NL Curriculum Standard

Plan of Training

Machinist

Government of Newfoundland and Labrador
Department of Immigration, Population Growth and Skills
Apprenticeship and Trades Certification Division

June 2019

PLAN OF TRAINING

Machinist

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Newfoundland Labrador

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Department of Advanced Education, Skills and Labour
Apprenticeship and Trades Certification Division

Approved by:

Dave Hi

Chairperson, Provincial Apprenticeship and Certification Board

Date: July 22, 2019

Preface

This NL curriculum standard is aligned with the 2018 Red Seal Occupational Standard (RSOS) and National Harmonization sequencing and levels for the Machinist trade. It describes the curriculum content for the Machinist training program.

Acknowledgements

The Provincial Trade Advisory Committee (PTAC), industry representatives, instructors and apprenticeship staff provided valuable input to the development of this provincial plan of training. Without their dedication to quality apprenticeship training, this document could not have been produced.

We offer a sincere thank you.

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Document Status	Date Approved	Mandatory Implementation Dates	Comments
New	June 2019	Level I September 2019	Direct entry version of the 2019 Plan of Training Aligns with 2018 RSOS and National Harmonization sequencing
		Level II September 2020	
		Level 3 September 2021	
		Level IV September 2022	
Approved	June 2020		Applied accessibility formatting.

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2018 RSOS Tasks and Sub-Task		2019 POT	
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2018 RSOS Tasks and Sub-Task		2019 POT	
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2018 RSOS Tasks and Sub-Task		2019 POT	
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12.05	Sets up conventional lathe accessories		
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		MW1931	Advanced Conventional Lathe
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2018 RSOS Tasks and Sub-Task		2019 POT	
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		MW2361	Horizontal/Universal Milling Machine Operation
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14.03	Sets up work holding devices for conventional milling machines	MW2001	Vertical Milling Machine Operation
14.04	Sets up tooling for conventional milling machines	MW1922	Introduction to Milling Machines
		MW2361	Horizontal/Universal Milling Machine Operation
		MW2001	Vertical Milling Machine Operation
14.05	Sets up milling accessories	MW2361	Horizontal/Universal Milling Machine Operation
		MW2001	Vertical Milling Machine Operation
		MW2090	Bevel, Helical and Worm Gears
14.06	Sets up workpiece on a conventional milling machine	MW2361	Horizontal/Universal Milling Machine Operation
14.07	Selects conventional milling machine speeds and feeds	MW2001	Vertical Milling Machine Operation
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15.01	Mills surfaces using a conventional milling machine	MW2361 MW2001	Horizontal/Universal Milling Machine Operation Vertical Milling Machine Operation
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 (indexing calculations).	MW1981	Gears and Gear Cutting
		MW2361	Horizontal/Universal Milling Machine Operation
		MW2001	Vertical Milling Machine Operation
		MW2090	Bevel, Helical and Worm Gears
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2018 RSOS Tasks and Sub-Task		2019 POT	
		MW2361	Horizontal/Universal Milling Machine Operation
		MW2090	Bevel, Helical and Worm Gears
15.06	Reams holes using a conventional milling machine	MW2001	Vertical Milling Machine Operation
		MW2361	Horizontal/Universal Milling Machine Operation
15.07	Cuts countersinks, counterbores, chamfers and spot faces using a conventional milling machine	MW2001	Vertical Milling Machine Operation
		MW1991	Quality Inspection
		MW2361	Horizontal/Universal Milling Machine Operation
15.08	Performs tapping using a conventional milling machine	MW2001	Vertical Milling Machine Operation
		MW1991	Quality Inspection
15.09	Bores holes using a conventional milling machine	MW2361	Horizontal/Universal Milling Machine Operation
		MW2001	Vertical Milling Machine Operation
		MW1981	Gears and Gear Cutting
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16.05	Sets up grinding accessories		
16.06	Sets up workpiece on precision grinding machines		
16.07	Selects precision grinding machine speeds and feeds		
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17.02	Grinds profiles	MW2032	Cylindrical Grinders
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		MW2041	Cutter and Tool Grinder

2018 RSOS Tasks and Sub-Task		2019 POT	
17.05	Finishes holes using a honing machine	MW2032	Cylindrical Grinders
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18.01	Creates process documentation	MW2400	CNC Programming, Set Up and Operation I
18.02	Creates manual input program	MW2500	CNC Programming, Set Up and Operation II
18.03	Transfers program to and from control memory.	MW2400	CNC Programming, Set Up and Operation I
18.04	Optimizes program	MW2500	CNC Programming, Set Up and Operation II
18.05	Creates 2D and 3D models	MW2600	CNC Programming, Set Up and Operation III
18.06	Programs using CAM	MW2400	CNC Programming, Set Up and Operation I
		MW2500	CNC Programming, Set Up and Operation II
		MW2600	CNC Programming, Set Up and Operation III
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19.01	Selects tooling and tool holders for CNC machines	MW2071	Computer Numerical Control (CNC) Operation 1
		MW2400	CNC Programming, Set Up and Operation I
		MW2500	CNC Programming, Set Up and Operation II
19.02	Sets up tooling and tool holders on CNC machines	MW2400	CNC Programming, Set Up and Operation I
		MW2500	CNC Programming, Set Up and Operation II
		MW2600	CNC Programming, Set Up and Operation III
19.03	Sets up workpiece on CNC machine	MW2400	CNC Programming, Set Up and Operation I
		MW2600	CNC Programming, Set Up and Operation III
19.04	Establishes work datum	MW2400	CNC Programming, Set Up and Operation I
		MW2500	CNC Programming, Set Up and Operation II
19.05	Verifies program	MW2400	CNC Programming, Set Up and Operation I
Task 20 – CNC Machine Operation			

2018 RSOS Tasks and Sub-Task		2019 POT	
20.01	Adjusts offsets	MW2400	CNC Programming, Set Up and Operation I
		MW2500	CNC Programming, Set Up and Operation II
		MW2600	CNC Programming, Set Up and Operation III
20.02	Monitors machining processes	MW2400	CNC Programming, Set Up and Operation I
20.03	Interrupts program cycle		
20.04	Restarts program cycle		

B. Program Structure

For each and every course, a formal assessment is required for which 70% is the pass mark. A mark of 70% must be attained in both the theory examination and the practical project assignment, where applicable as documented on an official transcript.

The order of course delivery within each level can be determined by the educational agency, as long as pre-requisite conditions are satisfied.

Upon completion of an entry level program, individuals may be required to complete other certifications (employer or job site specific) in order to gain employment.

Level 1				
Course No.	**AACS No.**	**Course Name**	**Hours**	**Pre-Requisite(s)**
MW1191	-	Machine Shop Safety	2	None
MW1773	-	Drawings and Specifications I	18	MW1191
MW1371	-	Basic Layout	6	MW1191
MW1382	-	Hand and Power Tools	6	MW1191
MW1391	-	Hand Threading and Reaming	6	MW1191
MW1783	-	Cutting Fluids, Coolants and Lubricants	3	MW1191
MW1763	-	Precision Measurement	18	MW1191 MW1371
MW1791	-	Machinable Materials	9	MW1191
MW1802	-	Angular Measurement	30	MW1763
MW2302	-	Power Sawing Equipment	18	MW1783
MW2312	-	Introduction to Grinding and Abrasives	18	MW1791
MW2322	-	Heat Treatment I	18	MW1191 MW1791
MW2371	-	Material Testing	12	MW1791 MW2322
MW1842	-	Hoisting, Lifting and Rigging	6	MW1191
MW1853	-	Drills and Drill Presses	18	MW1391 MW1783 MW1791
MW1862	-	Introduction to Conventional Lathes	18	MW1191
MW1873	-	Basic Conventional Lathe Operation	30	MW1191 MW1862

Level 1				
Course No.	**AACS No.**	**Course Name**	**Hours**	**Pre-Requisite(s)**
MW1882	-	Conventional Lathe Drilling, Boring, Reaming, Tapping and Die Threading	12	MW1191 MW1873
MW1900	-	Taper Turning	30	MW1191 MW1882
MW1913	-	Basic Threading	30	MW1191 MW1882
MW1231	-	Drawings and Specifications II	24	MW1773
MW2083	-	Mechanical Components	6	MW1191
MW2124	-	Oxy-Fuel Cutting and Welding	12	MW1191
MW2341	-	Reconditioning	15	MW1191
MW1952	-	Reciprocating Machines	12	MW1191
MW1922	-	Introduction to Milling Machines	40	MW1191
MW2071	-	Computer Numerical Control (CNC) Operation 1	45	MW1922 MW1913
MW1943	-	Job Planning	12	MW1191
MW1945	-	Mentoring	6	None
Total Level 1 Hours			**480**	

*A Direct Entry Machinist apprentice is **not** required to complete AM1100-Math Essentials course.

Required Work Experience

Level 2				
Course No.	**AACS No.**	**Course Name**	**Hours**	**Pre-Requisite(s)**
MW3100	-	Heat Treatment II	6	Level 1
MW1991	-	Quality Inspection	15	
MW2001	-	Vertical Milling Machine Operation	85	
MW2250	-	Component Refurbishment	6	
MW2101	-	Surface Grinders	40	
MW1931	-	Advanced Conventional Lathe Operation	105	
MW2400	-	CNC Programming, Set Up and Operation I	43	
Total Level 2 Hours			**300**	

Required Work Experience

Level 3				
Course No.	**AACS No.**	**Course Name**	**Hours**	**Pre-Requisite(s)**
MW2032		Cylindrical Grinders	35	Level 2
MW2041		Cutter and Tool Grinder	20	
MW2361		Horizontal/Universal Milling Machine Operation	60	
MW1981		Gears and Gear Cutting	45	Level 2 MW2361
MW2500		CNC Programming, Set Up and Operation II	80	Level 2
	Total Level 3 Hours		**240**	

Required Work Experience

Level 4				
Course No.	**AACS No.**	**Course Name**	**Hours**	**Pre-Requisite(s)**
MW2090	-	Bevel, Helical and Worm Gears	95	Level 3
MW2111	-	Electrical Arc Welding	35	Level 3
MW2600	-	CNC Programming, Operation and Set Up III	80	Level 3
MW3000	-	Program Review	30	Level 3
Total Level 4 Hours			**240**	

Total Course Credit Hours	**1260**

Level 1

MW1191 Machine Shop Safety

Learning Outcomes:

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

Duration: 2 Hours

Pre-Requisite(s): None

Objectives and Content:

1. Identify types of personal protective equipment (PPE) and safety equipment and describe their applications.
   i. vision
   ii. hearing
   iii. clothing
   iv. footwear
   v. respiratory

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

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

4. Explain fire regulations.
   i. alarms and evacuation procedures
   ii. fire exits
   iii. extinguishers

5. Identify workplace hazards and describe safe work practices.
   i. shop/facility
      - energy state awareness
      - electrical and mechanical
   ii. lock-out/tag-out
   iii. ventilation/fumes
   iv. fire
   v. environment
      - discharge/spills
      - material waste

vi. personal
vii. shop/facility
- energy state awareness (electrical and mechanical)
- lockout / tag out
- ventilation/fumes
- fire

viii. environment
ix. discharge/spills

6. Identify and follow workplace safety and health regulations.
   i. WHMIS
   ii. provincial/territorial OH&S

7. Explain the importance of conducting safety inspections of shops.

Practical Requirements:

None.

MW1773 Drawings and Specifications I

Learning Outcomes:

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

Duration: 18 Hours

Pre-Requisite(s): MW1191

Objectives and Content:

1. Define terminology associated with drawings.
   i. engineering
   ii. isometric
   iii. orthographic

2. Identify types of drawings and sketches and describe their purpose.

3. Interpret and extract information from drawing features.
   i. line types
   ii. projections
   iii. dimensions
   iv. notes

4. Explain the principles of orthographic projection.

5. Identify types of reference materials and their use.
   i. Machinery’s Handbook
   ii. material data sheets
   iii. manufacturers’ specifications

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

7. Identify drawing views and describe their characteristics, purpose and applications.
   i. isometric
   ii. orthographic

8. Identify and interpret industry symbols and markings and describe their applications.
   i. hidden (phantom) lines
   ii. datums

9. Identify types of sketches and describe their purpose.

10. Describe basic sketching techniques and types of views.

11. Identify dimensions used in creating sketches.

12. Describe how to interpret and extract information from parts to create a sketch.

Practical Requirements:

None.

MW1371 Basic Layout

Learning Outcome:

- Demonstrate knowledge of basic layout and its application.
- 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.
- Demonstrate knowledge of methods used to mark stock and workpieces.

Duration: 6 Hours

Pre-Requisite(s): MW1191

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. scribers
   iv. dividers and trammels
   v. hermaphrodite calipers
   vi. squares (adjustable, solid, master)
   vii. gauges
   viii. rulers
   ix. layout dye
   x. prick punches
   xi. centre punch
   xii. automatic centre punch
   xiii. layout tables
   xiv. surface plates
   xv. combination set
   xvi. surface gauges
   xvii. calipers (inside and outside)
   xviii. parallels
   xix. v-blocks

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

4. Describe the procedure to 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 stock and workpieces for identification.

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

9. Describe datum or reference surfaces, their purpose and applications.

10. Describe the procedures used to perform accurate layout of work on a flat surface.

Practical Requirements:

None.

MW1382 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 hand saws, their applications, maintenance and procedures for use.
- Demonstrate knowledge of deburring, the hand and power tools for deburring and the techniques used.
- Demonstrate knowledge of filing tools, their applications, maintenance and procedures for use.
- Demonstrate knowledge of safe work practices and procedures.

Duration: 6 Hours

Pre-Requisite(s): MW1191

Objectives and Content:

1. Identify hazards and describe safe work practices pertaining to hand and power tools.

Hand Tools

2. Identify types of hand tools and describe their applications and procedures for use.
    - i. vises
        - parts
        - sizing methods
        - mounting procedures
        - work holding methods
    - ii. hammers
    - iii. screw drivers
    - iv. wrenches
        - metric and imperial sizing systems
    - v. pliers
    - vi. punches
        - dressing procedures
    - vii. stamps
        - parts
    - viii. hacksaws

- parts

ix. files
x. scrapers
xi. deburring tools

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
      - portable bandsaw
      - hand grinders
   ii. cordless
      - drill
      - reciprocating saw
      - circular saw
   iii. hydraulic
      - press
   iv. pneumatic
      - die grinder
      - blow gun

5. Describe the procedures used to inspect, maintain and store power tools and equipment.

6. Define terminology associated with hands saws.

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

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

9. Identify potential problems during sawing operations and describe their causes and solutions.

10. Identify hazards and describe safe work practices pertaining to hand saws.

11. Identify features to be deburred.

12. Identify hand and power tools for deburring.
    i. files
    ii. die grinders and accessories

13. Identify types of filing tools and describe their applications and procedures for use.
    i. single cut
    ii. double cut
    iii. needle files
    iv. handle
    v. file card

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

15. Identify hazards and describe safe work practices pertaining to filing tools.

Practical Requirements:

None.

MW1391 Hand Threading and Reaming

Learning Outcomes:

- Demonstrate knowledge of basic threads and fits and their applications.
- Demonstrate knowledge of the procedures used to measure and gauge threads.
- Demonstrate knowledge of thread inserts and their applications.
- Demonstrate knowledge of procedures used to produce and restore internal and external threads.
- Demonstrate knowledge of safe work practices and procedures.

Duration: 6 Hours

Pre-Requisite(s): MW1191

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 solutions.

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.

<u>Taps and Dies</u>

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

11. Identify types of taps and dies and describe their applications and procedures for use.

12. Describe the procedure to extract broken taps.

13. Describe the different thread types.

14. Describe tap failures and remedies.

15. Describe the function of lubricants and the importance of selecting the lubricant.

16. Describe the different types of imperial and metric dies, their applications and use.

17. Describe the procedures used to restore threads with taps and dies.

18. Describe the procedures used to calculate tap drill sizes.

Hand Reamers

19. Identify reamers and describe their characteristics and applications.
    i. maintenance
    ii. storage

20. Describe the procedures used to perform hand reaming.

Practical Requirements:

None.

MW1783 Cutting Fluids, Coolants and Lubricants

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.
- Demonstrate knowledge of cleaning agents, their applications, and procedures for use.

Duration: 3 Hours

Pre-Requisite(s): MW1191

Objectives and Content:

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. Describe regulations pertaining to the use of cutting fluids and coolants.

4. Interpret codes and regulations pertaining to the use of fluids and coolants.

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

6. Describe the types of friction and their implications.
   i. sliding friction
   ii. rolling friction
   iii. fluid friction

7. Describe the procedures used to handle, store and dispose of fluids and coolants.
   i. cutting fluids
   ii. coolants
   iii. lubricants
   iv. solvents

8. Identify cleaning agents used to clean machines.

9. Describe process to clean machines.

10. Describe the application of cleaning agents.

Lubricants

11. Identify types of lubricants and describe their applications and procedures for use.
   i. hand oiler
   ii. wick feed
   iii. drip feed
   iv. slinger
   v. splash
   vi. pressure system
   vii. oil mist
   viii. grease nipples and cups

12. Describe the principles, purposes and importance of lubricants.

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

14. Describe the procedures used to handle, store and dispose of lubricants.

Practical Requirements:

None.

MW1763 Precision Measurement

Learning Outcomes:

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

Duration: 18 Hours

Pre-Requisite(s): MW1191, MW1371

Objectives and Content:

Applied Mathematics

1. Describe the procedure to perform accurate mathematical calculations using fractions.

2. Describe the procedure to perform calculations and conversions using the metric and imperial systems.

3. Interpret measurements using metric and imperial systems.

Basic Measurement

4. Define terminology associated with basic precision measurement.

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

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

7. Identify types of precision measuring instruments and describe their applications and procedures for use.
   i. micrometers
   ii. Vernier calipers
   iii. dial indicators
   iv. radius gauges
   v. combination sets
   vi. plug gauges
   vii. tool makers' buttons
   viii. telescopic gauges
   ix. feeler gauges
   x. go-no go gauges
   xi. wigglers
   xii. angle gauges
   xiii. small hole gauges
   xiv. solid square
   xv. thread gauges
   xvi. spring and firm-joint calipers
   xvii. depth and height gauges
   xviii. steel rules
   xix. machinist levels
   xx. master height gauge

8. Identify types of micrometers and describe their characteristics, applications, and procedures for use.
   i. adjustment
   ii. care and maintenance

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

10. Describe procedures used to inspect, clean, maintain and store basic precision measuring instruments.

11. Identify types of squares and describe their applications and procedures for use.

Practical Requirements:

1. Perform accurate measurements using a variety of measuring instruments (internal, external, height, depth).

MW1791 Machinable Materials

Learning Outcomes:

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

Duration: 9 Hours

Pre-Requisite(s): MW1191

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 materials and their chemical, physical and mechanical characteristics.

4. Describe the procedures used to determine the carbon content of metal.

5. Identify and interpret markings and documentation relating to material selection and 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. numbering system
   vi. mill certificates

6. 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

7. Explain the processing characteristics of materials.

8. Identify types of coolants used with machinable materials and describe the considerations affecting their selection.

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

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

Non-Metallic Materials

11. Identify non-metallic materials and describe their characteristics and applications.

12. Describe hazards and safety precautions involved in machining non-metallic materials.

13. Describe the principles and procedures for machining non-metallic materials.

14. Describe the procedures used to mark work pieces for identification.

Practical Requirements:

None.

MW1802 Angular Measurement

Learning Outcomes:

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

Duration: 30 Hours

Pre-Requisite(s): MW1763

Objectives and Content:

1. Describe the procedure to perform calculations for angular measurements using sine, cosine and tangents.

2. Identify types and grades of gauge blocks and describe their applications and procedures for use.
   i. metric
   ii. imperial
   iii. purpose
   iv. grades
   v. tolerance
   vi. accuracy
   vii. materials
   viii. set sizes and number of blocks

3. Identify pin and ball gauge sets.

4. Identify height build-ups and describe their applications and procedures for use.
   i. calculations

5. Identify types of wear blocks and describe their purpose and applications.

6. Describe the factors that affect gauge blocks and their impact.
   i. temperature
   ii. contaminants
   iii. maintenance
   iv. applications
   v. calculations

7. Identify types of precision measuring equipment used in quality inspection and describe their applications and procedures for use.

8. Explain the principles of angular measurement.
   i. angle gauge blocks

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

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

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

Practical Requirements:

1. Perform gauge block build ups to check the accuracy of an angle using a dial indicator.

2. Read a Vernier protractor to perform angular measurement.

3. Perform calculations to achieve required angles using gauge blocks and a sine bar.

4. Perform measurement using angle gauge blocks.

MW2302 Power Sawing Equipment

Learning Outcomes:

- Demonstrate knowledge of power saws, their applications, maintenance and safe procedures for use.
- Demonstrate knowledge of saw blades, their applications, maintenance and procedures for use.
- Demonstrate knowledge of safe work practices and procedures related to the use of power saws.

Duration: 18 Hours

Pre-Requisite(s): MW1783

Objectives and Content:

1. Define terminology associated with power saws.

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

3. Identify types of power saws and attachments and describe their applications.
   i. vertical
   ii. horizontal
   iii. reciprocating/power hacksaws
   iv. cold circular
   v. abrasive
   vi. cutoff
   vii. contour
   viii. friction
   ix. hacksaw
   x. rip fence
   xi. protective devices
   xii. saw guide selection
   xiii. power feed
   xiv. work holding devices

4. Identify types of accessories and components and describe their characteristics and applications.

5. Identify size and capacity of power saw.

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

i. contour
   - internal and external contour sawing
   - notching and slotting
   - radius cutting and splitting

ii. angular cutting
iii. stock cutting

7. Identify types of blades and describe their parameters, characteristics, applications and installation procedures.
   i. composition
   ii. sizing
   iii. bandsaw length calculations
   iv. teeth
   v. pitch

8. Describe the procedures used to adjust power saws.

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

10. Identify potential problems during sawing operations and describe their causes and remedies.
   i. incorrect speeds and feeds
   ii. binding and overheating blade
   iii. wandering

11. Identify potential problem when cutting irregular shapes and describe their causes and solutions.
   i. incorrect speeds and feeds
   ii. binding and overheating blade
   iii. incorrect pitch of blade
   iv. lack of lubrication

12. Calculate speed and feed requirements.
   i. factors
   ii. tables and charts

13. Describe the procedures used to adjust speeds and feeds.

14. Describe preventive maintenance procedures for sawing equipment.
   i. care
   ii. storage
   iii. blade welding

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

16. Describe the procedures used to butt weld bandsaw blades.

17. Describe the procedures used to secure workpiece on power saws.

18. Describe the procedures used to adjust table angle.

19. Describe the procedures to calculate and measure workpiece to be cut.

Practical Requirements:

None.

MW2312 Introduction to Grinding and Abrasives

- Demonstrate knowledge of off-hand grinding machines, their applications, and procedures for use.
- Demonstrate knowledge of abrasives, their applications and procedures for use.
- Demonstrate knowledge of abrasive finishing techniques.
- Demonstrate knowledge of safe work practices and procedures.

Duration: 18 Hours

Pre-Requisite(s): MW1791

Objectives and Content:

Grinding Machines

1. Define terminology associated with off-hand grinding machine.

2. Identify hazards and describe safe work practices pertaining offhand grinding machines.

3. Identify types of grinding machines and describe their applications.
   i. pedestal
   ii. surface
   iii. cylindrical
   iv. centreless
   v. tool and cutter grinder
   vi. die grinders
   vii. angle grinders

4. Describe the procedures used to perform offhand (bench) grinding operations.

5. Describe the procedures used to perform tool grinding operations on a carbide tool grinder.

6. Describe grinding wheels, their characteristics and applications.
   i. wire wheels and buffers
   ii. grinding disks
   iii. sanding disks
   iv. flap wheels
   v. rotary burrs
   vi. mounted points
   vii. loose abrasives
   viii. abrasives

7. Describe safety procedures and operating precautions related to grinding.
   i. speed
   ii. rests and guards
   iii. ring testing
   iv. machine condition
   v. dressing of wheels
   vi. wheel blotters

8. Describe types of hand dressers, their characteristics applications and procedures for use.
   i. abrasive stick
   ii. mechanical dressers (starwheel)

9. Describe the procedures used to test and mount a grinding wheel.

10. Describe the procedures used to dress a grinding wheel by hand.

Abrasives

11. Define terminology associated with abrasives.

12. Identify hazards and describe safe work practices related to abrasives.

13. Identify types of abrasives and describe their characteristics and applications.
   i. aluminum oxide
   ii. silicon carbide
   iii. zirconia-aluminum oxide
   iv. boron carbide
   v. ceramic aluminum oxide
   vi. diamond

14. Identify coated abrasives and describe their characteristics, construction and applications.

15. Describe the types of manufactured diamond and their characteristics.

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

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

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

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

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

Practical Requirements:

None.

MW2322 Heat Treatment I

Learning Outcomes:

- Demonstrate knowledge of basic heat treatment and its applications.

Duration: 18 Hours

Pre-Requisite(s): MW1191, MW1791

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 factors affecting the selection of tool steels.

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

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

Practical Requirements

1. Heat treat a workpiece.

2. Perform hardness test for metals.

MW2371 Material Testing

Learning Outcomes:

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

Duration: 12 Hours

Pre-Requisite(s): MW1791, MW2322

Objectives and Content:

1. Define terminology associated with material testing.
   i. hardness
   ii. composition
   iii. properties

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

3. 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
   iii. magnetic particle
   iv. spark
   v. file

4. Identify the machines and scales used to determine material hardness and describe their associated procedures.
   i. Rockwell
   ii. Brinell
   iii. Scleroscope

5. Describe the procedures used to test steels.
   i. tensile strength test
   ii. impact test
   iii. spark test
   iv. file test

Practical Requirements:

1. Perform file and spark test.

2. Perform the procedure for testing metals.

MW1842 Hoisting, Lifting and Rigging

Learning Outcomes:

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

Duration: 6 Hours

Pre-Requisite(s): MW1191

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 hoisting, lifting and rigging training and certification requirements.
4. Identify and interpret basic hand signals used for hoisting and lifting.
5. Identify types of hoisting and lifting equipment and accessories and describe their applications, limitations and procedures for use.
   i. rigging equipment
      - ropes
      - slings
      - chains
      - hooks
      - spreader bars
      - shackles
6. Explain angle considerations when using rigging.
   i. rigging charts
   ii. rule of thumb formula
   iii. compensation for angles in lifting of loads
7. Describe the considerations when rigging material/equipment for lifting.
   i. equipment and accessories

ii. anchor points

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

Practical Requirements:

None.

MW1853 Drills and Drill Presses

Learning Outcomes:

- Demonstrate knowledge of drill press tooling and drill presses, their applications, maintenance and procedures for use.
- Demonstrate knowledge of drilling, reaming and countersink operations.
- Demonstrate knowledge of jigs, fixtures and work holding devices, their applications, maintenance and procedures for use.
- Demonstrate knowledge of measurements and calculations pertaining to drilling operations.
- Demonstrate knowledge of measurements and calculations pertaining to countersinks, counterbores, chamfers and spot faces.
- Demonstrate knowledge of drill press tapping tools, their applications, maintenance and procedures for use.
- Demonstrate knowledge of hole finishing tooling, their applications, maintenance and procedures for use.
- Demonstrate knowledge of measurements pertaining to hole finishing operations.
- Demonstrate knowledge of calculations pertaining to hole finishing operations.
- Demonstrate knowledge of safe work practices and procedures.

Duration: 18 Hours

Pre-Requisite(s): MW1391, MW1783, MW1791

Objectives and Content:

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

2. Define terminology associated with dress press tapping tooling.
   i. tapping heads
   ii. collets
   iii. chucks
   iv. cutting and forming taps
   v. countersinks

3. Identify types of drill press tapping tools and describe their applications.

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

5. Identify types of drill press tooling and describe their applications.
   i. twist drills
   ii. counterbores
   iii. countersinks
   iv. hole saws
   v. machine taps
   vi. machine reamers
   vii. spot facing tools
   viii. center drills

6. Describe a drill press, its parts and applications.
   i. base
   ii. column
   iii. table
   iv. drilling head

7. Identify types of drill presses and describe their components and applications.
   i. sensitive
   ii. upright
      - parts
      - gear box
      - spindle advance
      - table
      - operating principles
      - capabilities
   iii. radial arm
      - parts
      - base
      - column
      - radial arm
      - drilling head
      - operating principles
      - capabilities

8. Identify safety precautions when working with a magnetic drilling machine.

9. Define terminology associated with jigs, fixtures and work holding devises.
   i. vices
      - plain
      - angular/swivel
      - compound
   ii. parallel clamps
   iii. c-clamps

10. Identify jigs, fixtures and work holding devices and describe their applications and procedures for use.
    i. jigs and fixtures
    ii. work holding devices
        - jacks
        - spacer blocks
        - parallels
    iii. tool holding devices
        - drill chucks (tapered and threaded)
        - key type
        - keyless
        - drill sleeves
        - drill socket
        - quick change
        - drifts

11. Identify types of machine reamers and describe their use.
    i. rose
    ii. fluted
    iii. carbide tipped
    iv. shell

12. Describe the procedures used to set up and perform drill press operations.
    i. drilling
    ii. counterboring
    iii. countersinking
    iv. tapping
    v. reaming
    vi. spot facing
    vii. center drilling

13. Describe the procedures used for drilling and reaming work.

14. Identify materials used to manufacture drills and their application.
    i. high speed steel
    ii. cobalt
    iii. carbide
    iv. coated

15. Describe the methods of drill sizing.
    i. fractional size
    ii. number size
    iii. letter size
    iv. metric drills
    v. use of a drill gauge

vi. measurement

16. Describe the procedures used to inspect and maintain drill press equipment, tooling, accessories and drill presses.

17. Describe the procedures used to install tool in spindle.

18. Describe the procedures used to sharpen drill bits.

19. Identify calculations to verify depth, sizing and positions.

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

21. Define terminology associated with hole finishing tooling.
    i. reamers

22. Identify types of hole finishing tooling and describe their applications.

Twist Drills

23. Identify twist drills and describe their characteristics and applications.
    i. components
        - shank (tapered and straight)
        - body (flutes, margin, body clearance, web)
        - point (chisel edge, lips, lip clearance, heel, angles, variation, clearances)

24. Describe types of drills and their applications.
    i. high helix
    ii. core drills
    iii. oil hole drills
    iv. straight-fluted drills
    v. deep hole
    vi. spade drills
    vii. hole-saws
    viii. centre drills
    ix. jobber drills

25. Describe potential problems during drilling operations, their causes, prevention and remedies.
    i. discoloration
    ii. broken or split drill
    iii. poor tool life
    iv. holes out of round
    v. drilling pressures
    vi. poor hole finish
    vii. chatter
    viii. squeaking and jamming

26. Describe the procedures used to sharpen a twist drill.
    i. using drill sharpening machine
    ii. using a bench grinder
    iii. point angle measurement
    iv. web thinning

Speeds and Feeds

27. 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

28. Describe the procedure to perform calculations for speed, feed and depth of cut in metric and imperial units.
    i. materials
    ii. tool geometry
    iii. tool material
    iv. machine setup/rigidity

29. Interpret drill charts and tables.

30. Describe the procedures used for reaming holes.

31. Describe the sequence for drilling operations.

Practical Requirements:

1. Sharpen a twist drill with correct clearance angles to suit various materials using freehand method and a drill sharpening machine.

2. Drill and size holes accurately.

3. Ream straight holes.

4. Use a Magnetic Drill Press in a vertical position.

MW1862 Introduction to Conventional Lathes

Learning Outcomes:

- Demonstrate knowledge of conventional lathes, their accessories, attachments and applications.
- Demonstrate knowledge of conventional lathe tools and accessories, and their applications.
- Demonstrate knowledge of workpiece set up.
- Demonstrate knowledge of safe work practices and procedures related to sharpening tools.

Duration: 18 Hours

Pre-Requisite(s): MW1191

Objectives and Content:

1. Define terminology associated with conventional lathes.

2. Describe safety procedures and precautions related to lathe operation.
   i. safety glasses
   ii. clothing and jewelry
   iii. safety guards and lockout controls
   iv. secure work and tool mounting
   v. chuck wrench removal
   vi. use of air hoses

3. Identify types of conventional lathes and describe their operating principles and applications.
   i. engine
   ii. turret
   iii. multispindle
   i. engine lathe
   ii. single and multi-spindle automatic lathes

4. Identify the five major components of conventional lathes.
   i. head stock
   ii. tail stock
   iii. bed
   iv. carriage
   v. quick change gearbox

5. Identify types of work holding devices and describe their applications.
   i. three-jaw chuck
   ii. four-jaw-chuck
   iii. faceplate
   iv. collect chuck
   v. between centers
   vi. magnetic chuck
   vii. chuck
   viii. lathe centres
      - dead
      - live
      - micro-set
      - adjustable
   x. chucks
      - three jaw universal
      - four jaw independent
      - spring collett
      - drill chuck
      - magnetic chuck
   xi. lathe dogs
      - standard bent-tail
      - straight tail
      - clamp type
   xii. mandrels
      - solid, expansion
      - gang
      - threaded
      - taper shank

6. Identify types of tool holding devices and describe their applications.
   i. toolposts and tool holders
      - left hand offset
      - right hand offset
      - straight turning
      - parting tool
      - threading tool
      - boring bar
   ii. knurling tool
   iii. turret toolpost
   iv. quick change toolpost
   v. face plate

7. Identify types of inspection equipment and describe their use.
   i. dial indicators
   ii. micrometers

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

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

10. 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. part off

11. Describe procedures used for preventative maintenance of lathe machines.
    i. cleaning
    ii. lubrication
    iii. adjustments
        - gibs
        - tailstock
        - drive belts

12. Identify types of spindle noses and describe the operating principles.

13. Describe the procedures used to mount and remove chucks.

14. Describe the procedures used to assemble a three-jaw chuck.

15. Describe the factors used to determine speed, feed and depth of cut.
    i. calculations
    ii. charts and tables
    iii. material hardness
    iv. tool material
    v. machine condition
    vi. finish required
    vii. coolants and cutting fluids

Cutting Tools

16. Explain tool nomenclature.
    i. cutting edge
    ii. face
    iii. flank nose
    iv. radius
    v. point
    vi. shank

17. Describe the procedures used to sharpen conventional lathe cutting tools.

18. Describe the procedures used to grind cutting tool angles.

19. Describe angles and clearances.
    i. cutting tools
    ii. side cutting edge
    iii. end cutting edge
    iv. side relief (clearance angle)
    v. back rake (top)side rake angle point angle

20. Describe the effects of tool characteristics and the importance of tool shape for lathe operations.
    i. roughing and finishing
    ii. facing
    iii. parting and grooving
    iv. threading tools
    v. round nose, forming and boring tools

21. Describe the procedures used to install tooling.

22. Describe the procedures used to face internal and external shapes and surfaces.

23. Describe the procedures used to set up and grind a tool bit.

Carbides

24. Interpret the ANSI and SI systems for the identification of carbide inserts/coatings and tool holders.

25. Describe speeds, feeds and depth of cut of carbide cutting tools.

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

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

Practical Requirements:

1. Grind a right hand turning and facing tool.
2. Grind a 60 degree threading tool.
3. Grind a parting off or grooving tool.
4. Perform adjustments for gibs and backlash in the crosslide and compound rest.

MW1873 Basic Conventional Lathe Operation

Learning Outcomes:

- Demonstrate knowledge of conventional lathes, their maintenance and procedures for use.
- Demonstrate knowledge of cutting tools, their maintenance and procedures for use.
- Demonstrate knowledge of conventional lathe accessories, their maintenance and procedures for use.
- Demonstrate knowledge of machines, troubleshooting and procedures for use.
- Demonstrate knowledge of maintenance and alignment of machines.
- Demonstrate knowledge of workpiece setup.
- Demonstrate knowledge of lathe speeds and feeds.
- Demonstrate knowledge of calculations required to adjust machine control.
- Demonstrate knowledge of work holding devices, their maintenance and procedures for use.
- Demonstrate knowledge of facing, turning, knurling, grooving and parting off operations.

Duration: 30 Hours

Pre- Requisite(s): MW1191, MW1862

Objectives and Content:

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

2. Describe safety procedures and precautions related to filing and polishing.

3. Describe sequencing of lathe activities.

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

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

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

7. Identify conventional lathe accessories and describe their applications.
   i. taper attachments
   ii. steady rests
   iii. follower rests
   iv. centres

8. Identify potential setup problems and describe their causes and solutions.
   i. misalignment
   ii. run-out
   iii. insufficient clearance
   iv. improper adjustments

9. Describe the procedures used to mount and adjust rests.

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

11. Describe the procedures used to set up work holding devices on lathes.
   i. three-jaw chuck
   ii. four-jaw chuck
   iii. face plate
   iv. collet chuck

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

13. Identify potential work holding devices setup problems and describe their causes and solutions.

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

15. Identify potential problem when facing surfaces with a conventional lathe and describe their causes and solutions.
   i. chatter
   ii. tool wear
   iii. incorrect tool height setting
   iv. chip management

16. Identify potential problems when turning external surfaces using a conventional lathe and describe their causes and solutions.
   i. chatter
   ii. tool deflection
   iii. taper
   iv. run-out

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

18. Identify potential problems when knurling using a conventional lathe and describe their causes and solutions.

19. Identify potential problems when grooving and describe their causes and solutions.

20. Identify potential problems when parting off using a conventional lathe and describe their causes and solutions.

21. Describe the procedures used to perform basic conventional lathe operations.
    i. grooving
    ii. facing
    iii. shoulders
    iv. parallel turning
    v. shoulder turning
    vi. undercutting diameter and shoulders
    vii. chamfering
    viii. machining between centres
    ix. knurling
    x. parting off
    xi. grooving

Machining in a Chuck

22. Describe the procedures used to mount work in a three-jaw chuck.

23. Describe the procedure used to mount work in a four-jaw chuck.

24. Describe the procedures used to set up in a four-jaw chuck using a dial indicator.

25. Describe factors that affect selection of tooling and accessories.

26. Describe the procedures used to cut or part off work in a chuck.

27. Describe the procedures used to set up and operate the lathe.

28. Describe the procedures used to produce rough and finished precision machined work in a chuck.

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

30. Describe the procedures used to inspect and maintain conventional lathes.

Practical Requirements:

1. Set up in a four-jaw chuck using a dial indicator.

2. Part off work in a chuck.

3. Perform the procedures for rough and finished turning work in a chuck.

4. Sharpen and use brazed carbide tooling.

5. Set up and operate a lathe.
   i. machine grooves
   ii. machine between centres
   iii. knurl
   iv. machine diameters to size
   v. face to length
   vi. machine to a shoulder
   vii. parallel turn

MW1882 Conventional Lathe Drilling, Boring, Reaming, Tapping and Die Threading

Learning Outcomes:

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

Duration: 12 Hours

Pre-Requisite(s): MW1191, MW1873

Objectives and Content:

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

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

3. Describe the procedures used for installing drills.

4. Identify potential problems when drilling operations using a conventional lathe and describe their causes and solutions.
   i. drill wandering
   ii. oversized holes
   iii. misalignment of tail stock/turret
   iv. damage to cutting tool
   v. chip management
   vi. incorrect drill geometry
   vii. insufficient chip and tool clearance
   viii. chatter
   ix. tool deflection
   x. taper
   xi. run-out

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

6. Identify cutting fluids and coolants used during lathe operations.

7. Describe the procedures used to set up speeds and feeds.

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

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

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

11. Describe the procedures used for spotting and drilling work on a conventional lathe.

12. Describe the procedures used for reaming work on a conventional lathe.
    i. reaming allowance
    ii. speeds
    iii. feed rates

13. Describe the procedures used for installing reamers.

14. Describe the procedures used for tapping on a conventional lathe.

15. Describe the procedures used for die threading on a conventional lathe.

16. Describe speed, feed and depth of cut for conventional lathe operations.
    i. reaming
    ii. drilling
    iii. tapping
    iv. die threading
    v. counterboring
    vi. countersinking

17. Identify and describe mandrels their applications and procedures for use.

18. Identify hazards and describe safe work practice pertaining to sharpening tools.

Practical Requirements:

1. Make a bushing.

MW1900 Taper Turning

Learning Outcomes:

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

Duration: 30 Hours

Pre-Requisite(s): MW1191, MW1882

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 taper
   ii. taper pin
   iii. metric taper
   iv. pipe thread taper
   v. milling machine taper
   vi. self-holding tapers
   vii. steep tapers

4. Identify types of taper attachments and describe their applications and procedures for use.
   i. plain
   ii. telescopic

5. 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
   vi. Prussian Blue
   vii. digital read out

6. Identify methods used to turn tapers and describe their associated procedures.
   i. taper attachment
   ii. tailstock offset
   iii. compound rest

7. Identify potential problems and describe their causes and solutions.
   i. insufficient chip and tool clearance
   ii. chatter, tool deflection
   iii. incorrect taper
   iv. run out

8. Describe the formula for taper calculations.
   i. taper per foot
   ii. taper per inch
   iii. metric tapers
   iv. taper advancement
   v. tail stock offset

9. Describe the procedure to perform angular measurements.

10. Describe the procedures used to fit an external taper.

Practical Requirements:

1. Turn tapers (internally and externally).
   i. compound rest
   ii. tailstock offset
   iii. taper attachment

2. Measure taper using available method.
   i. sinebar
   ii. three lines
   iii. chaulk or Prussian blue

MW1913 Basic Threading

Learning Outcomes:

- Demonstrate knowledge of setting up lathes to machine threads.
- Demonstrate knowledge of the procedures used to measure and gauge threads.
- Demonstrate knowledge of cutting internal and external threads according to classification.
- Demonstrate knowledge of basic threads and fits and their applications.
- Demonstrate knowledge of threading operations.
- Demonstrate knowledge of safe work practices and procedures.

Duration: 30 Hours

Pre-Requisite(s): MW1191, MW1882

Objectives and Content:

Thread Characteristics

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

2. Describe threads and their applications.

3. Explain thread parts and terminology.
   - i. screw thread
   - ii. internal and external threads
   - iii. major and minor diameter
   - iv. pitch diameter
   - v. number of threads
   - vi. pitch
   - vii. lead
   - viii. root
   - ix. crest
   - x. flank
   - xi. depth of thread
   - xii. angle of thread
   - xiii. helix or lead angle
   - xiv. right and left hand threads

4. Identify thread forms and describe their characteristics and applications.
   i. ISO metric
   ii. unified
   iii. ACME
   iv. National Pipe thread
   v. British Standard Whitworth
   vi. British Standard Fine
   vii. square and modified square
   viii. International Metric
   ix. buttress

5. Explain thread fit terms, classifications and symbols used for imperial and metric threads.
   i. fit allowance
   ii. tolerance
   iii. limits
   iv. nominal and actual size
   v. tolerance grades
   vi. allowance symbols and numbers

6. Describe the importance of thread fit and the use of thread gauges.

7. Identify thread formula that apply to thread forms and parts of a thread.
   i. 60 degree V thread
   ii. American National
   iii. Unified
   iv. Metric
   v. minor diameter
   vi. crest width
   vii. number thread size
   viii. tap drill size
   ix. pitch of the thread
   x. pitch diameter
   xi. root width
   xii. lead
   xiii. depth

8. Identify types of thread insert failures and describe their causes and solutions.

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

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

Thread Cutting Operations

11. Describe the considerations to determine speed and feed.

12. Identify cutting fluids and coolants used.

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

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

15. Describe the procedures used to deburr a workpiece.

16. Identify potential problems and describe their causes and solutions.
    i. chatter
    ii. tool deflection
    iii. taper
    iv. tool misalignment

17. Describe the procedures used to check and measure threads using inspection equipment.
    i. thread wires
    ii. thread micrometers
    iii. thread gauges
    iv. nut
    v. outside micrometers

18. Identify the thread chasing dial and describe its applications and procedures for use.

19. Describe procedures used to reset a threading tool.

Practical Requirements:

1. Machine an internal and external thread.

2. Machine a metric thread.

3. Perform measurement of threads using the three wire method.

4. Measure thread using alternative methods.

MW1231 Drawings and Specifications II

Learning Outcomes:

- Demonstrate knowledge of drawings and their applications.
- Demonstrate knowledge of interpreting and extracting information from drawing features.
- Demonstrate knowledge of reference materials and their use.
- Demonstrate knowledge of industry symbols and markings and their applications.
- Demonstrate knowledge of geometric dimensions and tolerances and their applications.

Duration: 24 Hours

Pre-Requisite(s): MW1773

Objectives and Content:

1. Define terminology associated with drawings.
   i. engineering
   ii. isometric
   iii. orthographic

2. Interpret and extract information from drawing features.
   i. lay/surface finish systems
   ii. welding symbols
   iii. material and processing specifications
   iv. machining allowances
   v. standard and geometric dimensioning and tolerancing (GD & T)

3. Identify drawing views and describe their characteristics, purpose and applications.
   i. sectional
   ii. auxiliary

4. Identify and interpret industry symbols and markings and describe their applications.
   i. surface textures
   ii. violations of true projections
   iii. auxiliary views
   iv. positional dimension
   v. hidden (phantom) lines
   vi. geometric dimensions and tolerances
   vii. datums

5. Explain the principles of geometric dimensioning and tolerancing.

Practical Requirements:

1. Produce intermediate drawings and transfer information from a workpiece.
2. Determine tolerances and finish symbols.
3. Determine geometric features for a given workpiece.

MW2083 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 press equipment, their applications, maintenance and procedures for use.
- Demonstrate knowledge of safe work practices and procedures.

Duration: 6 Hours

Pre-Requisite(s): MW1191

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. nuts
   ii. dowel pins
   iii. washers
   iv. studs
   v. snap rings
   vi. rivets
   vii. keys
   viii. splines
   ix. screws
   x. lock wires
   xi. bolts
   xii. self-locking nuts

4. Identify head styles of threaded fasteners and describe their characteristics and applications.

5. Explain the term “fit” and the types of fits and their applications relating to hubs.
   i. clearance fits
   ii. transition fits
   iii. interference fits

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

7. Define terminology associated with broaches and broaching equipment.

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

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

10. Explain the operating principles of broaching equipment.

11. Identify types of broaching equipment and describe their components and applications.

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

13. Describe the procedures for cutting keyways.

14. Identify types of keys, keyseats and keyways and describe their characteristics and applications.
   i. square
   ii. woodruff
   iii. flat
   iv. gib

15. Explain the principles of stepped keys.

16. Describe the procedures used to hand broach keyways.

17. Identify broaches and describe their characteristics and applications.

18. Describe the procedures used to perform hand broaching.

19. Describe the procedures used for safe operation of an arbor press.

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

21. Explain the operating principles of press equipment.

22. Identify types of press equipment and describe their components and applications.

23. Identify hazards and describe safe work practices pertaining to the use of press equipment.

Practical Requirements:

1. Broach a keyway.

MW2124 Oxy-Fuel Welding and Cutting

Learning Outcomes:

- Demonstrate knowledge of the set up and use oxy fuel welding equipment.
- Demonstrate knowledge of heating processes used in machining operations and their applications.
- Demonstrate knowledge of bending processes used in machining operations and their applications.
- Demonstrate knowledge of safe work practices and procedures.

Duration: 12 Hours

Pre-Requisite(s): MW1191

Objectives and Content:

1. Describe hazards and safe practices associated with oxy fuel welding equipment.
   i. welding screens
   ii. ventilation (local exhausts)

2. Describe the use of PPE associated with arc welding.
   i. eye and face protection
   ii. safety goggles
   iii. welding shields
   iv. welding jackets
   v. gloves
   vi. aprons
   vii. lens selection

3. Describe safe practices relating to the operation of oxygen and acetylene equipment.
   i. handling and transporting cylinders
   ii. storage of cylinders
   iii. cylinder safety devices
      - bursting discs
      - fusible plugs
      - release valves
   v. cylinder pressures
   vi. valve threads
   vii. contamination of oil and grease
   viii. flashback arrestor
   ix. flash back and back fires

4. Describe procedures used to set-up and use welding equipment (OFW).
   i. safety precautions
   ii. inspection of work area for possible hazards
   iii. equipment
   iv. set up
   v. adjustment
   vi. check for leaks
   vii. light-up procedure
   viii. flame adjustment
   ix. shut down procedures
   x. storage

5. Identify types of tips used in cutting and welding and describe their applications.
   i. numbering system for tips
   ii. styles of tips
      - cutting
      - welding
      - heating tips

6. Describe the procedure to perform cutting using oxygen fuel equipment.

7. Define terminology associated with heating processes.

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

9. Identify types of heating equipment and describe their applications.
   i. oxy-fuel torches

10. Describe the procedures used to inspect and store heating equipment.

11. Define terminology associated with bending processes.

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

13. Identify types of bending equipment and describe their applications.
   i. vises
   ii. hammers
   iii. presses

14. Identify hazards and describe safe work practices pertaining to heating and bending processes.

Practical Requirements:

1. Set up and use oxy-fuel welding equipment.
    i. cut mild steel freehand

MW2341 Reconditioning

Learning Outcomes:

- Demonstrate knowledge of the procedures used for reconditioning.
- Demonstrate knowledge of the procedures used for refurbishing components.
- Demonstrate knowledge of the procedures used to analyze components.
- Demonstrate knowledge of calculations required to measure components.
- Demonstrate knowledge of procedures used to prepare documentation.

Duration: 15 Hours

Pre-Requisite(s): MW1191

Objectives and Content:

1. Identify types of tools used in refurbishing and describe their procedures for use.
   i. pullers
   ii. presses
   iii. portable keyseat cutter
2. Interpret documentation pertaining to refurbishing components.
3. Describe the order of operations used to disassemble components.
4. Describe the instruments used to measure surface roughness.
5. Describe the instruments and procedure used to measure roundness.
6. Describe the instruments used to measure concentricity.
7. Describe the procedures used to clean components.
8. Identify inspection equipment used to inspect components.
   i. bore gauges
9. Describe the procedure to calculate and measure component features.
10. Describe the procedures used to prepare documentation.
11. Describe the procedures used to inspect components.

Practical Requirements:

1. Use portable keyseat cutter to machine a keyseat.

MW1952 Reciprocating Machines

Learning Outcomes:

- Demonstrate knowledge of slotters and shapers, their applications, set up and procedures for use.

Duration: 12 Hours

Pre-Requisite(s): MW1191

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 shapers and describe their components and applications.

4. Calculate speed and feed requirements.

Shapers

5. Identify shapers and describe their characteristics and applications.
   i. parts
   ii. capacity

6. Describe the procedures used for setting up shapers.
   i. stroke length
   ii. stroke positioning
   iii. work piece alignment
   iv. ram positioning

7. Describe the procedures used to grind a shaper cutting tool.

Slotters

8. Describe the procedures used to set up and operate slotters.
   i. stroke length
   ii. stroke angle
   iii. stroke positioning
   iv. workpiece alignment

9. Identify slotters and describe their characteristics and applications.
   i. capacity
   ii. applications

10. Describe the tool holders and cutters used with slotters.

11. Identify work holding devices used with slotters and describe their characteristics and applications.

Practical Requirements:

1. Perform speed, feed and depth calculations.

2. Set stroke length and ram positioning.
   i. cut a keyway using a slotter

MW1922 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.
- Demonstrate knowledge of conventional milling machines, their setup and procedure for use.
- Demonstrate knowledge of tool geometry and its use.

Duration: 40 Hours

Pre-Requisite(s): MW1191

Objectives and Content:

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. universal/horizontal
   iii. plain horizontal

4. Identify the components and controls of conventional milling machines and describe their purpose and operation.
   i. base
   ii. table
   iii. housing
   iv. overarm and arbor supports
   i. knee
   ii. column
   iii. saddle
   iv. speed and feed controls
   v. hand wheels, cranks and graduated collars
   vi. coolant system
   vii. backlash eliminator
   viii. table swivel block
   ix. feed trip dogs and limit stops
   x. parts and controls specific to vertical mills

xi. elevating mechanism
xii. drive
xiii. overarm (ram)
xiv. draw bolts
xv. digital readout

5. Identify types of milling machine accessories and attachments and describe their applications and maintenance.
   i. fixture
   ii. arbors, collets and adaptor
   iii. vises
   iv. dividing head
   v. backlash eliminator
   vi. clamps
   vii. t-nuts
   viii. slotting attachment
   ix. vertical attachment
   x. edge finder/centre finder
   xi. offset boring head

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.
   i. high speed steel
   ii. tungsten carbide
   iii. titanium
   iv. cemented carbides
   v. ceramic

9. Identify types of cutting tools and describe their applications.
   i. plain milling cutters
   ii. standard shank-type helical milling cutters
   iii. side milling cutters
   iv. face milling cutters
   v. angular cutters
   vi. formed cutters
   vii. metal saws
   viii. end mills
   ix. t-slot cutters
   x. dovetail cutter

xi. woodruff keyseat cutter
xii. flycutters

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

11. Describe climb and conventional milling.

12. Describe tool geometry.
    i. chip breaker
    ii. primary and secondary clearances

Milling Machine Setup

13. Describe the procedures used to install tooling and tool holding devices.
    i. drill chuck
    ii. collet chuck
    iii. end mill holders
    iv. shell mill holders
    v. arbors
    vi. boring heads

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

15. Describe the factors that determine milling feed, speed and depth of cut calculations and their importance.

16. Describe the procedures used to perform calculations for milling feed and depth of cut for metric and imperial milling operations.

17. Describe the procedures used to align a vise on a milling machine.

18. Describe procedures used to align vertical milling machine head.

19. Describe procedures used to locate an edge.

20. Describe the procedures used to clean and lubricate milling machines.

21. Describe potential set-up problems, their causes and remedies.

22. Describe the procedures used to set up and cut opposing keyways in a shaft.

23. Describe the rectangular coordinates system.

24. Describe procedures to perform basic indexing.

Practical Requirements:

1. Tram the head.

2. Machine keyseats.
   i. square

3. Drill bolt circle using digital readout.

4. Use an offset boring head and mill slots.

MW2071 Computer Numerical Control (CNC) Operation 1

Learning Outcomes:

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

Duration: 45 Hours

Pre-Requisite(s): MW1922, MW1913

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

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. tool offsets
   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.

Practical Requirements:

1. Write a program to produce a simple part on the CNC mill and lathe.

2. Operate the CNC mill and lathe to produce the part.

MW1943 Job Planning

Learning Outcomes:

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

Duration: 12 Hours

Pre-Requisite(s): MW1191

Objectives and Content:

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

2. Identify the considerations and requirements for selecting equipment and tooling to complete specified jobs.

3. Determine amount of materials required to complete specified jobs.

4. Interpret and complete relevant trade documentation.

5. Interpret advanced drawing specifications.
   i. tolerance
   ii. finish requirements
   iii. geometric dimensioning and tolerancing

6. Identify operations to be performed in priority sequence.

7. Calculate cutting time requirements.

8. Identify and explain fixed and variable costs.

Practical Requirements:

1. Perform a cost estimate for a given job.

MW1945 Mentoring

Learning Outcomes:

- Demonstrate knowledge of strategies for learning skills in the workplace.
- Demonstrate knowledge of strategies for teaching workplace skills.

Duration: 6 Hours

Pre-Requisite(s): None

Objectives and Content:

1. Describe the importance of individual experience.

2. Describe the shared responsibilities for workplace learning.

3. Determine one's own learning preferences and explain how these relate to learning new skills.

4. Recognize and describe the importance of different types of skills in the workplace.

5. Describe the importance of essential skills in the workplace.
   i. reading
   ii. writing
   iii. document use
   iv. oral communication
   v. numeracy
   vi. thinking skills
   vii. working with others
   viii. digital technology
   ix. continuous learning

6. Identify and utilize different learning styles.
   i. seeing it
   ii. hearing it
   iii. trying it
   iv. applying it

7. Identify different learning needs and describe the strategies to meet these needs.
   i. learning disabilities
   ii. learning preferences
   iii. language proficiency

8. Identify strategies to assist in learning a skill.
    i. understanding basic principles of instruction
    ii. developing coaching skills
    iii. being mature and patient
    iv. providing feedback

9. Identify different roles played by a workplace mentor.

10. Describe teaching skills.
    i. identifying the point of the lesson
    ii. linking the lesson
    iii. demonstrating the skill
    iv. providing practice
    v. giving feedback
    vi. assessing skills and progress

11. Explain the importance of identifying the point of a lesson.

12. Identify how to choose a good time to present a lesson.

13. Explain the importance of linking the lesson.

14. Identify the components of the skill (the context).

15. Describe considerations in setting up opportunities for skill practice.

16. Explain the importance of providing feedback.

17. Identify techniques for giving effective feedback.

18. Describe a skills assessment.

19. Identify methods of assessing progress.

20. Explain how to adjust a lesson to different situations.

Practical Requirements:

None.

Level 2

MW3100 Heat Treatment II

Learning Outcomes:

- Demonstrate knowledge of basic heat treatment and its applications.

Duration: 6 Hours

Pre-Requisite(s): Level 1

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.
5. Identify the processes used in the heat treatment of metals and describe their applications.
6. Identify and interpret reference data used in heat treatment.
7. Identify methods used for quenching steel and describe the properties of the steel produced by each.

Practical Requirements:

None.

MW1991 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.

Duration: 15 Hours

Pre-Requisite(s): Level 1

Objectives and Content:

1. Define terminology associated with quality inspection.
   i. basic dimension
   ii. limits
   iii. tolerances
   iv. allowance
   v. geometric

2. Describe the purpose, parts and applications of the coordinate measuring system.

3. 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. pin
   vii. ball
   viii. drill blank rods

4. Identify types of precision measuring instruments used in quality inspection and describe their applications and procedures for use.

5. Describe the procedures used to inspect workpieces.

6. Identify inspection equipment used to inspect components.

7. Identify types of comparators and describe their applications and procedures for use.
   i. mechanical
   ii. electronic
   iii. optical
   iv. pneumatic
   v. dial indicators

8. Describe the Rectangular, Cartesian, Cylindrical and Polar Coordinate Systems, its purpose and application.

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

10. Describe the instruments used to measure surface roughness.

11. Describe the instruments and procedure used to measure roundness.

12. Describe the instruments used to measure concentricity.

13. Identify thread inspection equipment.

14. Identify process to assess size of features according to specifications.
   i. design
   ii. standards
   iii. client
   iv. industry
   v. manufacturers' specifications
   vi. drawings

Practical Requirements:

1. Perform a quality assurance check on a part using appropriate equipment.

2. Perform runout and concentricity testing procedures.

3. Inspect surface finishes and interpret results.

4. Use a Coordinate Measuring Machine (CMM).

5. Use an Optical Measuring Machine.

6. Use Electronic Measuring equipment.

MW2001 Vertical Milling Machine Operation

Learning Outcomes:

- Demonstrate knowledge of vertical milling machines, their set up, maintenance and procedures for use.
- Demonstrate knowledge of work holding devices, their set up, and applications.
- Demonstrate knowledge of cleaning agents, their applications and procedures for use.
- Demonstrate knowledge of maintenance and alignment of machines.
- Demonstrate knowledge of machines, troubleshooting and procedures for use.

Duration: 85 Hours

Pre-Requisite(s): Level 1

Objectives and Content:

1. Identify vertical milling machines and describe their construction and features.

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

3. Describe the considerations used to determine speed, feed and depth of cut for vertical milling machine operations.
   i. selecting conventional milling machines
   ii. milling surfaces
   iii. milling profiles and pockets
   iv. milling slots, grooves and keyways
   v. cuts gears and splines
   vi. drilling holes
   vii. ream holes
   viii. cuts countersinks, counterbores, chamfers and spot faces
   ix. perform tapping
   x. bores holes

4. Describe the procedures used to set speeds and feeds.
   i. milling surfaces
   ii. milling profiles and pockets
   iii. milling slots, grooves and keyways
   v. drilling holes 15.05
   vi. ream holes 15.06
   vii. cuts countersinks, counterbores, chamfers and spot faces
   viii. perform tapping

ix. bores holes

5. Calculate speed, feed and depth of cut.

6. Interpret tables and charts of speeds and feeds.

7. Identify calculations required to determine amount of excess material.
   i. milling surfaces
   ii. milling slots, grooves and keyseats

8. Identify cutting fluids and coolants used.

9. Identify potential set up problems and describe their causes and remedies.

10. Describe the procedures used to align workpieces.

11. Describe the procedures used to set up and perform milling operations on vertical milling machines.
   i. mills profiles and pockets
      - pocketing
      - plunging
   ii. mills slots, grooves and keyways
      - keyways
      - t-slot
      - dovetail
   v. cuts countersinks, counterbores, chamfers and spot faces
      - countersinking
      - counterboring
      - chamfering
      - spot facing

12. Describe the procedure used to produce holes.
   i. reaming holes
   ii. spot face
   iii. counterbore
   iv. chamfer
   v. countersink
   iv. tapping
   v. drilling holes

13. Describe the procedures used to perform reaming operations.

14. Identify reaming allowance.

15. Identify tooling required for reaming.

16. Identify process to measure reamed hole.

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

18. Describe the procedures used to perform milling operations using rotary tables.
    i. machine angles and radii

19. Identify types of dividing heads and describe their characteristics and applications.
    i. standard

20. Explain the principles and perform calculations involved in indexing.
    i. direct
    ii. simple
    iii. angular
    iv. differential
    v. linear division

21. Describe the procedures used to perform tapping operations.

22. Identify tooling required for tapping.

23. Identify accessories used for tapping.

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

25. Identify techniques used to troubleshoot vertical milling operations and describe their associated procedures.

26. Identify types of work holding devices.
    i. chucks
    ii. vises
    iii. fixtures
    iv. dividing head
    v. rotary table
    vi. clamping kits

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

28. Identify cleaning agents used to clean machines.

29. Describe process to clean machines.

30. Describe the application of cleaning agents.

Advanced Milling Operations

31. Describe the various types of cams, cam motions and their applications.

32. Describe the procedures used for cam milling.

Practical Requirements:

1. Perform the calculations required to mill a cam.

2. Layout a bolt hole pattern on a rotary table.

3. Machine an internal and external dovetail.

4. Machine a T-slot.

MW2250 Component Refurbishment

Learning Outcomes:

- Demonstrate knowledge of the procedures used to analyze components.
- Demonstrate knowledge of calculations required to measure components.
- Demonstrate knowledge of the procedures used for assembling components.
- Demonstrate knowledge of calculations required to measure components.
- Demonstrate knowledge of the procedures used to prepare documentation.

Duration: 6 Hours

Pre-Requisite(s): Level 1

Objectives and Content:

1. Describe the procedures used to clean components.

2. Calculate and measure component features.

3. Describe the procedures used to prepare documentation.

4. Describe the procedures used to inspect components.

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

6. Identify types of materials used to fit and assemble components and describe their applications and procedures for use.

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

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

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

Practical Requirements:

None.

MW2101 Surface Grinders

Learning Outcomes:

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

Duration: 40 Hours

Pre-Requisite(s): Level 1

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. Describe the calculations used to determine feed and depth of cut.

4. Describe the calculations used to determine speed.

5. Describe the principles of the grinding process.

6. Describe the procedures used to set up grinders and accessories.

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

8. Identify types of grinding wheels and describe their characteristics and applications.

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

10. Describe the procedures used to test a grinding wheel on a surface grinding wheel flange.

11. Describe the procedures used to mount a grinding wheel.

12. Describe the procedures used to balance a grinding wheel.

13. Describe the procedures and precautions used for truing and dressing a grinding

wheel.

14. Identify the considerations and requirements for selecting a grinding wheel for profile grinding.
    i. grain grade
    ii. structure
    iii. bond

15. Describe the procedures used to align a workpiece.

16. Identify potential set up problems and describe their causes and remedies.

17. Describe the procedures used to inspect and maintain surface grinding machines.

Work Holding Devices

18. Identify types of work holding devices and describe their applications and maintenance.
    i. face plate
    ii. fixtures
    iii. magnetic chuck
    iv. chucks

19. Identify magnetic chuck accessories and describe their applications.
    i. adapter plate
    ii. magnetic chuck blocks
    iii. Magna-vise clamps
    iv. double-face tape

20. Describe the methods of applying coolants.

21. Describe the factors that affect surface finish.

Surface Grinding Operations

22. Identify sequence of grinding operations.

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

24. Describe the procedures used for mounting work pieces.

25. Describe the procedures used for dressing a convex radius on a grinding wheel.

26. Identify and correct problems during grinding operations.

Practical Requirements:

1. Grind previously made workpiece surfaces:
   i. flat
   ii. parallel
   iii. adjacent
   iv. perpendicular

2. Dress a grinding wheel.

MW1931 Advanced Conventional Lathe Operation

Learning Outcomes:

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

Duration: 105 hours

Pre-Requisite(s): Level 1

Objectives and Content:

Contours and Forms

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 mount and adjust rests.

5. Describe the procedures used for toolpost grinding.

Threads

6. Describe thread forms and classes of fit.

7. Describe the procedures used to perform imperial and metric thread calculations.

8. Describe the procedures used to change an imperial design lathe to metric threading.

9. Describe the procedures for cutting internal and external threads.

10. Describe the procedures used to cut threads on a tapered section.

11. Describe the procedures used to cut left hand thread.

12. Describe the instruments used to measure threads.

13. Describe the procedures used to measure threads.
    i. three-wire method
    ii. one-wire method
    iii. thread micrometer

Advanced Threading and Multiple Starts

14. Identify types of advanced threads and describe their purpose, characteristics and applications.
    i. specialty
        - ACME
        - buttress
        - tapered pipe
        - straight pipe
    ii. multiple start

15. 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

16. Identify methods used to cut specialty threads and describe their associated procedures.
    i. ACME
    ii. buttress
    iii. tapered pipe
        - straight pipe

17. Describe the procedures used to check and measure threads using inspection equipment.
    i. thread micrometers
    ii. thread gauges
    iii. nut
    iv. outside micrometers

18. Describe the procedure used to cut a tapered thread.

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

20. Describe the procedures used to set up and perform line boring.

Practical Requirements:

1. Calculate and measure using the one wire method (ACME).
2. Machine a double start ACME stud.
3. Machine a mating nut with 2A and 2B fit for an ACME thread.
4. Machine an eccentric.
5. Machine a tapered pipe thread.
6. Set up and machine a contour.
7. Perform line boring.

MW2400 CNC Programming, Set Up and Operation I

Learning Outcomes:

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

Duration: 43 Hours

Pre-Requisite(s): Level 1

Objectives and Content:

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

2. Define terminology associated with CNC machines and tooling.

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

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

5. Describe the procedures used to operate CNC machines.

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

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

8. Identify CNC control units and describe their purpose.

9. Identify types of tool holders and work holding devices used with CNC machines and describe their applications.

10. Describe the procedures used to adjust offsets.

11. Identify CNC related reference points and their location.

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

13. Define control features.
    i. single block mode
    ii. feed override
    iii. feed hold
    iv. reset

14. Identify types of programming codes and describe their applications.

15. Identify types of edit functions used and describe their applications.

16. Describe the procedures used to input datum surfaces.

17. Describe the procedures used to input datum information.

18. Describe the procedures used to download programs into CNC machines.

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

20. Define features for stepping through program.
    i. single bock mode
    ii. distance to go
    iii. feed hold
    iv. feed and rapid override

21. Describe the procedures used to restart program.

22. Describe the procedures used to perform CNC programming.

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

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

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

26. Define the differences between centerline programming and cutter radius compensation (CRC) programming.

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

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

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

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

31. Explain CANNED cycles.
    i. rough turning
    ii. finish turning
    iii. threading (internal/external)
    iv. grooving
    v. taper turning
    vi. drilling
    vii. tapping

Practical Requirements:

1. Write a program to produce a simple part on the CNC Mill and Lathe.

2. Operate the CNC Mill and Lathe to produce the part.

Level 3

MW2032 Cylindrical Grinders

Learning Outcomes:

- Demonstrate knowledge of cylindrical grinders, their set up, applications, 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 procedures for use.
- Demonstrate knowledge of tool and cutter grinding wheels, their applications, maintenance and procedures for use.
- Demonstrate knowledge of honing machines, their setup, maintenance and procedures for use.

Duration: 35 Hours

Pre-Requisite(s): Level 2

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

4. Describe the calculations used to determine speed.

5. Describe cylindrical grinders, their types, parts, characteristics and applications.

6. Describe the procedures used to plan the sequence for grinding operations.

7. Describe the procedures used to set up grinders and accessories.

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

9. Describe the procedures used to align the machine.

10. Describe the procedures used to align workpieces.

11. Identify potential set up problems and describe their causes and remedies.

12. Identify types of accessories used for cylindrical grinding operations and describe their applications.

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

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

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

16. Identify the considerations and requirements for selecting a grinding wheel for grinding.
    i. abrasive
    ii. grain
    iii. grade
    iv. structure
    v. bond

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

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

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

20. Describe the principles and procedures used to parallel grind an internal/external diameter and plunge.

21. Describe operating principles of a centreless grinder.

22. Identify techniques used to troubleshoot cylindrical grinding operations and describe their associated procedures.

23. Identify considerations for machining allowances for workpieces to be hardened prior to grinding.

24. Identify techniques used to inspect workpieces to ensure it meets specifications and job requirements.

25. Interpret documentation pertaining to material to be ground.

26. Describe grinding operations to be performed.

27. Identify types of honing machines, their setup and maintenance.

28. Identify honing techniques and describe their associated procedures.

29. Identify potential problems and describe their causes and solutions.
    i. bell mouth
    ii. chatter
    iii. glazing

Practical Requirements:

1. Grind a workpiece face, internal/external diameter, tapers, plunge and shoulder.

MW2041 Cutter and Tool Grinder

Learning Outcomes:

- Demonstrate knowledge of setting up and operating a universal cutter and tool grinder.
- Demonstrate knowledge of tool and cutter grinding wheels, their applications, maintenance and procedures for use.

Duration: 20 Hours

Pre-Requisite(s): Level 2

Objectives and Content:

1. Identify types of tool and cutter grinding wheels and describe their characteristics and applications.

2. Describe the procedures used to mount and balance tool and cutter grinding wheels.

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

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

5. Describe the procedures used to inspect, maintain and store tool and cutter grinding wheels.

Universal Cutter and Tool Grinder

6. Describe tool and cutter grinders, their parts, applications and safety precautions.

7. Describe tool cutter nomenclature.

8. Describe tool cutter grinder accessories and their applications.

9. Describe the procedures used to set up a tool and cutter grinder.

10. Describe methods used for calculating, grinding and checking clearance angles.

11. Describe the procedures used to grind clearance angles.
    i. clearance grinding
    ii. hollow grinding
    iii. circle grinding

12. Describe potential problems during operations, their causes and remedies.

13. Describe maintenance procedures for tool and cutter grinders.

Endmill Sharpeners

14. Describe endmill sharpeners, their parts, applications and safety precautions.

15. Describe endmill cutting angles.

16. Describe endmill sharpener accessories and their applications.

17. Describe the procedures used to set up endmill sharpeners.

18. Describe methods used for grinding and checking clearance angles.

Drill Sharpeners

19. Describe drill sharpeners, their parts, applications and safety precautions.

20. Describe drill cutting angles.

21. Describe drill sharpener accessories and their applications.

22. Describe the procedures used to set up drill sharpeners.

23. Describe methods used for grinding and checking clearance angles.

Practical Requirements:

1. Set up and sharpen a cutter using an endmill sharpener.

2. Setup and sharpen a drill using a drill sharpener.

MW2361 Horizontal/Universal Milling Machine Operation

Learning Outcomes:

- Demonstrate knowledge of horizontal/universal milling machines, their set up, and procedures for use.
- Demonstrate knowledge of conventional milling machines and accessories and their applications.
- Demonstrate knowledge of maintenance and alignment of machines.
- Demonstrate knowledge of machines, troubleshooting and procedures for use.

Duration: 60 Hours

Pre-Requisite(s): Level 2

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 when selecting conventional milling machines speeds and feeds.

4. Identify cutting fluids and coolants used.
   i. milling surfaces

5. Describe the procedures used to set speeds and feeds.
   i. milling surfaces
   ii. bores holes

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

7. Describe the procedures used to set up horizontal/universal to perform milling operations.

8. Describe the two basic types of milling machine operations.
   i. plain milling
   ii. face milling

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

10. Describe the procedures used for milling a flat surface.
    i. rough/finish
    ii. positioning cutter

11. Identify techniques used to troubleshoot machines.

12. Describe the procedures used to adjust and maintain horizontal/universal milling machines and machine alignment.

13. Describe the procedures used to perform milling operations on horizontal/universal milling machines.
    i. operations
        - slitting
        - slotting
        - gang
        - form cutting
        - single point
        - straddle milling
    ii. mills surfaces
        - straddle
        - gang
        - facing

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

15. Describe the procedure to calculate basic indexing calculations.

16. Identify the considerations and requirements for setting up a workpiece.

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

18. Describe the procedures used to establish workpiece datums.

19. Identify potential problems and describe their causes and solutions.
    i. incorrect speeds and feeds
    ii. improper work holding device
    iii. tool deflection

Practical Requirements:

1. Centre and set the cutter to the work surface.

2. Mill a flat surface.

3. Perform milling operations.
   i. face
   ii. side
   iii. straddle

4. Perform sawing/slitting operations.

5. Align the table on a universal milling machine.

MW1981 Gears and Gear Cutting

Learning Outcomes:

- Demonstrate knowledge of milling machines, their set up, maintenance and procedures for use.
- Demonstrate knowledge of gears, splines and gear cutting.
- Demonstrate knowledge of gear measurement.
- Demonstrate knowledge of gear milling operations.

Duration: 45 Hours

Pre-Requisite(s): Level 2, MW2361

Objectives and Content:

1. Define terminology associated with gears, splines and gear cutting.
   i. addendum
   ii. centre distance
   iii. chordal addendum
   iv. chordal thickness
   v. circular thickness
   vi. clearance
   vii. circular pitch
   viii. dedendum
   ix. diametrical pitch
   x. involute
   xi. linear pitch
   xii. module (metric gears)
   xiii. outside diameter
   xiv. pitch circle
   xv. pitch circumference
   xvi. pitch diameter
   xvii. pressure angle
   xviii. root circle
   xix. root diameter
   xx. tooth thickness
   xxi. whole depth
   xxii. working depth

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

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

4. Identify types of gears and splines, and describe their characteristics and applications.
   i. spur
   ii. helical
   iii. bevel
   iv. worm
   v. rack
   vi. internal
   vii. pinion
   viii. hypoid
   ix. herringbone
   x. miter
   xi. angular bevel
   xii. worm and worm gears

5. Describe the procedures used for rack milling.

Gear Tooth Measurement

6. Identify procedures to measure gear tooth and splines.

7. Identify calculations required to determine gear and spline cutting requirements.

8. Identify calculations required to determine ratios for simple and compound gear trains.

9. Identify methods of gear tooth measurement and describe their associated procedures.
   i. micrometer and wire
   ii. gear tooth Vernier

10. Describe the factors affecting accurate measurement of gear teeth.

Gear Cutting

11. Describe the characteristics of involute gear cutters.

12. Describe how gear cutters are sized.
   i. imperial
   ii. metric

13. Describe the characteristics of a gear cutter set and the factors relating to the number of gear teeth to be cut.

14. Describe the considerations and procedures used to determine speed, feed and depth of cut.

15. Identify cutting fluids and coolants used for gear cutting.

16. Describe the procedures used to cut a spur gear.

17. Calculate gear cutting requirements.

18. Calculate ratios for simple and compound gear trains.

19. Identify calculations required to determine amount of excessive material.

20. Identify machines and accessories used for cutting gears and splines.
    i. dividing head
    ii. rotary table
    iii. footstock
    iv. arbor

21. Identify tooling required for cutting gears and splines.
    i. involute cutter

22. Describe the procedures used to set up and produce gears using a horizontal mill.

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

24. Describe procedures used to cut a rack gear.

Practical Requirements:

1. Cut a spur gear.

2. Perform gear tooth measurement.

MW2500 CNC Programming, Set Up and Operation II

Learning Outcomes:

- Demonstrate knowledge of CNC machines and tooling, their accessories, attachments and applications.
- Demonstrate knowledge of CNC machines and tooling, their set up, operation, maintenance and procedures for use.
- Demonstrate knowledge of CNC programming and operations.
- Demonstrate knowledge of transferring CNC programs.
- Demonstrate knowledge of CNC machine operations.
- Demonstrate knowledge of calculations required to calculate deviations
- Demonstrate knowledge of geometry creation.
- Demonstrate knowledge of CAM software.

Duration: 80 Hours

Pre-Requisite(s): Level 2

Objectives and Content:

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

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

3. Identify types of tool holders and work holding devices used with CNC machines and describe their applications.

4. Describe the procedures used to set up workpieces on CNC machines.

5. Describe the procedures used to operate CNC machines.

6. Describe the procedures used to adjust offsets.

7. Define control features.
   i. single block mode
   ii. feed override
   iii. feed hold
   iv. reset

8. Identify types of programming codes and describe their applications.

9. Identify types of edit functions used and describe their applications.

10. Describe the procedures used to input datum surfaces.

11. Describe the procedures used to download programs into CNC machines.

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

13. Define features for stepping through program.
    i. single bock mode
    ii. distance to go
    iii. feed hold
    iv. feed and rapid override

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

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

16. Interpret documentation pertaining to the machining of workpieces.
    i. drawings
    ii. computer-aided design (CAD) files

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

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

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

20. Describe the procedures used to produce CNC programming using CAM software.

21. Describe process to create geometry using CAD software.

22. Identify dimensioning tools in CAD software.

23. Identify cutting tools in CAM software library.

24. Define types of CAM operations and tool paths.

25. Identify machine post processors in CAM software.

26. Explain the CAD/CAM Process from graphic generation to part completion.

27. Explain the procedure to modify 2D geometry.
    i. delete
    ii. mirror
    iii. rotate
    iv. translate
    v. trim

28. Describe the procedure to create wireframe geometry.

29. Explain CANNED cycles.
    i. rough turning
    ii. finish turning
    iii. threading (internal and external)
    iv. grooving
    v. drilling
    vi. tapping

Practical Objectives:

1. Create basic 2D geometry using CAD/CAM software for the CNC lathe and mill.

2. Create tool path for 2D geometry using CAD/CAM software for the CNC lathe and mill.

3. Create tool list for the CNC lathe and mill.

4. Create a set up sheet for the CNC lathe and mill.

5. Create a program for the CNC lathe and mill.

6. Produce a workpiece for the CNC lathe and mill.

Level 4

MW2090 Bevel, Helical and Worm Gears

Learning Outcomes:

- Demonstrate knowledge of various types of gears.
- Demonstrate knowledge of setting up and performing gear milling operations.
- Demonstrate knowledge of quality inspection and its use.

Duration: 95 Hours

Pre-Requisite(s): Level 3

Objectives and Content:

Bevel Gears

1. Identify the types of bevel gears and their characteristics.

2. Describe the procedures used to set up and mill bevel gears using indexing heads.

3. Describe the procedures used to calculate and mill bevel gears.

4. Describe the procedures used to inspect gears.

Helical Gears

5. Describe the different types of helical gears and their applications.

6. Describe the various applications of helical gears.

7. Describe the procedure for milling helical gears using indexing heads.

8. Describe the procedures used to calculate and mill helical gears.

Worm Gears

9. Identify the types of worm gears and their use.

10. Describe the calculations for the parts of a worm gear.
    i. addendum
    ii. center distance
    iii. dedendum clearance
    iv. face width
    v. lead of worm thread
    vi. lead angle
    vii. OD
        - worm
        - worm gear
    viii. pitch
        - worm
        - worm gear
    ix. pitch diameter
        - worm
        - worm gear
    x. throat diameter
    xi. radius of rim corner
    xii. throat radius
    xiii. ratio
    xiv. tooth depth
    xv. worm thread length

11. Describe the procedures used for hobbing gears.

12. Describe specialty gear cutting equipment.

Practical Requirements:

1. Machine bevel gear.

2. Machine a helical gear.

3. Perform worm gear, bevel gear and helical gear calculations.

MW2111 Electrical Arc Welding

Learning Outcomes:

- Demonstrate knowledge of basic electric arc welding processes used in machining operations, and their applications.
- Demonstrate knowledge of basic welding symbols.

Duration: 35 Hours

Pre-Requisite(s): Level 3

Objectives and Content:

1. Describe hazards and safe practices associated with arc welding.
   i. welding screens
   ii. ventilation (local exhausts)
   iii. freely movable hood
   iv. fixed enclosure
   v. down draft benches
   vi. confined spaces
   vii. electric shock hazards

2. Identify codes, regulations, training and certification requirements pertaining to welding.

3. Describe the use of PPE associated with arc welding.
   i. eye and face protection
   ii. safety goggles
   iii. welding shields
   iv. welding jackets
   v. gloves
   vi. aprons
   vii. respirators and dust masks
   viii. lens selection

4. Describe procedures used for set up and operation of electric arc welding equipment.
   i. AC and DC machines
   ii. straight and reverse polarity
   iii. grounding methods
   iv. electrode holders
   v. amperage setting for various electrodes
   vi. electrode storage

5. Describe procedures used for set up and operation of MIG (metal inert gas) welding equipment.
   i. gas selection
   ii. grounding methods
   iii. wire types and sizing
   iv. amperage setting

6. Explain the numbering system for electrodes.
   i. tensile strength
   ii. welding position (recommended for the electrode)
   iii. penetration

7. Describe types of joints encountered in welding.
   i. butt
   ii. tee
   iii. lap
   iv. plug
   v. tacking

8. Describe three basic welding positions.
   i. flat
   ii. vertical
   iii. horizontal

9. Identify and interpret welding symbols commonly found on blueprints.

Practical Requirements:

1. Weld a butt joint.

2. Build up on a piece of shafting using arc, then machine to size.

MW2600 CNC Programming, Operation and Set Up III

Learning Outcomes:

- Demonstrate knowledge of CNC machines and tooling, their set up, operation, maintenance and procedures for use.
- Demonstrate knowledge of CNC programming.
- Demonstrate knowledge of transferring CNC programs.
- Demonstrate knowledge of calculations required to calculate deviations.
- Demonstrate knowledge of geometry creation.
- Demonstrate knowledge of CAM software.

Duration: 80 Hours

Pre-Requisite(s): Level 3

Objectives and Content:

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

2. Identify primary and secondary and describe the relationship between them.

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

4. Identify types of programming codes and describe their applications.

5. Identify types of edit geometry functions used and describe their applications.

6. Describe the procedures used to establish work planes in the CAD/CAM geometry.

7. Describe the procedures used to modify tool path parameters.

8. Identify CNC post processors used with CAD/CAM software.

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

10. Describe the procedure to create set up sheets and tool lists for the CAD/CAM software.

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

12. Describe the procedures used to produce CNC programming using CAM software.

13. Identify dimensioning tools in CAD software.

14. Identify cutting tools in CAM software library.

15. Define types of CAM operations and tool paths.

16. Identify machine post processors in CAM software.

17. Explain the CAD/CAM process from graphic generation to part completion.

18. Explain the procedure to create geometry.
    i. point
    ii. line
    iii. circle/arc
    iv. fillet
    v. rectangle
    vi. polygon

19. Explain the procedure to create surface geometry.
    i. ruled
    ii. loft
    iii. revolved
    iv. net
    v. swept
    vi. draft

20. Explain the procedure to modify 2D geometry.
    i. delete
    ii. mirror
    iii. rotate
    iv. translate
    v. trim

21. Explain the procedure to modify surface geometry.
    i. fillet
    ii. trim
    iii. extend
    iv. flat boundary
    v. blend

22. Explain the procedure to create rough surface toolpaths.
    i. parallel
    ii. radial
    iii. project
    iv. flowline
    v. contour
    vi. pocket

23. Explain the procedure to crate finish surface toolpaths.
    i. parallel
    ii. radial
    iii. flowline
    iv. contour
    v. pencil

24. Explain the procedure to create a solid geometry.
    i. extrude
    ii. revolve
    iii. sweep
    iv. loft

25. Explain the procedure to modify a solid geometry.
    i. fillet
    ii. chamfer
    iii. trim
    iv. boolean

Practical Requirements:

1. Create basic 2D/3D geometry using CAD/CAM software for the CNC lathe and mill.

2. Create tool path for 2D/3D geometry using CAD/CAM software for the CNC lathe and mill.

3. Create tool list for the CNC lathe and mill.

4. Create a set up sheet for the CNC lathe and mill.

5. Create a program for the CNC lathe and mill.

6. Produce a workpiece for the CNC lathe and mill.

MW3000 Program Review

Learning Outcomes:

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

Duration: 30 Hours

Pre-Requisites: Level 3

Objectives and Content:

1. Define terminology associated with an RSOS.
   i. major work activities (MWA) / blocks
   ii. tasks
   iii. sub-tasks

2. Explain how a RSOS is developed and the link it has to the Interprovincial Examination.
   i. development
   ii. validation
   iii. MWA / block and task weighting
   iv. examination breakdown (pie chart)

3. Identify Red Seal products and describe their use when preparing for the Interprovincial Examination.
   i. Red Seal website
   ii. examination preparation guide
   iii. examination counselling sheets
   iv. sample questions
   v. preparation checklists

4. Explain the relationship between the RSOS and the Plan of Training (POT).

5. Review Common Occupational Skills for the Machinist trade as identified in the RSOS.
   i. safety-related tasks
   ii. work organization
   iii. communication and mentoring
   iv. workpiece material processing
   v. machine, tooling and inspection equipment maintenance

6. Review process to perform benchwork for the Machinist trade as identified in the RSOS.
   i. hand processes
   ii. component refurbishment

7. Review process to use power saws for the Machinist trade as identified in the RSOS.
   i. set up
   ii. operation

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

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

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

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

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

Practical Requirements:

None.

C. Conditions Governing Apprenticeship Training

1.0 General

The following general conditions apply to all apprenticeship training programs approved by the Provincial Apprenticeship and Certification Board (PACB) in accordance with the **Apprenticeship Training and Certification Act (1999).** If an occupation requires additional conditions, these will be noted in the specific Plan of Training for the occupation. In no case should there be a conflict between these conditions and the additional requirements specified in a certain Plan of Training. All references to Memorandum of Understanding will also apply to Letter of Understanding (LOU) agreements.

2.0 Entrance Requirements

2.1 Entry into the occupation as an apprentice requires:

Indenturing into the occupation by an employer who agrees to provide the appropriate training and work experiences as outlined in the Plan of Training.

2.2 Notwithstanding the above, each candidate must have successfully completed a high school program or equivalent, and in addition may be required to have completed certain academic subjects as specified in a particular Plan of Training. Mature students, at the discretion of the Director of Apprenticeship and Trades Certification, may be registered. A mature student is defined as one who has reached the age of 19 and who can demonstrate the ability and the interest to complete the requirements for certification.

2.3 At the discretion of the Director of Apprenticeship and Trades Certification, credit toward the apprenticeship program may be awarded to an apprentice for previous work experience and/or training as validated through prior learning assessment.

2.4 An Application for Apprenticeship form must be duly completed along with a Memorandum of Understanding as applicable to be indentured into an Apprenticeship. The Memorandum of Understanding must contain signatures of an authorized employer representative, the apprentice and an official representing the Provincial Apprenticeship and Certification Board to be valid.

2.5 A new Memorandum of Understanding must be completed for each change in an employer during the apprenticeship term.

3.0 Probationary Period

The probationary period for each Memorandum of Understanding will be six months or 900 employment credit hours. Within that period the memorandum may be terminated by either party upon giving the other party and the PACB one week notice in writing.

4.0 Termination of a Memorandum of Understanding

After the probationary period referred to in Section 3.0, the Memorandum of Understanding may be terminated by the PACB by mutual consent of the parties involved, or cancelled by the PACB for proper and sufficient cause in the opinion of the PACB, such as that stated inSection14.

5.0 Apprenticeship Progression Schedule, Wage Rates and Advanced Training Criteria

Progression Schedule

Machinist 7200 Hours			
Apprenticeship Level and Wages			
Level	Wage Rate	Requirements for Progression to Next Level	Next Level
1st	60%	▪ Completion of Level 1 training ▪ Registration as an apprentice ▪ Pass Level 1 exam* ▪ Minimum 1800 hours of combined relevant work experience and training	2nd Year
2nd	70%	▪ Completion of Level 2 training ▪ Pass Level 2 exam* ▪ Minimum 3600 hours of combined relevant work experience and training	3rd Year
3rd	80%	▪ Completion of Level 3 training ▪ Pass Level 3 exam* ▪ Minimum 5400 hours of combined relevant work experience and training	4th Year
4th	90%	▪ Completion of Level 4 training ▪ Pass Level 4 exam* ▪ Minimum 7200 hours of combined relevant work experience and training ▪ Sign-off of all workplace skills in apprentice logbook ▪ Pass certification exam	Journeyperson Certification

Wage Rates

- Rates are percentages of the prevailing journeyperson's wage rate in the place of employment of the apprentice.
- Rates must not be less than the wage rate established by the Labour Standards Act (1990), as now in force or as hereafter amended, or by other order, as amended from time to time replacing the first mentioned order.
- Rates must not be less than the wage rate established by any collective agreement which may be in force at the apprentice's workplace.
- Employers are free to pay wage rates above the minimums specified.

Level Exams*

- This program may **not** currently contain Level Exams, in which case this requirement will be waived until such time as Level Exams are available.

Machinist - 7200 Hours		
Class Calls (After Apprenticeship Registration)		
Call Level	Requirements for Class Call	Hours Awarded for In-School Training
Direct Entry Level 1	▪ Minimum of 1800 hours of relevant work experience ▪ Prior Learning Assessment (PLA) at designated college (if applicable)	480
Level 2	▪ Minimum of 3000 hours of relevant work experience and training	300
Level 3	▪ Minimum of 5000 hours of relevant work experience and training	240
Level 4	▪ Minimum of 7000 hours of relevant work experience and training	240
Class Calls at Minimum Hours: ▪ Class calls may not always occur at the minimum hours indicated. Some variation is permitted to allow for the availability of training resources and apprentices.		

6.0 Tools

Apprentices shall be required to obtain their own hand tools applicable for the designated occupation of registration or tools as specified by the PACB.

7.0 Periodic Examinations and Evaluation

7.1 Every apprentice shall submit to such occupational tests and examinations as the PACB shall direct. If after such occupational tests and examinations the apprentice is found to be making unsatisfactory progress, his/her apprenticeship level and rate of wage shall not be advanced as provided in Section 5 until his/her progress is satisfactory to the Director of Apprenticeship and Trades Certification and his/her date of completion shall be deferred accordingly. Persistent failure to pass required tests shall be a cause for revocation of his/her Memorandum of Understanding.

7.2 Upon receipt of reports of accelerated progress of the apprentice, the PACB may shorten the term of apprenticeship and advance the date of completion accordingly.

7.3 For each and every course, a formal assessment is required for which 70% is the pass mark. A mark of 70% must be attained in both the theory examination and the practical project assignment, where applicable as documented on an official transcript.

7.4 Course credits may be granted through the use of a PACB approved matrix which identifies course equivalencies between designated trades and between current and historical Plans of Training for the same trade.

8.0 Granting of Certificates of Apprenticeship

Upon the successful completion of apprenticeship, the PACB shall issue a Certificate of Apprenticeship.

9.0 Hours of Work

Any hours employed in the performance of duties related to the designated occupation will be credited towards the completion of the term of apprenticeship. Appropriate documentation of these hours must be provided.

10.0 Copies of the Registration for Apprenticeship

The Director of Apprenticeship and Trades Certification shall provide copies of the Registration for Apprenticeship form to all signatories to the document.

11.0 Ratio of Apprentices to Journeypersons

Under normal practice, the ratio of apprentices to journeypersons shall not exceed two apprentices to every one journeyperson employed. Other ratio arrangements would be determined and approved by the PACB.

12.0 Relationship to a Collective Bargaining Agreement

Where applicable in Section 5 of these conditions, Collective Agreements take precedence.

13.0 Amendments to a Plan of Apprenticeship Training

A Plan of Training may be amended at any time by the PACB.

14.0 Employment, Re-Employment and Training Requirements

14.1 The Plan of Training requires apprentices to regularly attend their place of employment.

14.2 The Plan of Training requires apprentices to attend training for that occupation as prescribed by the PACB.

14.3 Failure to comply with Sections 14.1 and/or 14.2 will result in cancellation of the Memorandum of Understanding. Apprentices may have their MOUs reinstated by the PACB but would be subject to a commitment to complete the entire program as outlined in the General Conditions of Apprenticeship. Permanent cancellation in the said occupation is the result of non-compliance.

14.4 Cancellation of the Memorandum of Understanding to challenge journeyperson examinations, if unsuccessful, would require an apprentice to serve a time penalty of two (2) years before reinstatement as an apprentice or qualifying to receive a class call to training as a registered Trade Qualifier. Cancellation must be mutually agreed upon by the employer and the apprentice.

14.5 An employer shall ensure that each apprentice is under the direct supervision of an approved journeyperson supervisor who is located at the same worksite as the apprentice, and that the apprentice is able to communicate with the journeyperson with respect to the task, activity or function that is being supervised.

14.6 Under the Plan of Training the employer is required to keep each apprentice employed as long as work is available, and if the apprentice is laid off due to lack of work, to give first opportunity to be hired before another is hired.

14.7 The employer will permit each apprentice to attend training programs as prescribed by the PACB.

14.8 Apprentices who cannot acquire all the workplace skills at their place of employment will have to be evaluated in a simulated work environment at a PACB authorized training institution and have sign-off done by instructors to meet the requirements for certification.

15.0 Appeals to Decisions Based on Conditions Governing Apprenticeship Training

Persons wishing to appeal any decisions based on the above conditions must do so in writing to the Minister of Immigration, Population Growth and Skills within 30 days of the decision.

D. Requirements for Red Seal Endorsement

1. Evidence the required work experiences outlined in this Plan of Training have been obtained. This evidence must be in a format clearly outlining the experiences and must be signed by an appropriate person or persons attesting that these experiences have been obtained to the level required.

2. Successful completion of all required courses in the program.

3. A combination of training from an approved training program and suitable work experience totaling 7200 hours.

   Or

   A total of 10800 hours of suitable work experience. Completion of a National Red Seal examination, to be set at a place and time determined by the Apprenticeship and Trades Certification Division.

E. Roles and Responsibilities of Stakeholders in the Apprenticeship Process

The apprenticeship process involves a number of stakeholders playing significant roles in the training of apprentices. This section outlines these roles and the responsibilities resulting from them.

The Apprentice:

- completes all required technical training courses as approved by the PACB.
- finds appropriate employment.
- completes all required work experiences in combination with the required hours.
- ensures work experiences are well documented.
- approaches apprenticeship training with an attitude and commitment that fosters the qualities necessary for a successful career as a qualified journeyperson.
- obtains the required hand tools as specified by the PACB for each period of training of the apprenticeship program.

The Employer:

- provides high quality work experiences in an environment conducive to learning.
- remunerates apprentices as set out in the Plan of Training or Collective Agreements.
- provides feedback to training institutions, Apprenticeship and Trades Certification Division and apprentices in an effort to establish a process of continuous quality improvement.
- where appropriate, releases apprentices for the purpose of returning to a training institution to complete the necessary technical courses.
- ensures work experiences of the apprentice are documented.
- ensures a certified journeyperson is currently on staff in the same trade area as the apprentice and whose certification is recognized by the NL Department of Immigration, Skills and Labour.

The Training Institution:

- provides a high quality learning environment.
- provides the necessary student support services that will enhance an apprentice's ability to be successful.
- participates with other stakeholders in the continual updating of programs.

The Apprenticeship and Trades Certification Division:

- establishes and maintains program advisory committees under the direction of the PACB.
- promotes apprenticeship training as a viable career option to prospective apprentices and other appropriate persons involved, such as career guidance counsellors, teachers, parents, etc.
- establishes and maintains a protocol with training institutions, employers and other appropriate stakeholders to ensure the quality of apprenticeship training programs.
- ensures all apprentices are appropriately registered and records are maintained as required.
- schedules all necessary technical training periods for apprentices to complete requirements for certification.
- administers Level, provincial and interprovincial examinations.

The Provincial Apprenticeship and Certification Board:

- sets policies to ensure the provisions of the **Apprenticeship and Certification Act (1999)** are implemented.
- ensures advisory and examination committees are established and maintained.
- accredits institutions to deliver apprenticeship training programs.
- designates occupations for apprenticeship training and/or certification.