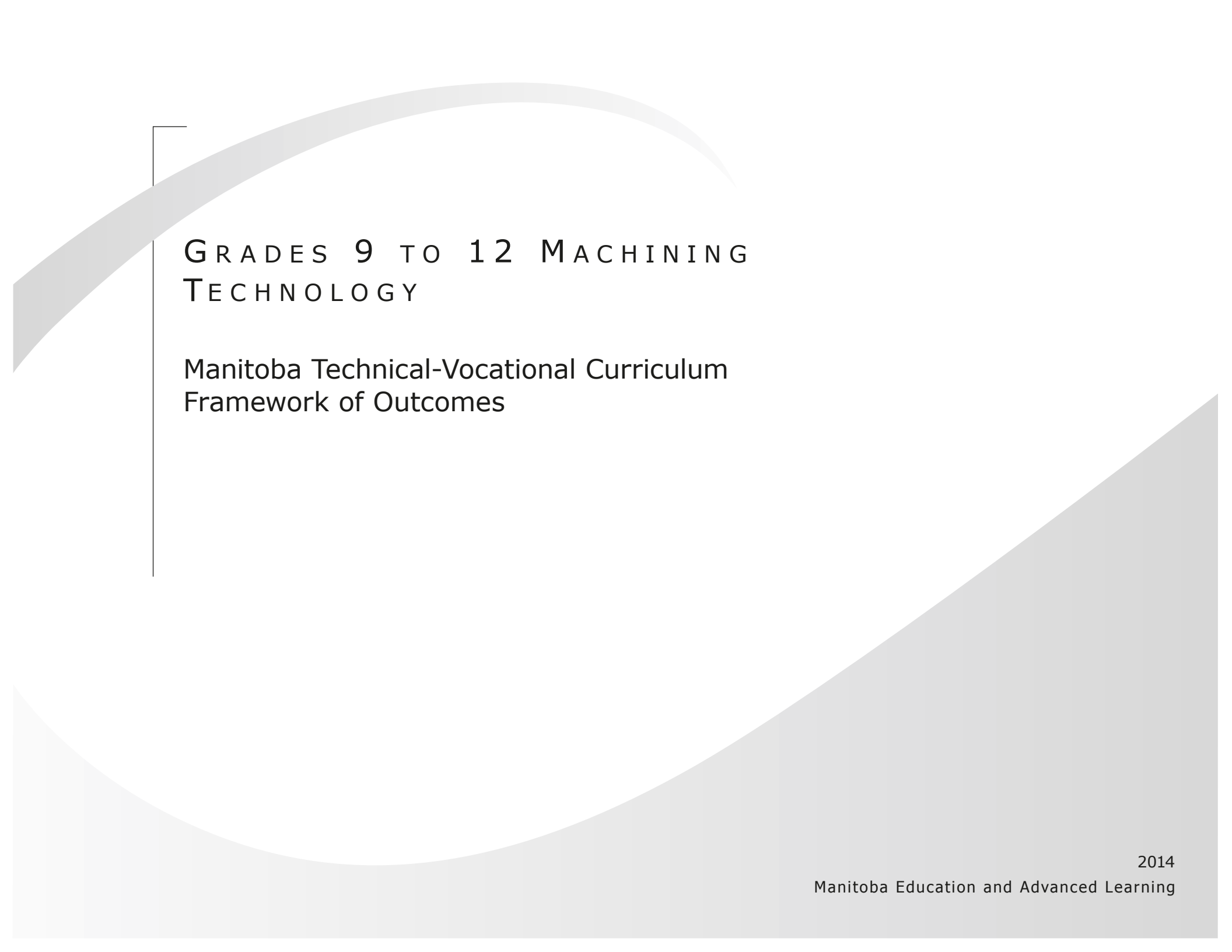


# Grades 9 to 12 Machining Technology

Manitoba Technical-Vocational  
Curriculum Framework  
of Outcomes





GRADES 9 TO 12 MACHINING  
TECHNOLOGY

Manitoba Technical-Vocational Curriculum  
Framework of Outcomes

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This resource is available on the Manitoba Education and Advanced  
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sy\\_tech\\_program.html](http://www.edu.gov.mb.ca/k12/cur/teched/sy_tech_program.html)>.

Available in alternate formats upon request.

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## TECHNICAL-VOCATIONAL EDUCATION OVERVIEW

In 2013, Manitoba Education released the document [Technical-Vocational Education Overview](#) to provide the philosophical and pedagogical underpinnings for curriculum development and the teaching of courses in the Senior Years Technology Education Program. This overview presents educators with the vision and goals of technical-vocational education (TVE) in Manitoba.

Topics include the following:

- curriculum revitalization and renewal
- curriculum framework and implementation
- articulation of programming
- assessment and reporting
- safety
- employability/essential skills and career development
- sustainable development

The TVE curriculum includes Grades 9 to 12 courses in a variety of areas, including machining technology.

## MACHINING TECHNOLOGY OVERVIEW

*Grades 9 to 12 Machining Technology: Manitoba Technical-Vocational Curriculum Framework of Outcomes* identifies the goals, general learning outcomes (GLOs), and specific learning outcomes (SLOs) for nine machining technology courses. This framework is intended for use in all Manitoba schools teaching machining technology as part of the Senior Years Technology Education Program.

All courses are intended for students pursuing a career in machining technology. They focus on theoretical principles and their practical applications.

A student who graduates from the Technical-Vocational Education Program with a specialization in Machining Technology can seek entry-level employment as an apprentice machinist. Graduates can also continue their apprenticeship from Apprenticeship Manitoba or seek employment in the following areas: machinist apprentice, metal manufacturing, aerospace, metal fabrication, and CNC operator.

In order to be qualified and continue as a machinist, students must seek apprenticeship and continue post-secondary training. Graduates are typically employed by the following industries: aerospace, transportation, and metal manufacturing.

The education requirements for entry to the machining technology industry vary from high school graduation and/or completion of the Technical-Vocational Program at the secondary level for entry-level employment, to college, apprenticeship, and university for related employment in the industry.

This program provides a foundation for students to go directly to work, or to continue into post-secondary education in machining technology, mechanical engineering, design manufacturing, and education and training. Graduates from this program can be found working with many types of equipment, such as lathes, milling machines, drill presses, saws, CNC machines, and specialized proprietary equipment.

Graduates from Machining Technology will be able to demonstrate the following:

- adherence to health and safety practices
- proficiency in all common machining equipment
- adherence to precise tolerances and engineering specifications
- interpretation of engineering drawings
- understanding and use of computerized systems
- communication and collaboration with peers, employers, and customers
- ability to think logically and make decisions
- ability to work independently or as part of a team
- ability for lifelong learning
- time management skills

- demonstration of mechanical aptitude and manual dexterity
- problem solving skills
- employability skills

## Implementation of Machining Technology Courses

To receive a TVE diploma from Manitoba Education and Advanced Learning, a student must complete a minimum of eight departmentally developed, required courses to a maximum of 14 credits, including a maximum of six Locally Developed Technical Education Courses (LDTEC). The grade level in which the courses are offered is a local school-based decision, but it is highly recommended that the sequencing of credits follow the schedule set out below.

Cross-curricular learning outcomes, which include essential skills from subject areas including, but not limited to, information and communication technology, science, English language arts, and mathematics, are to be integrated into the authentic activities of the course.

Learning outcomes dealing with the following topics are also integrated into most courses:

- health and safety
- sustainability
- ethical and legal standards
- employability skills
- career opportunities
- evolution, technological progression, and emerging trends

In most courses, the emphasis is on applied activities. For instructional purposes, the sequence of learning outcomes can vary based on the activities within the course. Teachers are advised to select the activities best suited to teach the outcomes, based on a variety of factors, including access to resources or regional needs.

1. The curriculum is not sequential. In other words, outcomes might be taught in an order different from how they appear in the document.
2. In light of rapid changes in technology, teachers are encouraged to update their activities in order to meet the needs of students.

## Level 1 Apprenticeship

In order to teach the courses listed above, teachers must refer to the machinist curriculum documents produced by Apprenticeship Manitoba, which can be found at <[www.gov.mb.ca/tce/apprent/apprentice/curriculum](http://www.gov.mb.ca/tce/apprent/apprentice/curriculum)>.

The specific learning outcomes in the eight mandatory courses include all of the objectives found in the Manitoba Apprenticeship training for machinists. In some cases, the Apprenticeship objectives have been reworded to make them more consistent with the frameworks or more appropriate for high school students. The alphanumeric designation found at the end of some of the learning outcomes represents objectives from the Apprenticeship curriculum. For example, (A1.1) represents Objective 1 in Unit A1 in Machinist Level 1, which is found on page 2 of that document.

The Apprenticeship documents provide necessary, detailed information and clarification of the Senior Years learning outcomes. Teachers must teach all of the objectives and content found in the Apprenticeship documents that are referenced in the curriculum frameworks of outcomes. This will ensure that students will have met all of the requirements for Level 1 certification from Apprenticeship Manitoba.

Machining Technology programs delivering the eight mandatory courses are eligible for accreditation with Apprenticeship Manitoba. More information on accreditation can be found at <[www.gov.mb.ca/tce/apprent/educator/apprenticeship\\_school.html](http://www.gov.mb.ca/tce/apprent/educator/apprenticeship_school.html)>.

Students obtaining an accumulated average of 70 percent or higher in the eight mandatory accredited Machining Technology courses may be eligible for their Level 1 Apprenticeship for Machinist.

## Trade Safety Awareness Manual

Apprenticeship Manitoba has developed a Trade Safety Awareness Unit, which is intended to increase student awareness of trade safety in the workplace. All students who are studying a designated trade, including those in high school, must complete this seven-hour unit. The learning outcomes from the Trade Safety Awareness Unit have been incorporated into Goal 1 of this curriculum. For more information and to access the Trade Safety Awareness Unit and its tests and other resources, please visit <[www.gov.mb.ca/tce/apprent/apprentice/trade\\_safety/](http://www.gov.mb.ca/tce/apprent/apprentice/trade_safety/)>.

## Goals and General Learning Outcomes (GLOs)

The specific learning outcomes for each course in Machining Technology were developed based on the following goals and general learning outcomes:

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**Goal 1:** Describe and apply appropriate **health and safety** practices as they relate to the **maintenance of a safe workspace**.

**GLO 1.1:** Create and maintain a **safe working environment** in machining technology.

**GLO 1.2:** Demonstrate knowledge of the **Trade Safety Awareness Manual**.

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**Goal 2:** Understand **terminology, abbreviations, symbols, and acronyms** related to machining technology.

**GLO 2.1:** Understand **terminology, abbreviations, symbols, and acronyms** related to machining technology.

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**Goal 3:** Understand **technical drawings**.

**GLO 3.1:** Understand **technical drawings**.

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**Goal 4:** Demonstrate **layout and planning**.

**GLO 4.1:** Demonstrate **planning and layout procedures**.

**GLO 4.2:** Demonstrate **layout on projects**.

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**Goal 5:** Use **measurement and quality control tools**.

**GLO 5.1:** Use **measurement and quality control tools**.

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**Goal 6:** Identify basic elements of **metallurgy**.

**GLO 6.1:** Identify basic elements of **metallurgy**.

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**Goal 7:** Understand **tools, equipment, and accessories**.

**GLO 7.1:** **Identify** tools, equipment, accessories, and work-holding devices.

**GLO 7.2:** **Use** tools, equipment, accessories, and work-holding devices.

**GLO 7.3:** Identify techniques used to **troubleshoot** and **predict potential problems**.

---

**Goal 8:** Describe and demonstrate the transferable **cross-curricular** knowledge and skills as they pertain to machining technology.

**GLO 8.1:** Apply **mathematical knowledge and skills** related to machining technology.

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**Goal 9:** Demonstrate an awareness of **education** and **career opportunities** in machining technology and associated occupations.

**GLO 9.1:** Describe **education** and **career opportunities** in machining technology.

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**Goal 10:** Describe the **history, technological progression, and emerging trends** in machining technology.

**GLO 10.1:** Describe the **history, technological progression, and emerging trends in machining technology**.

---

**Goal 11:** Demonstrate **employability skills** related to machining technology.

**GLO 11.1:** Demonstrate **employability skills** related to machining technology.

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**Goal 12:** Demonstrate awareness of the **ethical and legal standards** as they pertain to machining technology.

**GLO 12.1:** Demonstrate awareness of the **ethical and legal standards** as they pertain to machining technology.

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**Goal 13:** Demonstrate awareness of **sustainability** as it pertains to machining technology.

**GLO 13.1:** Demonstrate awareness of **human sustainability** on machinists.

**GLO 13.2:** Describe machining technology's **sustainability practices** and **impact on the environment**.

**GLO 13.3:** Demonstrate awareness of the **business sustainability** of a machining technology facility.

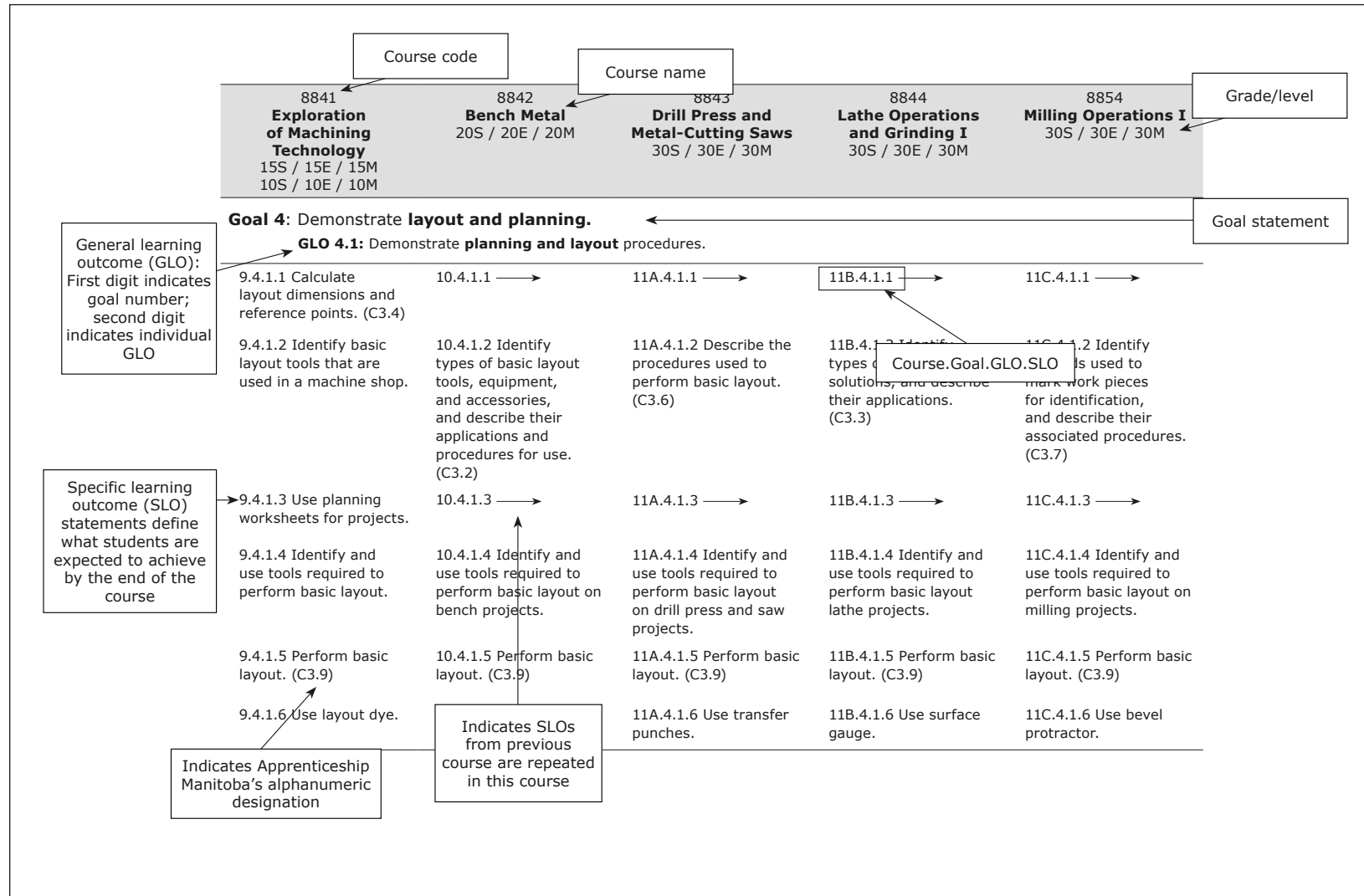
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## Specific Learning Outcomes

*Grades 9 to 12 Machining Technology: Manitoba Technical-Vocational Curriculum Framework of Outcomes* identifies specific learning outcomes (SLOs) for use in all Manitoba schools teaching Grades 9 to 12 machining technology courses as part of the Senior Years Technology Education Program. Specific learning outcome statements define what students are expected to achieve by the end of the course.

It is essential that students learn safety practices and employability skills; therefore, with a few exceptions, all SLOs related to safety and employability skills are repeated from course to course.

# Guide to Reading the Machining Technology Goals and Learning Outcomes



## Course Descriptions

Course titles, descriptions, and codes for the nine machining technology courses follow. For an explanation of the codes, refer to the *Subject Table Handbook: Technology Education: Student Records System and Professional School Personnel System* (Manitoba Education and Advanced Learning).

### 8841 Exploration of Machining Technology

15S/15E/15M

10S/10E/10M

This is an optional course intended for students who wish to sample machining technology. Students develop skills and knowledge necessary to perform basic calculations, basic machine and work set-up, and basic cutting of material in a safe, efficient, and responsible manner through the application of practical projects. An appreciation for the machining program is fostered through a safe, active, exciting, and informative learning environment.

### 8842 Bench Metal

20S/20E/20M

Students develop skills and knowledge necessary to select, operate, and maintain tools, as well as to perform calculations, interpret engineering drawings, work set-up, and cut material in a safe, efficient, and responsible manner through the application of practical projects related to the use of cutting and non-cutting hand tools and bench operations. Basic measurement, interpretation of engineering drawings, metallurgy, metal cutting physics, and semi-precision layout

are emphasized as a foundation for students who plan on pursuing future course studies.

### 8843 Drill Press and Metal Cutting Saws

30S/30E/30M

Students develop skills and knowledge necessary to select, operate, and maintain tools, as well as perform calculations, interpret engineering drawings, work set-up, and machine material in a safe, efficient, and responsible manner through the application of practical projects related to the drilling of holes and sawing of material. Framed as the two fundamental machine tools used in machining, emphasis is placed upon use and maintenance of sharp cutting tools, development of accuracy to produce a quality part, and the respect of safety rules for all machine tools.

### 8844 Lathe Operations and Grinding 1

30S/30E/30M

Students develop skills and knowledge necessary to select, operate, and maintain tools, as well as to perform calculations, interpret engineering drawings, work set-up, and machine material in a safe, efficient, and responsible manner through the application of practical projects related to the operation of the conventional lathe. Presented as a precision machining tool, emphasis is placed upon the set-up and machining of cylindrical parts to precise measurements using appropriate tools, speeds, and feed rates. Use of various work-holding devices and accessories is put into practice to complete common lathe operations. Importance is placed upon the machinist's responsibility to machine

accurate parts with the desired finish. Maintenance of equipment is emphasised to impress on students the need for sustainable accuracy of equipment. Offhand grinding and maintaining cutting tools with the pedestal grinder is introduced. Opportunity may also be taken to introduce CNC lathe machines.

#### 8854 Milling Operations I 30S/30E/30M

Students develop skills and knowledge necessary to select, operate, and maintain tools, as well as perform calculations, interpret engineering drawings, work set-up, and machine material in a safe, efficient, and responsible manner through the application of practical projects related to the milling machine. Presented as a precision machining tool, emphasis is placed upon the set-up and machining of flat features and angles to precise measurements using appropriate tools, speeds, and feed rates. Use of various work-holding devices and accessories are put into practice to complete common milling operations. Development of machining technique and consistency is reinforced through the close observation of the milling process. Opportunity may also be taken to introduce CNC milling machines.

#### 8855 Lathe Operations and Grinding II 40S/40E/40M

Students further develop skills and knowledge necessary to select, operate, and maintain tools, as well as to perform calculations, interpret engineering drawings, work set-up, and machine material in a safe, efficient, and responsible manner through the application of practical projects related to the operation of the conventional lathe and offhand grinding. Emphasis is placed upon taper calculation and taper turning. Identification, selection, and use of carbide cutting tools are presented to drive the students' knowledge and curiosity to more advanced levels. Offhand grinding is taught to shape and maintain high-speed steel cutters for use in general or special turning applications. Opportunity may also be taken to further introduce CNC lathe machines and CNC theory.

#### 8856 Milling Operations II 40S/40E/40M

Students further develop the skills and knowledge necessary to select, operate, and maintain tools, as well as to perform calculations, interpret engineering drawings, work set-up, and machine material in a safe, efficient, and responsible manner through the application of practical projects related to the milling machine. Emphasis is placed upon the set-up of the milling machine accessories and work-holding devices, the dividing head, and rotary table, to assist in the machining of accurate parts. Exploration of how to troubleshoot machining problems when they occur is introduced. Opportunity may also be taken to further introduce CNC milling machines and CNC theory.



8857 Applied Machining and  
Manufacturing Technology 40S/40E/40M

Students apply their skills and knowledge to machine projects in a safe, efficient, and responsible manner to industry standards using available machine shop tools. Emphasis is placed upon preparing students to meet the level of skill and knowledge expected of a first-year apprentice. Work experience is most often included as part of this course.

8858 CNC Machining 40S/40E/40M

Students develop skills and knowledge necessary to select, operate, and maintain tools, as well as perform calculations, interpret engineering drawings, work set-up, and cut material in a safe, efficient, and responsible manner through the application of practical projects related to CNC machining.

## Curriculum Implementation Dates

During **voluntary implementation**, teachers have the option of teaching the entire new draft curriculum as soon as Manitoba Education and Advanced Learning releases it on the [Technology Education](#) website. They also have the option of teaching the courses from the previous curriculum. Teachers who implement courses before system-wide implementation need to ensure that students who are already taking courses from the previous curriculum achieve all SLOs with a minimum of redundancy.

Voluntary implementation of all machining technology courses began in the fall of 2013 and will continue until their respective system-wide implementation dates.

Date	System-Wide Implementation
Fall 2014	Grade 9 (optional)
Fall 2015	Grade 10
Fall 2016	Grade 11
Fall 2017	Grade 12

Under **system-wide implementation**, all teachers in Manitoba teach the new curriculum and use the new course codes. Teachers will no longer be able to use the previous course codes. Course codes are found in the [Subject Table Handbook: Technology Education](#).





GRADES 9 TO 11  
MACHINING TECHNOLOGY

General and Specific Learning  
Outcomes by Goal



# GRADES 9 TO 11 MACHINING TECHNOLOGY

## GENERAL AND SPECIFIC LEARNING OUTCOMES BY GOAL

8841 <b>Exploration of Machining Technology</b> 15S / 15E / 15M 10S / 10E / 10M	8842 <b>Bench Metal</b> 20S / 20E / 20M	8843 <b>Drill Press and Metal-Cutting Saws</b> 30S / 30E / 30M	8844 <b>Lathe Operations and Grinding I</b> 30S / 30E / 30M	8854 <b>Milling Operations I</b> 30S / 30E / 30M
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**Goal 1:** Describe and apply appropriate **health and safety** practices as they relate to the **maintenance of a safe workplace.**

**GLO 1.1:** Create and maintain a **safe working environment** in machining technology.

9.1.1.1 Identify safety and health requirements. (A1.1)	10.1.1.1 →	11A.1.1.1 →	11B.1.1.1 →	11C.1.1.1 →
9.1.1.2 Identify personal protective equipment (PPE) and PPE procedures. (A1.2)	10.1.1.2 →	11A.1.1.2 →	11B.1.1.2 →	11C.1.1.2 →
9.1.1.3 Identify appropriate safety procedures for working with electricity. (A1.3)	10.1.1.3 →	11A.1.1.3 →	11B.1.1.3 →	11C.1.1.3 →
9.1.1.4 Identify appropriate safety procedures to reduce fire hazards. (A1.4)	10.1.1.4 →	11A.1.1.4 →	11B.1.1.4 →	11C.1.1.4 →
9.1.1.5 Identify ergonomically correct procedures to avoid injury (e.g., stress, strain). (A1.5)	10.1.1.5 →	11A.1.1.5 →	11B.1.1.5 →	11C.1.1.5 →

8841 <b>Exploration of Machining Technology</b> 15S / 15E / 15M 10S / 10E / 10M	8842 <b>Bench Metal</b> 20S / 20E / 20M	8843 <b>Drill Press and Metal-Cutting Saws</b> 30S / 30E / 30M	8844 <b>Lathe Operations and Grinding I</b> 30S / 30E / 30M	8854 <b>Milling Operations I</b> 30S / 30E / 30M
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**Goal 1:** Describe and apply appropriate **health and safety** practices as they relate to the **maintenance of a safe workplace.** *(continued)*

**GLO 1.1:** Create and maintain a **safe working environment** in machining technology. *(continued)*

9.1.1.6 Identify hazard recognition and control. (A1.6)	10.1.1.6 →	11A.1.1.6 →	11B.1.1.6 →	11C.1.1.6 →
9.1.1.7 Describe the hazards of confined-space entry. (A1.7)	10.1.1.7 →	11A.1.1.7 →	11C.1.1.7 →	11C.1.1.7 →
9.1.1.8 Identify first aid/cardiopulmonary resuscitation (CPR). (A1.8)	10.1.1.8 →	11A.1.1.8 →	11C.1.1.8 →	11C.1.1.8 →
9.1.1.9 Identify safety requirements as they apply to the WHMIS. (A1.9)	10.1.1.9 →	11A.1.1.9 →	11C.1.1.9 →	11C.1.1.9 →
9.1.1.10 Describe the identification and control of specified hazards. (A1.10)	10.1.1.10 →	11A.1.1.10 →	11C.1.1.10 →	11C.1.1.10 →

8841 <b>Exploration of Machining Technology</b> 15S / 15E / 15M 10S / 10E / 10M	8842 <b>Bench Metal</b> 20S / 20E / 20M	8843 <b>Drill Press and Metal-Cutting Saws</b> 30S / 30E / 30M	8844 <b>Lathe Operations and Grinding I</b> 30S / 30E / 30M	8854 <b>Milling Operations I</b> 30S / 30E / 30M
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**Goal 1:** Describe and apply appropriate **health and safety** practices as they relate to the **maintenance of a safe workplace.** *(continued)*

**GLO 1.1:** Create and maintain a **safe working environment** in machining technology. *(continued)*

9.1.1.11 Identify types of personal protective equipment (PPE), and describe their applications. (A2.1)	10.1.1.11 →	11A.1.1.11 →	11B.1.1.11 →	11C.1.1.11 →
9.1.1.12 Describe the procedures used to care for and maintain PPE. (A2.2)	10.1.1.12 →	11A.1.1.12 →	11B.1.1.12 →	11C.1.1.12 →
9.1.1.13 Identify types of fire extinguishing equipment, and describe their applications and procedures for use. (A2.3)	10.1.1.13 →	11A.1.1.13 →	11B.1.1.13 →	11C.1.1.13 →
9.1.1.14 Identify workplace hazards, and describe safe work practices and equipment. (A2.4)	10.1.1.14 →	11A.1.1.14 →	11B.1.1.14 →	11C.1.1.14 →

8841 <b>Exploration of Machining Technology</b> 15S / 15E / 15M 10S / 10E / 10M	8842 <b>Bench Metal</b> 20S / 20E / 20M	8843 <b>Drill Press and Metal-Cutting Saws</b> 30S / 30E / 30M	8844 <b>Lathe Operations and Grinding I</b> 30S / 30E / 30M	8854 <b>Milling Operations I</b> 30S / 30E / 30M
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**Goal 1:** Describe and apply appropriate **health and safety** practices as they relate to the **maintenance of a safe workplace.** *(continued)*

**GLO 1.1:** Create and maintain a **safe working environment** in machining technology. *(continued)*

9.1.1.15 Identify and interpret workplace safety and health regulations. (A2.4)	10.1.1.15 →	11A.1.1.15 →	11B.1.1.15 →	11C.1.1.15 →
9.1.1.16 Identify hazards, and describe safe work practices pertaining to fluids and coolants. (A8.2)	10.1.1.16 →	11A.1.1.16 →	11B.1.1.16 →	11C.1.1.16 →
9.1.1.17 Identify hazards, and describe safe work practices pertaining to hand and power tools. (B1.1)	10.1.1.17 →	11A.1.1.17 →	11B.1.1.17 →	11C.1.1.17 →
9.1.1.18 Demonstrate understanding and adherence to safe work procedures/job hazards analysis documents for each piece of equipment, tool, and consumable that they use.	10.1.1.18 →	11A.1.1.18 →	11B.1.1.18 →	11C.1.1.18 →



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**Goal 1:** Describe and apply appropriate **health and safety** practices as they relate to the **maintenance of a safe workplace.** *(continued)*

**GLO 1.1:** Create and maintain a **safe working environment** in machining technology. *(continued)*

9.1.1.19 Demonstrate understanding and adherence to safe practices and procedures for facilities, processes, tools, and equipment found in machining technology.	10.1.1.19 →	11A.1.1.19 →	11B.1.1.19. →	11C.1.1.19 →
9.1.1.20 Discuss worker’s responsibility to refuse unsafe work.	10.1.1.20 →	11A.1.1.20 →	11B.1.1.20 →	11C.1.1.20 →
9.1.1.21 Demonstrate use of personal protective equipment (PPE) and adherence to PPE procedures used in machining technology.	10.1.1.21 →	11A.1.1.21 →	11B.1.1.21 →	11C.1.1.21 →
9.1.1.22 Demonstrate the safe use of compressed air.	10.1.1.22 →	11A.1.1.22 →	11B.1.1.22 →	11C.1.1.22 →

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**Goal 1:** Describe and apply appropriate **health and safety** practices as they relate to the **maintenance of a safe workplace.** *(continued)*

**GLO 1.1:** Create and maintain a **safe working environment** in machining technology. *(continued)*

9.1.1.23 Practise appropriate cleaning and maintenance of the machining technology area and equipment for the promotion of a safe work/learning environment.	10.1.1.23 →	11A.1.1.23 →	11B.1.1.23 →	11C.1.1.23 →
9.1.1.24 Practise appropriate safe behaviour to ensure personal safety, as well as the safety of others.	10.1.1.24 →	11A.1.1.24 →	11B.1.1.24 →	11C.1.1.24 →
9.1.1.25 Demonstrate an understanding of the machinist's responsibility to maintain and clean equipment and tools.	10.1.1.25 →	11A.1.1.25 →	11B.1.1.25 →	11C.1.1.25 →
9.1.1.26 Develop appropriate safety habits.	10.1.1.26 →	11A.1.1.26 →	11B.1.1.26 →	11C.1.1.26 →

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**Goal 1:** Describe and apply appropriate **health and safety** practices as they relate to the **maintenance of a safe workplace.** *(continued)*

**GLO 1.1:** Create and maintain a **safe working environment** in machining technology. *(continued)*

9.1.1.27 Demonstrate a safe, clean, organized, and uncluttered work area.	10.1.1.27 →	11A.1.1.27 →	11B.1.1.27 →	11C.1.1.27 →
9.1.1.28 Explain the purpose/importance and use of accident report forms.	10.1.1.28 →	11A.1.1.28 →	11B.1.1.28 →	11C.1.1.28 →
9.1.1.29 Identify hazards, and describe safe work practices pertaining to being present in a machine shop.	10.1.1.29 →	11A.1.1.29 →	11B.1.1.29 →	11C.1.1.29 →
9.1.1.30 Identify machine-shop-related safety concerns.	10.1.1.30 →	11A.1.1.30 →	11B.1.1.30 →	11C.1.1.30 →
9.1.1.31 Practise safe set-up/operation of tools used.	10.1.1.31 →	11A.1.1.31 →	11B.1.1.31 →	11C.1.1.31 →

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**Goal 1:** Describe and apply appropriate **health and safety** practices as they relate to the **maintenance of a safe workplace.** *(continued)*

**GLO 1.2:** Demonstrate knowledge of the **Trade Safety Awareness Manual** ([www.gov.mb.ca/tce/apprent/apprentice/trade\\_safety/](http://www.gov.mb.ca/tce/apprent/apprentice/trade_safety/)).

10.1.2.1 Explain the importance of trade safety and health in reducing injuries and fatalities to young employees in Manitoba. (TSA 1)

10.1.2.2 Describe the rights and responsibilities of employees, employers, and supervisors under the *Workplace Safety and Health Act*. (TSA 2)

10.1.2.3 Describe the steps to use in the Right to Refuse process. (TSA 3)

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**Goal 1:** Describe and apply appropriate **health and safety** practices as they relate to the **maintenance of a safe workplace.** *(continued)*

**GLO 1.2:** Demonstrate knowledge of the **Trade Safety Awareness Manual** ([www.gov.mb.ca/tce/apprent/apprentice/trade\\_safety/](http://www.gov.mb.ca/tce/apprent/apprentice/trade_safety/)). *(continued)*

10.1.2.5 Demonstrate how to handle a potentially dangerous work situation. (TSA 5)

10.1.2.6 Explain the S.A.F.E. acronym. (TSA 6)

10.1.2.7 Define workplace safety and health hazards. (TSA 7)

10.1.2.8 Give examples of trade-specific workplace safety and health hazards. (TSA 8)

10.1.2.9 Give examples of five types of safety and health hazards. (TSA 9)

10.1.2.10 Define workplace safety and health risks. (TSA 10)

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**Goal 1:** Describe and apply appropriate **health and safety** practices as they relate to the **maintenance of a safe workplace.** *(continued)*

**GLO 1.2:** Demonstrate knowledge of the **Trade Safety Awareness Manual** ([www.gov.mb.ca/tce/apprent/apprentice/trade\\_safety/](http://www.gov.mb.ca/tce/apprent/apprentice/trade_safety/)). *(continued)*

10.1.2.11 Give examples of trade-specific workplace safety and health risks. (TSA 11)

10.1.2.12 Explain the principles of hazard recognition and control as they apply to the specific trade. (TSA 12)

10.1.2.13 Match the WHMIS hazardous materials symbols and their meanings. (TSA 14)

10.1.2.14 Describe the importance of the Material Safety Data Sheets (MSDS). (TSA 15)

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**Goal 1:** Describe and apply appropriate **health and safety** practices as they relate to the **maintenance of a safe workplace.** *(continued)*

**GLO 1.2:** Demonstrate knowledge of the **Trade Safety Awareness Manual** ([www.gov.mb.ca/tce/apprent/apprentice/trade\\_safety/](http://www.gov.mb.ca/tce/apprent/apprentice/trade_safety/)). *(continued)*

10.1.2.15 Demonstrate proper selection and use of a variety of personal protective equipment and fall protection systems. (TSA 17)

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**Goal 2:** Understand **terminology, abbreviations, symbols, and acronyms** related to machining technology.

**GLO 2.1:** Understand **terminology, abbreviations, symbols, and acronyms** related to machining technology.

9.2.1.1 Define <i>machinist</i> .	10.2.1.1 Identify metallurgical terminology, abbreviations, symbols, and acronyms.	11A.2.1.1 Describe metallurgical terminology, abbreviations, symbols, and acronyms.	11B.2.1.1 →	11C.2.1.1 →
9.2.1.2 Define <i>safety</i> as it pertains to machining.	10.2.1.2 Define terminology, abbreviations, symbols, and acronyms associated with basic layout. (C3.1)	11A.2.1.2 Define terminology, abbreviations, symbols, and acronyms associated with drills and drill presses. (B4.1)	11B.2.1.2 Identify terminology, abbreviations, symbols, and acronyms associated with conventional lathes.	11C.2.1.2 Identify terminology, abbreviations, symbols, and acronyms associated with milling machines.
9.2.1.3 Define <i>RPM</i> as it pertains to machining.	10.2.1.3 Define terminology, abbreviations, symbols, and acronyms associated with threads. (A4.1)	11A.2.1.3 Define terminology, abbreviations, symbols, and acronyms associated with metal-cutting saws.	11B.2.1.3 Identify terminology, abbreviations, symbols, and acronyms associated with basic precision measurement.	11C.2.1.3 Identify terminology, abbreviations, symbols, and acronyms associated with engineering drawings.
9.2.1.4 Define <i>workmanship</i> as it pertains to machining.	10.2.1.4 Define terminology, abbreviations, symbols, and acronyms associated with hand tools and bench work.	11A.2.1.4 Describe <i>swarf</i> as it pertains to machining.	11B.2.1.4 I Define <i>sustainability</i> as it pertains to machining.	11C.2.1.4 Define <i>tolerance</i> as it pertains to machining.



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**Goal 3: Understand technical drawings.**

**GLO 3.1: Understand technical drawings.**

9.3.1.1 Produce basic paper-and-pencil sketch of project.	10.3.1.1 →	11A.3.1.1 →	11B.3.1.1 →	11C.3.1.1 →
9.3.1.2 Interpret and extract information from drawings. (A6.3)	10.3.1.2 →	11A.3.1.2 →	11B.3.1.2 →	11C.3.1.2 →
9.3.1.3 Identify basic line types found on drawings.	10.3.1.3 Identify types of threads, and describe their purpose and applications. (A4.3)	11A.3.1.3 Identify the alphabet of lines.	11B.3.1.3 Describe the alphabet of lines.	11C.3.1.3 Identify industry methods of showing dimensions and tolerances.
9.3.1.4 Identify parts of the title block.	10.3.1.4 Explain thread fit, classifications, and series. (A4.4)	11A.3.1.4 Locate and explain information in the title block.	11B.3.1.4 Identify basic sketching techniques.	11C.3.1.4 Identify the principles of orthographic projection.

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**Goal 4: Demonstrate layout and planning.**

**GLO 4.1: Demonstrate planning and layout procedures.**

9.4.1.1 Calculate layout dimensions and reference points. (C3.4)	10.4.1.1 →	11A.4.1.1 →	11B.4.1.1 →	11C.4.1.1 →
9.4.1.2 Identify basic layout tools that are used in a machine shop.	10.4.1.2 Identify types of basic layout tools, equipment, and accessories, and describe their applications and procedures for use. (C3.2)	11A.4.1.2 Describe the procedures used to perform basic layout. (C3.6)	11B.4.1.2 Identify types of layout media/solutions, and describe their applications. (C3.3)	11C.4.1.2 Identify methods used to mark work pieces for identification, and describe their associated procedures. (C3.7)
9.4.1.3 Use planning worksheets for projects.	10.4.1.3 →	11A.4.1.3 →	11B.4.1.3 →	11C.4.1.3 →
9.4.1.4 Identify and use tools required to perform basic layout.	10.4.1.4 Identify and use tools required to perform basic layout on bench projects.	11A.4.1.4 Identify and use tools required to perform basic layout on drill press and saw projects.	11B.4.1.4 Identify and use tools required to perform basic layout on lathe projects.	11C.4.1.4 Identify and use tools required to perform basic layout on milling projects.
9.4.1.5 Perform basic layout. (C3.9)	10.4.1.5 →	11A.4.1.5 →	11B.4.1.5 →	11C.4.1.5 →
9.4.1.6 Use layout dye.	10.4.1.6 Use ruler and scribe.	11A.4.1.6 Use transfer punches.	11B.4.1.6 Use surface gauge.	11C.4.1.6 Use bevel protractor.

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**Goal 5: Use measurement and quality control tools.**

**GLO 5.1: Use measurement and quality control tools.**

9.5.1.1 Define <i>measurement</i> .	10.5.1.1 Describe the importance of thread fit and the use of thread gauges. (A4.6)	11A.5.1.1 Use basic measuring tools.	11B.5.1.1 Identify types of precision measuring instruments, and describe their applications and procedures for use. (C1.4)	11C.5.1.1 Describe the procedures used to inspect, maintain, and store basic precision measuring instruments. (C1.6)
9.5.1.2 Interpret rulers up to 1/32 of an inch.	10.5.1.2 Measure and gauge threads, and describe their associated procedures. (A4.9)	11A.5.1.2 Identify surface plates.	11B.5.1.2 Identify fixed gauges.	11C.5.1.2 Describe digital read-out (DRO).
9.5.1.3 Interpret micrometers to three decimal places.	10.5.1.3 Identify basic measuring tools.	11A.5.1.3 Measure using rulers.	11B.5.1.3 Measure using micrometers to four decimal places.	11C.5.1.3 Measure using Vernier caliper to three decimal places.
9.5.1.4 Measure with fractional ruler.	10.5.1.4 Describe care and calibration of measuring tools.	11A.5.1.4 Measure using a tape measure.	11B.5.1.4 Measure external diameters.	11C.5.1.4 Measure lengths.

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**Goal 6:** Identify basic elements of **metallurgy**.

**GLO 6.1:** Identify basic elements of **metallurgy**.

9.6.1.1 Identify basic metallurgy.	10.6.1.1 Identify metallurgical processes.	11A.6.1.1 Describe metallurgical processes.	11B.6.1.1 →	11C.6.1.1 →
9.6.1.2 Define metallurgy.	10.6.1.2 Identify the effects of carbon content on steel.	11A.6.1.2 Describe the effects of carbon content on steel.	11B.6.1.2 Identify metals by physical characteristics.	11C.6.1.2 Identify ferrous and nonferrous metals.
9.6.1.3 Identify requirements of various metal products.	10.6.1.3 Describe basic metallurgy.	11A.6.1.3 Identify seven properties of metal.	11B.6.1.3 Identify metals by chemical characteristics.	11C.6.1.3 Identify the process of steel manufacturing.
9.6.1.4 Compare aluminum and carbon steel.	10.6.1.4 Identify alloy metals.	11A.6.1.4 Describe alloy metals.	11B.6.1.4 Identify metals by mechanical characteristics.	11C.6.1.4 Identify hardness testing of metals.

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**Goal 7: Understand tools, equipment, and accessories.**

**GLO 7.1: Identify** tools, equipment, accessories, and work-holding devices.

9.7.1.1 Identify basic hand tools.	10.7.1.1 Identify types of thread inserts, and describe their applications and installation procedures. (A4.5)	11A.7.1.1 Identify saw types and attachments, and describe their applications.	11B.7.1.1 Identify types of conventional lathes, and describe their operating principles and applications. (D1.2)	11C.7.1.1 Identify types of milling machines, and describe their applications. (E1.3)
9.7.1.2 Identify standard machine tools.	10.7.1.2 Identify types of hand tools, and describe their applications and procedures for use. (B1.2)	11A.7.1.2 Identify types of drills, and describe their applications. (B4.3)	11B.7.1.2 Identify the components and controls of conventional lathes, and describe their purpose and operation. (D1.3)	11C.7.1.2 Identify the components and controls of milling machines, and describe their purpose and operation. (E1.4)
9.7.1.3 Identify common hand tools.	10.7.1.3 Identify types of power tools and equipment, and describe their applications and procedures for use. (B1.5)	11A.7.1.3 Identify types of drill presses, and describe their components and applications. (B4.4)	11B.7.1.3 Identify conventional lathe accessories and attachments, and describe their applications. (D1.4)	11C.7.1.3 Identify types of milling machine accessories and attachments, and describe their applications and maintenance. (E1.5)

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**Goal 7:** Understand **tools, equipment, and accessories.** *(continued)*

**GLO 7.1:** Identify tools, equipment, accessories, and work-holding devices. *(continued)*

9.7.1.4 Identify common measuring tools.	10.7.1.4 Identify chip-cutting machines.	11A.7.1.4 Identify drill press accessories, and describe their applications and procedures for use. (B4.5)	11B.7.1.4 Identify types of tool-holding devices, and describe their applications. (D1.5)
9.7.1.5 Identify common work-holding devices.	10.7.1.5 Identify non-chip-cutting machines.	11A.7.1.5 Describe how a drill press operates.	11B.7.1.5 Identify cutting fluids and coolants used during lathe operations. (D2.7)
	10.7.1.6 Identify new generation machines.	11A.7.1.6 Describe how a band saw operates.	11B.7.1.6 Identify considerations and requirements for selecting tools and accessories for specific operations. (D2.8)

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**Goal 7: Understand tools, equipment, and accessories.** *(continued)*

**GLO 7.2: Use** tools, equipment, accessories, and work-holding devices.

9.7.2.1 Describe the procedures used to inspect, maintain, and store hand tools. (B1.3)	10.7.2.1 →	11A.7.2.1 Describe the procedures used to set up and perform drill press operations. (B4.6)	11B.7.2.1 Describe the procedures used to sharpen conventional lathe cutting tools. (D1.8)	11C.7.2.1 Describe climb milling and conventional milling. (E1.10)
9.7.2.2 Perform the procedures used to inspect, maintain, and store hand tools. (B1.4)	10.7.2.2 →	11A.7.2.2 Describe the procedures used to inspect, maintain, and store drilling equipment and accessories. (B4.7)	11B.7.2.2 Describe the procedures used to grind cutting tool angles. (D1.9)	11C.7.2.2 Perform procedures used to handle, store, and dispose of fluids and coolants. (A8.9)
9.7.2.3 Describe the procedures used to inspect, maintain, and store power tools and equipment. (B1.6)	10.7.2.3 Describe the procedures used to inspect, maintain, and store power tools and equipment. (B1.6)	11A.7.2.3 Perform procedures used to sharpen drill bits. (B4.8)	11B.7.2.3 Describe the procedures used to set up lathes. (D2.5)	11C.7.2.3 Perform dialing in a vise parallel to table travel with a dial indicator.
9.7.2.4 Perform procedures used to inspect, maintain, and store power tools and equipment. (B1.7)	10.7.2.4 →	11A.7.2.4 Describe the considerations to determine speed, feed, and depth of cut for drill press operations. (B4.9)	11B.7.2.4 Describe the procedures used to set up eccentrics on conventional lathes. (D2.11)	11C.7.2.4 Mill a flat surface.

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**Goal 7: Understand tools, equipment, and accessories.** *(continued)*

**GLO 7.2: Use** tools, equipment, accessories, and work-holding devices. *(continued)*

9.7.2.5 Describe the procedures used to produce threads using taps and dies. (A4.10)	10.7.2.5 →	11A.7.2.5 Perform set-up and drill press operations. (B4.10)	11B.7.2.5 Describe the procedures used to inspect and maintain conventional lathes. (D2.14)	11C.7.2.5 Mill surfaces parallel and perpendicular.
9.7.2.6 Perform procedures used to cut or tap a thread. (A4.11)	10.7.2.6 →	11A.7.2.6 Perform spot-facing operations.	11B.7.2.6 Perform basic lathe operations. (D2.15)	11C.7.2.6 Use parallels in setup.
9.7.2.7 Use files.	10.7.2.7 →	11A.7.2.7 Perform counter-boring operation.	11B.7.2.7 Describe the procedures used for spotting and drilling work on a conventional lathe. (D3.1)	11C.7.2.7 Use two flute and four flute end mills.
9.7.2.8 Use hacksaw.	10.7.2.8 →	11A.7.2.8 Perform counter-sinking operation.	11B.7.2.8 Describe procedures for boring work on a conventional lathe. (D3.3)	11C.7.2.8 Use an edge finder.
9.7.2.9 Use bench vise.	10.7.2.9 →	11A.7.2.9 Perform reaming operation.	11B.7.2.9 Identify types of machine reamers, and describe their applications and procedures for use. (D3.4)	11C.7.2.9 Use the paper shim method for finding edge.



8841 <b>Exploration of Machining Technology</b> 15S / 15E / 15M 10S / 10E / 10M	8842 <b>Bench Metal</b> 20S / 20E / 20M	8843 <b>Drill Press and Metal-Cutting Saws</b> 30S / 30E / 30M	8844 <b>Lathe Operations and Grinding I</b> 30S / 30E / 30M	8854 <b>Milling Operations I</b> 30S / 30E / 30M
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**Goal 7:** Understand **tools, equipment, and accessories.** *(continued)*

**GLO 7.2:** Use tools, equipment, accessories, and work-holding devices. *(continued)*

9.7.2.10 Use punch and ball peen hammer.	10.7.2.10 →	11A.7.2.10 Perform tapping operation.	11B.7.2.10 Describe procedures for reaming work on a conventional lathe. (D3.5)	11C.7.2.10 Use milling machine vise as work-holding device.
9.7.2.11 Use chisels.	10.7.2.11 →	11A.7.2.11 Store tools away.	11B.7.2.11 Machine a project that requires a three-jaw chuck with reversed jaws as the work-holding device.	11C.7.2.11 Use a form milling cutter.
9.7.2.12 Use screwdrivers.	10.7.2.12 →	11A.7.2.12 Enlarge a hole with a twist drill.	11B.7.2.12 Machine a project that requires a faceplate as the work-holding device.	11C.7.2.12 Use a slitting saw cutter.
9.7.2.13 Use wrenches.	10.7.2.13 →		11B.7.2.13 Machine a project that requires a four-jaw chuck as the work-holding device.	

8841 <b>Exploration of Machining Technology</b> 15S / 15E / 15M 10S / 10E / 10M	8842 <b>Bench Metal</b> 20S / 20E / 20M	8843 <b>Drill Press and Metal-Cutting Saws</b> 30S / 30E / 30M	8844 <b>Lathe Operations and Grinding I</b> 30S / 30E / 30M	8854 <b>Milling Operations I</b> 30S / 30E / 30M
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**Goal 7: Understand tools, equipment, and accessories.** *(continued)*

**GLO 7.3: Identify techniques used to troubleshoot and predict potential problems.**

9.7.2.14 Develop an understanding of hand tools in machining technology.	10.7.2.14 Identify types of thread failures, and describe their causes and remedies. (A4.7)	11A.7.2.14 Identify potential set-up problems, and describe their causes and remedies as they pertain to drilling machines and twist drills.	11B.7.2.14 Identify potential set-up problems, and describe their causes and remedies. (D2.4)	11C.7.2.14 Identify potential set-up problems, and describe their causes and remedies as they pertain to milling machines.
9.7.2.15 Identify techniques used to troubleshoot tools.	10.7.2.15 Identify techniques used to troubleshoot hand tool operations, and describe their associated procedures.	11A.7.2.15 Identify techniques used to troubleshoot drill press/ band saw operations, and describe their associated procedures.	11B.7.2.15 Identify techniques used to troubleshoot conventional lathe operations, and describe their associated procedures. (D2.13)	11C.7.2.15 Identify techniques used to troubleshoot milling machine operations, and describe their associated procedures.

8841 <b>Exploration of Machining Technology</b> 15S / 15E / 15M 10S / 10E / 10M	8842 <b>Bench Metal</b> 20S / 20E / 20M	8843 <b>Drill Press and Metal-Cutting Saws</b> 30S / 30E / 30M	8844 <b>Lathe Operations and Grinding I</b> 30S / 30E / 30M	8854 <b>Milling Operations I</b> 30S / 30E / 30M
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**Goal 8:** Describe and demonstrate the transferable **cross-curricular** knowledge and skills as they pertain to machining technology.

**GLO 8.1:** Apply **mathematical knowledge and skills** related to machining technology.

9.8.1.1 Solve problems involving fractions and decimals.	10.8.1.1 →	11A.8.1.1 →	11B.8.1.1 →	11C.8.1.1 →
9.8.1.2 Solve problems involving metric and imperial measure.	10.8.1.2 →	11B.8.1.2 →	11B.8.1.2 →	11C.8.1.2 →
9.8.1.3 Solve problems involving length, perimeter, circumference, volume, area, mass, angles, ratio, and percentage.	10.8.1.3 →	11A.8.1.3 →	11B.8.1.3 →	11C.8.1.3 →
9.8.1.4 Convert between imperial and metric measurements.	10.8.1.4 →	11A.8.1.4 →	11B.8.1.4 →	11C.8.1.4 →
9.8.1.5 Use formulas to accurately calculate data for use in machining operations.	10.8.1.5 →	11A.8.1.5 →	11B.8.1.5 →	11C.8.1.5 →

8841 <b>Exploration of Machining Technology</b> 15S / 15E / 15M 10S / 10E / 10M	8842 <b>Bench Metal</b> 20S / 20E / 20M	8843 <b>Drill Press and Metal-Cutting Saws</b> 30S / 30E / 30M	8844 <b>Lathe Operations and Grinding I</b> 30S / 30E / 30M	8854 <b>Milling Operations I</b> 30S / 30E / 30M
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**Goal 8:** Describe and demonstrate the transferable **cross-curricular** knowledge and skills as they pertain to machining technology. *(continued)*

**GLO 8.1:** Apply **mathematical knowledge and skills** related to machining technology. *(continued)*

9.8.1.6 Accurately calculate and measure parts and angles.	10.8.1.6 →	11A.8.1.6 →	11B.8.1.6 →	11C.8.1.6 →
9.8.1.7 Perform mathematical calculations, conversions, and measurements, as required for the project.	10.8.1.7 →	11A.8.1.7 →	11B.8.1.7 →	11C.8.1.7 →
9.8.1.8 Perform basic arithmetic with ruler fractions.	10.8.1.8 Calculate and select tap drill sizes in metric and imperial. (A4.8)	11A.8.1.8 Describe the imperial and metric systems and the procedures used to perform conversions for machining operations. (C1.2)	11B.8.1.8 Describe the considerations to determine speed, feed, and depth of cut for conventional lathe operations. (D2.2)	11C.8.1.8 Describe the considerations to determine speed, feed, and depth of cut for milling operations.
9.8.1.9 Perform basic arithmetic with decimal measurements.	10.8.1.9 Estimate stock required.	11A.8.1.9 Accurately calculate rotations per minute (RPM) for drill press operations.	11B.8.1.9 Calculate speed, feed, and depth of cut. (D2.3)	11C.8.1.9 Accurately calculate feed rate for milling operations.

8841 <b>Exploration of Machining Technology</b> 15S / 15E / 15M 10S / 10E / 10M	8842 <b>Bench Metal</b> 20S / 20E / 20M	8843 <b>Drill Press and Metal-Cutting Saws</b> 30S / 30E / 30M	8844 <b>Lathe Operations and Grinding I</b> 30S / 30E / 30M	8854 <b>Milling Operations I</b> 30S / 30E / 30M
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**Goal 8:** Describe and demonstrate the transferable **cross-curricular** knowledge and skills as they pertain to machining technology. *(continued)*

**GLO 8.1:** Apply **mathematical knowledge and skills** related to machining technology. *(continued)*

9.8.1.10 Identify the importance of mathematics in machining.	10.8.1.10 Estimate time required for task completion.	11A.8.1.10 Accurately calculate tap drill size using tap drill size formula.	11B.8.1.10 Calculate for threads using thread formulas.	11C.8.1.10 Calculate angles for compound rest setting.
9.8.1.11 Identify math formulas.	10.8.1.11 Estimate material waste from material removal.	11A.8.1.11 Calculate length of band saw blades.	11B.8.1.11 Calculate angles for compound rest setting.	11C.8.1.11 Calculate angles for milling vise setting.
9.8.1.12 Identify charts used to obtain data for machining operations.	10.8.1.12 Use charts and reference books to determine tap drill sizes.	11A.8.1.12 →	11B.8.1.12 →	11C.8.1.12 →
9.8.1.13 Identify reference books used to obtain data for machining operations.	10.8.1.13 Use charts and reference books to determine conversions among metric, fractional, and decimal units of measurement.	11A.8.1.13 →	11B.8.1.13 →	11C.8.1.13 →

8841 <b>Exploration of Machining Technology</b> 15S / 15E / 15M 10S / 10E / 10M	8842 <b>Bench Metal</b> 20S / 20E / 20M	8843 <b>Drill Press and Metal-Cutting Saws</b> 30S / 30E / 30M	8844 <b>Lathe Operations and Grinding I</b> 30S / 30E / 30M	8854 <b>Milling Operations I</b> 30S / 30E / 30M
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**Goal 9:** Demonstrate an awareness of **education and career opportunities** in machining technology and associated occupations.

**GLO 9.1:** Describe **education and career opportunities** in machining technology

9.9.1.1 Describe the structure and scope of the trade. (A3.1)	10.9.1.1 →	11A.9.1.1 Recognize the relationship between career and employment opportunities and the machine technology program.	11B.9.1.1 Identify apprenticeship.	11C.9.1.1 Describe the Manitoba Machinist Apprenticeship Program. (A3.2)
9.9.1.2 Discuss future courses in machining technology.	10.9.1.2 Identify post-secondary opportunities that complement the skills of a machinist.	11A.9.1.2 Describe post-secondary opportunities that complement the skills of a machinist.	11B.9.1.2 Identify resources for machining-related information.	11C.9.1.2 Research educational opportunities for machining-related fields.

8841 <b>Exploration of Machining Technology</b> 15S / 15E / 15M 10S / 10E / 10M	8842 <b>Bench Metal</b> 20S / 20E / 20M	8843 <b>Drill Press and Metal-Cutting Saws</b> 30S / 30E / 30M	8844 <b>Lathe Operations and Grinding I</b> 30S / 30E / 30M	8854 <b>Milling Operations I</b> 30S / 30E / 30M
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**Goal 10:** Describe the **history, technological progression, and emerging trends** in machining technology.

**GLO 10.1:** Describe the **history, technological progression, and emerging trends** in machining technology.

9.10.1.1 Explore the history of machine tools.	10.10.1.1 Research the history of the machining trade and the evolution of machine tools.	11A.10.1.1 Research the evolution of machine tools.	11B.10.1.1 Discuss the evolution, technological progression, and emerging trends in machining.	11C.10.1.1 Identify lean manufacturing.
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8841 <b>Exploration of Machining Technology</b> 15S / 15E / 15M 10S / 10E / 10M	8842 <b>Bench Metal</b> 20S / 20E / 20M	8843 <b>Drill Press and Metal-Cutting Saws</b> 30S / 30E / 30M	8844 <b>Lathe Operations and Grinding I</b> 30S / 30E / 30M	8854 <b>Milling Operations I</b> 30S / 30E / 30M
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**Goal 11:** Demonstrate **employability skills** related to machining technology.

**GLO 11.1:** Demonstrate **employability skills** related to machining technology.

9.11.1.1 Demonstrate regular attendance and punctuality.	10.11.1.1 →	11A.11.1.1 →	11B.11.1.1 →	11C.11.1.1 →
9.11.1.2 Demonstrate accountability by taking responsibility for their actions.	10.11.1.2 →	11A.11.1.2 →	11B.11.1.2 →	11C.11.1.2 →
9.11.1.3 Demonstrate adaptability and effort.	10.11.1.3 →	11A.11.1.3 →	11B.11.1.3 →	11C.11.1.3 →
9.11.1.4 Demonstrate the ability to accept and follow directions and listen to feedback.	10.11.1.4 →	11A.11.1.4 →	11B.11.1.4 →	11C.11.1.4 →
9.11.1.5 Demonstrate the ability to stay on task and make effective use of time in class and shop environments.	10.11.1.5 →	11A.11.1.5 →	11B.11.1.5 →	11C.11.1.5 →



8841 <b>Exploration of Machining Technology</b> 15S / 15E / 15M 10S / 10E / 10M	8842 <b>Bench Metal</b> 20S / 20E / 20M	8843 <b>Drill Press and Metal-Cutting Saws</b> 30S / 30E / 30M	8844 <b>Lathe Operations and Grinding I</b> 30S / 30E / 30M	8854 <b>Milling Operations I</b> 30S / 30E / 30M
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**Goal 11:** Demonstrate **employability skills** related to machining technology. *(continued)*

**GLO 11.1:** Demonstrate **employability skills** related to machining technology. *(continued)*

9.11.1.6 Demonstrate the ability to communicate respectfully and effectively.	10.11.1.6 →	11A.11.1.6 →	11B.11.1.6 →	11C.11.1.6 →
9.11.1.7 Demonstrate being responsible to oneself and to the facility.	10.11.1.7 →	11A.11.1.7 →	11B.11.1.7 →	11C.11.1.7 →
9.11.1.8 Demonstrate behaviour appropriate to the workplace.	10.11.1.8 →	11A.11.1.8 →	11B.11.1.8 →	11C.11.1.8 →
9.11.1.9 Demonstrate neat personal appearance and proper hygiene.	10.11.1.9 →	11A.11.1.9 →	11B.11.1.9 →	11C.11.1.9 →
9.11.1.10 Prepare/revise a personal resumé specific to an application to an employer of machinists.	10.11.1.10 →	11A.11.1.10 →	11B.11.1.10 →	11C.11.1.10 →

8841 <b>Exploration of Machining Technology</b> 15S / 15E / 15M 10S / 10E / 10M	8842 <b>Bench Metal</b> 20S / 20E / 20M	8843 <b>Drill Press and Metal-Cutting Saws</b> 30S / 30E / 30M	8844 <b>Lathe Operations and Grinding I</b> 30S / 30E / 30M	8854 <b>Milling Operations I</b> 30S / 30E / 30M
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**Goal 12:** Demonstrate awareness of the **ethical and legal standards** as they pertain to machining technology.

**GLO 12.1:** Demonstrate awareness of the **ethical and legal standards** as they pertain to machining technology.

10.12.1.1 Understand the need for and the importance of ethics in the machining industry.

10.12.1.2 Discuss the need for and the uses of engineering specifications.

11A.12.1.1 Demonstrate ethical conduct in the school and machining technology department.

11B.12.1.1 Practise legal and ethical behaviours.

11C.12.1.1 Discuss ethical and legal standards.

8841 <b>Exploration of Machining Technology</b> 15S / 15E / 15M 10S / 10E / 10M	8842 <b>Bench Metal</b> 20S / 20E / 20M	8843 <b>Drill Press and Metal-Cutting Saws</b> 30S / 30E / 30M	8844 <b>Lathe Operations and Grinding I</b> 30S / 30E / 30M	8854 <b>Milling Operations I</b> 30S / 30E / 30M
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**Goal 13:** Demonstrate awareness of **sustainability** as it pertains to machining technology.

**GLO 13.1:** Demonstrate awareness of **human sustainability** on machinists.

9.13.1.1 Identify human sustainability.	10.13.1.1 Discuss human sustainability.	11A.13.1.1 Discuss the impact of sustainable practices on health and well-being for a machinist.	11B.13.1.1 Discuss the importance of working conditions as they pertain to sustainability for a machinist.	11C.13.1.1 Identify sustainable factors that influence health and lifelong well-being for a machinist.
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8841 <b>Exploration of Machining Technology</b> 15S / 15E / 15M 10S / 10E / 10M	8842 <b>Bench Metal</b> 20S / 20E / 20M	8843 <b>Drill Press and Metal-Cutting Saws</b> 30S / 30E / 30M	8844 <b>Lathe Operations and Grinding I</b> 30S / 30E / 30M	8854 <b>Milling Operations I</b> 30S / 30E / 30M
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**Goal 13:** Demonstrate awareness of **sustainability** as it pertains to machining technology. *(continued)*

**GLO 13.2:** Describe machining technology's **sustainability practices** and **impact on the environment**.

9.13.2.1 Identify environmental sustainability.	10.13.2.1 Discuss and demonstrate appropriate recycling, reduction of waste, and reusing of materials as they pertain to the machining industry.	11A.13.2.1 →	11B.13.2.1 →	11C.13.2.1 →
9.13.2.2 Discuss the impact of environmental sustainability.	10.13.2.2 Discuss and demonstrate the appropriate disposal of coolants, oils, and non-recyclable waste.	11A.13.2.2 →	11B.13.2.2 →	11C.13.2.2 →

8841 <b>Exploration of Machining Technology</b> 15S / 15E / 15M 10S / 10E / 10M	8842 <b>Bench Metal</b> 20S / 20E / 20M	8843 <b>Drill Press and Metal-Cutting Saws</b> 30S / 30E / 30M	8844 <b>Lathe Operations and Grinding I</b> 30S / 30E / 30M	8854 <b>Milling Operations I</b> 30S / 30E / 30M
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**Goal 13:** Demonstrate awareness of **sustainability** as it pertains to machining technology.

**GLO 13.3:** Demonstrate awareness of the **business sustainability** of a machining technology facility.

9.13.3.1 Identify business sustainability.	10.13.3.1 Discuss the importance of machining to the economy.	11A.13.3.1 Discuss the importance of producing a quality product.	11B.13.3.1 Discuss the importance of working conditions on employee retention.	11C.13.3.1 Discuss the influence of machining on the local economy.
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# GRADE 12 MACHINING TECHNOLOGY

General and Specific Learning  
Outcomes by Goal





# GRADE 12 MACHINING TECHNOLOGY

## GENERAL AND SPECIFIC LEARNING OUTCOMES BY GOAL

8855 <b>Lathe Operations and Grinding 2 (12A)</b> 40S / 40E / 40M	8856 <b>Milling Operations 2 (12B)</b> 40S / 40E / 40M	8857 <b>Applied Machining and Manufacturing Technology (12C)</b> 40S / 40E / 40M	8858 <b>CNC Machining (12D)</b> 40S / 40E / 40M
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**Goal 1:** Describe and apply appropriate **health and safety practices** as they relate to the **maintenance of a safe workspace.**

**GLO 1.1:** Create and maintain a **safe working environment** in machining technology.

12A.1.1.1 Identify safety and health requirements. (A1.1)	12B.1.1.1 →	12C.1.1.1 →	12D.1.1.1 →
12A.1.1.2 Identify personal protective equipment (PPE) and PPE procedures. (A1.2)	12B.1.1.2 →	12C.1.1.2 →	12D.1.1.2 →
12A.1.1.3 Identify appropriate safety procedures for working with electricity. (A1.3)	12B.1.1.3 →	12C.1.1.3 →	12D.1.1.3 →
12A.1.1.4 Identify appropriate safety procedures to reduce fire hazards. (A1.4)	12B.1.1.4 →	12C.1.1.4 →	12D.1.1.4 →
12A.1.1.5 Identify ergonomically correct procedures to avoid injury (e.g., stress, strain). (A1.5)	12B.1.1.5 →	12C.1.1.5 →	12D.1.1.5 →
12A.1.1.6 Identify hazard recognition and control. (A1.6)	12B.1.1.6 →	12C.1.1.6 →	12D.1.1.6 →

8855 <b>Lathe Operations and Grinding 2 (12A)</b> 40S / 40E / 40M	8856 <b>Milling Operations 2 (12B)</b> 40S / 40E / 40M	8857 <b>Applied Machining and Manufacturing Technology (12C)</b> 40S / 40E / 40M	8858 <b>CNC Machining (12D)</b> 40S / 40E / 40M
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**Goal 1:** Describe and apply appropriate **health and safety practices** as they relate to the **maintenance of a safe workspace.** *(continued)*

**GLO 1.1:** Create and maintain a **safe working environment** in machining technology. *(continued)*

12A.1.1.7 Describe the hazards of confined-space entry. (A1.7)	12B.1.1.7 →	12C.1.1.7 →	12D.1.1.7 →
12A.1.1.8 Identify first aid/ cardiopulmonary resuscitation (CPR). (A1.8)	12B.1.1.8 →	12C.1.1.8 →	12D.1.1.8 →
12A.1.1.9 Identify safety requirements as they apply to the WHMIS. (A1.9)	12B.1.1.9 →	12C.1.1.9 →	12E.1.1.9 →
12A.1.1.10 Describe the identification and control of specified hazards. (A1.10)	12B.1.1.10 →	12C.1.1.10 →	12D.1.1.10 →
12A.1.1.11 Identify types of personal protective equipment (PPE), and describe their applications. (A2.1)	12B.1.1.11 →	12C.1.1.11 →	12D.1.1.11 →
12A.1.1.12 Describe the procedures used to care for and maintain PPE. (A2.2)	12B.1.1.12 →	12C.1.1.12 →	12D.1.1.12 →
12A.1.1.13 Identify types of fire extinguishing equipment, and describe their applications and procedures for use. (A2.3)	12B.1.1.13 →	12C.1.1.13 →	12D.1.1.13 →

8855 <b>Lathe Operations and Grinding 2 (12A)</b> 40S / 40E / 40M	8856 <b>Milling Operations 2 (12B)</b> 40S / 40E / 40M	8857 <b>Applied Machining and Manufacturing Technology (12C)</b> 40S / 40E / 40M	8858 <b>CNC Machining (12D)</b> 40S / 40E / 40M
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**Goal 1:** Describe and apply appropriate **health and safety practices** as they relate to the **maintenance of a safe workspace.** *(continued)*

**GLO 1.1:** Create and maintain a **safe working environment** in machining technology. *(continued)*

12A.1.1.14 Identify workplace hazards, and describe safe work practices and equipment. (A2.4)	12B.1.1.14 →	12C.1.1.14 →	12D.1.1.14 →
12A.1.1.15 Identify and interpret workplace safety and health regulations. (A2.4)	12B.1.1.15 →	12C.1.1.15 →	12D.1.1.15 →
12A.1.1.16 Identify hazards, and describe safe work practices pertaining to fluids and coolants. (A8.2)	12B.1.1.16 →	12C.1.1.16 →	12D.1.1.16 →
12A.1.1.17 Identify hazards, and describe safe work practices pertaining to hand and power tools. (B1.1)	12B.1.1.17 →	12C.1.1.17 →	12D.1.1.17 →
12A.1.1.18 Demonstrate understanding and adherence to safe work procedures/job hazards analysis documents for each piece of equipment, tool, and consumable that they use.	12B.1.1.18 →	12C.1.1.18 →	12D.1.1.18 →

8855 <b>Lathe Operations and Grinding 2 (12A)</b> 40S / 40E / 40M	8856 <b>Milling Operations 2 (12B)</b> 40S / 40E / 40M	8857 <b>Applied Machining and Manufacturing Technology (12C)</b> 40S / 40E / 40M	8858 <b>CNC Machining (12D)</b> 40S / 40E / 40M
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**Goal 1:** Describe and apply appropriate **health and safety practices** as they relate to the **maintenance of a safe workspace.** *(continued)*

**GLO 1.1:** Create and maintain a **safe working environment** in machining technology. *(continued)*

12A.1.1.19 Demonstrate understanding and adherence to safe practices and procedures for facilities, processes, tools, and equipment found in machining technology.	12B.1.1.19 →	12C.1.1.19 →	12D.1.1.19 →
12A.1.1.20 Discuss worker's responsibility to refuse unsafe work.	12B.1.1.20 →	12C.1.1.20 →	12D.1.1.20 →
12A.1.1.21 Demonstrate use of personal protective equipment (PPE) and adherence to PPE procedures used in machining technology.	12B.1.1.21 →	12C.1.1.21 →	12D.1.1.21 →
12A.1.1.22 Demonstrate the safe use of compressed air.	12B.1.1.22 →	12C.1.1.22 →	12D.1.1.22 →
12A.1.1.23 Practise appropriate cleaning and maintenance of the machining technology area and equipment for the promotion of a safe work/learning environment.	12B.1.1.23 →	12C.1.1.23 →	12D.1.1.23 →

8855 <b>Lathe Operations and Grinding 2 (12A)</b> 40S / 40E / 40M	8856 <b>Milling Operations 2 (12B)</b> 40S / 40E / 40M	8857 <b>Applied Machining and Manufacturing Technology (12C)</b> 40S / 40E / 40M	8858 <b>CNC Machining (12D)</b> 40S / 40E / 40M
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**Goal 1:** Describe and apply appropriate **health and safety practices** as they relate to the **maintenance of a safe workspace.** *(continued)*

**GLO 1.1:** Create and maintain a **safe working environment** in machining technology. *(continued)*

12A.1.1.24 Practise appropriate safe behaviour to ensure personal safety, as well as safety of others.	12B.1.1.24 →	12C.1.1.24 →	12D.1.1.24 →
12A.1.1.25 Develop safe habits.	12B.1.1.25 →	12C.1.1.25 →	12D.1.1.25 →
12A.1.1.26 Demonstrate a safe, clean, organized, and uncluttered work area.	12B.1.1.26 →	12C.1.1.26 →	12D.1.1.26 →
12A.1.1.27 Explain the purpose/importance and use of accident report forms.	12B.1.1.27 →	12C.1.1.27 →	12D.1.1.27 →
12A.1.1.28 Identify hazards, and describe safe work practices pertaining to grinding machines. (F1.2)	12B.1.1.28 Identify hazards, and describe safe work practices pertaining to conventional milling machines. (E1.2)	12C.1.1.28 Identify hazards, and describe safe work practices pertaining to hoisting, lifting, and rigging. (A5.2)	12D.1.1.28 Identify hazards, and describe safe work practices pertaining to CNC machines.
12A.1.1.29 Identify precautions related to the operation of grinding machines.	12B.1.1.29 Practise safe set-up/operation of milling machines.	12C.1.1.29 Demonstrate an understanding of the importance of machining equipment.	12D.1.1.29 Practise safety procedures related to CNC machine safety.
12A.1.1.30 Practise safe set-up/operation of lathes and grinding machines.	12B.1.1.30 Practise safe set-up/operation of milling machines.	12C.1.1.30 Practise safe set-up/operation of machining tools used.	12D.1.1.30 Practise safe set-up/operation of CNC machines.

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**Goal 2:** Understand **terminology, abbreviations, symbols, and acronyms** related to machining technology.

**GLO 2.1:** Understand **terminology, abbreviations, symbols, and acronyms** related to machining technology.

12A.1.2.1 Define metallurgical terminology, abbreviations, symbols, and acronyms.	12B.1.2.1 →	12C.1.2.1 →	12D.1.2.1 Define terminology, abbreviations, symbols, and acronyms associated with computer numerical control machining.
12A.1.2.2 Define terminology, abbreviations, symbols, and acronyms associated with grinding machines. (F1.1)	12B.1.2.2 →	12C.1.2.2 Define terminology, abbreviations, symbols, and acronyms associated with lean manufacturing.	12D.1.2.2 Define and describe Cartesian coordinates.
12A.1.2.3 Define terminology, abbreviations, symbols, and acronyms associated with conventional lathes. (D1.1)	12B.1.2.3 Define terminology, abbreviations, symbols, and acronyms associated with basic precision measurement. (C1.1)	12C.1.2.3 Define terminology associated with hoisting, lifting, and rigging. (A5.1)	12D.1.2.3 Define computer-aided design and computer-aided machining.
12A.1.2.4 Define work ethic as it pertains to machining.	12B.1.2.4 Define terminology, abbreviations, symbols, and acronyms associated with drawings. (A6.1)	12C.1.2.4 Define terminology, abbreviations, symbols, and acronyms associated with fluids and coolants. (A8.1)	12D.1.2.4 Define computer numerical control.

8855 <b>Lathe Operations and Grinding 2 (12A)</b> 40S / 40E / 40M	8856 <b>Milling Operations 2 (12B)</b> 40S / 40E / 40M	8857 <b>Applied Machining and Manufacturing Technology (12C)</b> 40S / 40E / 40M	8858 <b>CNC Machining (12D)</b> 40S / 40E / 40M
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**Goal 3: Understand technical drawings.**

**GLO 3.1: Understand technical drawings.**

12A.1.3.1 Produce basic paper-and-pencil sketch of project.	12B.1.3.1 →	12C.1.3.1 →	12D.1.3.1 →
12A.1.3.2 Interpret and extract information from drawings. (A6.3)	12B.1.3.2 →	12C.1.3.2 →	12D.1.3.2 →
12A.1.3.3 Identify types of basic drawings and sketches, and describe their purpose. (A6.2)	12B.1.3.3 Describe industry methods of showing dimensions and tolerances.	12C.1.3.3 Identify dimensions found on drawings.	12D.1.3.3 Describe dimensions found on drawings.
12A.1.3.4 Describe basic sketching techniques. (A6.5)	12B.1.3.4 Explain the principles of orthographic projection. (A6.4)	12C.1.3.4 Identify tolerances found on drawings.	12D.1.3.4 Describe tolerances found on drawings.

8855 <b>Lathe Operations and Grinding 2 (12A)</b> 40S / 40E / 40M	8856 <b>Milling Operations 2 (12B)</b> 40S / 40E / 40M	8857 <b>Applied Machining and Manufacturing Technology (12C)</b> 40S / 40E / 40M	8858 <b>CNC Machining (12D)</b> 40S / 40E / 40M
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**Goal 4: Demonstrate layout and planning.**

**GLO 4.1: Demonstrate planning and layout procedures.**

12A.4.1.1 Calculate layout dimensions and reference points. (C3.4)	12B.4.1.1 →	12C.4.1.1 →	12D.4.1.1 →
12A.4.1.2 Describe the procedures used to read and transfer sizes from a drawing. (C3.5)	12B.4.1.2 Describe the procedures used to inspect, maintain, and store layout tools and equipment. (C3.8)	12C.4.1.2 Use layout tools for projects and assignments.	12D.4.1.2 Describe the datum or reference surfaces, their applications, and advantages.
12A.4.1.3 Use planning worksheet for projects.	12B.4.1.3 →	12C.4.1.3 →	12D.4.1.3 →

**Goal 4: Demonstrate layout and planning.**

**GLO 4.2: Demonstrate layout on projects.**

12A.4.2.1 Identify and use tools required to perform advanced layout on lathe projects.	12B.4.2.1 Identify and use tools required to perform advanced layout on milling projects.	12C.4.2.1 Identify and use tools required to perform advanced layout on projects.	12D.4.2.1 Produce a basic CNC program for lathe and machining centres.
12A.4.2.2 Perform basic layout. (C3.9)	12B.4.2.2 →	12C.4.2.2 →	12D.4.2.2 →
12A.4.2.3 Use centring head from combination square set.	12B.4.2.3 Use Vernier height gauge.	12C.4.2.3 Use sine bar.	12D.4.2.3 Use graph paper to plot Cartesian coordinates of project.



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**Goal 5: Use measurement and quality control tools.**

**GLO 5.1: Use measurement and quality control tools.**

12A.5.1.1 Describe the procedures used to perform basic calibration of measuring instruments. (C1.5)	12B.5.1.1 Demonstrate applications and procedures when inspecting, maintaining, and storing precision measuring instruments. (C1.7)	12C.5.1.1 Describe the procedures used to read basic precision measuring instrument scales. (C1.3)	12D.5.1.1 Identify coordinate measuring machine.
12A.5.1.2 Use fixed gauges.	12B.5.1.2 Use digital read-out. (DRO)	12C.5.1.2 Use surface plates.	12D.5.1.2 Identify surface finish with surface comparator gauge.
12A.5.1.3 Use three-wire method of measuring threads.	12B.5.1.3 Use dial indicator.	12C.5.1.3 Use gauge blocks.	12D.5.1.3 Describe rework of CNC-machined parts.
12A.5.1.4 Measure internal diameters.	12B.5.1.4 Measure angles.	12C.5.1.4 Calibrate measuring tools.	12D.5.1.4 Describe the operation of a coordinate measuring machine.

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**Goal 6:** Identify basic elements of **metallurgy**.

**GLO 6.1:** Identify basic elements of **metallurgy**.

12A.6.1.1 Distinguish metallurgical processes.	12B.6.1.1 →	12C.6.1.1 Identify the effects on cutting tools for different metals.	12D.6.1.1 Describe the effects on cutting tools for different metals.
12A.6.1.2 Describe metals by physical characteristics.	12B.6.1.2 Describe ferrous and nonferrous metals.	12C.6.1.2 Identify physics of metal cutting.	12D.6.1.2 Describe physics of metal cutting.
12A.6.1.3 Describe metals by chemical characteristics.	12B.6.1.3 Describe the process of steel manufacturing.	12C.6.1.3 Identify heat treatment.	12D.6.1.3 Describe heat treatment.
12A.6.1.4 Describe metals by mechanical characteristics.	12B.6.1.4 Describe hardness testing of metals.	12C.6.1.4 Identify heat treatment processes.	12D.6.1.4 Describe heat treatment processes.

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**Lathe Operations and  
 Grinding 2 (12A)**  
 40S / 40E / 40M

8856  
**Milling Operations 2  
 (12B)**  
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8857  
**Applied Machining  
 and Manufacturing  
 Technology (12C)**  
 40S / 40E / 40M

8858  
**CNC Machining  
 (12D)**  
 40S / 40E / 40M

**Goal 7: Understand tools, equipment, and accessories.**

**GLO 7.1: Identify** tools, equipment, accessories, and work-holding devices.

12A.7.1.1 Identify carbide cutting tools.

12B.7.1.1 Identify types of tool-holding devices, and describe their applications. (E1.6)

12C.7.1.1 Identify types of fluids and coolants, and describe their purpose, characteristics, and applications. (A8.4)

12D.7.1.1 Describe CNC machining centres and accessories.

12A.7.1.2 Identify types of work-holding devices, and describe their applications. (F1.3)

12B.7.1.2 Identify types of work-holding devices, and describe their applications and maintenance. (E1.7)

12C.7.1.2 Interpret regulations pertaining to the use of fluids and coolants. (A8.3)

12D.7.1.2 Identify various work-holding devices.

12A.7.1.3 Identify types of grinding machines and accessories, and describe their applications. (F1.4)

12B.7.1.3 Identify types of materials used in milling cutter construction, and describe their characteristics. (E1.8)

12C.7.1.3 Identify types of rigging equipment and accessories, and describe their applications, limitations, and procedures for use. (A5.4)

12D.7.1.3 Describe various work-holding devices.

12A.7.1.4 Identify types of work-holding devices, and describe their applications. (D1.6)

12B.7.1.4 Identify types of cutting tools, and describe their applications. (E1.9)

12C.7.1.4 Identify and interpret hand signals used for hoisting and lifting. (A5.5)

12A.7.1.5 Identify types of conventional lathe tools, and describe their characteristics and applications. (D1.7)

12C.7.1.5 Identify types of hoisting and lifting equipment and accessories, and describe their applications, limitations, and procedures for use. (A5.6)

12A.7.1.6 Identify types of boring tools, and describe their applications and procedures for use. (D3.2)

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**Goal 7: Understand tools, equipment, and accessories.** *(continued)*

**GLO 7.2: Use tools, equipment, accessories, and work-holding devices.**

12A.7.2.1 Describe the procedures used to perform offhand (bench) grinding operations. (F1.5)	12B.7.2.1 Describe the procedures used to apply and maintain lubricants. (A8.5)	12C.7.2.1 Describe the procedures used to apply cutting fluids and coolants. (A8.7)	12D.7.2.1 Describe CNC lathes and accessories.
12A.7.2.2 Perform offhand (bench) grinding operations. (F1.6)	12B.7.2.2 Set milling head to perform a milling operation at an angle.	12C.7.2.2 Describe the considerations when rigging material/equipment for lifting. (A5.7)	12D.7.2.2 Describe CAD and CAM.
12A.7.2.3 Describe the procedures used to perform special (form) grinding operations. (F1.7)	12B.7.2.3 Set up dividing head to mill a project.	12C.7.2.3 Describe the procedures used to inspect, maintain, and store hoisting, lifting, and rigging equipment. (A5.8)	12D.7.2.3 Compare the accuracy of a conventional machine tool with that of a CNC machine tool.
12A.7.2.4 Perform procedures for changing and dressing a grinding wheel. (F1.8)	12B.7.2.4 Set up rotary table to mill a project.	12C.7.2.4 Perform procedures used to inspect, maintain, and store hoisting, lifting, and rigging equipment. (A5.9)	12D.7.2.4 Discuss advantages and disadvantages of CNC.
12A.7.2.5 Describe the procedures used to mount and adjust rests. (D2.6)	12B.7.2.5 Use step blocks and clamps as work-holding devices.	12C.7.2.5 Describe the procedures used to handle, store, and dispose of fluids and coolants. (A8.9)	12D.7.2.5 Describe various types of CNC equipment (e.g., water jet, laser, plasma...).
12A.7.2.6 Describe the procedures used to adjust and maintain conventional lathes. (D2.9)	12B.7.2.6 Machine a keyway on a shaft.	12C.7.2.6 Perform procedures used for mixing, maintaining, and adjusting coolants. (A8.6)	12D.7.2.6 Prepare a basic CNC program for a milling machine.

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**Goal 7: Understand tools, equipment, and accessories.** *(continued)*

**GLO 7.2: Use tools, equipment, accessories, and work-holding devices.** *(continued)*

12A.7.2.7 Describe the procedures used to align lathe centres. (D2.10)	12B.7.2.7 Use fly cutter to produce a flat surface.	12C.7.2.7 Machine a plate with a bolt-hole circle.	12D.7.2.7 Prepare a basic CNC program for a lathe.
12A.7.2.8 Describe the procedures used to perform basic conventional lathe operations. (D2.11)	12B.7.2.8 Use indexable insert cutters.	12C.7.2.8 Machine a sleeve to shrink-fit onto a shaft.	12D.7.2.8 Describe the format of a CNC program.
12A.7.2.9 Describe the procedures used for tapping on a conventional lathe. (D3.7)	12B.7.2.9 Mill a pocket.	12C.7.2.9 Machine a shaft to accommodate a bearing.	12D.7.2.9 Compare g-code and m-code.
12A.7.2.10 Describe the procedures used for die threading on a conventional lathe. (D3.8)	12B.7.2.10 Mill an internal and an external dovetail.	12C.7.2.10 Machine an external O-ring groove.	12D.7.2.10 Define tool path.
12A.7.2.11 Describe the procedures used for counterboring and countersinking work on a conventional lathe. (D3.9)	12B.7.2.11 Mill a keyway using a woodruff cutter.	12C.7.2.11 Machine an internal O-ring groove.	12D.7.2.11 Compare incremental and absolute positioning.
12A.7.2.12 Describe speed, feed, and depth of cut for conventional lathe operations. (D3.10)	12B.7.2.12 Cut a profile using gang milling.	12C.7.2.12 Machine project with mating threads.	12D.7.2.12 Compare linear and circular interpolation.

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**Goal 7: Understand tools, equipment, and accessories.** *(continued)*

**GLO 7.2: Use** tools, equipment, accessories, and work-holding devices. *(continued)*

12A.7.2.13 Perform processes for speed, feed, and depth of cut for conventional lathe operations. (D3.11)	12B.7.2.12 Use offset boring chuck to enlarge a hole.	12C.7.2.12 Machine a student-initiated project.	
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**Goal 7: Understand tools, equipment, and accessories.** *(continued)*

**GLO 7.3: Identify** techniques used to **troubleshoot** and **predict potential problems.**

12A.7.3.1 Identify potential grinding machine set-up problems, and describe their causes and solutions.	12B.7.3.1 Identify potential milling machine set-up problems, and describe their causes and solutions.	12C.7.3.1 Identify potential set-up problems, and describe their causes and solutions.	12D.7.3.1 Identify potential CNC machining set-up problems, and describe their causes and solutions.
12A.7.3.2 Identify techniques used to troubleshoot grinding machine operations, and describe their associated procedures.	12B.7.3.2 Identify techniques used to troubleshoot milling machine operations, and describe their associated procedures.	12C.7.3.2 Identify techniques used to troubleshoot machining operations, and describe their associated procedures.	12D.7.3.2 Identify techniques used to troubleshoot CNC machine operations, and describe their associated procedures.

8855 <b>Lathe Operations and Grinding 2 (12A)</b> 40S / 40E / 40M	8856 <b>Milling Operations 2 (12B)</b> 40S / 40E / 40M	8857 <b>Applied Machining and Manufacturing Technology (12C)</b> 40S / 40E / 40M	8858 <b>CNC Machining (12D)</b> 40S / 40E / 40M
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**Goal 8:** Describe and demonstrate the transferable **cross-curricular** knowledge and skills as they pertain to machining technology.

**GLO 8.1:** Apply **mathematical knowledge and skills** related to machining technology.

12A.8.1.1 Solve problems involving fractions and decimals.	12B.8.1.1 →	12C.8.1.1 →	12D.8.1.1 →
12A.8.1.2 Solve problems involving metric and imperial measure.	12B.8.1.2 →	12C.8.1.2 →	12D.8.1.2 →
12A.8.1.3 Solve problems involving length, perimeter, circumference, volume, area, mass, angles, ratio, and percentage.	12B.8.1.3 →	12C.8.1.3 →	12D.8.1.3 →
12A.8.1.4 Convert between imperial and metric measurements.	12B.8.1.4 →	12C.8.1.4 →	12D.8.1.4 →
12A.8.1.5 Use formulas to accurately calculate data for use in machining operations.	12B.8.1.5 →	12C.8.1.5 →	12D.8.1.5 →
12A.8.1.6 Accurately calculate and measure parts and angles.	12B.8.1.6 →	12C.8.1.6 →	12D.8.1.6 →

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**Goal 8:** Describe and demonstrate the transferable **cross-curricular** knowledge and skills as they pertain to machining technology. *(continued)*

**GLO 8.1:** Apply **mathematical knowledge and skills** related to machining technology. *(continued)*

12A.8.1.7 Perform mathematical calculations, conversions, and measurements, as required for the project.	12B.8.1.7 →	12C.8.1.7 →	12D.8.1.7 →
12A.8.1.8 Calculate taper per foot and angle of taper.	12B.8.1.8 Calculate for the dividing or indexing head to produce various machining operations.	12C.8.1.8 Perform product estimation techniques, including material and labour costs.	12D.8.1.8 Plot points using Cartesian coordinates.
12A.8.1.9 Calculate a taper accurately using the tailstock offset method.	12B.8.1.9 Use mathematical concepts (e.g., volume, density, mass, slope, ratio, proportion, and angles) related to machining.	12C.8.1.9 Problem-solve for missing dimensions on an engineering drawing.	12D.8.1.9 Accurately calculate RPM for CNC lathe and machining centres.
12A.8.1.10 Demonstrate an understanding of right-angle trigonometry.	12B.8.1.10 Calculate machining time based on RPM and feed rate.	12C.8.1.10 Calculate right-angle trigonometry problems.	12D.8.1.10 Accurately calculate feed rate for CNC lathe and machining centres.
12A.8.1.11 Calculate machine setup to turn a #3 Morse taper.	12B.8.1.11 Calculate angles for milling head setting.	12C.8.1.11 Calculate weight reduction between pre-machined and post-machined parts.	12D.8.1.11 Accurately calculate feed rate for CNC lathe and machining centres.
12A.8.1.12 Use charts and reference books to determine tap drill sizes.	12B.8.1.12 →	12C.8.1.12 →	12D.8.1.12 →



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**Goal 8:** Describe and demonstrate the transferable **cross-curricular** knowledge and skills as they pertain to machining technology. *(continued)*

**GLO 8.1:** Apply **mathematical knowledge and skills** related to machining technology. *(continued)*

12A.8.1.13 Use charts and reference books to determine conversions among metric, fractional, and decimal units of measurement.	12B.8.1.13 →	12C.8.1.13 →	12D.8.1.13 →
12A.8.1.14 Use charts and reference books to obtain data for use in machining operation calculations.	12B.8.1.14 →	12C.8.1.14 →	12D.8.1.14 →

**Goal 9:** Demonstrate an awareness of **education** and **career opportunities** in machining technology and associated occupations.

**GLO 9.1:** Describe **education** and **career opportunities** in machining technology.

12A.9.1.1 Discuss high school apprenticeship option.	12B.9.1.1 Discuss training and career opportunities in machining.	12C.9.1.1 Explain journeyman certification requirements.	12D.9.1.1 Compare machinist, CNC machinist, CNC operator, CNC programmer, and CNC set-up person.
12A.9.1.2 Discuss post-secondary opportunities that complement the skills of a machinist.	12B.9.1.2 Research apprenticeship and post-secondary opportunities for machining.	12C.9.1.2 Describe special opportunities and challenges re: machinist training. (A3.3)	12D.9.1.2 Locate information about the various occupations that are available specific to CNC.

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**Goal 10:** Describe the **history, technological progression, and emerging trends** in machining technology.

**GLO 10.1:** Describe the **history, technological progression, and emerging trends** in machining technology.

12A.10.1.1 Discuss emerging trends in machining of materials.	12B.10.1.1 Discuss the evolution of computer-aided machining.	12C.10.1.1 Discuss lean manufacturing.	12D.10.1.1 Research the evolution, technological progression, and emerging trends in CNC machining.
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**Goal 11:** Demonstrate **employability skills** related to machining technology.

**GLO 11.1:** Demonstrate **employability skills** related to machining technology.

12A.11.1.1 Demonstrate regular attendance and punctuality.	12B.11.1.1 →	12C.11.1.1 →	12D.11.1.1 →
12A.11.1.2 Demonstrate accountability by taking responsibility for their actions.	12B.11.1.2 →	12C.11.1.2 →	12D.11.1.2 →
12A.11.1.3 Demonstrate adaptability and effort.	12B.11.1.3 →	12C.11.1.3 →	12D.11.1.3 →
12A.11.1.4 Demonstrate the ability to accept and follow direction and feedback.	12B.11.1.4 →	12C.11.1.4 →	12D.11.1.4 →
12A.11.1.5 Demonstrate the ability to stay on task and effectively use time in class and shop environments.	12B.11.1.5 →	12C.11.1.5 →	12D.11.1.5 →

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**Goal 11:** Demonstrate **employability skills** related to machining technology.

**GLO 11.1:** Demonstrate **employability skills** related to machining technology.

12A.11.1.6 Demonstrate the ability to communicate respectively and effectively.	12B.11.1.6 →	12C.11.1.6 →	12D.11.1.6 →
12A.11.1.7 Demonstrate being responsible to oneself and to the facility.	12B.11.1.7 →	12C.11.1.7 →	12D.11.1.7 →
12A.11.1.8 Demonstrate behaviour appropriate to the workplace.	12B.11.1.8 →	12C.11.1.8 →	12D.11.1.8 →
12A.11.1.9 Demonstrate neat personal appearance and hygiene.	12B.11.1.9 →	12C.11.1.9 →	12D.11.1.9 →
12A.11.1.10 Prepare/revise a personal resumé specific to application to an employer of machinists.	12B.11.1.10 →	12C.11.1.10 →	12D.11.1.10 →

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**Goal 12:** Demonstrate awareness of the **ethical and legal standards** as they pertain to machining technology.

**GLO 12.1:** Demonstrate awareness of the **ethical and legal standards** as they pertain to machining technology.

<p>12A.12.1.1 Discuss ethical concerns in the machining industry as they relate to safety.</p> <p>12A.12.1.2 Discuss ethical and legal considerations related to poor quality materials and workmanship.</p>	<p>12B.12.1.1 Discuss ethical and legal expectations of machinists.</p>	<p>12C.12.1.1 Discuss the relationship between ethics and employability skills, such as creating a respectful workplace and demonstrating a strong work ethic.</p> <p>12C.12.1.2 Identify codes and regulations pertaining to rigging, hoisting, and lifting. (A5.3)</p>
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**Goal 13:** Demonstrate awareness of **sustainability** as it pertains to machining technology.

**GLO 13.1:** Demonstrate awareness of **human sustainability** on machinists.

<p>12A.13.1.1 Discuss sustainable factors in the machining industry that influence the health and well-being of machinists.</p>	<p>12B.13.1.1 Discuss the sustainability of the machinists' working conditions, including working hours and shift work.</p>	<p>12C.13.1.1 Discuss the importance to employers of having a sustainable workforce.</p>
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8855 <b>Lathe Operations and Grinding 2 (12A)</b> 40S / 40E / 40M	8856 <b>Milling Operations 2 (12B)</b> 40S / 40E / 40M	8857 <b>Applied Machining and Manufacturing Technology (12C)</b> 40S / 40E / 40M	8858 <b>CNC Machining (12D)</b> 40S / 40E / 40M
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**Goal 13:** Demonstrate awareness of **sustainability** as it pertains to machining technology. *(continued)*

**GLO 13.2:** Describe machining technology's **sustainability practices** and **impact on the environment**.

12A.13.2.1 Discuss and demonstrate appropriate recycling, reduction of waste, and reuse of materials as they pertain to the machining industry.	12B.13.2.1 →	12C.13.2.1 →	12D.13.2.1 →
12A.13.2.2 Discuss and demonstrate the appropriate disposal of coolants, oils, and non-recyclable waste.	12B.13.2.2 →	12C.13.2.2 →	12D.13.2.2 →

**Goal 13:** Demonstrate awareness of **sustainability** as it pertains to machining technology. *(continued)*

**GLO 13.3:** Demonstrate awareness of the **business sustainability** of a machining technology facility.

12A.13.3.1 Discuss why businesses seek out and find new business opportunities.	12B.13.3.1 Discuss why businesses put resources into research and development.	12C.13.3.1 Discuss why businesses need to keep up with emerging trends and technology.	12D.13.3.1 Discuss the relationship between employee training and business sustainability.
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