			
1.01	Uses personal protective equipment (PPE) and safety equipment.		Throughout all Levels
1.02	Maintains safe work environment.		Throughout all Levels
Task A-2 – Organizes Work.			
2.01	Interprets documentation.	MCH-115	Drawings
		MCH-420	Job Planning
2.02	Plans sequence of operation.	MCH-165	Basic Lathe Operation
		MCH-420	Job Planning
Task A-3 – Uses communications and mentoring techniques.			
3.01	Uses communication techniques.	MENT-700	Mentoring I
		MENT-701	Mentoring II
3.02	Uses mentoring techniques.	MENT-700	Mentoring I
		MENT-701	Mentoring II
Task A-4 – Processes workpiece material.			
4.01	Selects workpiece material.	MCH-175	Machinable Material
		MCH-200	Heat Treatment
4.02	Uses hoisting, lifting and rigging equipment.	MCH-110	Hoisting, Lifting and Rigging
4.03	Mark workpiece for identification.	MCH-150	Introduction to Layout
		MCH-175	Machinable Material
4.04	Performs heat treatment.	MCH-200	Heat Treatment
4.05	Performs quality control of workpiece.	MCH-120	Precision Measurement I
		MCH-180	Material Testing
		MCH-245	Introduction to CNC Machine Operation
		MCH-310	Horizontal/Universal Conventional Milling Machine Set Up
		MCH-315	Horizontal/Universal Conventional Milling Machine Operation
		MCH-325	CNC Set Up/Operation II
		MCH-400	Gears and Gear Cutting
		MCH-405	Quality Inspection
		MCH-415	CNC Set Up/Operation III
4.06	Deburrs workpiece.	MCH-125	Hand and Power Tools
4.07	Sketches parts.	MCH-115	Drawings
Task A-5 – Maintains machines, tooling and inspection equipment.			
5.01	Cleans machines.	MCH-145	Fluids and Coolants

RSOS Sub-Task		AACS Unit	
		MCH-165	Basic Lathe Operation
		MCH-170	Introduction to Milling Machines
		MCH-210	Surface Grinders
		MCH-220	Advanced Lathe Operation
		MCH-225	Vertical Milling Machine Set Up/Operation
		MCH-230	Taper Turning
		MCH-245	Introduction to CNC Machine Operation
5.02	Lubricates machines.	MCH-145	Fluids and Coolants
5.03	Sharpens tooling.	MCH-155	Drills and Drill Presses
		MCH-160	Introduction to Conventional Lathes Set Up
		MCH-300	Cutting Tools
5.04	Applies cutting fluid and coolant.	MCH-145	Fluids and Coolants
5.05	Troubleshoots equipment.	MCH-165	Basic Lathe Operation
		MCH-170	Introduction to Milling Machines
		MCH-210	Surface Grinders
		MCH-220	Advanced Lathe Operation
		MCH-225	Vertical Milling Machine Set Up/Operation
		MCH-230	Taper Turning
		MCH-245	Introduction to CNC Machine Operation
		MCH-310	Horizontal/Universal Conventional Milling Machine Set Up
		MCH-315	Horizontal/Universal Conventional Milling Machine Operation
		MCH-325	CNC Set Up/Operation II
5.06	Maintains machine alignment.	MCH-165	Basic Lathe Operation
		MCH-210	Surface Grinders
		MCH-170	Introduction to Milling Machines
		MCH-220	Advanced Lathe Operation
		MCH-225	Vertical Milling Machine Set Up/Operation
		MCH-230	Taper Turning
		MCH-245	Introduction to CNC Machine Operation
5.07	Maintains inspection equipment.	MCH-120	Precision Measurement I
		MCH-165	Basic Lathe Operation
Task B-6 – Performs hand processes.			
6.01	Performs layout.	MCH-150	Introduction to Layout

RSOS Sub-Task		AACS Unit	
6.02	Saws workpiece.	MCH-125	Hand and Power Tools
6.03	Files workpiece.	MCH-125	Hand and Power Tools
6.04	Performs hole making operations.	MCH-155	Drills and Drill Presses
6.05	Performs threading operations.	MCH-135	Hand Threading
6.06	Installs thread inserts.	MCH-135	Hand Threading
6.07	Broaches workpiece.	MCH-190	Introduction to Mechanical Components
6.08	Performs pressing operations.	MCH-125	Hand and Power Tools
6.09	Forms workpiece.	MCH-195	Heating and Bending Processes
6.10	Finishes workpiece.	MCH-185	Abrasive Finishing
Task B-7 – Refurbishes components.			
7.01	Disassembles components.	MCH-190	Introduction to Mechanical Components
		MCH-205	Reconditioning/Refurbishment
7.02	Analyzes components.	MCH-190	Introduction to Mechanical Components
		MCH-205	Reconditioning/Refurbishment
7.03	Assembles components.	MCH-205	Reconditioning/Refurbishment
Task C-8 – Sets up power saws.			
8.01	Selects power saw types.	MCH-140	Power Saws
8.02	Selects saw blades.	MCH-140	Power Saws
8.03	Installs saw blades.	MCH-140	Power Saws
8.04	Selects power saw speeds and feeds.	MCH-140	Power Saws
8.05	Makes power saw adjustments.	MCH-140	Power Saws
8.06	Sets up workpiece on power saw.	MCH-140	Power Saws
Task C-9 – Operates power saws.			
9.01	Saws straight and angle cuts.	MCH-140	Power Saws
9.02	Cuts irregular shapes.	MCH-140	Power Saws
Task D-10 – Sets up drill presses.			
10.01	Selects drill press types.	MCH-155	Drills and Drill Presses
10.02	Plans operation of drill presses.	MCH-155	Drills and Drill Presses
10.03	Selects drill press speeds and feeds.	MCH-155	Drills and Drill Presses
10.04	Sets up jig, fixtures and work holding devices for drill presses.	MCH-155	Drills and Drill Presses
10.05	Sets up tooling for drill presses.	MCH-155	Drills and Drill Presses
Task D-11 – Operates drill presses.			
11.01	Drills holes using a drill press.	MCH-155	Drills and Drill Presses

RSOS Sub-Task		AACS Unit	
11.02	Cuts countersinks, counterbores, chamfers and spot faces using a drill press.	MCH-155	Drills and Drill Presses
11.03	Performs tapping using a drill press.	MCH-155	Drills and Drill Presses
11.04	Finishes holes using a drill press.	MCH-155	Drills and Drill Presses
Task E-12 – Sets up conventional lathes.			
12.01	Selects conventional lathes types.	MCH-160	Introduction to Conventional Lathes Set Up
12.02	Plans operation of conventional lathes.	MCH-160	Introduction to Conventional Lathes Set Up
		MCH-220	Advanced Lathe Operation
		MCH-230	Taper Turning
12.03	Sets up work holding devices for conventional lathes.	MCH-160	Introduction to Conventional Lathes Set Up
		MCH-220	Advanced Lathe Operation
		MCH-230	Taper Turning
12.04	Sets up tooling for conventional lathes.	MCH-160	Introduction to Conventional Lathes Set Up
		MCH-220	Advanced Lathe Operation
		MCH-230	Taper Turning
12.05	Sets up conventional lathe accessories.	MCH-160	Introduction to Conventional Lathes Set Up
		MCH-220	Advanced Lathe Operation
		MCH-230	Taper Turning
12.06	Sets up workpiece on conventional lathe.	MCH-160	Introduction to Conventional Lathes Set Up
		MCH-220	Advanced Lathe Operation
		MCH-230	Taper Turning
12.07	Selects conventional lathe speeds and feeds.	MCH-160	Introduction to Conventional Lathes Set Up
Task E-13 – Operates conventional lathes.			
13.01	Faces surfaces using a conventional lathe.	MCH-165	Basic Lathe Operation
13.02	Turns external surfaces using a conventional lathe.	MCH-165	Basic Lathe Operation
		MCH-220	Advanced Lathe Operation
13.03	Drills using a conventional lathe.	MCH-165	Basic Lathe Operation
13.04	Bores holes using a conventional lathe.	MCH-165	Basic Lathe Operation
		MCH-220	Advanced Lathe Operation
13.05	Reams holes using a conventional lathe.	MCH-165	Basic Lathe Operation
13.06		MCH-165	Basic Lathe Operation

RSOS Sub-Task		AACS Unit	
	Turns tapers using a conventional lathe.	MCH-215	Precision Measurement II
		MCH-230	Taper Turning
13.07	Knurls using a conventional lathe.	MCH-165	Basic Lathe Operation
13.08	Cuts grooves using a conventional lathe.	MCH-165	Basic Lathe Operation
		MCH-220	Advanced Lathe Operation
13.09	Cuts threads using a conventional lathe.	MCH-165	Basic Lathe Operation
		MCH-220	Advanced Lathe Operation
13.10	Parts off workpiece using a conventional lathe.	MCH-165	Basic Lathe Operation
Task F-14 – Sets up conventional milling machines.			
14.01	Selects conventional milling machine types.	MCH-170	Introduction to Milling Machines
		MCH-225	Vertical Milling Machine Operation
14.02	Plans operation of conventional lathes.	MCH-225	Vertical Milling Machine Set Up/Operation
		MCH-310	Horizontal/Universal Conventional Milling Machine Set Up
14.03	Sets up work holding devices for conventional milling machines.	MCH-225	Vertical Milling Machine Operation
		MCH-310	Horizontal/Universal Conventional Milling Machine Set Up
14.04	Sets up tooling for conventional milling machines.	MCH-170	Introduction to Milling Machines
		MCH-225	Vertical Milling Machine Operation
		MCH-310	Horizontal/Universal Conventional Milling Machine Set Up
14.05	Sets up milling accessories.	MCH-215	Precision Measurement II
		MCH-225	Vertical Milling Machine Operation
		MCH-310	Horizontal/Universal Conventional Milling Machine Set Up
		MCH-400	Gears and Gear Cutting
14.06	Sets up workpiece on a conventional milling machine.	MCH-225	Vertical Milling Machine Operation
		MCH-310	Horizontal/Universal Conventional Milling Machine Set Up
14.07	Selects conventional milling machine speeds and feeds.	MCH-225	Vertical Milling Machine Operation
		MCH-310	Horizontal/Universal Conventional Milling Machine Set Up
		MCH-320	CNC Programming II
Task F-15 – Operates conventional milling machines.			
15.01	Mills surfaces using a conventional milling machine.	MCH-225	Vertical Milling Machine Operation
		MCH-315	Horizontal/Universal Conventional Milling Machine Operation
15.02	Mills profiles and pockets using a conventional milling machine.	MCH-120	Precision Measurement I
		MCH-225	Vertical Milling Machine Operation

RSOS Sub-Task		AACS Unit	
		MCH-315	Horizontal/Universal Conventional Milling Machine Operation
15.03	Mills slots, grooves and keyways using a conventional milling machine.	MCH-225	Vertical Milling Machine Operation
		MCH-315	Horizontal/Universal Conventional Milling Machine Operation
15.04	Cuts gears and splines using a conventional milling machine (indexing calculations).	MCH-225	Vertical Milling Machine Operation
		MCH-315	Horizontal/Universal Conventional Milling Machine Operation
		MCH-400	Gears and Gear Cutting
15.05	Drills holes using a conventional milling machine.	MCH-120	Precision Measurement I
		MCH-225	Vertical Milling Machine Operation
15.06	Reams holes using a conventional milling machine.	MCH-225	Vertical Milling Machine Operation
15.07	Cuts countersinks, counterbores, chamfers and spot faces using a conventional milling machine.	MCH-225	Vertical Milling Machine Operation
15.08	Performs tapping using a conventional milling machine.	MCH-225	Vertical Milling Machine Operation
15.09	Bores holes using a conventional milling machine.	MCH-225	Vertical Milling Machine Operation
		MCH-315	Horizontal/Universal Conventional Milling Machine Operation
Task G-16 – Sets up precision grinding machines.			
16.01	Selects precision grinding machine types.	MCH-130	Introduction to Grinding Machines
		MCH-210	Surface Grinders
		MCH-305	Advanced Grinding
16.02	Plans operation of grinding machines.	MCH-210	Surface Grinders
		MCH-305	Advanced Grinding
16.03	Sets up work holding devices for precision grinding machines.	MCH-210	Surface Grinders
		MCH-215	Precision Measurement II
		MCH-305	Advanced Grinding
16.04	Mounts grinding wheel.	MCH-210	Surface Grinders
		MCH-305	Advanced Grinding
16.05	Sets up grinding accessories.	MCH-210	Surface Grinders
		MCH-305	Advanced Grinding
16.06	Sets up workpiece on precision grinding machines.	MCH-210	Surface Grinders
		MCH-215	Precision Measurement II
		MCH-305	Advanced Grinding
16.07	Selects precision grinding machine speeds and feeds.	MCH-210	Surface Grinders
		MCH-305	Advanced Grinding
Task G-17 – Operates precision grinding machines.			
17.01	Grinds flat surfaces using a surface grinder.	MCH-210	Surface Grinders

RSOS Sub-Task		AACS Unit	
17.02	Grinds profiles.	MCH-305	Advanced Grinding
17.03	Grinds internal and external cylindrical and tapered surfaces.	MCH-305	Advanced Grinding
17.04	Grinds tools and cutters.	MCH-305	Advanced Grinding
17.05	Finishes holes using a honing machine.	MCH-305	Advanced Grinding
Task H-18 – Performs CNC programming.			
18.01	Creates process documentation.	MCH-235	Introduction to CNC Programming
		MCH-320	CNC Programming II
18.02	Creates manual input program.	MCH-235	Introduction to CNC Programming
		MCH-320	CNC Programming II
18.03	Transfers program to and from control memory.	MCH-235	Introduction to CNC Programming
18.04	Optimizes program.	MCH-320	CNC Programming II
		MCH-410	CNC Programming III
18.05	Creates 2D and 3D models.	MCH-320	CNC Programming II
		MCH-410	CNC Programming III
18.06	Programs using CAM.	MCH-320	CNC Programming II
		MCH-410	CNC Programming III
Task H-19 – Sets up CNC machines.			
19.01	Selects tooling and tool holders for CNC machines.	MCH-240	Introduction to CNC Machine Set Up
		MCH-325	CNC Set Up/Operation II
19.02	Sets up tooling and tool holders on CNC machines.	MCH-245	Introduction to CNC Machine Set Up
		MCH-325	CNC Set Up/Operation II
19.03	Sets up workpiece on CNC machines.	MCH-245	Introduction to CNC Machine Set Up
		MCH-325	CNC Set Up/Operation II
		MCH-415	CNC Set Up and Operation III
19.04	Establishes work datum.	MCH-240	Introduction to CNC Machine Set Up
		MCH-325	CNC Set Up/Operation II
19.05	Verifies program.	MCH-240	Introduction to CNC Machine Set Up
Task H-20 – Operates CNC machines.			
20.01	Adjusts offsets.	MCH-245	Introduction to CNC Machine Operation
		MCH-325	CNC Set Up/Operation II
		MCH-415	CNC Set Up/Operation III
20.02	Monitors machining processes.	MCH-245	Introduction to CNC Machine Operation
20.03	Interrupts program cycle.	MCH-245	Introduction to CNC Machine Operation
20.04	Restarts program cycle.	MCH-245	Introduction to CNC Machine Operation

Level 1

Unit Code	Title	Hours	Page Number
MCH-100	Safety	6	20
MENT-700	Mentoring I	6	22
MCH-110	Hoisting, Lifting and Rigging	6	24
MCH-115	Drawings	18	26
MCH-120	Precision Measurement I	12	28
MCH-125	Hand and Power Tools	12	30
MCH-130	Introduction to Grinding Machines	9	33
MCH-135	Hand Threading	9	34
MCH-140	Power Saws	9	36
MCH-145	Fluids and Coolants	3	38
MCH-150	Introduction to Layout	9	40
MCH-155	Drills and Drill Presses	12	42
MCH-160	Introduction to Conventional Lathes Set Up	18	46
MCH-165	Basic Lathe Operation	48	49
MCH-170	Introduction to Milling Machines	18	53
MCH-175	Machinable Material	9	55
MCH-180	Material Testing	6	57
MCH-185	Abrasive Finishing	6	58
MCH-190	Introduction to Mechanical Components	12	60
MCH-195	Heating and Bending Processes	12	63

MCH-100 Safety

Learning Outcomes:

- Demonstrate knowledge of safe work practices.
- Demonstrate knowledge of regulatory requirements pertaining to safety.
- Demonstrate knowledge of PPE and safety equipment, their applications, maintenance and procedures for use.

2018 Red Seal Occupational Standard Reference:

1.01 Maintains safe work environment.
1.02 Uses personal protective equipment (PPE) and safety equipment.

Suggested Hours:

6 Hours

Theoretical Objectives:

1. Identify workplace hazards and describe safe work practices.
    i) personal
    ii) shop/facility
        - energy state awareness (electrical and mechanical)
        - lockout/tag-out
        - ventilation/fumes
        - slippery floors
        - tangled air lines/power cords
        - dust
        - inadequate lighting
    iii) fire
    iv) environment
        - discharge/spills
        - material waste

2. Identify and Interpret jurisdictional workplace safety and health regulations.
    i) federal
        - Safety Data Sheets (SDS)
        - Workplace Hazardous Material information system (WHMIS)
        - disposal
        - labelling
        - use of PPE
        - training
    ii) provincial/territorial
        - Occupational Health and Safety (OHS)

3. Identify types of PPE and safety equipment and describe their applications and procedures for use.

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

5. Describe the procedures used to care for and maintain PPE and safety equipment.

6. Describe the procedures used to comply with lock-out and tag-out.

Practical Objectives:

N/A

MENT-700 Mentoring I

Learning Outcomes:

- Demonstrate knowledge of effective communication practices as a learner.
- Demonstrate knowledge of strategies for learning skills in the workplace.

Red Seal Occupational Standard Reference:

3.01 Uses communication techniques
3.02 Uses mentoring techniques

Suggested Hours:

6 hours

Theoretical Objectives:

1. Describe the importance of one's own individual experiences.
2. Identify behaviours that demonstrate positive learning experiences.
3. Identify the benefits of workplace mentoring for the apprentice, mentor, and employer.
4. Identify the partners involved in apprenticeship training.
5. Describe the shared responsibilities for workplace learning in apprenticeship.
6. Identify different learning needs and strategies to address challenges or barriers in the workplace.
   i) learning disabilities
   ii) language
   iii) underrepresentation
7. Identify the components that create a positive and inclusive workplace culture.
   i) workplace characteristics
   ii) individual behaviours
8. Identify various learning styles and determine one’s own learning preferences.
9. Explain how learning preferences impact learning new skills.

10. Identify different learning strategies to meet individual learning needs.

11. Describe the importance of adapting to a variety of teaching and learning methods in the workplace.

12. Identify techniques for effective communication as a learner.
    i) verbal and non-verbal
    ii) active listening

13. Identify and describe personal responsibilities and attitudes that contribute to on-the-job success.
    i) self advocating
    ii) asking questions
    iii) accepting constructive feedback
    iv) working safely
    v) employing time management techniques and being punctual

Practical Objectives:

N/A

MCH-110 Hoisting, Lifting and Rigging

Learning Outcomes:

- Demonstrate knowledge of hoisting, lifting and rigging equipment, their applications, limitations and procedures for use.

2018 Red Seal Occupational Standard Reference:

4.02 Uses hoisting, lifting and rigging equipment.

Suggested Hours:

6 Hours

Theoretical Objectives:

1. Define terminology associated with hoisting, lifting and rigging.

2. Identify hazards and describe safe work practices pertaining to hoisting, lifting and rigging.

3. Identify and interpret codes and regulations pertaining to:
   i) hoisting, lifting and rigging
   ii) training and certification requirements

4. Identify types of rigging equipment and describe their applications, limitations and procedures for use.
   i) ropes
   ii) slings
   iii) chains
   iv) hooks
   v) spreader bars
   vi) shackles

5. Identify and interpret hand signals used for hoisting and lifting.

6. Identify types of hoisting and lifting equipment and accessories and describe their applications, limitations and procedures for use.
   i) hoisting
   ii) lifting

7. Describe the considerations when rigging material/equipment for lifting.
   i) load characteristics
   ii) equipment and accessories
   iii) environmental factors
   iv) anchor points
   v) sling angles

8. Describe the procedures used to inspect, maintain and store hoisting, lifting and rigging equipment.

Practical Objectives:

N/A

MCH-115 Drawings

Learning Outcomes:

- Demonstrate knowledge of drawings and their applications.
- Demonstrate knowledge of sketching and its application.
- Demonstrate knowledge of interpreting and extracting information from drawing features.
- Demonstrate knowledge of reference materials and their use.
- Demonstrate knowledge of geometric dimensions and tolerances and their applications.

2018 Red Seal Occupational Standard Reference:

2.01 Interprets documentation.
4.07 Sketches parts.

Suggested Hours:

18 Hours

Theoretical Objectives:

1. Define terminology associated with drawings.
   - i) nominal size
   - ii) limits and fits
   - iii) tolerance
   - iv) allowance
   - v) scale
   - vi) symmetry
   - vii) standard dimensioning and tolerancing
   - viii) geometric dimensioning and tolerancing

2. Interpret and extract information from drawings features.
   - i) line types
   - ii) projections
   - iii) dimensions
   - iv) notes
   - v) lay/surface finish symbols
   - vi) welding symbols
   - vii) material and processing specifications
   - viii) machining allowances
   - ix) standard and geometric

3. Interpret and extract information from parts to create a sketch.

4. Explain the principles of geometric dimensioning and tolerancing.

5. Explain the principles of orthographic projection.

6. Identify types of drawings and sketches and describe their purpose.
   i) engineering
   ii) isometric
   iii) orthographic
   iv) sketches
   v) 2D and 3D geometry
   vi) process

7. Identify types of reference materials and their use.
   i) machinery handbook
   ii) material data sheets
   iii) manufacturers' specifications

8. Identify information from reference materials and determine the calculations.

9. Identify types of sketches and describe their purpose.

10. Identify dimensions used in creating sketches.

11. Identify drawing views and describe their purpose and applications.
   i) isometric
   ii) orthographic
   iii) sectional
   iv) auxiliary

12. Identify and interpret industry symbols and markings and describe their applications.
   i) surface textures
   ii) hidden (phantom) lines
   iii) geometric dimensions and tolerances
   iv) datums
   v) moldings, forgings and castings

13. Describe basic sketching techniques and types of views.

14. Describe the procedures used to transfer dimensions to sketch.

Practical Objectives:

N/A

MCH-120 Precision Measurement I

Learning Outcomes:

- Demonstrate knowledge of precision measuring equipment and its use.
- Demonstrate knowledge of quality inspection and its use.

2018 Red Seal Occupational Standard Reference:

4.05 Performs quality control of workpiece.
5.07 Maintains inspection equipment.

Suggested Hours:

12 Hours

Theoretical Objectives:

1. Define terminology associated with basic precision measurement.

2. Identify types of precision measuring equipment used in quality inspection and describe their applications and procedures for use.
   i) micrometers
   ii) vernier calipers
   iii) dial indicators
   iv) height gauges
   v) optical comparator
   vi) scales and rules

3. Describe the procedures used to read basic precision measuring instrument scales.

4. Describe the procedures used to perform basic calibration of measuring instruments.

5. Describe the procedures used for the care and handling of gauge blocks.

6. Describe the procedures used to inspect, maintain and store basic precision measuring equipment.

7. Identify types of inspection equipment used to verify workpieces.
   i) precision square
   ii) combination square
   iii) steel rule
   iv) tape measure
   v) caliper and micrometer

vi) depth gauge
vii) straight edge
viii) protractors
ix) templates
x) radius gauges
xi) gauge blocks
xii) universal bevel protractor
xiii) sine bar
xiv) precision height gauge
xv) gauge blocks
xvi) surface plate
xvii) depth micrometer
xviii) inside micrometer
xix) bore gauges
xx) telescopic gauges

8. Describe the procedures used to verify a workpiece to meet specifications.

9. Describe the imperial and metric measuring systems and the procedures used to perform conversions for machining operations.

10. Perform sine bar calculations.

Practical Objectives:

N/A

MCH-125 Hand and Power Tools

Learning Outcomes:

- Demonstrate knowledge of hand tools, their applications, maintenance and procedures for use.
- Demonstrate knowledge of power tools, their applications, maintenance and procedures for use.
- Demonstrate knowledge of press equipment, their applications, maintenance and procedures for use.

2018 Red Seal Occupational Standard Reference:

4.06 Deburrs workpiece.
6.02 Saws workpiece.
6.03 Files workpiece.
6.08 Performs pressing operations.

Suggested Hours:

12 Hours

Theoretical Objectives:

1. Define terminology related to hand and power tools and press equipment.

2. Identify hazards and describe safe work practices related to hand and power tools and press equipment.

3. Explain the operating principles of press equipment.

4. Identify types of hand tools and describe their applications and procedures for use.
   i) vices
   ii) hammers
   iii) screw drivers
   iv) wrenches
   v) pliers
   vi) punches
   vii) stamps
   viii) hacksaws
   ix) files
   x) scrappers
   xi) deburring tools
   xii) chisels

xiii) taps
xiv) dies
xv) arbor presses
xvi) extractors

5. Identify work holding devices and describe their applications and procedures for use.
   i) vices
   ii) soft jaws
   iii) parallel clamps
   iv) c-clamps

6. Identify types of press equipment and describe their components and applications.
   i) press
      - arbor
      - hydraulic
   ii) work holding device
      - V-blocks
      - table blocks
      - collars

7. Identify types of power tools and equipment and describe their applications and procedures for use.
   i) electrical
   ii) cordless
   iii) hydraulic
   iv) pneumatic

8. Identify types of hand saws and describe their applications.

9. Identify types of sawing operations and describe their associated procedures.

10. Identify types of blades and describe their parameters, applications and installation procedures.

11. Identify potential problems during sawing operations with handsaws and describe their causes and solutions.
   i) dull blade
   ii) worn set
   iii) broken teeth
   iv) incorrect pitch

12. Identify features to be deburred.

13. Identify potential problems during filing operations with filing tools.
    i) file pinning
    ii) rounded edges
    iii) damage to file

14. Identify potential problems during pressing operations.
    i) misalignment
    ii) galling
    iii) insufficient power
    iv) seizing
    v) bending
    vi) trapped air

15. Describe the procedures used to inspect, maintain and store hand tools.

16. Describe the procedures used to inspect and store power tools and equipment.

17. Describe the procedures used to inspect, maintain and store filing tools.

18. Describe the procedures used to set up and operate press equipment.

Practical Objectives:

N/A

MCH-130 Introduction to Grinding Machines

Learning Outcomes:

- Demonstrate knowledge of offhand and pedestal grinding operations.
- Demonstrate knowledge of safety practices and procedures related to pedestals and bench grinders.

2018 Red Seal Occupational Standard Reference:

16.01 Selects precision grinding machine types.

Suggested Hours:

9 Hours

Theoretical Objectives:

1. Define terminology associated with pedestal and bench grinding machines.

2. Identify hazards and describe safe work practices related to pedestal and bench grinding.

3. Identify types of grinding machines and accessories and describe their applications.
   - i) machines
     - bench
     - pedestal
   - ii) accessories
     - dressing stone
     - coolant systems
     - wheel dressers

4. Describe grinding operations to be performed.
   - i) offhand (bench)
   - ii) pedestal

Practical Objectives:

1. Change a wheel on a bench grinder.

MCH-135 Hand Threading

Learning Outcomes:

- Demonstrate knowledge of threads and thread inserts and their application.
- Demonstrate knowledge of the procedures used to measure and gauge threads.
- Demonstrate knowledge of safe work practices and procedures pertaining to threads and thread inserts.

2018 Red Seal Occupational Standard Reference:

6.05 Performs threading operations.
6.06 Installs thread inserts.

Suggested Hours:

9 Hours

Theoretical Objectives:

1. Define terminology associated with threads.

2. Identify hazards and describe safe work practices pertaining to threading.

3. Explain thread fit, classifications and series.

4. Identify tools and methods used to measure and gauge threads and describe their associated procedures.

5. Identify types of threads and describe their purpose and applications.

6. Identify types of thread inserts and describe their applications and installing procedures.

7. Identify types of thread and inserts failures and describe their causes and solutions.
   i) damaged threads
   ii) broken taps
   iii) cross threading
   iv) improper axis alignment

8. Identify types of taps and dies and describe their application and procedures for use.

9. Describe the importance of thread fit and the use of thread gauge.

10. Describe the procedures used to produce threads using taps and dies.

11. Describe the procedure to extract broken taps.

12. Calculate and select tap drill sizes in metric and imperial.

Practical Objectives:

1. Install a threaded insert.

MCH-140 Power Saws

Learning Outcomes:

- Demonstrate knowledge of power saws and saw blades, their applications, maintenance and procedures for use.

2018 Red Seal Occupational Standard Reference:

8.01 Selects power saws types.
8.02 Selects saw blades.
8.03 Installs saw blades.
8.04 Selects power saw speeds and feeds.
8.05 Makes power saw adjustments.
8.06 Sets up workpiece on power saw.
9.01 Saws straight and angle cuts.
9.02 Cuts irregular shapes.

Suggested Hours:

9 Hours

Theoretical Objectives:

1. Define terminology associated with power saws.

2. Identify hazards and describe safe work practices pertaining to power saws and saw blades.

3. Identify the size and capacity of power saws.

4. Identify types of power saws and attachments and describe their applications.
   i) vertical
   ii) horizontal
   iii) reciprocating/power hack saw
   iv) cold circular
   v) abrasive cut-off
   vi) contour
   vii) friction

5. Identify types of blades and describe their parameters, applications and installation procedures.

6. Identify types of power saw accessories and describe their applications.
    i) push block
    ii) clamps
    iii) guard
    iv) air blast
    v) workpiece support
    vi) work stops
    vii) coolant pumps
    viii) mechanical feed
    ix) rip fence

7. Identify types of power sawing operations and describe their associated procedures.

8. Identify potential problems during sawing operations and describe their causes and solutions.
    i) incorrect speeds and feeds
    ii) binding and overheating blade
    iii) wandering
    iv) lack of lubrication
    v) incorrect pitch of blade

9. Describe the procedures used to select and adjust a saw blade.

10. Describe the procedures used to butt weld and grind bandsaw blades.

11. Describe the procedures used to adjust speeds and feeds of power saws.

12. Describe the procedures used to secure regular and irregular shaped workpieces on power saws.

13. Describe the procedures used to inspect and maintain power saws.

14. Describe the procedures used to adjust table angle.

15. Calculate speed and feed requirements of power saws.

16. Calculate and measure workpiece to be cut with power saws.

Practical Objectives:

1. Remove, select and install a bandsaw blade.

MCH-145 Fluids and Coolants

Learning Outcomes:

- Demonstrate knowledge of cleaning agents, their applications, and procedures for use.
- Demonstrate knowledge of lubricants, cutting fluids and coolants, their applications, and procedures for use.
- Demonstrate knowledge of safe work practices and procedures pertaining to fluids and coolants.

2018 Red Seal Occupational Standard Reference:

5.01 Cleans machines.
5.02 Lubricates machines.
5.04 Applies cutting fluid and coolant.

Suggested Hours:

3 Hours

Theoretical Objectives:

1. Define terminology associated with cutting fluids and coolants.

2. Identify hazards and describe safe work practices pertaining to cutting fluids and coolants.
   i) personal
   ii) shop/facility
   iii) environmental

3. Identify and describe regulations pertaining to the use of cutting fluids and coolants.

4. Identify the tools used for mixing, maintaining and adjusting coolants.

5. Identify types of fluids and coolants and describe their purpose, characteristics and applications.
   i) cutting fluids
   ii) coolants
   iii) lubricants
   iv) solvents
   v) cleaning agents

6. Describe the procedures used to select, apply and maintain lubricants.

7. Describe the procedures used for mixing, maintaining and adjusting coolants.

8. Describe the procedures used to apply cutting fluids and coolants.

Practical Objectives:

1. Check coolant concentration with a refractometer.

MCH-150 Introduction to Layout

Learning Outcomes:

- Demonstrate knowledge of methods used to mark stock and workpieces.
- Demonstrate knowledge of layout tools and their applications.
- Demonstrate knowledge of the procedures to perform basic layout operations.

2018 Red Seal Occupational Standard Reference:

4.03 Marks workpiece for identification.
6.01 Performs layout.

Suggested Hours:

9 Hours

Theoretical Objectives:

1. Define terminology associated with basic layout.

2. Identify precision layout tools and describe their applications and procedures for use.
   i) universal bevel protractor
   ii) sine bar
   iii) precision height gauge
   iv) gauge blocks
   v) surface plate

3. Identify types of basic layout tools and describe their applications and procedures for use.
   i) surface tables
   ii) angle plate
   iii) scribers
   iv) dividers and trammels
   v) hermaphrodite calipers
   vi) squares
   vii) gauges
   viii) rulers
   ix) layout dye
   x) surfaces gauges
   xi) prick punches
   xii) combination sets

4. Identify types of layout media/solutions and describe their applications.

5. Describe the procedures used to read and transfer sizes from drawings.

6. Describe the procedures used to perform a basic layout.

7. Describe the procedures used to inspect, maintain and store layout tools and equipment.

8. Describe the procedures used to perform a precision layout.

9. Describe the procedures used to inspect, maintain and store precision layout tools.

10. Calculate layout dimensions and reference points.

11. Calculate sine bar values.

12. Calculate angles, arcs and location from reference point.

Practical Objectives:

N/A

MCH-155 Drills and Drill Presses

Learning Outcomes:

- Demonstrate knowledge of drills and drill presses and their applications.
- Demonstrate knowledge of the procedures to perform drilling operations.

2018 Red Seal Occupational Standard Reference:

5.03 Sharpens tooling.
6.04 Performs hole making operations.
10.01 Selects drill press types.
10.02 Plans operation of drill presses.
10.03 Selects drill press speeds and feeds.
10.04 Sets up jigs, fixtures and work holding devices for drill presses.
10.05 Sets up tooling for drill presses.
11.01 Drills holes using a drill press.
11.02 Cuts countersinks, counterbores, chamfers and faces using a drill press.
11.03 Performs tapping using a drill press.
11.04 Performs holes using a drill press.

Suggested Hours:

12 Hours

Theoretical Objectives:

1. Define terminology associated with drill press tooling and drill presses.

2. Define terminology associated with hole finishing tooling.

3. Define terminology associated with drill press tapping tooling.

4. Identify hazards and describe safe work practices pertaining to drills and drill presses.

5. Identify hazards and describe safe work practices pertaining to sharpening tools.

6. Identify jigs, fixtures and work holding devices and describe their applications and procedures for use.
   i) vices
      - plain
      - swivel
      - compound
   ii) parallel clamps

iii) c-clamps

7. Identify types of drills and hand reamers and procedures for use.

8. Identify types of drill presses and describe their components and applications.
   i) types
      - sensitive
      - upright
      - radial arm
      - magnetic base
   ii) components
      - jigs and fixtures
      - work holding devices
      - tool holding devices

9. Identify types of drill press tooling and describe their applications.
   i) twist drills
   ii) reamers
   iii) taps
   iv) countersinks
   v) counterbore
   vi) hole saws
   vii) gun drill

10. Identify types of inspection equipment for drill press tooling and describe their application.
   i) sample piece
   ii) depth micrometer
   iii) calipers

11. Identify types of drill press tapping tooling and describe their applications.
   i) centre
   ii) drill
   iii) tapping heads
   iv) collets
   v) chucks
   vi) cutting and forming taps
   vii) countersinks

12. Identify types of hole finishing tooling and describe their applications.
   i) drills
   ii) reamers
   iii) boring bars

13. Identify types of inspection equipment used for finishing a hole using a drill press and describe their application and procedure for use.
    i) bore gauges
    ii) telescopic gauges
    iii) calipers
    iv) inside micrometers

14. Identify potential problems during drilling with drill press operations and describe their causes and solutions.
    i) drill wandering
    ii) oversized holes
    iii) out of specification surface finish
    iv) chatter
    v) damage to cutting tool
    vi) burring
    vii) insufficient depth

15. Identify potential problems during tapping with drill press operations and describe their causes and solutions.
    i) damaged thread
    ii) broken taps
    iii) cross threading

16. Identify potential problems during finishing with drill press operations and describe their causes and solutions.
    i) surface finish defects
    ii) under/oversized holes
    iii) damage to cutting tool

17. Identify methods of measuring a workpiece pertaining to hole finishing operations.

18. Identify calculations required to verify sizing and positions of countersinks, counterbores, chamfers and spot faces.

19. Identify calculations required to verify sizing and positions pertaining to hole finishing operations.

20. Describe the procedures used to set up and perform drill press operations.
    i) set up
        - alignment
        - positioning
        - adjustments
    ii) operations
        - drilling

- counterboring
- countersinking
- tapping
- reaming

21. Describe the procedures used to sharpen drill bits.
    i) thinned web
    ii) proper angle for different materials

22. Describe the procedures used for hand drilling and hand reaming work.

23. Describe the procedures used for spotting and hand drilling work.

24. Describe the procedures used to inspect and maintain drill press tooling and drill presses.

25. Describe the procedures used to install a tool in a spindle.

26. Describe the considerations to determine speed, feed and depth of cut for drill press operations.
    i) workpiece material
    ii) cutting tool material
    iii) manufacturers' specifications
    iv) formulas
    v) rigidity of machine and tool set-up

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

Practical Objectives:

N/A

MCH-160 Introduction to Conventional Lathes Set Up

Learning Outcomes:

- Demonstrate knowledge of conventional lathes, their accessories, attachments and tools and applications.
- Demonstrate knowledge of safe work practices and procedures related to sharpening tools.
- Demonstrate knowledge of conventional lathes, their maintenance and procedures for use.
- Demonstrate knowledge of work holding devices, and their applications.
- Demonstrate knowledge of lathe speeds and feeds.
- Demonstrate knowledge of calculations required to adjust machine controls.

2018 Red Seal Occupational Standard Reference:

5.03 Sharpens tooling.
12.01 Selects conventional lathe types.
12.02 Plans operation of conventional lathes.
12.03 Sets up work holding devices for conventional lathes.
12.04 Sets up tooling for conventional lathes.
12.05 Sets up conventional lathe accessories.
12.06 Sets up workpiece on conventional lathes.
12.07 Selects conventional lathe speeds and feeds.

Suggested Hours:

18 Hours

Theoretical Objectives:

1. Define terminology associated with conventional lathes.

2. Identify hazards and describe safe work practices pertaining to sharpening tools.

3. Identify tools required to set up work holding devices on lathes.
   i) wrenches
   ii) keys
   iii) hook spanners
   iv) chuck wrenches

4. Identify conventional lathe tools and accessories and describe their characteristics and applications.
   i) tools

- turning
- boring
- threading
- grooving
- facing
- knurling
- parting off
- reaming
- tool post grinding
- drilling

ii) accessories
- steady rest
- taper attachment
- lathe dog
- turning tool
- centres
- follower rest

5. Identify types of conventional lathes and describe their operating principles and applications.
   i) engine
   ii) turret
   iii) vertical turret
   iv) vertical boring mill
   v) multispindle

6. Identify types of work holding devices and describe their applications.
   i) three-jaw chuck
   ii) four-jaw chuck
   iii) faceplate
   iv) collet chuck
   v) between centers
   vi) magnetic chuck

7. Identify types of inspection equipment required on conventional lathe and describe their use.
   i) dial indicators
   ii) micrometers
   iii) surface gauges
   iv) hole gauges

8. Identify types of tool holding devices and describe their applications.

9. Identify types of cutting tools and describe their applications.

i) turning tool
ii) boring bar
iii) threading tool
iv) knurling tool
v) part-off blade

10. Identify the components and controls of conventional lathes and describe their purpose and operation.

11. Identify the considerations and requirements for selecting conventional lathe tools and accessories for specific operations.

12. Identify potential set up problems and describe their causes and solutions.

13. Identify calculations for speed, feed and depth of cut.

14. Describe the procedures used to set up work holding devices on lathes.

15. Describe the procedures used to inspect and clean conventional lathe accessories.

16. Describe the procedures used to set up cutting tools on lathes.

17. Describe the procedures used to sharpen conventional lathe cutting tools.
    i) chip breaker

18. Describe the procedures used to grind tool angles.

19. Describe the procedure used to adjust and readjust machine controls.

20. Calculate spindle speed.

Practical Objectives:

N/A

MCH-165 Basic Lathe Operation

Learning Outcomes:

- Demonstrate knowledge of conventional lathes, their set up and procedures for use.
- Demonstrate knowledge of procedures to face surfaces.
- Demonstrate knowledge of procedures to turn external surfaces.
- Demonstrate knowledge of procedures to drill.
- Demonstrate knowledge of procedures to bore holes.
- Demonstrate knowledge of procedures to ream holes.
- Demonstrate knowledge of procedures to knurl.
- Demonstrate knowledge of procedures to cut grooves.
- Demonstrate knowledge of procedures to part off workpiece.
- Demonstrate knowledge of procedures to troubleshoot and maintain conventional lathes.

2018 Red Seal Occupational Standard Reference:

2.02 Plans sequence of operations.
5.01 Cleans machine.
5.05 Troubleshoots equipment.
5.06 Maintains machine alignment.
5.07 Maintains inspection equipment.
13.01 Faces surfaces using conventional lathe.
13.02 Turns external surfaces using a conventional lathe.
13.03 Drills using a conventional lathe.
13.04 Bores holes using a conventional lathe.
13.05 Reams holes using a conventional lathe.
13.06 Turns tapers using a conventional lathe.
13.07 Knurls using a conventional lathe.
13.08 Cuts grooves using a conventional lathe.
13.09 Cuts threads using a conventional lathe.
13.10 Parts off workpiece using a conventional lathe.

Suggested Hours:

48 Hours

Theoretical Objectives:

1. Identify hazards and describe safe work practices pertaining to the operations of conventional lathes.

2. Identify facing inspection equipment used to verify that workpieces meet specifications.

i) precision square
ii) straight edge
iii) caliper
iv) dial indicator

3. Identify reaming inspection equipment used to verify if workpiece meets specifications.
   i) go/no go gauges
   ii) bore gauges
   iii) telescopic gauges

4. Identify knurling inspection equipment used to verify if workpiece meets specifications.
   i) sample piece
   ii) calipers
   iii) microscope

5. Identify types of facing tools and describe their applications and procedures for use.

6. Identify types of boring tools and describe their applications and procedure for use.

7. Identify types of threads, and describe their purpose, characteristics and applications.

8. Identify thread types and class of fit.
   i) metric
   ii) unified
   iii) acme
   iv) buttress
   v) left-handed
   vi) pipe

9. Identify the considerations and requirements for selecting equipment and tooling to complete specified job.

10. Identify methods used to cut threads and describe their associated procedures.

11. Identify techniques used to troubleshoot conventional lathe operations and describe their associated procedures.

12. Identify potential problems during facing work with a conventional lathe and describe their causes and solutions.
   i) chatter
   ii) tool wear
   iii) incorrect tool height setting
   iv) chip management

13. Identify potential problems during drilling with a conventional lathe and describe their causes and solutions.
    i) drill wandering
    ii) oversized hole
    iii) misalignment of tail stock/turret
    iv) damage to cutting tool
    v) chip management
    vi) incorrect drill geometry

14. Identify potential problems boring or turning with a conventional lathe and describe their causes and solutions.
    i) insufficient chip and tool clearance
    ii) chatter
    iii) tool deflection
    iv) taper
    v) run-out

15. Identify potential problems during reaming with a conventional lathe and describe their causes and solutions.
    i) chatter
    ii) oversized holes
    iii) misalignment of tail stock/turret
    iv) damage to cutting tool
    v) bell-mouth

16. Identify potential problems during knurling with a conventional lathe and describe their causes and solutions.
    i) galling
    ii) flaking
    iii) incorrect form
    iv) workpiece deflection
    v) insufficient lubrication
    vi) double cutting

17. Identify potential problems during parting off with a conventional lathe and describe their causes and solutions.
    i) chattering
    ii) galling
    iii) tool wandering
    iv) chip management
    v) tool misalignment
    vi) incorrect tool height

18. Describe the procedures used to set speeds and feeds.

19. Describe the procedures used to determine amount of materials required to complete specified jobs.

20. Describe the procedures used for facing work on a conventional lathe.

21. Describe the procedures used for centre drilling and drilling on a conventional lathe.

22. Describe the procedures used for installing and removing drills.

23. Describe the procedures used for boring work on a conventional lathe.

24. Describe the procedures used for counter boring and chamfering work on a conventional lathe.

25. Describe the procedures used for reaming work on a conventional lathe.

26. Describe the procedures used for installing and removing reamers.

27. Describe considerations to determine speed, feed and depth of cut for conventional lathe operations.

28. Describe the considerations to determine speed and feed for knurling operations.

29. Describe the procedures used to adjust, inspect and maintain conventional lathes alignment of tool.

30. Describe the procedures used to perform basic conventional lathe operations.
    - i) turning
    - ii) boring
    - iii) threading
    - iv) grooving
    - v) facing
    - vi) knurling
    - v) parting off
    - vi) reaming
    - vii) drilling
    - viii) taper turning

31. Calculate speed, feed and depth of cut.

Practical Objectives:

1. Perform basic turning operations.

MCH-170 Introduction to Milling Machines

Learning Outcomes:

- Demonstrate knowledge of milling machines, their accessories, attachments and applications.
- Demonstrate knowledge of conventional milling machines, their set up and procedures for use.
- Demonstrate knowledge of milling tools and their applications.

2018 Red Seal Occupational Standard Reference:

5.01 Cleans machines.
5.05 Maintains inspection equipment.
5.06 Maintains machine alignment.
14.01 Selects conventional milling types.
14.04 Sets up tooling for conventional milling machines.

Suggested Hours:

18 Hours

Theoretical Objectives:

1. Define terminology associated with conventional milling machines.

2. Identify hazards and describe safe work practices pertaining to conventional milling machines.

3. Identify types of conventional milling machines and describe their applications.
   i) vertical
   ii) horizontal
   iii) universal
   iv) horizontal boring mill
   v) jig borer

4. Identify types of tooling of conventional milling machines and describe their application.
   i) end mills
   ii) shell mills
   iii) indexible carbide tooling
   iv) boring bar
   v) face mills

5. Identify types of tool holding devices of conventional milling machines.
   i) drill chuck
   ii) collet chuck
   iii) end mill holders
   iv) shell mill holders
   v) boring heads

6. Identify types of work holding devices.

7. Identify the components and controls of conventional milling machines and describe their purpose and operation.

8. Identify types of materials used in milling construction and describe their characteristics.

9. Identify milling cutter failures and describe their causes and remedies.

10. Describe the procedures used to install and remove tooling and tool holding devices for conventional milling machines.

11. Describe climb and conventional milling.

Practical Objectives:

N/A

MCH-175 Machinable Material

Learning Outcomes:

- Demonstrate knowledge of materials, their applications and procedures for use.
- Demonstrate knowledge of methods used to mark stock and workpieces.

2018 Red Seal Occupational Standard Reference:

4.01 Selects workpiece material.
4.03 Marks workpiece for identification.

Suggested Hours:

9 Hours

Theoretical Objectives:

1. Define terminology associated with machinable materials.

2. Identify hazards and describe safe work practices pertaining to machining material.

3. Explain the operating principles of machining materials.
   i) metallic
   ii) non-metallic
   iii) specialty

4. Identify and interpret markings and documentation relating to material identification systems.
   i) identification systems
      - American Society of Mechanical Engineers (ASME)
      - American National Standards Institute (ANSI)
      - Society of Automotive Engineers (SAE)
      - Material Test Report (MTR)
      - colour coding (manufacturer specific)
      - number
   ii) documentation
      - mill certificates
   iii) required information
      - heat numbers
      - part numbers
      - composition
      - country of origin
      - trade name

- material

5. Identify coolants used with machinable materials and describe the considerations affecting their selection.

6. Identify types of materials and describe their characteristic pertaining to material.
   i) metallic
      - ferrous
      - non-ferrous
   ii) non-metallic
   iii) specialty
      - alloys
      - refractory metals
      - precious metals

7. Identify methods to mark stock and workpiece for identification.

8. Describe the properties of materials and their chemical, physical and mechanical characteristics.
   i) machinability
   ii) tensile strength
   iii) wear resistance
   iv) hardness

9. Describe the procedures used to set up and machine materials.

Practical Objectives:

N/A

MCH-180 Material Testing

Learning Outcomes:

- Demonstrate knowledge of material testing and its applications and procedures.

2018 Red Seal Occupational Standard Reference:

4.05 Performs quality control of workpiece.

Suggested Hours:

6 Hours

Theoretical Objectives:

1. Define terminology associated with material testing.

2. Identify hazards and describe safe work practices pertaining to material testing.

3. Identify the machines and scales used for hardness testing and describe their associated procedures.
   - i) rockwell
   - ii) brinell
   - iii) abrasion testing

4. Identify types of tests performed on materials and describe their applications.
   - i) destructive
     - tensile strength
     - impact
   - ii) non-destructive
     - x-ray
     - dye penetrant /liquid penetrant
     - magnetic particle
   - iii) spark
   - iv) file

5. Describe the purpose and application of material testing.
   - i) hardness
   - ii) composition
   - iii) properties

Practical Objectives:

N/A

MCH-185 Abrasive Finishing

Learning Outcomes:

- Demonstrate knowledge of abrasive finishing, its application and procedures for use.
- Demonstrate knowledge of safe work practices and procedures related to abrasives.
- Demonstrate knowledge of abrasive finishing techniques.

2018 Red Seal Occupational Standard Reference:

6.10 Finishes workpiece.

Suggested Hours:

6 Hours

Theoretical Objectives:

1. Define terminology associated with abrasive finishing.

2. Identify hazards and describe safe work practices pertaining to abrasive finishing.

3. Identify abrasive inspection equipment used to verify if workpiece meets specifications.
   i) precision square
   ii) surface finish comparators
   iii) profilometers

4. Identify types of abrasives and describe their characteristics and applications.

5. Identify types of materials and equipment used to lap and hone workpieces.

6. Identify types of materials and equipment used to buff and polish workpieces.

7. Identify types of finishing processes and describe their characteristics and applications.
   i) lapping
   ii) honing
   iii) deburring
   iv) polishing
   v) scraping
   vi) filing
   vii) stoning
   viii) burnishing

8. Identify types of material used to protect finished workpieces.

i) rust inhibitors
ii) paper
iii) crating
iv) packing

9. Identify lapping and honing techniques and describe their associated procedures.

10. Identify polishing and blending techniques and describe their associated procedures.

11. Identify potential problems during finishing processes and describe their causes and solutions.
    i) scratching
    ii) rounded edges
    iii) damage to hone
    iv) surface finish deficiencies

12. Describe the procedures used to shape or finish a workpiece using abrasive techniques.

Practical Objectives:

N/A

MCH-190 Introduction to Mechanical Components

Learning Outcomes:

- Demonstrate knowledge of mechanical components, their applications and procedures for use.
- Demonstrate knowledge of broaches and broaching equipment, their applications, set up and procedures for use.
- Demonstrate knowledge of safe work practices and procedures pertaining to broaching a workpiece.
- Demonstrate knowledge of procedures used to analyze components.

2018 Red Seal Occupational Standard Reference:

6.07 Broaches workpiece.
7.01 Disassembles components.
7.02 Analyzes components.

Suggested Hours:

12 Hours

Theoretical Objectives:

1. Define terminology associated with mechanical components.

2. Define terminology associated with broaches and broaching using equipment.

3. Identify hazards and describe safe work practices pertaining to broaches and broaching machines.

4. Explain the principles of stepped keys.

5. Explain the operating principles of hand broaching equipment.

6. Identify grades nuts and bolts and describe their characteristics and applications.

7. Identify inspection equipment used to inspect components.

8. Identify types of fasteners, retainers and locators and describe their characteristics and applications.
   i) bonds
   ii) nuts
   iii) dowel pins

iv) washers and spacers
v) studs
vi) snap rings
vii) bolts

9. Identify types of keys, keyseats and keyways and describe their characteristics and applications.
   i) square
   ii) woodruff
   iii) flat/rectangular
   iv) gib
   v) taper

10. Identify types of fits, clearances, tolerances and serviceable limits.

11. Identify types of mechanical components and describe their characteristics and applications.
   i) bearings
   ii) seals
   iii) adapters/bushings
   iv) gears and pulleys
   v) fasteners
   vi) shafts

12. Identify types of tools used in refurbishing and describe their procedures for use.
   i) pullers
   ii) hex keys
   iii) snap-ring Pliers
   iv) wrenches
   v) presses

13. Identify types of hand broaching equipment and describe their components and applications.

14. Identify types of tooling for broaching equipment and describe their applications.

15. Identify records of disassembly used during disassembling components.
   i) photos
   ii) sketches
   iii) notes

16. Identify components of inspection equipment used to verify if workpieces meet specifications.
   i) dial indicators

ii) bore gauges
iii) calipers
iv) micrometers
v) height gauges

17. Identify potential problems during broaching workpieces and describe their causes and solutions.
    i) jamming
    ii) breaking broach
    iii) tapered cuts

18. Describe the order of operations used to disassemble mechanical components.

19. Describe the procedures used to clean components.

20. Describe the procedures used to inspect components.

21. Describe the procedures used to prepare documentation.

22. Describe the procedures used to set up and operate hand broaching equipment.

23. Describe the procedures used to hand broach keyways.

24. Calculate and measure component features.

Practical Objectives:

N/A

MCH-195 Heating and Bending Processes

Learning Outcomes:

- Demonstrate knowledge of heating and bending processes used in machining operations and their applications.
- Demonstrate knowledge of work practices and procedures when forming workpiece.

2018 Red Seal Occupational Standard Reference:

6.09 Forms workpiece.

Suggested Hours:

12 Hours

Theoretical Objectives:

1. Define terminology associated with heating and bending processes.

2. Define terminology associated with bending equipment.

3. Identify hazards and describe safe work practices pertaining to heating and forming processes.

4. Identify types of heating equipment and describe their applications.
   i) oxy-fuel torches
   ii) propane torches
   iii) induction heaters

5. Identify heating processes and describe their characteristics and applications.

6. Identify types of bending equipment and describe their applications.

7. Identify types of work holding devices and describe their applications.
   i) vise
   ii) tongs
   iii) anvil
   iv) soft jaws
   v) C-clamps
   vi) parallel clamps

8. Identify bending processes and describe their characteristics and applications.

9. Identify potential problems during forming workpieces and describe their causes and solutions.
    i) excessive and insufficient heat
    ii) bending force and speeds

10. Identify oxy-fuel heating and cutting processes and describe their characteristics and applications.

11. Describe the procedures used to inspect and store heating and cutting equipment.

12. Describe the procedures used to perform heating applications.
    i) bending

13. Describe the procedures used to perform basic oxy-fuel cutting.

Practical Objectives:

1. Start up and shut down an oxy-fuel torch.

2. Perform a free-hand cut and bend with oxy-fuel.

Level 2

Unit Code	Title	Hours	Page Number
MCH-200	Heat Treatment	15	68
MCH-205	Reconditioning/Refurbishment	12	70
MCH-210	Surface Grinders	15	72
MCH-215	Precision Measurement II	6	75
MCH-220	Advanced Lathe Operation	57	76
MCH-225	Vertical Milling Machine Operation	60	79
MCH-230	Taper Turning	15	84
MCH-235	Introduction to CNC Programming	15	86
MCH-240	Introduction to CNC Machine Set Up	15	88
MCH-245	Introduction to CNC Machine Operation	30	91

MCH-200 Heat Treatment

Learning Outcomes:

- Demonstrate knowledge of materials, their applications and procedures for use.
- Demonstrate knowledge of heat treatment and its applications.
- Demonstrate knowledge of material testing and its applications and procedures.
- Demonstrate knowledge of quality inspection and its use.

2018 Red Seal Occupational Standard Reference:

4.01 Selects workpiece material.
4.04 Performs heat treatment.

Suggested Hours:

15 Hours

Theoretical Objectives:

1. Define terminology associated with heat treatment and material testing.

2. Identify hazards and describe safe work practices pertaining to heat treatment and material testing.

3. Explain the processing characteristics of materials.
   i) chemical
   ii) physical
   iii) mechanical

4. Identify methods used to determine the carbon content of steels.

5. Identify heat treatment processes and describe their applications.
   i) annealing
   ii) normalizing
   iii) hardening
   iv) tempering
   v) quenching
   vi) case hardening

6. Identify and interpret reference data used in heat treatment.
   i) charts
   ii) tables
   iii) machinery handbook

iv) steel manufacturers' specifications
v) ASME
vi) ANSI

7. Identify methods used for quenching steel and describe the properties of the steel produced by each.
   i) water hardening
   ii) brine hardening
   iii) oil hardening
   iv) air hardening

8. Identify methods used to heat treat metals and describe their associated procedures and equipment.
   i) flame
   ii) furnace/oven
   iii) pot type

9. Identify and interpret markings and documentation relating to material identification systems.
   i) American Society of Mechanical Engineers (ASME)
   ii) American National Standards Institute (ANSI)
   iii) Society of Automotive Engineers (SAE)
   iv) colour coding (manufacturer specific)
   v) number
   vi) Material Test Report (MTR)

10. Describe the procedures used to determine properties of metals.
   i) chemical
   ii) physical
   iii) mechanical

11. Describe the procedures used to check the hardness.
   i) abrasion testing
   ii) Rockwell
   iii) Brinell

Practical Objectives:

1. Perform a hardness test.

MCH-205 Reconditioning/Refurbishment

Learning Outcomes:

- Demonstrate knowledge of the procedures to refurbish mechanical components.

2018 Red Seal Occupational Standard Reference:

7.01 Dissembles components.
7.02 Analyses components.
7.03 Assembles components.

Suggested Hours:

12 Hours

Theoretical Objectives:

1. Interpret documentation pertaining to refurbishing components.

2. Identify tools used to assemble components.
   i) feeler gauges
   ii) wrenches
   iii) hex keys
   iv) snap-ring pliers
   v) presses
   vi) pullers

3. Identify types of materials used to fit and assemble components and describe their applications and procedures for use.
   i) adhesives
   ii) sealants
   iii) lubricants and lubricants systems

4. Identify inspection equipment used to inspect components.
   i) dial indicators
   ii) bore gauges
   iii) calipers
   iv) micrometers
   v) height gauges

5. Identify types of mechanical components and describe their assembly.
   i) bearings
   ii) seals

iii) threaded inserts
iv) adapters/bushings
v) gears and pulleys
vi) fasteners
vii) snap rings
viii) shafts
ix) bushings

6. Identify the types of component defects.
   i) breakage
   ii) cracks
   iii) excessive wear
   iv) damaged seals

7. Describe the procedures used to clean components.

8. Describe the procedures used to inspect components.

9. Describe the procedures used to prepare documentation.

10. Describe the procedures used to repair or replace mechanical components.

11. Describe the procedures used to fit and assemble components.

12. Describe the order of operations used to assemble components.

13. Identify techniques used to torque fasteners and describe their associated procedures.

14. Calculate and measure component features.

Practical Objectives:

N/A

MCH-210 Surface Grinders

Learning Outcomes:

- Demonstrate knowledge of grinding machines and accessories, and their applications.
- Demonstrate knowledge of electrical discharge machines and accessories and describe their applications.
- Demonstrate knowledge of surface grinders, their set up, maintenance and procedures for use.
- Demonstrate knowledge of safety practices and procedures related to surface grinders.

2018 Red Seal Occupational Standard Reference:

5.01 Cleans machines.
5.05 Troubleshoots equipment.
5.06 Maintains machine alignment.
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.
17.01 Grinds flat surfaces using a surface grinder.

Suggested Hours:

15 Hours

Theoretical Objectives:

1. Define terminology associated with grinding machines.

2. Identify hazards and describe safe work practices pertaining to surface grinding.

3. Interpret documentation pertaining to the material to be ground.

4. Identify types of grinding machines and accessories and describe their applications.

5. Identify types of electrical discharge machines and accessories and describe their applications.

6. Identify types of work holding devices and describe their applications and maintenance.
   i) chucks

ii) face plate
iii) fixtures
iv) magnetic chucks
v) angle plates
vi) precision vises

7. Identify types of wheel dressers and describe their applications.

8. Identify types of accessories used for surface grinding operations and describe their applications.

9. Identify sequence of grinding operations.

10. Identify techniques used to troubleshoot machines.

11. Identify potential set up problems and describe their causes and solutions.
    i) incorrect speeds and feeds
    ii) incorrect depth of cut
    iii) wheel glazing or loading
    iv) incorrect consistency of coolant

12. Describe the procedures used to set up grinding machine and accessories.

13. Describe the procedures used to align a workpiece and work holding devices of surface grinders.

14. Describe the procedures used to set up and mount wheels on surface grinders.

15. Describe the procedures used to true and dress grinding wheels of surface grinders.

16. Describe procedures used to balance grinding wheels.

17. Describe the procedures used to inspect, maintain and store grinding wheels.

18. Describe the procedures used to set up workpieces on surface grinders using accessories.

19. Describe the procedures used to check alignment of workpieces.

20. Describe the factors used to determine feed and depth of cut for grinding operations.
    i) wheel size
    ii) part dimensions
    iii) material

21. Describe the calculations used to determine speed.

22. Describe the procedures used to adjust and maintain surface grinding machines.

23. Describe the procedures used to perform surface grinding operations.

Practical Objectives:

N/A

MCH-215 Precision Measurement II

Learning Outcomes:

- Demonstrate knowledge of gauge blocks, their applications and procedures for use.
- Demonstrate knowledge of angular measurement and its use.

2018 Red Seal Occupational Standard Reference:

4.05 Performs quality control of workpiece.
13.06 Turns tapers using a conventional lathe.
14.05 Sets up milling accessories.
16.03 Sets up work holding devices for precision grinding machine.
16.06 Sets up workpiece on a precision grinding machine.

Suggested Hours:

6 Hours

Theoretical Objectives:

1. Explain the principles of angular measurement.

2. Identify types and grades of gauge blocks and describe their applications and procedures for use.
   i) metric
   ii) imperial

3. Calculate and perform gauge block build-ups.

4. Identify types of wear blocks and describe their purpose and application.

5. Identify universal bevel protractors and describe their applications and procedures for use.

6. Identify sine bars and describe their applications and procedures for use.

7. Identify compound sine plates and describe their applications and procedures for use.

8. Describe procedures used to maintain and store gauge blocks.

Practical Objectives:

N/A

MCH-220 Advanced Lathe Operation

Learning Outcomes:

- Demonstrate knowledge of conventional lathes, their set up and procedures for use.
- Demonstrate knowledge of procedures to perform advanced turning operations.
- Demonstrate knowledge of procedures to perform advanced boring operations.
- Demonstrate knowledge of procedures to perform advanced grooving operations.
- Demonstrate knowledge of advanced threads and multiple starts.
- Demonstrate knowledge of procedures to troubleshoot and maintain lathes.

2018 Red Seal Occupational Standard Reference:

5.01 Cleans machines.
5.05 Troubleshoots equipment.
5.06 Maintains machine alignment.
12.02 Plans operation of conventional lathe.
12.03 Set up work holding devices for conventional lathes.
12.04 Sets up tooling for conventional lathes.
12.05 Sets up conventional lathe accessories.
12.06 Sets up workpiece on conventional lathe.
13.02 Turns external surfaces using a conventional lathe.
13.04 Bores holes using a conventional lathe.
13.08 Cuts grooves using a conventional lathe.
13.09 Cuts threads using a conventional lathe.

Suggested Hours:

57 Hours

Theoretical Objectives:

1. Identify hazards and describe safe work practices pertaining to using a conventional lathe.

2. Identify tools required to set up work holding devices on lathes.

3. Identify conventional lathe tools and describe their applications.

4. Identify types of boring tools and describe their applications and procedures for use.

5. Identify types of threads, and describe their purpose, characteristics and applications.

6. Identify types of work holding devices and describe their applications.

7. Identify types of cutting tools and describe their applications.

8. Identify types of inspection equipment and describe their use.

9. Identify the cutting fluids and coolants used during conventional lathe operations.

10. Identify the components and controls of conventional lathes and describe their purpose and operation.

11. Identify conventional lathe accessories and describe their applications.

12. Identify methods used to cut threads and describe their associated procedures.
    i) slotted drive or faceplate
    ii) indexing of spindle gear
    iii) use of thread chasing dial
    iv) compound rest

13. Identify potential problems and describe their causes and solutions when turning external surfaces using a conventional lathe.

14. Identify potential problems and describe their causes and solutions when performing boring operations.
    i) insufficient chip and tool clearance
    ii) chatter
    iii) tool deflection
    iv) taper
    v) run-out

15. Identify potential problems and describe their causes and solutions when performing grooving operations.

16. Identify potential problems and describe their causes and solutions pertaining to work holding devices.

17. Identify potential set up problems and describe their causes and solutions pertaining to cutting tools.

18. Identify potential setup problems and describe their causes and solutions pertaining to conventional lathe accessories.

19. Identify the considerations and requirements for selecting conventional lathe tools and accessories for specific operations.

20. Describe the considerations to determine speed, feed and depth of cut for conventional lathe operations.
    i) reaming
    ii) drilling
    iii) tapping
    iv) die threading
    v) counterboring
    vi) countersinking

21. Describe the procedures used to set speeds and feeds.

22. Describe the procedures used for boring work on a conventional lathe.

23. Describe the procedures used for counterboring and chamfering work on a conventional lathe.

24. Describe the procedures used when grooving work on a conventional lathe.

25. Describe the procedures used to deburr a workpiece.

26. Describe the procedures used to check and measure threads using inspection equipment.

27. Describe the procedures used to set up work holding devices on lathes.

28. Describe the procedures used to set up eccentrics on conventional lathes.

29. Describe the procedures used to ensure parts run true.

Practical Objectives:

1. Machine a multi start acme thread.

2. Machine an eccentric shaft.

3. Perform an operation with a steady rest.

MCH-225 Vertical Milling Machine Operation

Learning Outcomes:

- Demonstrate knowledge of vertical conventional machines, their set up and procedures for use.
- Demonstrate knowledge of procedures to mill profiles and pockets.
- Demonstrate knowledge of procedures to perform drilling operations.
- Demonstrate knowledge of procedures to perform reaming operations.
- Demonstrate knowledge of procedures to cut countersinks, counterbores, chambers and spot faces.
- Demonstrate knowledge of procedures to bore holes.
- Demonstrate knowledge of procedures to troubleshoot and maintain vertical milling machines.

2018 Red Seal Occupational Standard Reference:

5.01 Cleans machines.
5.05 Troubleshoots equipment.
5.06 Maintains machine alignment.
14.01 Selects conventional milling machine types.
14.02 Plans operation of milling machine.
14.03 Sets up work holding devices for conventional milling machines.
14.04 Sets up tooling for conventional milling machines.
14.05 Sets up milling accessories.
14.06 Sets up workpieces on a conventional milling machine.
14.07 Selects conventional machine speeds and feeds.
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, chamfers and spot faces using a conventional milling machine.
15.08 Performs tapping using a conventional milling.
15.09 Bores holes using a conventional milling machine.

Suggested Hours:

60 Hours

Theoretical Objectives:

1. Define terminology associated with vertical conventional milling machines.

2. Identify hazards and describe safe work practices pertaining to vertical conventional milling machines.

3. Identify machines and accessories used for cutting gears and splines on vertical milling machines.
   i) dividing head
   ii) rotary table
   iii) footstock
   iv) arbor

4. Identify the tooling required for cutting gears and splines using vertical milling machines.
   i) involute cutter
   ii) tapered end mill
   iii) form tool

5. Identify the tooling required for drilling holes using vertical milling machines.
   i) centre drills
   ii) spot drills
   iii) drills
   iv) edge finders

6. Identify the tooling required for reaming on vertical milling machines.
   i) tapered reamer
   ii) rose reamer
   iii) straight reamer
   iv) expansion reamer

7. Identify types of vertical milling machine accessories and attachments and describe their applications.

8. Identify types of work holding devices and describe their applications.
   i) chucks
   ii) vises
   iii) dividing head
   iv) rotary table
   v) fixtures
   vi) clamping kits

9. Identify types of cutting tools and describe their applications.

10. Identify types of work holding devices on vertical milling machines.

11. Identify types of rotary tables and describe their construction, applications and procedures for use.

12. Identify cutting fluids and coolants used.

13. Identify accessories used for drilling holes using vertical milling machines.
    i) dividing head
    ii) rotary table
    iii) angle plates
    iv) parallels

14. Identify the components and controls of vertical milling machines and describe their purpose and operation.

15. Identify reaming allowance.

16. Identify the process to measure reamed hole.

17. Identify the considerations and requirements for selecting tools and accessories for milling operations with vertical milling machines.

18. Identify potential set up problems and describe their causes and solution with vertical milling machines.

19. Identify potential problems and describe their causes and solutions pertaining to milling operations on vertical machines.
    i) incorrect speeds and feeds
    ii) wrong depth of cut
    iii) incorrect cutter geometry
    iv) tool wear
    v) lack of lubrication
    vi) improper work holding device
    vii) tool deflection
    viii) backlash

20. Identify potential problems and describe their causes and solutions for drilling operations using vertical milling machines.

21. Identify potential problems and describe their causes and solutions, for reaming operations using vertical milling machines.

22. Identify calculations required to determine amount of excess material.

23. Describe the procedures used to perform milling operations on vertical milling machines.

24. Describe the procedures used to align vertical milling machines.

25. Describe the procedures used to set up vertical milling machines to perform milling operations.

26. Describe the procedures used to align workpiece on vertical milling machines.

27. Describe the procedures used to secure and align work holding devices on vertical milling machines.

28. Describe the procedures used to install tooling and tool holding devices on vertical milling machines.

29. Describe the procedures used to set up a workpiece on vertical milling machines.

30. Describe the procedures used to establish workpiece datums on vertical milling machines.

31. Describe the procedures and calculations used to perform milling operations on vertical milling machines.
    i) key seats
    ii) dovetails
    iii) t-slots

32. Describe the procedures used to set speeds and feeds on vertical milling machines.

33. Describe the considerations to determine speed and feed for vertical milling machines.

34. Describe the procedures used to mill profiles and pockets using vertical milling machines.

35. Describe the procedures used to perform drilling operations using vertical milling machines.

36. Describe the considerations to determine speed and feed to perform drilling operation with vertical milling machines.

37. Describe the procedures used to perform reaming operations on vertical milling machines.

Practical Objectives:

1. Machine a dovetail.
2. Machine a t-slot.
3. Machine a key seat.
4. Machine a bolt hole pattern.

MCH-230 Taper Turning

Learning Outcomes:

- Demonstrate knowledge of tapers and their applications.
- Demonstrate knowledge of procedures to turn papers using a conventional lathe.

2018 Red Seal Occupational Standard Reference:

5.01 Cleans machines.
5.05 Troubleshoots equipment.
5.06 Maintains machine alignment.
12.02 Plans operation of conventional lathe.
12.03 Set up work holding devices for conventional lathes.
12.04 Sets up tooling for conventional lathes.
12.05 Sets up conventional lathe accessories.
12.06 Sets up workpiece on conventional lathe.
13.06 Turns tapers using a conventional lathe.

Suggested Hours:

15 Hours

Theoretical Objectives:

1. Define terminology associated with taper turning.

2. Identify hazards and describe safe work practices pertaining to taper turning.

3. Identify types of tapers and describe their applications.
   i) self-holding taper
   ii) self-releasing tapers

4. Identify types of inspection equipment and describe their use.

5. Identify taper attachments and describe their applications and procedures for use.
   i) plain
   ii) telescopic

6. Identify the metric and imperial calculations required for tapers.

7. Identify methods used to check tapers and describe their associated procedures.
   i) plug gauge
   ii) parallels and pins

iii) ring gauge
iv) sine bar
v) layout lines
vi) dial indicator
vii) prussian blue
viii) digital read out
ix) micrometers

8. Identify methods used to turn tapers and describe their associated procedures.
   i) taper attachment
   ii) tailstock offset
   iii) compound rest
   iv) form tool

9. Identify potential problems and describe their causes and solutions when turning tapers.
   i) insufficient chip and tool clearance
   ii) chatter
   iii) tool deflection
   iv) incorrect taper
   v) run-out

10. Identify potential set up problems and describe their causes and solutions pertaining to turning tapers.

11. Describe the procedures used to ensure parts run true.

Practical Objectives:

N/A

MCH-235 Introduction to CNC Programming

Learning Outcomes:

- Demonstrate knowledge of Computer Numerical Control (CNC) machines, their set up, maintenance and procedures for use.
- Demonstrate knowledge of basic CNC programming.
- Demonstrate knowledge of transferring CNC programs.

2018 Red Seal Occupational Standard Reference:

18.01 Creates process documentation.
18.02 Creates manual input program.
18.03 Transfers program to and from control memory.

Suggested Hours:

15 Hours

Theoretical Objectives:

1. Interpret documentation pertaining to the machining of a workpiece.
   i) drawings
   ii) Computer-Aided Design (CAD) files
   iii) machine manuals
   iv) production plans/traveller

2. Identify CNC control units and describe their purpose.

3. Identify machine and work reference points and their location.

4. Identify types of programming codes and describe their applications.
   i) G-codes
   ii) M-codes
   iii) conversational

5. Identify types of coordinate systems and machine movements.
   i) coordinate systems
      - cartesian
      - polar

   ii) movements
      - linear
      - circular

- absolute
- incremental

6. Identify types of edit functions used and describe their applications.
   i) insert
   ii) alter
   iii) delete
   iv) copy
   v) paste
   vi) export

7. Describe the differences between centerline programming and cutter radius compensation (CRC) programming.

8. Describe the procedures used to transfer programs to and from the CNC machine and computer, network or storage device.

Practical Objectives:

N/A

MCH-240 Introduction to CNC Machine Set Up

Learning Outcomes:

- Demonstrate knowledge of CNC machines and tooling, their accessories, attachments and applications.
- Demonstrate knowledge of CNC machines, their set up, maintenance and procedures for use.
- Demonstrate knowledge of CNC programming.

2018 Red Seal Occupational Standard Reference:

19.01 Selects tooling and tool holders for CNC machines.
19.02 Sets up tooling and tool holders on CNC machines.
19.03 Sets up workpiece on CNC machines.
19.04 Establishes work datum.
19.05 Verifies program.

Suggested Hours:

15 Hours

Theoretical Objectives:

1. Define terminology associated with CNC machines and tooling.

2. Identify the hazards and describe safe work practices pertaining to CNC machines.

3. Identify CNC axes and describe the relationship between them.

4. Identify CNC control units and describe their purpose.

5. Identify types of CNC machines and tooling and describe their characteristics and applications.

6. Identify types of accessories and tool changers used with CNC machines and describe their applications.
   i) accessories
      - tail stock
      - steady rest
      - follower rest
   ii) mill/lathe tool changers
      - sequential
      - random

- fully-random

7. Identify types of tool holders and work holding devices used with CNC machines and describe their applications.
   i) vises
   ii) fixtures
   iii) clamps
   iv) soft jaws
   v) hard jaws
   vi) chucks
   vii) fixtures

8. Describe the procedures used to set up tooling and tool holders on CNC machines.

9. Describe methods for determining tool offsets.
   i) using feeler gauges
   ii) performing visual inspections

10. Describe the procedures used to set up workpieces in CNC machines.
   i) send/receive program
   ii) select and set up tooling and tool holder
   iii) dial tools
   iv) set up workpiece
   v) establish work datum
   vi) verify program

11. Describe the procedures used to touch off datum surfaces.

12. Describe the procedures used to input datum information.

13. Describe the procedures used to perform dry run or graphic simulation of a program.

14. Define features for stepping through a program.
   i) single block mode
   ii) distance to go
   iii) feed holds
   iv) feed and rapid override

15. Describe the procedures used to perform basic CNC programming.
   i) review process documentation
   ii) calculate coordinate for tool path
   iii) create coordinate for tool path
   iv) create basic program
   v) input program data into control memory

16. Describe the procedures for saving modified program into master file.

17. Describe the procedures used to perform basic preventative maintenance.

Practical Objectives:

N/A

MCH-245 Introduction to CNC Machine Operation

Learning Outcomes:

- Demonstrate knowledge of CNC machines, their maintenance and procedures for use.
- Demonstrate knowledge of calculations required to calculate deviations.
- Demonstrate knowledge of CNC machine operations.
- Demonstrate knowledge of CNC programming and operations.

2018 Red Seal Occupational Standard Reference:

4.05 Performs quality control of workpiece**.**
5.01 Cleans machines.
5.05 Troubleshoots equipment.
5.06 Maintains machine alignment.
20.01 Adjusts offsets.
20.02 Monitors machining process.
20.03 Interrupts program cycle.
20.04 Restarts program cycle.

Suggested Hours:

30 Hours

Theoretical Objectives:

1. Identify hazards and describe safe work practices pertaining to CNC machines.

2. Identify issues with operating conditions.
   i) sound
   ii) vibrations
   iii) abnormal chip formations
   iv) chip evacuation

3. Identify CNC-related reference points and their location.

4. Identify levels of urgency requiring a type of stop.

5. Describe the procedures used to operate CNC machines.
   i) visual inspection
   ii) reading spindle load meter
   iii) drive axis load meters
   iv) checking surface finish

6. Describe the procedures used to adjust offsets.

7. Describe the procedures used to inspect and maintain CNC machines.

8. Describe control features.
   i) single block mode
   ii) feed override
   iii) feed hold
   iv) reset

9. Describe the procedures used to restart program.

10. Describe the different methods used to produce CNC programming.
   i) manual
   ii) conversational
   iii) CAM (Computer Aided Manufacturing)

11. Calculate deviations from specifications.

Practical Objectives:

1. Operate a CNC mill and lathe to produce a part.

Level 3

Unit Code	Title	Hours	Page Number
MCH-300	Cutting Tools	15	94
MCH-305	Advanced Grinding	30	96
MCH-310	Horizontal/Universal Conventional Milling Machine Set Up	18	99
MCH-315	Horizontal/Universal Conventional Milling Machine Operation	24	102
MCH-320	CNC Programming II	48	104
MCH-325	CNC Set Up/Operation II	45	106

MCH-300 Cutting Tools

Learning Outcomes:

- Demonstrate knowledge of cutting tools, their applications, and procedures for use.
- Demonstrate knowledge of tool geometry and its use.
- Demonstrate knowledge of procedures to sharpen tooling.

2018 Red Seal Occupational Standard Reference:

5.03 Sharpens tooling.

Suggested Hours:

15 Hours

Theoretical Objectives:

1. Define terminology associated with cutting tools.

2. Identify hazards and describe safe work practices pertaining to cutting tools.

3. Explain the principles of chip formation.

4. Explain tool geometry and its purpose.
   i) chip breaker
   ii) clearance and angle

5. Identify types of cutting tools and describe their characteristics and applications.
   i) indexible insert
   ii) High Speed Steel (HSS)
   iii) brazed carbide

6. Identify types of cutting tool materials and describe their applications and procedures for use.
   i) High Speed (HSS)
   ii) carbide
   iii) cobalt
   iv) ceramic

7. Identify types of carbide tool holding devices and describe their applications.

8. Identify carbide tool failures and describe their causes and remedies.

9. Interpret the systems for the identification of carbide inserts/coatings and tool holders.

10. Describe the procedures used to sharpen cutting tools.
    i) American National Standards Institute (ANSI)
    ii) International System of Units (SI)

11. Describe the effect of carbide cutting tools on speed, feed and depth of cut.

Practical Objectives:

N/A

MCH-305 Advanced Grinding

Learning Outcomes:

- Demonstrate knowledge of grinders, their setup, maintenance and procedures for use.
- Demonstrate knowledge of grinding wheels, their applications, maintenance and procedures for use.
- Demonstrate knowledge of cylindrical grinders, their setup, maintenance and procedures for use.
- Demonstrate knowledge of safety practices and procedures related to cylindrical grinding.
- Demonstrate knowledge of cylindrical grinding wheels, their applications, maintenance and procedure for use.
- Demonstrate knowledge of grinding wheels, their applications, maintenance and procedures for use.
- Demonstrate knowledge of honing machines, their setup, maintenance and procedures for use.
- Demonstrate knowledge of special (form) grinding operations.

2018 Red Seal Occupational Standard Reference:

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 machines speeds and feeds.
17.02 Grinds profile.
17.03 Grinds internal and external cylindrical and tapered surfaces.
17.04 Grinds tools and cutters.
17.05 Finishes holes using a honing machine.

Suggested Hours:

30 Hours

Theoretical Objectives:

1. Identify hazards and describe safe work practices pertaining to cylindrical grinding.

2. Identify types of grinding wheels and describe their characteristics and applications.
   i) abrasive
   ii) grain
   iii) grade

iv) structure
v) bond

3. Identify types of wheel dressers and describe their applications.

4. Identify types of cylindrical grinding wheels and describe their characteristics and applications.

5. Identify types of wheel dressers and describe their applications.
   i) dressing stick (stone)
   ii) diamond dressing tool
   iii) angle/radius dresser

6. Identify types of tool and cutter grinding wheels and describe their characteristics and applications.
   i) cup
   ii) saucer
   iii) plain
   iv) dish
   v) tapered

7. Identify types of honing machines, their setup and maintenance.
   i) horizontal
   ii) vertical
   iii) CNC

8. Identify types of tooling required for honing.

9. Identify honing techniques and describe their associated procedures.

10. Identify techniques used to troubleshoot profile grinding operations and describe their associated procedures.

11. Identify the considerations and requirements for selecting a grinding wheel for profile grinding.
   i) operations
   ii) type of finish

12. Identify the considerations and requirements for selecting a grinding wheel for cylindrical grinding.

13. Identify the considerations and requirements for selecting a grinding wheel for tool and cutting grinding.
   i) end mills grinding

ii) plain cutter grinding
iii) reamers grinding
iv) form relief cutters
v) angle grinding
vi) special form

14. Identify potential problems and describe their causes and solutions pertaining to honing.
    i) bell mouth
    ii) lack of cylindricity
    iii) chatter
    iv) lack of lubrication
    v) glazing

15. Describe the procedures used to true and dress grinding wheels.

16. Describe the procedures used to calculate the amount of excess material.

17. Describe the procedures used to grind profiles.

18. Describe the procedures used to align workpieces.

19. Describe the procedures used to perform cylindrical grinding operations.

20. Describe the procedures used to calculate feed and depth of cut.

21. Describe the procedures used to inspect and maintain cylindrical grinding machines.

22. Describe the procedures used to mount and balance cylindrical grinding wheels.

23. Describe the procedures used to inspect, maintain and store cylindrical grinding wheels.

24. Describe the procedures used to set up tool and cutter grinders and accessories.

25. Describe the procedures used to align centers on cylindrical grinder.

26. Describe tool and cutter geometry.

27. Describe the procedures used to inspect, maintain and store tool and cutting grinding wheels.

Practical Objectives:

N/A

MCH-310 Horizontal/Universal Conventional Milling Machine Set Up

Learning Outcomes:

- Demonstrate knowledge of horizontal/universal conventional milling machines, their setup and procedures for use.
- Demonstrate knowledge of procedures to mill surfaces.
- Demonstrate knowledge of procedures to troubleshoot and maintain horizontal/universal milling machines.

2018 Red Seal Occupational Standard Reference:

4.05 Performs quality control of workpiece.
5.05 Troubleshoots equipment.
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.
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.

Suggested Hours:

18 Hours

Theoretical Objectives:

1. Identify hazards and describe safe work practices pertaining to horizontal/universal conventional milling machines.

2. Identify types of tool holding devices and describe their applications.
   i) drill chuck
   ii) collet chuck
   iii) end mill holders
   iv) shell mill holders
   v) arbors
   vi) boring head

3. Identify types of work holding devices and describe their applications.
   i) chucks
   ii) vises
   iii) dividing head
   iv) rotary table
   v) fixtures
   vi) clamping kits

4. Identify types of cutting tools and describe their applications.

5. Identify types of rotary tables and describe their construction, applications and procedures for use.

6. Identify types of dividing heads and describe their characteristics and applications.

7. Identify potential setup problems and describe their causes and solutions.

8. Identify the considerations and requirements for selecting tools and accessories for milling operations.

9. Identify the considerations and requirements used for selecting tooling and tool holding devices for milling operations.

10. Identify the considerations and requirements used for selecting accessories for milling operations.
    - i) dividing head
    - ii) rotary table
    - iii) angle plates
    - iv) parallels
    - v) edge finder

11. Identify methods of indexing.
    - i) simple
    - ii) plain
    - iii) angular
    - iv) differential

12. Identify the considerations and requirements used for setting up a workpiece.

13. Describe the procedures used to mill surfaces on horizontal/universal conventional milling machines.
    - i) facing
    - ii) straddle
    - iii) gang

14. Describe the procedures used to align horizontal/universal conventional milling machine heads and table.

15. Describe the procedures used to set up horizontal/universal conventional milling machines to prepare for milling operations.
    - i) contouring
    - ii) facing

iii) keyways
iv) straddle
v) gang
vi) T-slot
vii) end milling
viii) slitting
ix) slotting
x) dovetail
xi) boring
xii) drilling

16. Describe the procedures used to align workpieces.

17. Describe the procedures used to secure and align work holding devices.

18. Describe the procedures used to install tooling and tool holding devices.

19. Describe the procedures used to set up a workpiece.

20. Describe the procedures used to establish workpiece datums.

21. Describe the considerations used to determine speed, feed and depth of cut for milling machine operations.

22. Interpret tables and charts of speeds and feeds.

23. Calculate speed, feed and depth of cut.

Practical Objectives:

N/A

MCH-315 Horizontal/Universal Conventional Milling Machine Operation

Learning Outcomes:

- Demonstrate knowledge of horizontal/universal conventional milling machines, their setup and procedures for use.
- Demonstrate knowledge of procedures to mill surfaces using horizontal/universal conventional milling machines.
- Demonstrate knowledge of procedures to mill profiles and pockets.
- Demonstrate knowledge of procedures to mill slots, grooves and keyways.
- Demonstrate knowledge of procedures to bore holes.
- Demonstrate knowledge of procedures to troubleshoot and maintain horizontal/universal milling machines.
- Demonstrate knowledge of gears and splines, their purpose and use.

2018 Red Seal Occupational Standard Reference:

4.05 Performs quality control of workpiece.
5.05 Troubleshoots equipment**.**
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.
15.09 Bores holes a conventional milling machine.

Suggested Hours:

24 Hours

Theoretical Objectives:

1. Define terminology associated with gears and splines.

2. Identify hazards and describe safe work practices pertaining to gears and splines.

3. Identify cuttings fluids and coolants used.

4. Identify tooling required for milling operations.
   i) centre drills
   ii) drills
   iii) boring heads
   iv) indexable tooling
   v) boring bar
   vi) milling cutters

5. Identify accessories used for milling operations.

6. Identify procedures to produce spur gears.

7. Identify procedures to perform gear tooth measurement.

8. Identify calculations required to determine amount of excess material.

9. Describe the procedures used to perform milling operations.
   - i) facing
   - ii) straddle
   - iii) gang
   - iv) contouring
   - v) pocketing
   - vi) plunging
   - vii) keyways
   - viii) t-slot
   - ix) slitting
   - x) slotting
   - xi) dovetail

10. Identify potential problems and describe their causes and solutions.
   - i) incorrect speeds and feeds
   - ii) wrong depth of cut
   - iii) incorrect cutter geometry
   - iv) tool wear
   - v) lack of lubrication
   - vi) improper work holding device
   - vii) tool deflection
   - viii) backlash
   - ix) chip evacuation

11. Describe the considerations to determine speed and feed.

12. Describe the procedures used to set speeds and feeds.

13. Describe the process to determine feature size according to specifications.

Practical Objectives:

N/A

MCH-320 CNC Programming II

Learning Outcomes:

- Demonstrate knowledge of CNC programming.
- Demonstrate knowledge of geometry creation.
- Demonstrate knowledge of Computer-Aided Manufacturing (CAM) software.

2018 Red Seal Occupational Standard Reference:

14.07 Selects conventional milling machine speeds and feeds.
18.01 Creates process documentation.
18.02 Creates manual input program.
18.04 Optimizes program.
18.05 Creates 2D and 3D models.
18.06 Programs using computer-aided manufacturing (CAM).

Suggested Hours:

48 Hours

Theoretical Objectives:

1. Identify the hazards and describe safe work practices pertaining to CNC machines.

2. Identify dimensioning tools in CAD software.

3. Identify CAM software work reference points and their location.
   i) viewing plane
   ii) construction plane
   iii) tool plane

4. Identify cutting tools in CAM software library.

5. Identify machine post processors in CAM software.

6. Identify types of programming codes and describe their applications.
   i) G-codes
      - canned cycles
      - repetitive cycles
   ii) M-codes
   iii) coordinates
      - polar
      - circular
      - linear

7. Identify types of CAM operations and tool paths.

8. Identify potential setup problems and describe their causes and solutions.

9. Describe the procedures used to calculate speed, feed and depth of cuts.

10. Describe the procedures used to perform manual CNC programming.
    i) turning center
        - external/internal turning
        - grooving /part-off
        - drilling
        - threading/tapping
    ii) machining center
        - facing
        - contouring
        - pocketing
        - drilling
        - tapping

11. Describe process to create geometry using Computer-Aided Design (CAD) software.
    i) lines
    ii) arcs
    iii) points
    iv) surfaces
    v) solids

Practical Objectives:

1. Create a basic program for milling and turning.

2. Create a basic 2-dimension CAD/CAM drawing.

MCH-325 CNC Set Up/Operation II

Learning Outcomes:

- Demonstrate knowledge of CNC machines and tooling, their accessories, attachments and applications.
- Demonstrate knowledge of CNC machines, their setup, maintenance and procedures for use.
- Demonstrate knowledge of calculations required to calculate deviations.

2018 Red Seal Occupational Standard Reference:

4.05 Performs quality control of workpiece**.**
5.05 Troubleshoots equipment.
19.01 Selects tooling and tool holders for CNC.
19.02 Sets up tooling and tool holders on CNC machines.
19.03 Sets up workpieces on CNC machines.
19.04 Establishes work datum.
20.01 Adjusts offsets.

Suggested Hours:

45 Hours

Theoretical Objectives:

1. Define terminology associated with CNC machines and tooling.

2. Identify hazards and describe safe work practices pertaining to CNC machines.

3. Identify types of CNC machines and tooling and describe their characteristics and applications.

4. Identify CNC axes and describe the relationship between them.

5. Identify CNC control units and describe their purpose.

6. Describe the procedures used to set up tooling and tool holders on CNC machines.

7. Describe methods for determining tool offsets.
   i) using tool presetters
   ii) touching off tool on workpiece surface
   iii) measuring and cutting tools
   iv) probing

8. Describe the procedures used to set up workpieces in CNC machines.

9. Describe the procedures used to touch off datum surfaces.

10. Describe the procedures used to input datum information.

11. Describe the procedures used to operate CNC machines.

12. Describe the procedures used to adjust offsets.

13. Calculate deviations from specifications.

Practical Objectives:

1. Set up a workpiece on a CNC lathe and milling machine.

2. Perform a tool and work offset.

Level 4

Unit Code	Title	Hours	Page Number
MCH-400	Gears and Gear Cutting	45	110
MCH-405	Quality Inspection	15	112
MCH-410	CNC Programming III	45	114
MCH-415	CNC Set Up/Operation III	39	116
MCH-420	Job Planning	30	117
MENT-701	Mentoring II	6	119
MCH-430	Program Review	30	120

MCH-400 Gears and Gear Cutting

Learning Outcomes:

- Demonstrate knowledge of gears and splines, their characteristics and applications.
- Demonstrate knowledge of procedures to cut gears and splines using a conventional milling machine.
- Demonstrate knowledge of gear measurement.

2018 Red Seal Occupational Standard Reference:

4.05 Performs quality control workpiece.
14.05 Sets up milling accessories.
15.04 Cuts gears and splines using a conventional milling machine.

Suggested Hours:

45 Hours

Theoretical Objectives:

1. Define terminology associated with gears and splines.

2. Explain the principles of gears and splines and describe their purpose and operation.

3. Identify hazards and describe safe work practices pertaining to gear, splines and gear cutting.

4. Identify tooling required for cutting gears and splines.

5. Identify machines and accessories used for cutting gears and splines.

6. Identify cutting fluids and coolants used.

7. Identify types of rotary tables and describe their construction, applications and procedures for use.

8. Identify types of dividing heads and describe their characteristics and applications.

9. Identify types of gears and splines and describe their characteristics and applications.
   i) gears
      - bevel
      - worm
      - helical

ii) splines
- straight-tooth
- involute-tooth

10. Identify the considerations and requirements used for selecting accessories for milling operations.

11. Identify potential problems and describe their causes and solutions.

12. Describe the procedures used to perform milling operations.

13. Describe the considerations to determine speed and feed.

14. Describe the procedures used to set speeds and feeds.

15. Describe the procedures used to cut gears and splines using a conventional milling machine.

16. Describe the procedures used to measure gear tooth and splines.

17. Identify calculations required to perform gear and gear cutting calculations.
    i) excess material
    ii) cutting requirements
    iii) simple and compound gear trains

Practical Objectives:

1. Machine a gear.

MCH-405 Quality Inspection

Learning Outcomes:

- Demonstrate knowledge of quality inspection.
- Demonstrate knowledge of coordinate measuring machines (CMM), their applications for use.

2018 Red Seal Occupational Standard Reference:

1.01 Maintains safe work environment.
4.05 Performs quality control of workpiece.

Suggested Hours:

15 Hours

Theoretical Objectives:

1. Define terminology associated with quality inspection.
   i) basic dimension
   ii) limits
   iii) tolerances
   iv) allowances

2. Identify types of precision gauges used in quality inspection and describe their applications and procedures for use.
   i) fixed
   ii) cylindrical
   iii) ring
   iv) taper
   v) snap
   vi) thread

3. Identify types of precision measuring tools used in quality inspection and describe their applications and procedures for use.
   i) micrometers
   ii) calipers
   iii) CMM
   iv) bevel protractor
   v) sine bar
   vi) gauge blocks
   vii) master height gauge

4. Identify types of comparators and describe their applications and procedures for use.

i) mechanical
ii) electronic
iii) optical
iv) pneumatic

5. Identify types of CMMs and describe their components, applications and procedures for use.

6. Describe the procedures used to inspect workpieces.

7. Describe the Cartesian coordinate system, its purpose and applications.

Practical Objectives:

N/A

MCH-410 CNC Programming III

Learning Outcomes:

- Demonstrate knowledge of CNC programming.
- Demonstrate knowledge of geometry creation.
- Demonstrate knowledge of CAM software.

2018 Red Seal Occupational Standard Reference:

18.04 Optimizes program.
18.05 Creates 2D and 3D models.
18.06 Programs using computer-aided manufacturing (CAM).

Suggested Hours:

45 Hours

Theoretical Objectives:

1. Identify hazards and describe safe work practices pertaining to CNC machines.

2. Identify cutting tools in CAM software library.

3. Identify types of programming codes and describe their applications.
   i) G-codes
   ii) M-codes

4. Identify machine post processors in CAM software.

5. Identify types of CAM operations and tool paths.

6. Describe the procedures used to perform CNC programming.
   i) boring
   ii) threading
   iii) grooving

7. Describe process to create geometry using CAD software.
   i) lines
   ii) arcs
   iii) points
   iv) surfaces
   v) solids

8. Describe the procedures used to perform manual and CAM CNC programming.
   i) turning center
      - external/internal turning
      - grooving /part-off
      - drilling
      - threading/tapping
   ii) machining center
      - facing
      - contouring
      - pocketing
      - drilling
      - tapping

Practical Objectives:

1. Create a 3-dimension model.

2. Create a basic CAM program.

MCH-415 CNC Set Up/Operation III

Learning Outcomes:

- Demonstrate knowledge of CNC machines, their setup, maintenance and procedure for use.
- Demonstrate knowledge of CNC machines and their procedures for use.
- Demonstrate knowledge of calculations required to calculate deviations.

2018 Red Seal Occupational Standard Reference:

4.05 Performs quality control of workpiece**.**
19.03 Sets up workpieces on CNC machines.
20.01 Adjusts offsets.

Suggested Hours:

39 Hours

Theoretical Objectives:

1. Identify hazards and describe safe work practices pertaining to CNC machines.

2. Identify CNC control units and describe their purpose.

3. Describe the procedures used to set up workpieces in CNC machines.

4. Describe the procedures used to operate CNC machines.

5. Describe the procedures used to adjust offsets.

6. Calculate deviations from specifications.
   i) design
   ii) standards
   iii) client
   iv) industry
   v) manufacturers'
   vi) drawings

Practical Objectives:

1. Produce a basic part on a mill and lathe machine.

MCH-420 Job Planning

Learning Outcomes:

- Demonstrate knowledge of the procedures used to plan and organize jobs.

2018 Red Seal Occupational Standard Reference:

2.01 Interprets documentation.
2.02 Plans sequence of operations.

Suggested Hours:

30 Hours

Theoretical Objectives:

1. Identify sources of information relevant to job planning.
    i) documentation
        - work orders/shop orders
        - technical data
        - reference materials
    ii) drawings
    iii) related professionals
    iv) clients
    v) quality standards
        - International Standards Organization (ISO)

2. Interpret and complete relevant trade documentation.

3. Interpret advanced drawings specifications.
    i) tolerance
    ii) finish requirements
    iii) geometric dimensioning and tolerancing

4. Describe effective information gathering and communication techniques.
    i) questioning
    ii) translating technical information
    iii) using communication equipment

5. Identify the considerations and requirements when planning jobs and job tasks.
    i) materials
    ii) machines and tooling
    iii) sequence of work
    iv) clean-up

6. Identify the considerations and requirements for selecting machines and tooling to complete specified jobs.

7. Calculate cutting time requirements.

8. Calculate materials and costs required to complete specified jobs.

Practical Objectives:

N/A

MENT-701 Mentoring II

Learning Outcomes:

- Demonstrate knowledge of effective communication practices as a mentor.
- Demonstrate knowledge of strategies for teaching workplace skills.

Red Seal Occupational Standard Reference:

3.01 Uses communication techniques
3.02 Uses mentoring techniques

Suggested Hours:

6 hours

Theoretical Objectives:

1. Identify the different roles played by a workplace mentor.

2. Identify strategies to create a supportive learning environment.

3. Identify techniques for effective communication as a mentor.
   i) constructive feedback
   ii) active listening
   iii) leading meetings and one-on-one sessions

4. Describe the steps in teaching a skill.
   i) identifying the point of lesson
   ii) linking the lesson
   iii) demonstrating the skill
   iv) providing practice
   v) giving feedback
   vi) assessing skill and progress

5. Identify strategies to assist in teaching a skill while meeting individual learning needs.
   i) principles of instruction
   ii) coaching skills

6. Explain how to adjust a lesson for various situations.

MCH-430 Program Review

Learning Outcomes:

- Demonstrate knowledge of the Red Seal Occupational Standard (RSOS) and its relationship to the Red Seal Examination.
- Demonstrate knowledge of overall comprehension of the trade in preparation for the Red Seal Examination.

2018 Red Seal Occupational Standard Reference:

N/A

Suggested Hours:

30 Hours

Theoretical Objectives:

1. Define terminology associated with a Red Seal Occupational Standard (RSOS).
   i) major work activities (MWA)
   ii) tasks
   iii) sub-tasks

2. Explain how a RSOS is developed and the link it has to the Red Seal Examination.
   i) development
   ii) validation
   iii) MWA and task weighting
   iv) examination breakdown

3. Identify Red Seal products and describe their use when preparing for the Red Seal Examination.
   i) Red Seal website
   ii) examination preparation guide
   iii) sample questions
   iv) self-assessment
   v) examination breakdown
   vi) types of exam questions
   vii) acronyms
   viii) mathematical formulas (if applicable)

4. Explain the relationship between the RSOS and the Curriculum Standard.

5. Review Common Occupational Skills for the Machinist trade as identified in the RSOS.

i) safety-related tasks
ii) organize work
iii) communication and mentoring
iv) workplace material
v) machines, tooling and inspection equipment

6. Review the process to perform benchwork trade activities for the Machinist trade as identified in the RSOS.
i) hand process
ii) refurbish components

7. Review the process to machine using power saws for the Machinist trade as identified in the RSOS.
i) set up power saws
ii) operate power saws

8. Review the process to machine using drill presses for the Machinist trade as identified in the RSOS.
i) set up drill presses
ii) operate drill presses

9. Review the process to machine using conventional lathes for the Machinist trade as identified in the RSOS.
i) set up conventional lathes
ii) operate conventional lathes

10. Review the process to machine using conventional milling machines for the Machinist trade as identified in the RSOS.
i) set up conventional milling machines
ii) operate conventional milling machines

11. Review the process to machine using precision grinding machines for the Machinist trade as identified in the RSOS.
i) set up precision grinding machines
ii) operate precision grinding machines

12. Review the process to machine using computer numerical control (CNC) machines for the Machinist trade as identified in the RSOS.
i) performs CNC programming
ii) set up CNC machines
iii) operate CNC machines

Practical Objectives:

N/A

Feedback and Revisions

This AACS will be amended periodically; comments or suggestions for improvements should be directed to:

New Brunswick:
Apprenticeship and Occupational Certification
Post-Secondary Education, Training and Labour
470 York St., Rm. 110, PO Box 6000
Fredericton, NB E3B 5H1
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Prince Edward Island:
Apprenticeship, Training and Certification
Atlantic Technology Centre
212-176 Great George St., PO Box 2000
Charlottetown, PE C1A 7N8
Tel: 902-368-4460
www.apprenticeship.pe.ca

Newfoundland and Labrador:
Apprenticeship and Trades Certification
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Confederation Bldg., West Block
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St. John's, NL A1B 4J6
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Toll Free in NS: 1-800-494-5651
www.nsapprenticeship.ca

Any comments or suggestions received will be reviewed and considered to determine the course of action required. If the changes are deemed to be minor, they will be held for implementation during the next review cycle. If immediate change is deemed appropriate and approved by the Atlantic Trade Advisory Committee, it will result in a revision to this version of the AACS and will be detailed in the following section.

Version Changes

Revision Date	Section	Description of Change
May 2024	Levels 1 and 4	Integration of MENT-700 Mentoring I and MENT-701 Mentoring II