

Machinist

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Foreword

The Canadian Council of Directors of Apprenticeship (CCDA) recognizes this Interprovincial Program Guide (IPG) as the national curriculum for the occupation of Machinist.

Jurisdictions have long recognized the benefit of pooling resources in the development and maintenance of apprenticeship training standards. A successful example of this is the Interprovincial Standards Red Seal Program itself. Essential to the establishment of standards is the development of suitable training systems and programs which enable tradespeople to acquire certification based on these standards. While certification is the responsibility of Apprenticeship administrators throughout Canada, the development and delivery of technical training is the responsibility of jurisdictions.

In 1999, work to develop common training for apprenticeship programs within the Atlantic Provinces began. To date, 22 Curriculum Standards have been developed through the Atlantic Standards Partnership (ASP) project to assist programming staff and instructors in the design and delivery of technical training. Similarly, the CCDA embarked on a process for the development of national IPGs for the Boilermaker, Carpenter and Sprinkler System Installer trades. At its January 2005 strategic planning session, the CCDA identified developing common training standards as one of the key activities in moving towards a more cohesive apprenticeship system.

With the support of Human Resources and Skills Development Canada (HRSDC), several provinces and territories have partnered to build on the ASP and the CCDA processes to further develop IPGs to be used across the country. This partnership will create efficiencies in time and resources and promote consistency in training and apprentice mobility.

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Steve Jubinville	Prince Edward Island
Winston Manuel	Newfoundland and Labrador
Jake Shaw	Prince Edward Island

In addition to the representatives above, various federal, provincial and territorial representatives contributed to the development of this document including the host province of Nova Scotia.

In 2011, a review, update and jurisdictional validation of this IPG were completed to ensure adequate coverage of the occupation as outlined in the 2010 National Occupational Analysis (NOA).

As this program guide will be amended periodically, comments or suggestions for improvement should be directed to:

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Table of Contents

Foreward	2
Acknowledgements	3
User Guide	5
IPG Glossary of Terms	7
Essential Skills Profiles	9
Profile Chart.....	10
Recommended Level Structure.....	12
2010 NOA Sub-Task to IPG Unit Comparison	13

PROGRAM CONTENT

Level 1.....	21
Level 2.....	40
Level 3.....	56
Level 4.....	70

User Guide

According to the Canadian Apprenticeship Forum, the IPG is: "a list of validated technical training outcomes, based upon those sub-tasks identified as common core in the NOA, and validated by industry in the provinces and territories as incorporating the essential tasks, knowledge and skills associated with a given trade."

Learning outcomes contained in the IPG represent the minimum common core content for the development of jurisdictional training standards and outlines. IPGs are developed based on the NOAs and extensive industry consultation. The IPG is intended to assist program development staff in the design of jurisdictional plans for training. Each jurisdiction has the flexibility to add additional content.

The IPG was deliberately constructed for ease of use and flexibility of structure in order to adapt to all delivery requirements. It details units of training, unit outcomes and objectives. It does 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 IPG does not dictate study materials, textbooks or learning activities to be used in delivery.

The IPG document includes a recommended levelling structure to facilitate mobility for apprentices moving from one jurisdiction to another. Because of difference in jurisdictional regulations and program durations, levels are offered as suggestions only.

Structure

The IPG is divided into units. The unit codes are used as a means of identification and are not intended to convey the order of delivery. Prerequisites have not been detailed. Each unit consists of *Learning Outcomes* and *Objectives and Content*.

The *Learning Outcomes* are the specific performances that must be evaluated. Wording of the learning outcomes, "Demonstrate knowledge of...", acknowledges the broad spectrum of ways in which knowledge can be shown. It is at the discretion of each jurisdiction to determine the manner in which learning outcomes are evaluated; theoretically, practically or a combination of both.

User Guide (continued)

The *Objectives and Content* for the unit details the information to be covered in order to achieve the performances specified in the *Learning Outcomes*. These objectives can be either theoretical or practical in nature, based on the requirements identified through the industry consultation process. The learning activities used to cover the objectives are at the discretion of the jurisdiction; however, practically worded objective statements have been used where industry indicated a need for the apprentices to receive exposure to performing the task or skill outlined while attending technical training. For example, this exposure could be done through instructor demonstration or individual or group performance of the skill or task. This practical training will help to reinforce the theoretical component of the technical training.

Detailed content for each objective has not been developed. Where detail is required for clarity, content has been provided. The content listed within the IPG document is **not** intended to represent an inclusive list; rather, it is included to illustrate the intended direction for the objective. Content may be added or extended in jurisdictional training plans as required.

Jurisdictions are free to deliver the IPG units one at a time or concurrently, provided that all *Learning Outcomes* are met. The IPG does not indicate the amount of time to be spent on a particular unit as the length of time required to deliver the *Learning Outcomes* successfully will depend upon the learning activities and teaching methods used.

IPG Glossary of Terms

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

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 you 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.

IPG Glossary of Terms *(continued)*

TECHNIQUE	Within a procedure, the manner in which technical skills are applied.
TEST	<p>v. To subject to a procedure that ascertains effectiveness, value, proper function, or other quality.</p> <p>n. A way of examining something to determine its characteristics or properties, or to determine whether or not it is working correctly.</p>
TROUBLESHOOT	To follow a systematic procedure to identify and locate a problem or malfunction and its cause.

Essential Skills Profiles

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

Over the past several years, the Government of Canada has conducted research examining the skills people use at work. From this research, Essential Skills Profiles have been developed for various occupations.

For more information regarding Essential Skills and to access Essential Skills Profiles for specific occupations, visit HRSDC's Essential Skills website at:

<http://www.hrsdc.gc.ca/eng/workplaceskills/LES/profiles/profiles.shtml>

Profile Chart

OCCUPATIONAL SKILLS			
MCH-100 Safety	MCH-105 Hoisting, Lifting and Rigging	MCH-110 Basic Drawings	MCH-205 Advanced Drawings
MCH-125 Hand Threading	MCH-135 Fluids and Coolants	MCH-240 Mechanical Components	MCH-300 Machinable Materials
MCH-250 Heat Treatment	MCH-305 Material Testing	MCH-245 Introduction to Welding	MCH-400 Job Planning
MCH-420 Reconditioning			
TOOLS			
MCH-120 Hand and Power Tools	MCH-230 Power Saws	MCH-235 Contour Bandsaws	MCH-140 Drills and Drill Presses
MCH-215 Cutting Machine Tools	MCH-320 Reciprocating Machines		
LAYOUT AND MEASUREMENT			
MCH-115 Precision Measurement I	MCH-210 Precision Measurement II	MCH-130 Basic Layout	MCH-340 Precision Layout
MCH-405 Quality Inspection			
LATHES			
MCH-150 Introduction to Conventional Lathes	MCH-155 Basic Conventional Lathe Operation	MCH-160 Conventional Lathe Drilling, Boring, Reaming, Tapping and Die Threading	MCH-220 Advanced Conventional Lathe Operation
MCH-225 Taper Turning			
MILLING MACHINES			
MCH-165 Introduction to Milling Machines	MCH-200 Vertical Milling Machine Operation	MCH-310 Horizontal/Universal Milling Machine Operation	MCH-315 Gears and Gear Cutting

Profile Chart *(continued)*

GRINDERS			
MCH-145 Introduction to Grinding Machines	MCH-325 Abrasive Finishing	MCH-330 Surface Grinders	MCH-335 Cylindrical Grinders
COMPUTER NUMERICAL CONTROL (CNC) MACHINES			
MCH-410 Computer Numerical Control (CNC) Machine-Tools	MCH-415 Computer Numerical Control (CNC) Operation		

Recommended Level Structure

LEVEL 1					
Unit Code	Title	Page	Unit Code	Title	Page
MCH-100	Safety	22	MCH-135	Fluids and Coolants	31
MCH-105	Hoisting, Lifting and Rigging	23	MCH-140	Drills and Drill Presses	32
MCH-110	Basic Drawings	25	MCH-145	Introduction to Grinding Machines	34
MCH-115	Precision Measurement I	26	MCH-150	Introduction to Conventional Lathes	35
MCH-120	Hand and Power Tools	27	MCH-155	Basic Conventional Lathe Operation	37
MCH-125	Hand Threading	29	MCH-160	Conventional Lathe Drilling, Boring, Reaming, Tapping and Die Threading	39
MCH-130	Basic Layout	30	MCH-165	Introduction to Milling Machines	40
LEVEL 2					
Unit Code	Title	Page	Unit Code	Title	Page
MCH-200	Vertical Milling Machine Operation	42	MCH-230	Power Saws	50
MCH-205	Advanced Drawings	44	MCH-235	Contour Bandsaws	51
MCH-210	Precision Measurement II	45	MCH-240	Mechanical Components	52
MCH-215	Cutting Machine Tools	46	MCH-245	Introduction to Welding	54
MCH-220	Advanced Conventional Lathe Operation	48	MCH-250	Heat Treatment	55
MCH-225	Taper Turning	49			
LEVEL 3					
Unit Code	Title	Page	Unit Code	Title	Page
MCH-300	Machinable Materials	58	MCH-325	Abrasive Finishing	65
MCH-305	Material Testing	60	MCH-330	Surface Grinders	67
MCH-310	Horizontal/Universal Milling Machine Operation	61	MCH-335	Cylindrical Grinders	68
MCH-315	Gears and Gear Cutting	63	MCH-340	Precision Layout	69
MCH-320	Reciprocating Machines	64			
LEVEL 4					
Unit Code	Title	Page	Unit Code	Title	Page
MCH-400	Job Planning	72	MCH-415	Computer Numerical Control (CNC) Operation	76
MCH-405	Quality Inspection	73	MCH-420	Reconditioning	78
MCH-410	Computer Numerical Control (CNC) Machine-Tools	75			

2010 NOA Sub-Task to IPG Unit Comparison

NOA Sub-task		IPG Unit	
Task 1 – Organizes work.			
1.01	Interprets documentation.	MCH-110	Basic Drawings
		MCH-205	Advanced Drawings
		MCH-400	Job Planning
1.02	Plans sequence of operation.	MCH-400	Job Planning
1.03	Maintains safe work environment.	MCH-100	Safety
1.04	Uses personal protective equipment (PPE) and safety equipment.	MCH-100	Safety
1.05	Uses hoisting, lifting and rigging equipment.	MCH-105	Hoisting, Lifting and Rigging
Task 2 – Processes workpiece material.			
2.01	Selects workpiece material.	MCH-300	Machinable Materials
2.02	Performs layout.	MCH-130	Basic Layout
		MCH-340	Precision Layout
2.03	Marks workpiece for identification.	MCH-130	Basic Layout
		MCH-300	Machinable Materials
2.04	Performs basic heat treatment.	MCH-250	Heat Treatment
2.05	Tests workpiece materials.	MCH-250	Heat Treatment
		MCH-305	Material Testing
		MCH-405	Quality Inspection
2.06	Deburs workpiece.	MCH-120	Hand and Power Tools
2.07	Sketches parts.	MCH-110	Basic Drawings
Task 3 – Maintains machines and tooling.			
3.01	Cleans machines.	MCH-135	Fluids and Coolants
		MCH-155	Basic Conventional Lathe Operation
		MCH-200	Vertical Milling Machine Operation
		MCH-310	Horizontal/Universal Milling Machine Operation
3.02	Lubricates machines.	MCH-135	Fluids and Coolants
		MCH-155	Basic Conventional Lathe Operation
		MCH-200	Vertical Milling Machine Operation
		MCH-310	Horizontal/Universal Milling Machine Operation

NOA Sub-task		IPG Unit	
3.03	Sharpens tooling.	MCH-150	Introduction to Conventional Lathes
		MCH-215	Cutting Machine Tools
3.04	Applies cutting fluids and coolants.	MCH-135	Fluids and Coolants
		MCH-155	Basic Conventional Lathe Operation
3.05	Troubleshoots equipment.	MCH-155	Basic Conventional Lathe Operation
		MCH-200	Vertical Milling Machine Operation
		MCH-310	Horizontal/Universal Milling Machine Operation
		MCH-330	Surface Grinders
		MCH-335	Cylindrical Grinders
3.06	Maintains machine alignment.	MCH-155	Basic Conventional Lathe Operation
		MCH-200	Vertical Milling Machine Operation
3.07	Maintains inspection equipment.	MCH-115	Precision Measurement I
		MCH-405	Quality Inspection
Task 4 – Performs hand processes.			
4.01	Files workpiece.	MCH-120	Hand and Power Tools
4.02	Saws workpiece.	MCH-230	Power Saws
4.03	Performs hole-making operations.	MCH-160	Conventional Lathe Drilling, Boring, Reaming, Tapping and Die Threading
4.04	Performs threading operations.	MCH-125	Hand Threading
		MCH-160	Conventional Lathe Drilling, Boring, Reaming, Tapping and Die Threading
		MCH-220	Advanced Conventional Lathe Operation
4.05	Installs thread inserts.	MCH-125	Hand Threading
		MCH-420	Reconditioning
4.06	Broaches workpiece.	MCH-240	Mechanical Components
		MCH-320	Reciprocating Machines
4.07	Performs pressing operations.	MCH-120	Hand and Power Tools
		MCH-420	Reconditioning
4.08	Bends workpiece.	MCH-245	Introduction to Welding
4.09	Finishes workpiece.	MCH-325	Abrasive Finishing

NOA Sub-task		IPG Unit	
Task 5 – Refurbishes components.			
5.01	Disassembles components.	MCH-420	Reconditioning
5.02	Analyzes components.	MCH-420	Reconditioning
5.03	Assembles components.	MCH-420	Reconditioning
Task 6 – Sets up drill presses.			
6.01	Selects drill press types.	MCH-140	Drills and Drill Presses
6.02	Plans drill press sequence.	MCH-140	Drills and Drill Presses
6.03	Selects drill press speeds and feeds.	MCH-140	Drills and Drill Presses
6.04	Sets up jigs, fixtures and work holding devices for drill presses.	MCH-420	Reconditioning
		MCH-140	Drills and Drill Presses
6.05	Sets up tooling for drill presses.	MCH-140	Drills and Drill Presses
Task 7 – Operates drill presses.			
7.01	Drills holes using a drill press.	MCH-140	Drills and Drill Presses
7.02	Cuts countersinks, counterbores, chamfers and spot faces using a drill press.	MCH-140	Drills and Drill Presses
7.03	Performs tapping using a drill press.	MCH-140	Drills and Drill Presses
7.04	Finishes holes using a drill press.	MCH-140	Drills and Drill Presses
Task 8 – Sets up conventional lathes.			
8.01	Selects conventional lathe types.	MCH-150	Introduction to Conventional Lathes
8.02	Plans sequence of operations for conventional lathes.	MCH-155	Basic Conventional Lathe Operation
8.03	Sets up work holding devices for conventional lathes.	MCH-155	Basic Conventional Lathe Operation
8.04	Sets up tooling for conventional lathes.	MCH-155	Basic Conventional Lathe Operation
8.05	Sets up conventional lathe accessories.	MCH-155	Basic Conventional Lathe Operation
8.06	Sets up workpiece on conventional lathe.	MCH-155	Basic Conventional Lathe Operation
8.07	Selects conventional lathe speeds and feeds.	MCH-155	Basic Conventional Lathe Operation
8.08	Sets up eccentrics on conventional lathes.	MCH-155	Basic Conventional Lathe Operation
		MCH-220	Advanced Conventional Lathe Operation

NOA Sub-task		IPG Unit	
Task 9 – Operates conventional lathes.			
9.01	Turns external surfaces using a conventional lathe.	MCH-155	Basic Conventional Lathe Operation
9.02	Bores holes using a conventional lathe.	MCH-155	Basic Conventional Lathe Operation
		MCH-160	Conventional Lathe Drilling, Boring, Reaming, Tapping and Die Threading
9.03	Faces surfaces using a conventional lathe.	MCH-155	Basic Conventional Lathe Operation
9.04	Turns tapers on a conventional lathe.	MCH-225	Taper Turning
9.05	Knurls using a conventional lathe.	MCH-155	Basic Conventional Lathe Operation
9.06	Parts off workpiece using a conventional lathe.	MCH-155	Basic Conventional Lathe Operation
9.07	Drills using a conventional lathe.	MCH-160	Conventional Lathe Drilling, Boring, Reaming, Tapping and Die Threading
9.08	Reams holes using a conventional lathe.	MCH-155	Basic Conventional Lathe Operation
		MCH-160	Conventional Lathe Drilling, Boring, Reaming, Tapping and Die Threading
9.09	Cuts grooves using a conventional lathe.	MCH-155	Basic Conventional Lathe Operation
9.10	Cuts threads using a conventional lathe.	MCH-155	Basic Conventional Lathe Operation
		MCH-220	Advanced Conventional Lathe Operation
Task 10 – Sets up conventional milling machines.			
10.01	Selects conventional milling machine types.	MCH-165	Introduction to Milling Machines
10.02	Plans milling sequence.	MCH-200	Vertical Milling Machine Operation
		MCH-310	Horizontal/Universal Milling Machine Operation
10.03	Sets up work holding devices for conventional milling machines.	MCH-200	Vertical Milling Machine Operation
		MCH-310	Horizontal/Universal Milling Machine Operation

NOA Sub-task		IPG Unit	
10.04	Sets up tooling for conventional milling machines.	MCH-200	Vertical Milling Machine Operation
		MCH-310	Horizontal/Universal Milling Machine Operation
10.05	Sets up milling accessories.	MCH-200	Vertical Milling Machine Operation
		MCH-310	Horizontal/Universal Milling Machine Operation
10.06	Sets up workpiece on a conventional milling machine.	MCH-200	Vertical Milling Machine Operation
		MCH-310	Horizontal/Universal Milling Machine Operation
10.07	Selects conventional milling machine speeds and feeds.	MCH-200	Vertical Milling Machine Operation
		MCH-310	Horizontal/Universal Milling Machine Operation
Task 11 – Operates conventional milling machines.			
11.01	Mills surfaces using a conventional milling machine.	MCH-200	Vertical Milling Machine Operation
		MCH-310	Horizontal/Universal Milling Machine Operation
11.02	Mills profiles and pockets using a conventional milling machine.	MCH-200	Vertical Milling Machine Operation
		MCH-310	Horizontal/Universal Milling Machine Operation
11.03	Mills slots, grooves and keyways using a conventional milling machine.	MCH-200	Vertical Milling Machine Operation
		MCH-310	Horizontal/Universal Milling Machine Operation
11.04	Cuts gears and splines using a conventional milling machine.	MCH-200	Vertical Milling Machine Operation
		MCH-310	Horizontal/Universal Milling Machine Operation
		MCH-315	Gears and Gear Cutting
11.05	Drills holes using a conventional milling machine.	MCH-200	Vertical Milling Machine Operation
		MCH-315	Gears and Gear Cutting
11.06	Reams holes using a conventional milling machine.	MCH-200	Vertical Milling Machine Operation

NOA Sub-task		IPG Unit	
		MCH-310	Horizontal/Universal Milling Machine Operation
11.07	Cuts countersinks, counterbores, chamfers and spot faces using a conventional milling machine.	MCH-200	Vertical Milling Machine Operation
11.08	Performs tapping using a conventional milling machine.	MCH-200	Vertical Milling Machine Operation
		MCH-310	Horizontal/Universal Milling Machine Operation
11.09	Bores holes using a conventional milling machine.	MCH-200	Vertical Milling Machine Operation
Task 12 – Sets up power saws.			
12.01	Selects power saw types.	MCH-230	Power Saws
12.02	Selects saw blades.	MCH-230	Power Saws
12.03	Installs saw blades.	MCH-230	Power Saws
12.04	Selects power saw speeds and feeds.	MCH-230	Power Saws
12.05	Makes power saw adjustments.	MCH-230	Power Saws
12.06	Sets up workpiece on power saw.	MCH-230	Power Saws
Task 13 – Operates power saws.			
13.01	Saws straight and angle cuts.	MCH 230	Power Saws
13.02	Cuts irregular shapes.	MCH-235	Contour Bandsaws
Task 14 – Sets up precision grinding machines.			
14.01	Selects precision grinding machine types.	MCH-145	Introduction to Grinding Machines
14.02	Plans grinding sequence.	MCH-330	Surface Grinders
14.03	Sets up work holding devices for precision grinding machines.	MCH-330	Surface Grinders
		MCH-335	Cylindrical Grinders
14.04	Mounts grinding wheel.	MCH-325	Abrasive Finishing
14.05	Sets up grinding accessories.	MCH-330	Surface Grinders
		MCH-335	Cylindrical Grinders
14.06	Sets up workpiece on precision grinding machines.	MCH-330	Surface Grinders
		MCH-335	Cylindrical Grinders
14.07	Selects precision grinding machine speeds and feeds.	MCH-330	Surface Grinders
		MCH-335	Cylindrical Grinders
Task 15 – Operates precision grinding machines.			
15.01	Grinds flat surfaces using a surface grinder.	MCH-330	Surface Grinders
		MCH-335	Cylindrical Grinders
15.02	Grinds profiles.	MCH-330	Surface Grinders
		MCH-335	Cylindrical Grinders
15.03	Grinds internal and external	MCH-335	Cylindrical Grinders

NOA Sub-task		IPG Unit	
	cylindrical and tapered surfaces.		
15.04	Grinds tools and cutters.	MCH-325	Abrasive Finishing
		MCH-335	Cylindrical Grinders
15.05	Finishes holes using a honing machine.	MCH-325	Abrasive Finishing
Task 16 – Performs basic CNC programming.			
16.01	Reviews process documentation.	MCH-415	Computer Numerical Control (CNC) Operation
16.02	Calculates coordinates for tool path.	MCH-330	Surface Grinders
		MCH-415	Computer Numerical Control (CNC) Operation
16.03	Creates basic program.	MCH-415	Computer Numerical Control (CNC) Operation
16.04	Inputs program data into control memory.	MCH-415	Computer Numerical Control (CNC) Operation
16.05	Optimizes program.	MCH-415	Computer Numerical Control (CNC) Operation
Task 17 – Sets up CNC machine-tools.			
17.01	Selects tooling and tool holders for CNC machine-tools.	MCH-410	Computer Numerical Control (CNC) Machine-Tools
17.02	Sets up tooling and tool holders for CNC machine-tools.	MCH-415	Computer Numerical Control (CNC) Operation
17.03	Sets up workpiece on CNC machine-tool.	MCH-415	Computer Numerical Control (CNC) Operation
17.04	Establishes work datum.	MCH-415	Computer Numerical Control (CNC) Operation
17.05	Verifies program.	MCH-415	Computer Numerical Control (CNC) Operation
Task 18 – Operates CNC machine-tools.			
18.01	Adjusts offsets.	MCH-415	Computer Numerical Control (CNC) Operation
18.02	Monitors machining processes.	MCH-415	Computer Numerical Control (CNC) Operation
18.03	Interrupts program cycle.	MCH-415	Computer Numerical Control (CNC) Operation
18.04	Restarts program cycle.	MCH-415	Computer Numerical Control (CNC) Operation

LEVEL 1

MCH-100 Safety

Learning Outcomes:

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

Objectives and Content:

1. Identify types of personal protective equipment (PPE) and describe their applications.
2. Describe the procedures used to care for and maintain PPE.
3. Identify types of fire extinguishing equipment and describe their applications and procedures for use.
4. Identify workplace hazards and describe safe work practices and equipment.
 - i) personal
 - ii) shop/facility
 - energy state awareness (electrical and mechanical)
 - lockout / tag out
 - ventilation/fumes
 - fire
 - iii) environment
 - discharge/spills
 - material waste
5. Identify and interpret workplace safety and health regulations.
 - i) federal
 - Material Safety Data Sheets (MSDS)
 - Workplace Hazardous Material Information System (WHMIS)
 - ii) provincial/territorial
 - Occupational Health and Safety (OHS)

MCH-105 Hoisting, Lifting and Rigging

Learning Outcomes:

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

Objectives and Content:

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 codes and regulations pertaining to rigging, hoisting and lifting.
 - i) training and certification requirements
4. Identify types of rigging equipment and accessories 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.
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.

MCH-110 Basic Drawings

Learning Outcomes:

- Demonstrate knowledge of basic drawings and their applications.
- Demonstrate knowledge of interpreting and extracting information from drawings.

Objectives and Content:

1. Define terminology associated with drawings.
 - i) nominal size
 - ii) limits
 - iii) tolerance
 - iv) allowance
 - v) scale
 - vi) symmetry
2. Identify types of basic drawings and sketches and describe their purpose.
3. Interpret and extract information from drawings.
 - i) lines
 - ii) projections
 - iii) dimensions
 - iv) notes
 - v) lay/surface finish symbols
 - vi) welding symbols
4. Explain the principles of orthographic projection.
5. Describe basic sketching techniques.

MCH-115 Precision Measurement I

Learning Outcomes:

- Demonstrate knowledge of basic precision measurement and its use.
- Demonstrate knowledge of basic precision measuring instruments, their applications and procedures for use.

Objectives and Content:

1. Define terminology associated with basic precision measurement.
2. Describe the imperial and metric measuring systems and the procedures used to perform conversions for machining operations.
3. Describe the procedures used to read basic precision measuring instrument scales.
4. Identify types of precision measuring instruments and describe their applications and procedures for use.
 - i) micrometers
 - ii) vernier callipers
 - iii) dial indicators
 - iv) gauges
5. Describe the procedures used to perform basic calibration of measuring instruments.
6. Describe procedures used to inspect, maintain and store basic precision measuring instruments.

MCH-120 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.

Objectives and Content:

1. Identify hazards and describe safe work practices pertaining to hand and power tools.
2. 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) scrapers
 - xi) deburring tools
 - xii) chisels
 - xiii) taps
 - xiv) dies
 - xv) arbor press
 - xvi) extractors
3. Describe the procedures used to inspect, maintain and store hand tools.

4. Identify types of power tools and equipment and describe their applications and procedures for use.
 - i) electrical
 - ii) cordless
 - iii) hydraulic
 - iv) pneumatic
5. Describe the procedures used to inspect, maintain and store power tools and equipment.

MCH-125 Hand Threading

Learning Outcomes:

- Demonstrate knowledge of basic threads and fits and their applications.
- Demonstrate knowledge of the procedures used to measure and gauge threads.

Objectives and Content:

1. Define terminology associated with threads.
2. Identify hazards and describe safe work practices pertaining to threading.
3. Identify types of threads and describe their purpose and applications.
4. Explain thread fit, classifications and series.
5. Identify types of thread inserts and describe their applications and installation procedures.
6. Describe the importance of thread fit and the use of thread gauges.
7. Identify types of thread failures and describe their causes and remedies.
8. Calculate and select tap drill sizes in metric and imperial.
9. Identify methods used to measure and gauge threads and describe their associated procedures.
10. Describe the procedures used to produce threads using taps and dies.

MCH-130 Basic Layout

Learning Outcome:

- Demonstrate knowledge of basic layout and its use.
- Demonstrate knowledge of basic layout tools and equipment, their applications, maintenance and procedures for use.
- Demonstrate knowledge of the procedures used to perform a basic layout.

Objectives and Content:

1. Define terminology associated with basic layout.
2. Identify types of basic layout tools, equipment and accessories and describe their applications and procedures for use.
 - i) surface tables
 - ii) angle plates
 - iii) scribes
 - iv) dividers and trammels
 - v) hermaphrodite calipers
 - vi) squares
 - vii) gauges
 - viii) rulers
3. Identify types of layout media/solutions and describe their applications.
4. Calculate layout dimensions and reference points.
5. Describe the procedures used to read and transfer sizes from a drawing.
6. Describe the procedures used to perform a basic layout.
7. Identify methods used to mark workpieces for identification and describe their associated procedures.
8. Describe the procedures used to inspect, maintain and store layout tools and equipment.

MCH-135 Fluids and Coolants

Learning Outcomes:

- Demonstrate knowledge of cutting fluids, their applications, and procedures for use.
- Demonstrate knowledge of coolants, their applications, and procedures for use.
- Demonstrate knowledge of lubricants, their applications and procedures for use.
- Demonstrate knowledge of solvents, their applications, and procedures for use.

Objectives and Content:

1. Define terminology associated with fluids and coolants.
2. Identify hazards and describe safe work practices pertaining to fluids, and coolants.
 - i) personal
 - ii) shop/facility
 - iii) environmental
3. Interpret regulations pertaining to the use of fluids and coolants.
4. Identify types of fluids and coolants and describe their purpose, characteristics and applications.
 - i) cutting fluids
 - ii) coolants
 - iii) lubricants
 - iv) solvents
5. Describe the procedures used to apply and maintain lubricants.
6. Describe the procedures used for mixing, maintaining and adjusting coolants.
7. Describe the procedures used to apply cutting fluids and coolants.
8. Describe the procedures used to handle, store and dispose of fluids and coolants.
 - i) cutting fluids
 - ii) coolants
 - iii) lubricants
 - iv) solvents

MCH-140 Drills and Drill Presses

Learning Outcomes:

- Demonstrate knowledge of drills and drill presses, their applications, maintenance and procedures for use.

Objectives and Content:

1. Define terminology associated with drills and drill presses.
2. Identify hazards and describe safe work practices pertaining to drills and drill presses.
3. Identify types of drills and describe their applications.
4. Identify types of drill presses and describe their components and applications.
 - i) sensitive
 - ii) upright
 - iii) radial arm
 - iv) magnetic
5. Identify drill press accessories and describe their applications and procedures for use.
 - i) jigs and fixtures
 - ii) work holding devices
 - iii) tool holding devices
6. Describe the procedures used to set up and perform drill press operations.
 - i) drilling
 - ii) counterboring
 - iii) countersinking
 - iv) tapping
 - v) reaming
7. Describe the procedures used to inspect, maintain and store drilling equipment and accessories.
8. Describe the procedures used to sharpen drill bits.

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

MCH-145 Introduction to Grinding Machines

Learning Outcomes:

- Demonstrate knowledge of grinding machines, their applications, and procedures for use.
- Demonstrate knowledge of offhand (bench) grinding operations.
- Demonstrate knowledge of special (form) grinding operations.

Objectives and Content:

1. Define terminology associated with grinding machines.
2. Identify hazards and describe safe work practices pertaining to grinding machines.
3. Identify types of work holding devices and describe their applications.
4. Identify types of grinding machines and accessories and describe their applications.
 - i) pedestal
 - ii) surface
 - iii) cylindrical
 - iv) centreless
 - v) tool and cutter grinder
5. Describe the procedures used to perform offhand (bench) grinding operations.
6. Describe the procedures used to perform special (form) grinding operations.

Learning Outcomes:

- Demonstrate knowledge of conventional lathes, their accessories, attachments and applications.
- Demonstrate knowledge of lathe tools and their applications.

Objectives and Content:

1. Define terminology associated with conventional lathes.
2. Identify types of conventional lathes and describe their operating principles and applications.
3. Identify the components and controls of conventional lathes and describe their purpose and operation.
4. Identify conventional lathe accessories and attachments and describe their applications.
5. Identify types of tool holding devices and describe their applications.
6. Identify types of work holding devices and describe their applications.
 - i) four jaw chuck
 - ii) three jaw chuck
 - iii) faceplate
 - iv) between centers
7. Identify types of conventional lathe tools and describe their characteristics and applications.
 - i) turning
 - ii) boring
 - iii) threading
 - iv) grooving
 - v) facing
 - vi) knurling
 - vii) parting off
 - viii) reaming

- ix) tool post grinding
- x) drilling

8. Describe the procedures used to sharpen conventional lathe cutting tools.
9. Describe the procedures used to grind cutting tool angles.

MCH-155 Basic Conventional Lathe Operation

Learning Outcomes:

- Demonstrate knowledge of conventional lathes, their maintenance and procedures for use.

Objectives and Content:

1. Identify hazards and describe safe work practices pertaining to conventional lathes.
2. Describe the considerations to determine speed, feed and depth of cut for conventional lathe operations.
3. Calculate speed, feed and depth of cut.
4. Identify potential set up problems and describe their causes and remedies.
5. Describe the procedures used to set up lathes.
6. Describe the procedures used to mount and adjust rests.
7. Identify cutting fluids and coolants used during lathe operations.
8. Identify the considerations and requirements for selecting tools and accessories for specific operations.
9. Describe the procedures used to adjust and maintain conventional lathes.
10. Describe the procedures used to align lathe centres.
11. Describe the procedures used to perform basic conventional lathe operations.
 - i) turning
 - ii) boring
 - iii) threading
 - iv) grooving
 - v) facing
 - vi) knurling

- vii) parting off
 - viii) reaming
 - ix) drilling
-
- 12. Describe the procedures used to set up eccentrics on conventional lathes.
 - 13. Identify techniques used to troubleshoot conventional lathe operations and describe their associated procedures.
 - 14. Describe the procedures used to inspect and maintain conventional lathes.

Learning Outcomes:

- Demonstrate knowledge of conventional lathe drilling, boring, reaming, tapping and die threading operations.

Objectives and Content:

1. Describe the procedures used for spotting and drilling work on a conventional lathe.
2. Identify types of boring tools and describe their applications and procedures for use.
3. Describe the procedures used for boring work on a conventional lathe.
4. Identify types of machine reamers and describe their applications and procedures for use.
5. Describe the procedures used for reaming work on a conventional lathe.
6. Identify types of machine taps and dies and describe their applications and procedures for use.
7. Describe the procedures used for tapping on a conventional lathe.
8. Describe the procedures used for die threading on a conventional lathe.
9. Describe the procedures used for counterboring and countersinking work on a conventional lathe.
10. Describe speed, feed and depth of cut for conventional lathe operations.
 - i) reaming
 - ii) drilling
 - iii) tapping
 - iv) die threading
 - v) counterboring
 - vi) countersinking

MCH-165 Introduction to Milling Machines

Learning Outcomes:

- Demonstrate knowledge of milling machines, their accessories, attachments and applications.
- Demonstrate knowledge of milling cutting tools and their applications.

Objectives and Content:

1. Define terminology associated with milling machines.
2. Identify hazards and describe safe work practices pertaining to conventional milling machines.
3. Identify types of milling machines and describe their applications.
 - i) vertical
 - ii) horizontal/universal
 - iii) ram and turret
 - iv) horizontal boring mill
 - v) vertical boring mill
4. Identify the components and controls of milling machines and describe their purpose and operation.
5. Identify types of milling machine accessories and attachments and describe their applications and maintenance.
6. Identify types of tool holding devices and describe their applications.
7. Identify types of work holding devices and describe their applications and maintenance.
8. Identify types of materials used in milling cutter construction and describe their characteristics.
9. Identify types of cutting tools and describe their applications.
10. Describe climb and conventional milling.

LEVEL 2

Learning Outcomes:

- Demonstrate knowledge of vertical milling machines, their set up, maintenance and procedures for use.

Objectives and Content:

1. Identify hazards and describe safe work practices pertaining to vertical milling machines.
2. Describe the considerations used to determine speed, feed and depth of cut for vertical milling machine operations.
3. Calculate speed, feed and depth of cut.
4. Identify potential set up problems and describe their causes and remedies.
5. Describe the procedures used to align vertical milling machine heads.
6. Describe the procedures used to align workpieces.
7. Describe the procedures used to set up vertical milling machines to perform basic milling operations.
8. Identify the considerations and requirements used for selecting tools and accessories for milling operations.
9. Describe the procedures used to perform milling operations on vertical milling machines.
 - i) contouring
 - ii) pocketing
 - iii) boring
 - iv) reaming
 - v) grooving
 - vi) surfacing
 - vii) drilling
 - viii) tapping

- ix) countersinking
 - x) counterboring
 - xi) chamfering
 - xii) spotfacing
 - xiii) dovetailing
-
- 10. Describe the procedures used to mill profiles using vertical milling machines.
 - 11. Describe the procedures used to perform gear cutting operations on vertical milling machines.
 - 12. Describe the procedures used to inspect and maintain vertical milling machines.
 - 13. Identify types of rotary tables and describe their construction, applications and procedures for use.
 - 14. Identify types of dividing heads and describe their characteristics and applications.
 - 15. Explain the principles and perform calculations involved in indexing.
 - 16. Identify milling cutter failures and describe their causes and remedies.
 - 17. Identify techniques used to troubleshoot vertical milling operations and describe their associated procedures.

Learning Outcomes:

- Demonstrate knowledge of views of drawings and their applications.
- Demonstrate knowledge of industry symbols and markings and their applications.
- Demonstrate knowledge of geometric dimensions and tolerances and their applications.

Objectives and Content:

1. Identify drawing views and describe their purpose and applications.
 - i) isometric
 - ii) orthographic
 - iii) sectional
 - iv) auxiliary
2. 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
3. Explain the principles of geometric dimensioning and tolerancing.

MCH-210 Precision Measurement II

Learning Outcomes:

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

Objectives and Content:

1. Identify types and grades of gauge blocks and describe their applications and procedures for use.
 - i) metric
 - ii) imperial
2. Calculate and perform gauge block build-ups.
3. Identify types of wear blocks and describe their purpose and applications.
4. Explain the principles of angular measurement.
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.

MCH-215 Cutting Machine Tools

Learning Outcomes:

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

Objectives and Content:

1. Define terminology associated with cutting machine tools.
2. Identify hazards and describe safe work practices pertaining to cutting machine tools.
3. Explain the principles of chip formation.
4. Identify types of cutting machine tools and describe their characteristics and applications.
 - i) indexable insert
 - ii) high speed steel (HSS)
 - iii) brazed carbide
5. Identify types of cutting tool materials and describe their applications and procedures for use.
 - i) carbide
 - ii) high speed steel (HSS)
 - iii) ceramic
6. Explain tool geometry and its purpose.
7. Describe the procedures used to sharpen cutting tools.
8. Interpret the systems for the identification of carbide inserts/coatings and tool holders.
 - i) American National Standards Institute (ANSI)
 - ii) International System of Units (SI)
9. Describe the effect of carbide cutting tools on speed, feed and depth of cut.

10. Identify types of carbide tool holding devices and describe their applications.
11. Identify carbide tool failures and describe their causes and remedies.

Learning Outcomes:

- Demonstrate knowledge of turning contours and forms.
- Demonstrate knowledge of advanced threading and multiple starts.

Objectives and Content:

1. Explain the principles of form turning.
2. Identify types of form turning tools and describe their characteristics and applications.
3. Describe the procedures used to turn forms.
4. Describe the procedures used to set up, position work and turn eccentrics.
5. Identify types of advanced threads, and describe their purpose, characteristics and applications.
 - i) specialty
 - Acme
 - buttress
 - tapered pipe
 - straight pipe
 - ii) multiple start
6. Identify methods used to cut multiple start threads and describe their associated procedures.
 - i) slotted drive or faceplate
 - ii) indexing of the spindle gear
 - iii) use of thread chasing dial
 - iv) compound rest method
7. Identify methods used to cut specialty threads and describe their associated procedures.
8. Describe the procedures used to check and measure threads.

MCH-225 Taper Turning

Learning Outcomes:

- Demonstrate knowledge of tapers, their attachments and applications.
- Demonstrate knowledge of taper turning operations.

Objectives and Content:

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) Morse
 - ii) taper pin
 - iii) pipe thread taper
 - iv) machine taper
4. Identify types of taper attachments and describe their applications and procedures for use.
 - i) plain
 - ii) telescopic
5. Calculate dimensions of tapers in metric and imperial.
6. Identify methods used to turn tapers and describe their associated procedures.
 - i) taper attachment
 - ii) tailstock
 - iii) compound rest
7. Identify methods used to check tapers and describe their associated procedures.
 - i) plug gauge
 - ii) ring gauge
 - iii) sine bar
 - iv) layout lines
 - v) dial indicator

MCH-230 Power Saws

Learning Outcomes:

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

Objectives and Content:

1. Define terminology associated with power saws.
2. Identify hazards and describe safe work practices pertaining to power saws.
3. Identify types of saws and attachments and describe their applications.
 - i) vertical
 - ii) horizontal
 - iii) reciprocating/power hacksaws
 - iv) cold circular
 - v) abrasive cutoff
4. Identify types of sawing operations and describe their associated procedures.
5. Identify types of blades and describe their parameters, applications and installation procedures.
6. Identify potential problems during sawing operations and describe their causes and remedies.
7. Calculate speed and feed requirements.
8. Describe the procedures used to inspect and maintain power saws.

Learning Outcomes:

- Demonstrate knowledge of contour bandsaws, their applications, maintenance and procedures for use.

Objectives and Content:

1. Define terminology associated with contour bandsaws.
2. Identify hazards and describe safe work practices pertaining to contour bandsaws.
3. Identify the components and accessories of contour bandsaws and describe their characteristics and applications.
4. Identify types of blades and describe their characteristics and applications.
5. Describe the procedures used to set up and operate contour bandsaws.
 - i) irregular shapes
 - ii) internal/external contours
6. Calculate speed and feed requirements.
7. Describe the procedures used to butt weld bandsaw blades.
8. Describe the procedures used to inspect and maintain contour band saws.
9. Calculate the length of blade.

MCH-240 Mechanical Components

Learning Outcomes:

- Demonstrate knowledge of mechanical components, their applications and procedures for use.

Objectives and Content:

1. Define terminology associated with mechanical components.
2. Identify hazards and describe safe work practices pertaining to mechanical components.
3. Identify types of fasteners, retainers and locators and describe their characteristics and applications.
 - i) bonds
 - ii) nuts
 - iii) dowel pins
 - iv) washers
 - v) studs
 - vi) snap rings
4. Identify head styles of threaded fasteners and describe their characteristics and applications.
5. Identify techniques used to torque fasteners and describe their associated procedures.
6. Identify nut and bolt designs and describe their characteristics and applications.
7. Identify grades of nuts and bolts and describe their characteristics and applications.
8. Identify types of keys, keyseats and keyways and describe their characteristics and applications.
 - i) square
 - ii) woodruff
 - iii) flat/rectangular

- iv) gib
- v) taper

9. Explain the principles of stepped keys.
10. Describe the procedures used to hand broach keyways.
11. Identify types of bearings and bushings and describe their characteristics and applications.

Learning Outcomes:

- Demonstrate knowledge of basic welding processes used in machining operations and their applications.

Objectives and Content:

1. Define terminology associated with basic welding.
2. Identify hazards and describe safe work practices pertaining to basic welding processes.
3. Interpret codes and regulations pertaining to welding.
 - i) training and certification requirements
4. Identify welding processes and describe their characteristics and applications.
5. Identify types of welding equipment and describe their applications.
6. Describe the procedures used to perform basic welding and heating applications.
 - i) bending
 - ii) tacking
7. Describe the procedures used to perform basic oxy-fuel cutting.
8. Describe the procedures used to inspect and store welding equipment.

MCH-250 Heat Treatment

Learning Outcomes:

- Demonstrate knowledge of basic heat treatment and its applications.

Objectives and Content:

1. Define terminology associated with heat treatment.
2. Identify hazards and describe safe work practices pertaining to heat treatment.
3. Identify methods used to determine the carbon content of steels.
4. Describe the procedures used to determine properties of metals.
 - i) chemical
 - ii) physical
 - iii) mechanical
5. Identify the processes used in the heat treatment of metals and describe their applications.
 - i) annealing
 - ii) hardening
 - iii) normalizing
 - iv) stress relieving
 - v) tempering
6. Identify and interpret technical data used in the heat treatment of metals.
 - i) charts
 - ii) tables
7. Identify methods used for hardening steel and describe the properties of the steel produced by each.
 - i) water hardening
 - ii) oil hardening
 - iii) air hardening
 - iv) case hardening

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

LEVEL 3

MCH-300 Machinable Materials

Learning Outcomes:

- Demonstrate knowledge of metals and their characteristics.
- Demonstrate knowledge of machinable materials, their applications and procedures for use.

Objectives and Content:

1. Define terminology associated with machinable materials.
2. Identify hazards and describe safe work practices pertaining to machining materials.
3. Describe the properties of metals and their characteristics.
 - i) chemical
 - ii) physical
 - iii) mechanical
4. Identify and interpret markings and documentation relating to material selection.
 - i) identification systems
 - American Society of Mechanical Engineering (ASME)
 - ANSI
 - colour coding (manufacturer specific)
 - number
 - ii) documentation
 - mill certificates
5. Identify types of machinable materials and describe their characteristics and applications.
 - i) metallic
 - ferrous
 - non-ferrous
 - ii) non-metallic
 - iii) specialty
 - alloys
 - refractory metals
 - precious metals

6. Identify types of coolants used with machinable materials and describe the considerations affecting their selection.
7. Explain the operating principles of machining materials.
 - i) metallic
 - ii) non-metallic
 - iii) specialty
8. Describe the procedures used to set up and machine materials.

MCH-305 Material Testing

Learning Outcomes:

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

Objectives and Content:

1. Define terminology associated with material testing.
2. Identify hazards and describe safe work practices pertaining to material testing.
3. Describe the purpose and applications of material testing.
 - i) hardness
 - ii) composition
 - iii) properties
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. Identify the machines and scales used to determine material hardness and describe their associated procedures.
 - i) Rockwell
 - ii) Brinell

Learning Outcomes:

- Demonstrate knowledge of horizontal/universal milling machines, their set up, maintenance and procedures for use.

Objectives and Content:

1. Identify hazards and describe safe work practices pertaining to horizontal/universal milling machines.
2. Describe the considerations used to determine speed, feed and depth of cut for horizontal/universal milling machine operations.
3. Calculate speed, feed and depth of cut.
4. Identify potential set up problems and describe their causes and remedies.
5. Describe the procedures used to align workpieces.
6. Describe the procedures used to set up horizontal/universal milling machines to perform basic milling operations.
7. Identify the considerations and requirements for selecting tools and accessories for milling operations.
8. Describe the procedures used to inspect and maintain horizontal/universal milling machines.
9. Describe the procedures used to perform milling operations on horizontal/universal milling machines.
 - i) contouring
 - ii) surfacing
 - iii) keyways and keyseats
 - iv) straddle
 - v) gang
 - vi) T-slot
 - vii) end milling

- viii) slitting
 - ix) slotting
10. Identify milling cutter failures and describe their causes and remedies.
 11. Identify techniques used to troubleshoot horizontal/universal milling operations and describe their associated procedures.

MCH-315 Gears and Gear Cutting

Learning Outcomes:

- Demonstrate knowledge of gears and gear cutting.
- Demonstrate knowledge of gear measurement.
- Demonstrate knowledge of gear milling operations.

Objectives and Content:

1. Define terminology associated with gears and gear cutting.
2. Identify hazards and describe safe work practices pertaining to gears and gear cutting.
3. Explain the principles of gears and describe their purpose and operation.
4. Identify types of gears and describe their characteristics and applications.
 - i) spur
 - ii) helical
 - iii) bevel
 - iv) worm
 - v) rack
 - vi) splines
5. Identify methods of gear tooth measurement and describe their associated procedures.
6. Calculate gear cutting requirements.
7. Calculate ratios for simple and compound gears.
8. Identify machines and accessories used to cut gears.
9. Identify types of gear cutting tools and describe their characteristics and applications.
10. Describe the procedures used to set up and produce gears.

MCH-320 Reciprocating Machines

Learning Outcomes:

- Demonstrate knowledge of slotters, their applications, set up and procedures for use.
- Demonstrate knowledge of broaching and keyseating machines, their applications, set up and procedures for use.

Objectives and Content:

1. Define terminology associated with reciprocating machines.
2. Identify hazards and describe safe work practices pertaining to reciprocating machines.
3. Identify types of slotters and describe their components and applications.
4. Calculate speed and feed requirements.
5. Describe the procedures used to set up and operate slotters.
6. Describe the procedures used to set up and operate shapers.
7. Explain the operating principles of machine broaching and keyseating.
8. Identify types of broaching and keyseating machines and describe their components and applications.
9. Identify types of tooling for broaching and keyseating machines and describe their applications.
10. Describe the procedures used to set up and operate broaching and keyseating machines.

MCH-325 Abrasive Finishing

Learning Outcomes:

- Demonstrate knowledge of abrasives, their applications and procedures for use.
- Demonstrate knowledge of grinding wheels, their applications, maintenance and procedures for use.
- Demonstrate knowledge of abrasive finishing techniques.

Objectives and Content:

1. Define terminology associated with abrasive finishing.
2. Identify hazards and describe safe work practices pertaining to abrasives.
3. Identify types of abrasives and describe their characteristics and applications.
4. Identify types of grinding wheels and describe their characteristics and applications.
5. Identify the considerations and requirements for selecting a grinding wheel for common grinding operations.
 - i) abrasive
 - ii) grain
 - iii) grade
 - iv) structure
 - v) bond
6. Describe the procedures used to mount and balance grinding wheels.
7. Identify types of wheel dressers and describe their applications.
8. Describe the procedures used to true and dress grinding wheels.
9. Describe the procedures used to inspect, maintain and store grinding wheels.
10. Describe the procedures used to shape or finish a workpiece using abrasive techniques.

11. Identify types of materials and equipment used to lap and hone workpieces.
12. Identify lapping and honing techniques and describe their associated procedures.
13. Identify types of materials and equipment used to buff and polish workpieces.
14. Identify polishing and blending techniques and describe their associated procedures.

MCH-330 Surface Grinders

Learning Outcomes:

- Demonstrate knowledge of surface grinders, their set up, maintenance and procedures for use.

Objectives and Content:

1. Identify hazards and describe safe work practices pertaining to surface grinding.
2. Describe the considerations used to determine feed and depth of cut for grinding operations.
3. Calculate feed and depth of cut.
4. Describe the procedures used to set up grinders and accessories.
5. Describe the procedures used to align a workpiece.
6. Identify potential set up problems and describe their causes and remedies.
7. Identify types of accessories used for surface grinding operations and describe their applications.
8. Describe the procedures used to adjust and maintain surface grinding machines.
9. Describe the procedures used to perform surface grinding operations.
10. Identify techniques used to troubleshoot surface grinding operations and describe their associated procedures.
11. Identify types of wheel dressers and describe their applications.
12. Describe the procedures used to true and dress grinding wheels.

MCH-335 Cylindrical Grinders

Learning Outcomes:

- Demonstrate knowledge of cylindrical grinders, their set up, maintenance and procedures for use.

Objectives and Content:

1. Identify hazards and describe safe work practices pertaining to cylindrical grinding.
2. Describe the considerations used to determine feed and depth of cut for grinding operations.
3. Calculate feed and depth of cut.
4. Describe the procedures used to set up grinders and accessories.
5. Describe the procedures used to align or dial workpieces.
6. Identify potential set up problems and describe their causes and remedies.
7. Identify types of accessories used for cylindrical grinding operations and describe their applications.
8. Describe the procedures used to inspect and maintain cylindrical grinding machines.
9. Describe the procedures used to perform cylindrical grinding operations.
10. Identify techniques used to troubleshoot cylindrical grinding operations and describe their associated procedures.
11. Identify types of wheel dressers and describe their applications.
12. Describe the procedures used to true and dress grinding wheels.

MCH-340 Precision Layout

Learning Outcomes:

- Demonstrate knowledge of precision layout and its applications.
- Demonstrate knowledge of precision layout tools and equipment, their applications, maintenance and procedures for use.

Objectives and Content:

1. Identify precision layout tools and equipment and describe their applications and procedures for use.
 - i) universal bevel protractor
 - ii) sine bar
 - iii) precision height gauge
 - iv) gauge blocks
 - v) granite table
 - vi) surface plate
2. Describe the procedures used to perform a precision layout.
3. Calculate sine bar values.
4. Calculate angles, arcs and location from reference point.
5. Describe the procedures used to inspect, maintain and store precision layout tools and equipment.

LEVEL 4

MCH-400 Job Planning

Learning Outcomes:

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

Objectives and Content:

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 drawing specifications.
 - i) tolerance
 - ii) finish requirements
 - iii) geometric dimensioning and tolerancing
4. Identify the considerations and requirements when planning jobs and job tasks.
 - i) materials
 - ii) machines and tooling
 - iii) sequence of work
 - iv) clean-up
5. Calculate cutting time requirements.
6. Identify the considerations and requirements for selecting machines and tooling to complete specified jobs.
7. Calculate materials required to complete specified jobs.

MCH-405 Quality Inspection

Learning Outcomes:

- Demonstrate knowledge of quality inspection and its use.
- Demonstrate knowledge of the Cartesian Coordinate System and its use.
- Demonstrate knowledge of coordinate measuring machines, their applications and procedures for use.

Objectives and Content:

1. Define terminology associated with quality inspection.
 - i) basic dimension
 - ii) limits
 - iii) tolerances
 - iv) allowance
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 instruments used in quality inspection and describe their applications and procedures for use.
4. Describe the procedures used to inspect workpieces.
5. Identify types of comparators and describe their applications and procedures for use.
 - i) mechanical
 - ii) electronic
 - iii) optical
 - iv) pneumatic
6. Describe the Cartesian Coordinate System, its purpose and applications.

7. Identify types of coordinate measuring machines and describe their components, applications and procedures for use.

Learning Outcomes:

- Demonstrate knowledge of CNC machine-tools, their accessories, attachments and applications.

Objectives and Content:

1. Define terminology associated with CNC machine-tools.
2. Identify the hazards and describe safe work practices pertaining to CNC machines-tools.
3. Describe the advantages of using CNC machine-tools.
4. Identify CNC axes and describe the relationship between them.
5. Identify types of CNC machine-tools and describe their characteristics and applications.
6. Identify types of accessories and tool changers used with CNC machine-tools and describe their applications.
7. Identify types of tool holders and work holding devices used with CNC machine-tools and describe their applications.

Learning Outcomes:

- Demonstrate knowledge of basic CNC programming.
- Demonstrate knowledge of CNC machine-tools, their set up, maintenance and procedures for use.

Objectives and Content:

1. Identify CNC control units and describe their purpose.
2. Identify types of basic programming codes and languages and describe their applications.
 - i) G-codes
 - ii) M-codes
 - iii) conversational
3. Identify CNC-related reference points and their location.
4. Describe the procedures used to perform basic CNC programming.
 - i) review process documentation
 - ii) calculate coordinates for tool path
 - iii) create basic program
 - iv) input program data into control memory
 - v) optimize program
5. Describe the procedures used to set up 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

6. Describe the procedures used to operate CNC machines.
 - i) adjust offsets
 - ii) load/unload workpiece
 - iii) monitor process
 - iv) interrupt program cycle
 - v) restart program cycle
7. Describe the procedures used to perform basic preventative maintenance.

MCH-420 Reconditioning

Learning Outcomes:

- Demonstrate knowledge of the procedures used for reconditioning.

Objectives and Content:

1. Identify types of fits, clearances, tolerances and serviceable limits.
2. Identify types of mechanical components and describe their disassembly procedures.
 - i) bearings
 - ii) seals
 - iii) threaded inserts
 - iv) adapters/bushings
3. Describe the procedures used to repair or replace mechanical components.
4. Identify types of equipment used in reconditioning and describe their procedures for use.
 - i) pullers
 - ii) presses
5. Identify types of materials used to fit and reassemble components and describe their applications and procedures for use.
 - i) adhesives
 - ii) sealants
 - iii) lubricants and lubrication systems
6. Describe the procedures used to fit and reassemble components.