Apprenticeship Manitoba

Manitoba

Tool and Die Maker
Level 1

Rev. March, 2013

Apprenticeship Manitoba

Tool and Die Maker

Unit: A1 Safety in the Machine Shop

Level: One

Duration: 7 hours

Theory: 7 hours

Practical: 0 hours

Overview:

This unit of instruction is designed to introduce safety requirements and Workplace Hazardous Materials Information System, WHMIS, identification and compliance with machine shop (basic) safety, and safe procedures used in erecting and securing block and tackle equipment according to manufacturer's guidelines. Material covered includes:

Safety requirements and WHMIS
Machine shop (basic) safety
Block and tackle fundamentals

Objectives and Content: **Percent of Unit Mark (%)**

1. **Identify the safety requirements as they apply to WHMIS with emphasis on** — **25%**
   a. Positive perspective regarding accident prevention and job site safety
   b. WHMIS defined and the format used to convey information about hazardous materials in the workplace
   c. Information found on supplier and workplace labeling using WHMIS
   d. Information from Manitoba Labour, Workplace and Safety and Health Division - Workplace Bulletins
   e. Hazardous materials in accordance with WHMIS
   f. Compliance with government safety standards and regulations
2. **Identifies and complies with machine shop (basic) safety:** — **50%**
   a. General safety precautions
   b. Housekeeping, personal protective equipment, clothing
   c. Guards
   d. Grinding
   e. Block and tackle
   f. Specific health hazards and associated precautions
      - Fumes and skin-contact with toxic substances
      - Mechanical vibration
      - Noise
   g. Fire prevention controls
      - Types of fire-fighting equipment
      - Types of fires
      - Personal protective clothing
   h. Installation, maintenance and inspection of safety equipment
      - Fire extinguishers

i. Personal Protective equipment
   - Dust mask
   - Respirator
   - Hearing protection
   - Safety glasses
   - Protective clothing

3. Identify block and tackle fundamentals: 25%

a. Synthetic slings, their characteristics, applications and limitations:
   - Polyethylene slings
   - Polyester slings
   - Nylon slings

b. Proper procedures and equipment for handling objects with block and tackle equipment

c. Hand signals

d. Various types of overhead cranes and procedures for their safe use:

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Tool and Die Maker

Unit: **A2 Professional Development**

Level: One

Duration: 7 hours

Theory: 7 hours

Practical: 0 hours

Overview:

This unit of instruction is designed to provide the Tool and Die Maker with the knowledge and understanding of professional development. Material covered includes:

Work practices of the trade
Standards
Lifelong learning
Careers in metalworking industry
History of machines
Factories of the future

Objectives and Content:	**Percent of Unit Mark (%)**
1. Identify work practices of the trade	**20%**
a. Trade associations	
2. Describe and identify standards	**50%**
a. International Organization for Standards (IS0)	
• ISO defined	
• ISO exposure	
b. Quality Control	
• Standards	
3. Identify lifelong learning and continuing education	**20%**
a. Technology curriculums	
b. Technology courses	
c. Modular training system	
d. Apprenticeship training	
4. Identify careers in metalworking industry	**20%**
a. Machine trade opportunities	
b. New technologies	
c. Machine operator	
d. Maintenance machinist	
e. Machinist	
f. Tool and die maker	
g. CNC machine operator	
h. CNC machine programmer	

i. Technician
j. Technologies
k. Quality control inspector
l. Instrument makers
    - Nylon slings

b. Proper procedures and equipment for handling objects with block and tackle equipment
c. Hand signals
d. Various types of overhead cranes and procedures for their safe use:

5. Describe history of machines **10%**

a. Shapers and planers
b. Common machine tools
c. Standard machine tools:
    - Drill press
    - Engine lathe
    - Metal saw
    - Milling machine
    - Grinder
    - Special machine tools

d. Computer numerical control machines
e. Major developments in metalworking over the past half century
    - Babbitt and babbitting procedure

6. Factories of the Future **10%**

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Tool and Die Maker

Unit: A3 Communication

Level: One
Duration: 25 hours
Theory: 10 hours
Practical: 15 hours

Overview:

This unit of instruction is designed to provide the Tool and Die Maker Apprentice with the knowledge and understanding of trade-related communication skills. Material covered includes:

Team building
Problem solving
Collaborating
Communicating
orally/writing
Careers in metalworking industry
History of machines
Factories of the future

Objectives and Content:	**Percent of Unit Mark (%)**
1. Describe team building skills	**25%**
2. Describe problem solving skills	**25%**
3. Describe collaborating skills	**25%**
4. Identify communicating skills	**25%**

a. Oral
b. Written
- Presentation on a topic suitable for the machinist industry
- Industrial and business subjects with clarity and precision
- Major types of formal/informal reports found in industry:
  Inspection report
  Job traveller (written instructions that accompany engineering drawings)

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Tool and Die Maker

Unit: A4 Hand Tools, Power Tools and Benchwork

Level: One
Duration: 22 hours
Theory: 10 hours
Practical: 12 hours

Overview:

This unit of instruction is designed to provide the Tool and Die Maker Apprentice with the knowledge and skills necessary to use and care for holding, striking, and assembling tools of the Tool and Die Maker trade in a safe, efficient and responsible manner. Hand tools may be divided into two classes: non-cutting and cutting. Non-cutting tools include vises, hammers, screwdrivers, wrenches, and pliers, which are used basically for holding, assembling, or dismantling parts. Material covered includes:

Hand and power tools, shop equipment, tools and facilities
Safety practices in the use and care of equipment and tools
Operation and maintenance of hand and power tools
Thread-cutting tools and procedures
    Hand and power tools, shop equipment, tools and facilities
    Safety practices in the use and care of equipment and tools
    Operation and maintenance of hand and power tools
Finishing Processes
    Reaming, broaching, and lapping

Objectives and Content: **Percent of Unit Mark (%)**

1. **Identify, holding, striking and assembling tools** **10%**
2. **Use and maintain holding, striking and assembling tools** **10%**
   a. Holding, striking and assembling tools and procedures for correct use:
      - Bench Vice
      - Hammers
      - Screwdrivers
        Care of a screwdriver
        Regrinding a standard screwdriver blade
      - Wrenches
      - Pliers
3. **Identify cutting hand tools** **10%**
4. **Use and maintain cutting hand tools** **10%**
   a. Hacksaws, their applications and procedures for correct use:
      - Parts
      - Types
      - Safety precautions
      - Care and storage of files

b. Types, characteristics and applications of hacksaw blades
c. Factors that determine blade selection
d. Files, their parts, applications and procedures for use:
   - Size, make and shape
   - Coarseness classifications
   - Cut classification
   - Tool and Die Maker files
   - Care and maintenance
   - Safety precautions
e. Different filing methods and their applications
f. Scrapers:
   - Types
   - Applications
   - Care and storage
   - Procedure for safe use
g. Deburring tools:
   - Types
   - Applications
   - Care and storage
   - Procedure for safe use

5. Identify hand tools and safety procedures **10%**

6. Use and maintain hand tools **10%**

a. Screwdrivers
b. Wrenches
c. Hand Tools:
   - Hammers
d. Chisels, Punches, Centre Punches
e. Files
f. Hacksaw
g. Taps and Dies

7. Identify taps and dies **10%**

8. Use and maintain taps and dies **10%**

a. Different thread types and number taps and their applications
b. Tap failures and remedies
c. Procedures for correct use of tap extractors
d. Function of lubricants and the importance of selecting the correct lubricant
e. Different types of imperial and metric dies, their applications and use
f. Procedure for the installation and use of:
   - Tap drill
   - Dies
   - Extractors
   - Helicoils
g. Consequences of thread failure
h. Importance of thread fit
i. Thread fit extractors, their applications and procedures for use
j. Procedures used to cut threads with taps and dies
k. Procedures used to calculate tap drill sizes

9. Identify hand reamers and hand broaching **10%**

10. Use and maintain hand reamers and hand broaching **10%**

a. Broaches, their characteristics and applications
b. Reamers, their characteristics and applications
c. Correct maintenance and storage of broaches
d. Procedures for the correct maintenance and storage of reamers

e. Procedures used to perform hand reaming
f. Procedures used to perform hand broaching
g. Describe the procedures for safe operation of an arbour press

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Tool and Die Maker

Unit: A5 Drill Presses, Accessories and Drill Press Operations

Level: One
Duration: 15 hours
Theory: 7 hours
Practical: 8 hours

Overview:

This unit of instruction is designed to provide the Tool and Die Maker Apprentice with the knowledge and understanding of how to perform calculations, set-up and machine operations related to the drilling of holes. Material covered includes:

Drill presses
Drilling machine accessories
How to perform calculations, set-up and machine operations related to the drilling of holes
Reaming
Speed, feed and depth of cut
Twist Drills

Objectives and Content:

Reaming, Percent of Unit Mark (%)

1. **Identify drill press safety** — **20%**
2. **Identify drilling machines** — **10%**
3. **Identify drilling machine accessories** — **10%**
   a. Work holding devices and their applications and procedures for use:
      - Drill vise
      - Drill drifts
      - Angle vise
      - V-block
      - Step blocks
      - Angle plate
      - Drill jigs
      - Clamps
      - Jacks
      - Spacer blocks
      - Parallels
      - Trepanning
   b. Tool holding devices and their applications:
      - Key type
      - Keyless
      - Precision keyless

- Drill sleeves
- Drill socket
- Quick change
- Power tapping attachment
- Drill drifts

c. Various materials used to manufacture drills

d. Methods of drill sizing:
- Fractional size
- Number size
- Letter size
- Metric drills
- Use of a drill gauge
- Measurement

e. Preventative maintenance, care and storage of drilling equipment

4. Perform drilling holes and drill press operations **20%**

a. Procedure for correct tooling and setup for web thinning, reasons and methods of correcting:
- Drilling
- Counterboring
- Countersinking
- Tapping
- Reaming

b. Procedures for performing spotfacing, counterboring and countersinking operations

c. Safety procedures and precautions related to drilling operations

d. Different types of reamers and their applications

e. Procedure for reaming holes

f. Sequence for drilling operations

g. Potential problems pertaining to drilling operations, their causes and remedies

5. Perform speed, feed and depth of cut **20%**

a. Calculations for metric and imperial formulas

b. Drill charts and tables

c. Speed definitions and variables (general rules)

6. Use twist drills **20%**

a. Twist drills, their component parts and applications
- Materials
- Sizing
- Shank (tapered and straight)
- Body (flutes, margin, body clearance, web)
- Point (chisel edge, lips, lip clearance, heel, angles, variation clearances)
- High helix

b. Different specialty drills and their applications:
- High helix
- Core drills
- Oil hole drills
- Straight-fluted drills
- Deep hole, gun and ejector drills
- Spade drills
- Hole-saws
- Centre drills
- Jobber drills
- Trepanning tools

c. Potential problems during drilling operations, their causes, prevention and remedies:
- Discolouration

- Broken or split drill
- Poor tool life
- Hole out of round
- Colour and chip shape
- Drilling pressures
- Poor hole finish
- Chatter
- Squeaking and jamming

d. Procedures used to grind a twist drill:
   - Using offhand grinders
   - Using drill sharpening machine
   - Measuring angles for different materials
   - Point angle measurement
   - Web thinning

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Apprenticeship Manitoba

Tool and Die Maker

Unit: B1 Read and Interpret Drawings I

Level: One
Duration: 32 hours
Theory: 37 hours
Practical: 0 hours

Overview:

This unit of instruction introduces the Tool and Die Maker Apprentice with the knowledge and skills necessary to read and interpret engineering drawings and apply to the workpiece. Material covered includes:

Care and handling of drawings
Interpretation of drawings

Objectives and Content:	**Reaming, Percent of Unit Mark (%)**
1. Identify procedures for proper care and handling of basic engineering drawings:	**20%**
a. Notes/changes	
b. Filing/rolling	
c. Storage	
d. Terms “scale” and “dimension”, their use and location on drawings	
2. Describe the terms used in engineering drawings, their meaning and use:	**20%**
a. Nominal size	
b. Limits	
c. Tolerance	
d. Allowance	
e. Symmetry	
3. Describe and interpret the markings used on engineering drawings:	**10%**
a. Lines	
b. Projections	
c. Dimensions	
d. Views	
e. Notes	
f. Finish symbols	
4. Describe the procedures used to perform accurate reading and transfer of sizes	**20%**
5. Describe the procedures used to transfer information to the workpiece	**20%**
6. Locate and interpret welding symbols	**20%**

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Tool and Die Maker

Unit: C1 Trade Mathematics I

Level: One
Duration: 25 hours
Theory: 24 hours
Practical: 0 hours

Overview:

This unit of instruction is designed to introduce the Tool and Die Maker Apprentice to the principles of trade mathematics and is designed to meet the requirements of the Tool and Die Maker Apprentice course. It consists of basic mathematics principles beginning with whole numbers as used in the measuring systems and ending with basic algebra.

Objectives and Content: **Percent of Unit Mark (%)**

1. Perform basic arithmetic **50%**

a. Whole numbers
- Order of operations
- Dimensioning and shop related applications

b. Fractions and decimals
- Manipulation of common and decimal fractions
- Fraction to decimal and decimal to fraction conversions

c. Metric measurement
- Units of metric measure
- Shop related applications

d. Imperial measurement
- Units of Imperial measure
- Imperial and metric conversions
- Shop related applications

e. Percent: practical applications

f. Ratio and proportion
- Writing comparisons as ratios
- Direct proportions: gear ratios, tapers
- Inverse proportions: gear and pulley systems

2. Perform basic algebra **50%**

a. Signed numbers: comparison of signed numbers

b. Basic equations
- Algebraic operations: addition, subtraction, multiplication, division, powers, roots
- Solving equations using principles of equality and transposition
- Solving equations using combined operations
- Shop related applications

c. Formulas
- Formula manipulation
- Solve cutting speed, rpm and cutting time formulas
- Solve production time problems

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Apprenticeship Manitoba

Tool and Die Maker

Unit: D1 Trade Science I

Level: One

Duration: 25 hours

Theory: 24 hours

Practical: 0 hours

Overview:

This unit introduces the Tool and Die Apprentice to the basic concepts of trade science. Apprentices will receive instruction in basic metallurgy as applied to the production of steel. Apprentices will learn about the physical and chemical characteristics of heat treatment on metal. Mechanical testing of metals is also a topic area.

Objectives and Content: **Percent of Unit Mark (%)**

1. Identify and describe basic metallurgy **50%**

a. Basic chemistry
- States of matter
- Atoms, elements and compounds
- Structures of iron

b. Production of steel
- Ore extraction and refining
- Furnaces
- Classification of steel: low, medium high carbon
- Alloys used in steel manufacture
- AISI designations
- Cast Iron

c. Mechanical testing methods related to:
- Tensile strength
- Impact resistance
- Hardness

d. Physical properties of metals

e. Manufacture of ferrous metals
   - Pig iron
   - Raw materials
     - Hematite
     - Limonite
     - Magnetite
     - Taconite
   - Pelletizing process
   - Manufacture of pig iron

f. Direct ironmaking
   - Manufacture of cast iron
   - Manufacture of steel
     - Manufacturing process
       - Basic oxygen process
       - Electric furnace

g. Direct steelmaking
   - Steel processing
   - Strand or continuous casting

h. Minimills
   - The minimill process

i. Chemical composition of steel

j. Classification of steel
   - Plain carbon steels
   - Alloy steels
     - High-strength, low-alloy steels
     - Effects of the alloying elements

2. Identify and describe heat treatment **50%**

a. Solidification of metals and microstructures: Phase Diagrams

b. Heat treatment methods
   - Hardening and tempering
   - Annealing
   - Case hardening
   - Quenching methods and applications to specific steels

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Apprenticeship Manitoba

Tool and Die Maker

Unit: E1 Basic Measurement

Level: One

Duration: 15 hours

Theory: 10 hours

Practical: 5 hours

Overview:

This unit of instruction is designed to provide the Tool and Die Maker Apprentice with the knowledge and understanding of basic measurement. Material covered includes:

Basic measurement and apply to shop processes
Gauges (basic)
Precision measurement I
micrometers – precision measuring tools
vernier calipers

Objectives and Content:	**Percent of Unit Mark (%)**
1. Identify basic measurement and applied mathematics	**10%**
2. Perform basic measurement and applied mathematics	**20%**
a. Perform accurate mathematical calculations using fractions	
b. Perform calculations using the metric and imperial systems	
c. Read measurements using metric and imperial systems	
d. Perform calculations for angular measurement	
3. Identify simple measuring tools and instruments, their parts, applications and procedures for use:	**10%**
a. Tools and instruments:	
• Combination sets	
• Plug gauges	
• Telescopic gauges	
• Feeler gauges	
• Go-no go gauges	
• Angle gauges	
• Small hole gauges	
• Solid square	
• Thread gauges	
• Spring and firm-joint calipers	
• Steel rules	
• Machinist levels	

- Surface gauge
- Combination square

b. Applications and correct use of the various measuring tools and instruments
c. Correct use of the different types of squares
d. Correct care and use of surface plates and granite tables
e. Different types of micrometer, including their adjustment and maintenance
   - Keep the working surface clean
   - Cover the plate or table when it is not in use
   - Carefully place the work on the surface plate-do not drop it onto the plate
   - Use parallels under the workpiece whenever possible
   - Never hammer or punch any layout on a surface plate
   - Remove burrs from cast-iron plates and always protect their surfaces with a thin film of oil and cover when they are not in use
f. Different types of vernier micrometer, their adjustment and maintenance

Procedures used to calibrate precision measuring tools

Correct cleaning, maintenance and storage of measuring tools and instruments

Different types of metal stamps and how they are sized

Procedure for correct transfer of sizes

4. Identify fixed gauges **10%**

5. Use fixed gauges **20%**

a. Cylindrical plug gauges
b. Plain ring gauges
c. Taper plug gauges
d. Taper ring gauges
e. Care of plug and ring gauges
f. Thread plug gauges
g. Thread ring gauges
h. Snap gauges

6. Identify precision measurement **10%**

7. Perform precision measurement **20%**

a. Micrometers – precision measuring tools:
   - Principal of the inch micrometer
   - Vernier micrometer
   - Metric micrometer
   - Metric vernier micrometer
   - Combination inch-metric micrometer
   - Micrometer adjustments
   - Testing the accuracy of micrometers
   - Special-purpose micrometers
   - Screw thread micrometers
b. Vernier calipers
   - Measuring a workpiece with a 25-division inch vernier caliper
   - The 50-division inch vernier caliper
   - The metric vernier caliper
   - To read a metric vernier caliper
   - Measuring a workpiece with a 25-division inch vernier caliper

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Tool and Die Maker

Unit: F1 Basic Layout Materials, Tools and Accessories

Level: One
Duration: 7 hours
Theory: 3 hours
Practical: 4 hours

Overview:

This unit of instruction is designed to provide the Tool and Die Maker Apprentice with information about basic layout materials, tools, and accessories.

Objectives and Content:	**Percent of Unit Mark (%)**
1. Describe the different types of layout tools, their applications and use:	**25%**
a. Layout tables	
b. Surface plates	
c. Scribers	
d. Dividers	
e. Trammels	
f. Hermaphrodite calipers	
g. Squares (adjustable, solid, master)	
h. Combination set	
i. Surface gauge	
j. Height gauge	
k. Steel rules	
l. Calipers (spring tempered, flexible, narrow, hook, inside and outside)	
2. Describe the different accessories for layout work, their applications and use:	**25%**
a. Angle plate	
b. Tool makers clamp	
c. Parallels	
d. V-blocks	
e. Keyseat rules	
f. Keyseat clamp	
3. Describe the datum or reference surfaces, their applications and advantages	**25%**
4. Describe the procedures used to perform accurate layout of work	**25%**

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Apprenticeship Manitoba

Tool and Die Maker

Unit: F2 Basic or Semiprecision Layout

Level: One

Duration: 8 hours

Theory: 2 hours

Practical: 6 hours

Overview:

This unit of instruction is designed to provide the Tool and Die Maker Apprentice with information about basic or semiprecision layout.

Objectives and Content:	**Percent of Unit Mark (%)**
1. Identify layout of hole locations, slots, and radii	**25%**
2. Perform lay out of hole locations, slots and radii	**25%**

a. Procedure to layout hole locations, slots and radii

- Select the proper stock
- Cut off the stock, allowing enough material to square the ends if required
- Remove all burrs
- Clean the surface thoroughly and apply layout dye
- Place a suitable angle plate on a surface plate
- Clamp the work to the angle plate with a finished edge of the part against the surface plate or on a parallel
- Leave one end of the angle protruding beyond the workpiece a centreline for the full length of the workpiece
- With the surface gauge set to the proper height, scribe a centreline for the full length of the workpiece
- Using the centerline as a reference, set the surface gauge for each horizontal line and scribe the centerlines for all hole and radii locations
- With the work still clamped to the angle plate, turn the angle plate 90 degrees with one edge down and scribe the baseline at the bottom of the workpiece
- Using the baseline as a reference line, locate and scribe the other centerlines for each hole
- Locate the starting points for the angular layout
- Remove the workpiece from the angle plate
- Prick-punch the centre of all hole or radii locations

3. Identify lay out of a keyseat in a shaft	**25%**
4. Perform lay out of a keyseat in a shaft	**25%**

a. Procedure to lay out a keyseat in a shaft

- Apply layout dye to the end of the shaft and to the area where the keyseat is to be

laid out

- Mount the workpiece in a V-block
- Set the surface gauge scriber to the center of the shaft
- Scribe a line across the end and continue it along the shaft to the keyseat location
- Rotate the workpiece in the V-block and mark the length and the position of the keyseat on the shaft

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Apprenticeship Manitoba

Tool and Die Maker

Unit: G1 Types of Metal Saws

Level: One
Duration: 7 hours
Theory: 2 hours
Practical: 5 hours

Overview:

This unit of instruction is designed to provide the Tool and Die Maker Apprentice with the knowledge and understanding of various types of power tools and their use. Apprentices will gain the knowledge and skills required to perform cutting operations. Material covered includes:

Power saws and cut-off machines

Objectives and Content:	**Percent of Unit Mark (%)**
1. Identify power saw safety	**50%**
a. Power saw safety rules	
2. Identify saw types, attachments and applications	**25%**
a. Different types of saws: • Hacksaw • Vertical and horizontal bandsaws • Abrasive and cut-off saw • Cold cut saw	
b. Applications and procedures associated with the various sawing operations and attachments: • Friction sawing • Stock cutting • Internal and external contour sawing • Notching and slotting • Radius cutting and splitting • Angular cutting • Disc cutting • Cut-off and mitering • Rip fence • Protective devices • Blade changes	

- Abrasive wheels
- Saw guide selection
- Power feed
- Work holding jaw

c. Blade types and their characteristics:
- Sizing
- Teeth
- Pitch
- Set

d. Procedures used to perform various sawing operations for all saw types:
- Stock cutting
- Internal and external contour sawing
- Notching and slotting
- Radius cutting and splitting
- Angular cutting
- Friction sawing

e. Potential problems during sawing operations, their causes and remedies

f. Preventative maintenance procedures for sawing equipment
- Care
- Storage
- Blade welding

g. Procedures used to perform speed and feed calculations:
- Factors
- Formulae
- Tables and charts

3. **Identify power cutting tools** **25%**

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Tool and Die Maker

Unit: H1 Engine Lathe Parts and Accessories

Level: One

Duration: 15 hours

Theory: 15 hours

Practical: 0 hours

Overview:

This unit of instruction is designed to introduce the Tool and Die Maker Apprentice to lathe machines and their accessories as well as operator level maintenance procedures. The types and characteristics of cutting tools are covered to give students some basic knowledge toward tool selection. Material covered includes:

Safety procedures and precautions
Conventional lathes
Lathe accessories

Objectives and Content:	**Percent of Unit Mark (%)**
1. Describe safety procedures related to lathe operation	**25%**
a. Safety rules and procedures	
2. Identify precautions related to lathe operation	**25%**
a. Safety glasses	
b. Clothing and jewellery	
c. Safety guards and lockout controls	
d. Secure work and tool mounting	
e. Chuck wrench removal	
f. Use of air hoses	
b. Applications and procedures associated with the various sawing operations and attachments:	
3. **Identify conventional lathes**	**25%**
a. Lathe machines, their parts, sizing, and applications:	
• Engine lathe	
• Single and multi-spindle automatic lathes	
b. Preventative maintenance of lathe machines:	
• Cleaning	
• Lubrication	
c. Describe the procedures used to adjust the various types of lathes	

4. **Describe lathe accessories and work holding devices, their purpose and applications:** **25%**

   a. Lathe centres (dead, live, micro-set adjustable)
   b. Chucks (three jaw universal, four jaw independent, spring collett, Jacobs collett chuck, magnetic chuck
   c. Lathe dogs (standard bent-tail, straight tail, clamp type)
   d. Mandrels (solid, expansion, gang, threaded, taper shank)
   e. Toolposts and tool holder types (left hand offset, right hand offset, straight, parallel, cutting off or parting tools, threading, light boring, knurling tool)
   f. Turret toolposts
   g. Multi-toolpost
   h. Face plate
   i. Follow rest
   j. Steady rest

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Apprenticeship Manitoba

Tool and Die Maker

Unit: H2 Lathe Operations I

Level: One

Duration: 85 hours

Theory: 15 hours

Practical: 70 hours

Overview:

This unit of instruction combines theory with the material that covers the principles and practices involved in the operation of lathe machines and their accessories as well as operator level maintenance procedures. Apprentices will become familiar with a number of different operations performed on a lathe and their associated procedures. Material covered includes:

Operating procedures
Alignment of workpieces
Machining in a chuck
Potential problems
Cutting speed, feed, and depth of cut
Physics of metal cutting
Machinability of metals
Cutting tools
Operating conditions and tool life
Carbide cutting tools
Specialty tools
Cutting fluids – types and applications
Mounting, removing and aligning lathe centres
Grinding lathe cutting tools

Objectives and Content:	**Percent of Unit Mark (%)**
A. Lathe operations	**10%**
1. Identify procedures for lathe operations internal and external	
2. Use procedures for lathe operations internal and external	
a. Safety procedures and precautions related to lathe operation	
b. Safety procedures and precautions related to filing and polishing	
c. Plan sequence of lathe activities	
d. Tooling and accessories for specific operations:	

e. Tool selection
f. Procedure for setting correct tool height
g. Procedures for operating, adjusting and maintaining lathe machinery
h. Procedures for aligning lathe centres
i. Procedure used to:
- Machine diameters to size
- Machine face to length
- Machine to shoulder chamfering
- Parallel turning
- Shoulder turning
- Undercut diameter and shoulders
- Boring

j. Potential problems encountered during lathe operations, their causes, effects, prevention and correction
l. Procedures used to knurl a workpiece
m. Procedures used to set up a lathe to machine grooves

3. Perform machining using a chuck

a. Types of spindle noses and how each operates
b. Procedures used to mount and remove chucks
c. Procedures used to assemble a three-jaw chuck
d. Procedures used to mount work in a three-jaw chuck
e. Procedure used to mount work in a four-jaw chuck
f. Procedures used to set up a four-jaw chuck using a dial indicator
g. Factors that affect selection of correct tooling and accessories
h. Procedures used to cut or part off work in a chuck
i. Procedures used to set up and operate the lathe
j. Procedures used to produce rough and finished precision machining work in a chuck

4. Identify tapping

5. Perform tapping

a. Purpose and applications of tapping
b. Types of taps, their characteristics and applications
c. Procedures used to perform tapping operations

B. Cutting speed, feed, and depth of cut — 10%

1. Describe the factors used to determine speed, feed and depth of cut:

a. **Calculations**
b. **Charts and tables**
c. **Material hardness**
d. **Tool material**
e. **Machine condition**
f. **Finish required**
g. **Coolants and cutting fluids**

2. Describe potential problems encountered during lathe operations and their solutions

C. Physics of metal cutting — 10%

1. Identify need for metal-cutting research

2. Identify metal-cutting terminology

a. Flat punch
b. Narrow-faced punch
c. Knife-edge punch

3. Identify chip types:

a. Type 1 – Discontinuous (segmented) chip
b. Type 2 – Continuous Chip
c. Type 3 – Continuous Chip with a built-up edge

D. Machinability of metals — 10%

1. Identify non-metallic materials

a. **Non-metallic materials, their characteristics and applications**
b. **Hazards and safety precautions involved in machining non-metallic materials**
c. **Principles and procedures for machining non-metallic materials**
d. **Procedures used to mark workpieces for identification**

2. Identify specialty steels

a. Ferrous metals, their characteristics and applications
b. Hazards and safety precautions involved in machining specialty steels
c. Selection and safe application of coolants with specialty steels
d. Non-ferrous metals, their characteristics and applications
e. Effects and purposes of alloying metal
f. Characteristics and applications of:
   - White metals
   - Refractory metals
   - Precious metals

E. Cutting tools — 5%

1. Identify cutting-tool materials

a. High-speed steel toolbits
b. Cast alloy toolbits
c. Cemented-carbide toolbits
d. Coated carbide toolbits
e. Ceramic toolbits
f. Cermet toolbits
g. Diamond toolbits
h. Cubic boron nitride toolbits

2. Identify cutting-tool nomenclature

3. Identify lathe toolbit angles and clearances

a. Positive rake angle
b. Negative rake angle

4. Identify cutting-tool shape

5. Identify tool life

6. Identify principles of machining

a. Turning
b. Planing
c. Plain milling
d. End and face milling
e. Drilling

F. Operating conditions and tool life — 5%

1. Identify operating conditions and tool life

a. Depth of cut, feed rate, and cutting speed
b. Effects of changing operating conditions
c. General operating condition rules

G. Carbide cutting tools – specialty tools — 5%

1. Identify carbide tooling

a. Manufacture, composition, applications and advantages of carbides:
   - Materials
   - Blending
   - Composition
   - Presintering
   - Sintering
   - Safety precautions
b. Types of carbide tools, their advantages and disadvantages:
   - Brazed tip

- Indexable inserts

c. Characteristics of the various types of carbide tools
d. Grading of carbides and factors affecting it
e. Nomenclature related to carbide tooling
   - Front or end relief (clearance)
   - Side relief (clearance) side cutting edge angle
   - Rose radius
   - Side rack
   - Back rack
   - Negative/positive carbide insert geometry
   - Procedures used for machining with carbides
   - Factors affecting speed, feed and depth of cut

H. Cutting fluids — 5%

1. Describe the types of friction and their implications:
a. Sliding friction
b. Rolling friction
c. Fluid friction

2. Describe the principles, purpose and importance of lubricants

3. Describe correct handling, storage and disposal of lubricants

4. Describe the types of lubricants and associated methods of application:
a. Hand oiler
b. Wick feed
c. Drip feed
d. Slinger
e. Splash
f. Pressure system
g. Oil mist
h. Grease nipples and cups

5. Identify cutting fluids and coolants
a. Importance and functions of coolants
b. Procedures for mixing and adjusting coolants
c. Procedures used to apply coolants effectively for machining operations
d. Importance and functions of cutting fluids
e. Characteristics of a good cutting fluid
f. Methods of application for cutting fluids for the following operations:
g. Possible hazards associated with the use of cutting fluids and coolants
h. Safe handling of cutting fluids and coolants

6. Identify solvents
a. Solvents, their characteristics and applications
b. Procedures for safe use of solvents

I. Lathe centres — 10%

1. Identify procedure to mount lathe centres

2. Identify procedure to remove lathe centres

3. Identify procedure to align of lathe centres
a. **Align centres by the trial-cut method**
b. **Align centres using a dial indicator and test bar**

J. Tapers and taper turning — 10%

1. Calculate and perform applied mathematics
a. Procedure to calculate tapers in both imperial and metric measurements
b. Procedure to perform angular measurements

2. Identify tapers and taper turning in basic machining operations

3. Use tapers and taper turning in basic machining operations
a. **Various self-holding tapers, and their characteristics and applications**

b. **Steep tapers, their characteristics and applications**
c. **Standard tapers, their characteristics and applications**
d. **Formulas for taper calculations for the following taper methods:**
   - Taper per foot
   - Taper per inch
   - Metric tapers

K. Threads and thread cutting — 10%

1. Identify thread characteristics in basic machine operations

2. Turn a thread in basic machine operations

L. Grinding lathe cutting tools — 10%

1. Identify, cutting tools

2. Use and maintain cutting tools

a. Tooling:
   - Types
   - Composition
   - Applications
b. Tool nomenclature:
   - Cutting edge
   - Face
   - Radius
c. Describe the angles and clearances relating to:
   - Cutting tools
   - Side cutting edge
   - End cutting edge
   - Side relief (clearance angle)
   - Back rake (top)
   - Side rank angle point angle
d. Describe the effects of tool characteristics and the importance of tool shape for:
   - Roughing and finishing
   - Facing
   - Parting and grooving
   - Threading tools
   - Round nose, forming and boring tools
e. Describe the procedures used to install tooling
f. Describe the procedures used to face internal and external shapes and surfaces
g. Describe the procedures used to set up and grind a toolbit

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Apprenticeship Manitoba

Tool and Die Maker

Unit: I1 Milling Operations I

Level: One
Duration: 15 hours
Theory: 7 hours
Practical: 8 hours

Overview:

This unit of instruction is designed to introduce the Tool and Die Maker Apprentice to the principles and characteristics of the horizontal milling machine and its accessories. Apprentices will learn the procedures used to set up the machine, align and secure workpieces. Material covered includes:

Safety
Milling machines, their parts and accessories
Milling cutters and applications
Cutting speeds, feed and depth of cut
Milling Operations
Milling Machine Setup

Objectives and Content:	**Percent of Unit Mark (%)**
1. Identify milling machine safety	**10%**
2. Identify milling machines	**10%**

a. Types of milling machines and their characteristics:
- Knee and column
- Plain horizontal
- Universal horizontal
- Standard vertical
- Ram-type vertical
- Manufacturing types
- Numerically controlled machine centres

b. Parts and controls of milling machines, their purpose and operation:
- Base
- Table
- Housing

- Overarm and arbor supports
- Knee
- Column
- Saddle
- Speed and feed controls
- Handwheels, cranks and graduated collars
- Coolant system
- Backlash eliminator
- Table swivel block
- Feed trip dogs and limit stops
- Parts and controls specific to vertical mills
- Levating mechanism
- Drive
- Overarm (ram)
- Draw bolts
- Digital readout

c. Various milling machine accessories and attachments and their applications:
- Fixture
- Arbours, collets and adaptors
- Vises
- Dividing head
- Backlash eliminator
- Clamps
- T-nuts
- Slotting attachment
- Vertical attachment

3. Describe the various types of cutters and their applications: 10%

a. Plain milling cutters
b. Standard shank-type helical milling cutters
c. Side milling cutters
d. Face milling cutters
e. Angular cutters
f. Formed cutters
g. Metal saws
h. End mills
i. T-slot cutters
j. Dovetail cutter
k. Woodruff keyseat cutter
l. Flycutters

4. Identify cutting speed, feed and depth of cut 10%

a. Factors that determine milling feed, speed and depth of cut calculations and their importance
b. Procedures used to perform calculations for milling feed and depth of cut for metric and imperial milling operations
c. Two types of feed directions and their difference and applications

5. Identify milling operations 10%

6. Use and maintain milling operations 20%

a. Two basic types of milling machine operations:
- Plain milling
- Face milling

b. Procedures for setting the cutter to the work surface
- Rough
- Precision
- Locating an edge

Edge/centre finders
Wigglers

d. Procedures for machining:
   - Cavities
   - Angles
   - Keyways
   - Slots

e. Procedures used to perform milling operations:
   - Flat surface
   - Face milling
   - Side milling
   - Straddle milling
   - Gang milling

f. Procedures using sawing and slitting cutters

g. Causes of milling cutter failure and practices for prevention **10%**

7. Identify milling machine setup **20%**

8. Perform milling machine setup

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Apprenticeship Manitoba

Tool and Die Maker

Unit: K1 Offhand Grinding

Level: One

Duration: 7 hours

Theory: 3 hours

Practical: 4 hours

Overview:

This unit of instruction introduces the Tool and Die Maker Apprentice to grinding safety and types of abrasives, selection and preparation of grinding wheels. Offhand grinding refers to sharpening a tool on a pedestal grinder.

Objectives and Content:	**Percent of Unit Mark (%)**
1. Describe safety concerns when grinding	**20%**
2. Describe abrasives:	**10%**
a. Aluminum oxide	
b. Silicon carbide	
c. Zirconia-aluminum oxide	
d. Boron carbide	
e. Ceramic aluminum oxide	
f. Diamond abrasives and cubic boron nitrate	
g. Coated abrasives	
3. Describe the processes involved in grinding wheel manufacture	**10%**
4. Describe the factors involved in selection of a grinding wheel:	**10%**
a. Abrasive	
b. Grain	
c. Grade	
d. Structure	
e. Bond	
f. Application	
g. Shapes	
5. Read and interpret grinding wheel codes	**10%**
6. Describe the types of grinding wheels, their characteristics and applications	**10%**

7.	**Describe the procedures for inspecting grinding wheels**	**10%**
8.	**Identify the lapping method and procedures**	**10%**
9.	**Describe honing techniques and procedures**	**10%**

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